ENVIRONMENTAL CONSULTANTS

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3920 Arkwright Road, Suite 101
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January 31, 2025

Mr. Jared Kelly
Chief of Solid Waste - Engineering Section
Alabama Department of Environmental Management
1400 Coliseum Boulevard
Montgomery, AL 36110

**Re: Arrowhead Landfill**
**Solid Waste Permit (#53-03) Major Modification**
**Vertical Expansion**
**HHNT Project No. 6215-018-01**

Dear Mr. Kelly:

A Major Modification to the Solid Waste Permit is being proposed for the subject site. HHNT, on behalf of Perry County Associates, LLC, has enclosed the major modification application, which includes:

1. A check in the amount of $32,615.00 for the major modification application fee.
2. Updated Application Binder (Volumes 1 & 2 of 2)
3. Updated D&O Plans

We request that all previously approved variances for the subject facility be included, with the exception of variance A, which has been modified in this application. A list of the approved variances from Section X of the current permit is listed below:

A. A variance is granted for the Arrowhead Landfill from Rule 335-13-4-.22.(1)(b) which states that all waste shall be confined to as small an area as possible. Under this variance the Arrowhead Landfill is allowed to operate three working faces. Two working faces have been approved as follows: the first for the placement of MSW/Construction and Demolition waste and the second for the placement of ash waste. Additionally, a temporary working face has been approved for newly constructed cells. This working face will consist of a fluff layer or selected waste that will protect the integrity of the liner and will only be applicable for newly constructed cells until a sufficiently thick initial fluff lift has been achieved. Each of the working faces should be confined to as small an area as possible.

B. A variance is granted from Rule 335-13-4-.20(2)(c)3. requiring terraces every 20 feet rise in elevation. This variance requires terraces every 40 feet rise in elevation.

C. The Permittee is allowed to solidify waste within the waste solidification mixing pit constructed as shown in the Application. Solidification shall follow the procedures specified in the Application. The solidification mixing pit shall be located within a lined cell area at all times.

The proposed revision to variance A:

A. A modified variance is requested to operate 3 working faces: two (2) working faces may be utilized for disposal operations in two separate Tracts simultaneously, and a third for a fluff layer over the liner of newly constructed cells. Splitting waste volume between working faces allows for a safe management of permitted waste volumes as a Tract approaches closure grades. All working faces should be confined to as small an area as possible.

A variance is requested from Rule 335-13-4-.22 (1) (c) which states that a completed daily cell shall not exceed eight feet in vertical thickness measured perpendicular to the slope of the preceding cell. This variance will remove the 8' vertical thickness limit for a daily cell. Due to the volume of waste accepted, a greater vertical thickness is required in order to appropriately manage the size of the working face.

We appreciate your assistance with this project. Please let me know if there is anything else that you need or if you have any questions, please call.

Sincerely,

**HODGES, HARBIN, NEWBERRY & TRIBBLE, INC.**

K. Matthew Cheek, P.E.
Professional Engineer

Kevin G. Berry, P.E.
Professional Engineer

KMC/KGB/yc

*Enclosure*

cc: Hunter Baker (w/ enclosure)
William Gay (w/ enclosure)
Robert Berns (w/ enclosure)
Brady Stewart (w/ enclosure)
Joel Falbo (w/ enclosure)
Michelle Langhorne (w/ enclosure)
Mike Smith (w/ enclosure)

# 2025 MAJOR MODIFICATION APPLICATION

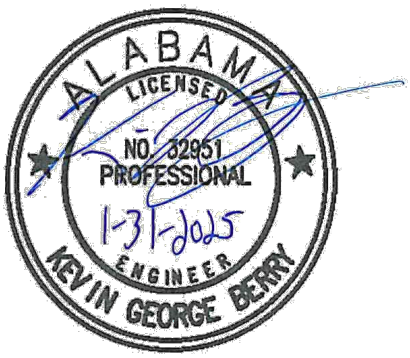
## ARROWHEAD LANDFILL
## PERMIT #53-03

## PERRY COUNTY ASSOCIATES, LLC
## PERRY COUNTY, ALABAMA

## JANUARY 2025

## VOLUME 1 OF 2

HHNT
HODGES, HARBIN, NEWBERRY & TRIBBLE, INC.
*Consulting Engineers*

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# TABLE OF CONTENTS

## VOLUME 1 of 2

**1.0 INTRODUCTION**

**2.0 DESIGN AND OPERATIONS**

2.1 General Design Standards for Disposal Facilities (335-13-4-.11)
2.2 Plans and Operational Reports (335-13-4-.12)
2.3 Site Geology and Hydrology (335-13-4-.13)
2.4 Groundwater Resources (335-13-4-.14)
2.5 Cover (335-13-4-.15)
2.6 Explosive Gases (335-13-4-.16)
2.7 Drainage (335-13-4-.17)
2.8 Liners and Leachate Collection (335-13-4-.18)
2.9 Access (335-13-4-.19)
2.10 Closure and Post-Closure (335-13-4-.20)
2.11 General Operational Standards for Landfill Units (335-13-4-.21)
2.12 Specific Requirements for Municipal Solid Waste Landfills (335-13-4-.22)
2.13 Septic Tank Pumpings and Sewage Sludge (335-13-4-.24)
2.14 Requirements for Management and Disposal of Special Waste (335-13-4-.26).
2.15 Recordkeeping Requirements (335-13-4-.29).

**3.0 CLOSURE PLAN**

3.1 Closure and Post-Closure (335-13-4-.20).

**4.0 POST CLOSURE CARE PLAN**

4.1 Closure and Post-Closure (335-13-4-.20).

**5.0 CONSTRUCTION QUALITY ASSURANCE (CQA) PLAN**

**6.0 TECHNICAL SPECIFICATIONS**

**7.0 ENVIRONMENTAL MONITORING PLAN**

**8.0 LEACHATE COLLECTION SYSTEM CALCULATIONS**

**9.0 STORMWATER, EROSION AND SEDIMENT CONTROL DESIGN CALCULATIONS**

## VOLUME 2 of 2

**10.0 FINANCIAL ASSURANCE**

**11.0 PROHIBITED WASTE EXCLUSION PLAN**

**12.0 GEOTECHNICAL DESIGN CALCULATIONS**

**APPENDIX**

A. Permit Application (Form 439)

B. Application Fee

C. List of Adjacent Property Owners & Addresses

D. Site Location Map

E. Site Analysis Report, prepared by JJ&G Inc. & dated September 2005 - (Hydrogeologic Evaluation)

F. Alabama Historical Commission Clearance Letter

G. Updated FEMA Flood Insurance Rate Map

H. Statement of Consistency from the Alabama-Tombigbee Regional Commission

I. Host Government Approval

J. CCR Acceptance Plan

# 1.0 INTRODUCTION

This ***2025 Major Modification Application*** for a vertical expansion has been prepared and is being submitted in accordance with Chapter 335-13-5, Procedures for Obtaining Permits, of the Alabama Department of Environmental Management (ADEM) Rules for the Arrowhead Landfill. The current permit is scheduled to expire on March 2, 2033. This Municipal Solid Waste Facility currently operates under Permit No. 53-03 and is owned by Perry County Associates, LLC. This major modification application contains all of the components as required under Chapter 335-13-4, Permit Requirements, of the ADEM Rules and incorporates all of the Minor Modifications that have been approved for this facility to date.

With this **2025 Major Modification Application**, the applicant requests a Major Modification to expand the vertical limits of the landfill.

The Arrowhead Landfill is located on a 973.85 acre tract of land in unincorporated Perry County. This permitted facility is divided into three separate disposal areas. This 2025 Major Modification application includes the currently permitted footprints in Tract No. 1 (117.6 acres), Tract No. 2 (159.3 acres), and Tract No. 3 (148.4 acres). The total combined waste footprint of the currently permitted facility is 425.3 acres. Portions of the Tract No. 1 area have been constructed and approved to accept waste for disposal. A portion of Tract No. 1 was certified closed in January 2012. No other waste disposal units in Tracts No. 2 or 3 have been constructed at this time. The remaining acreage on this property is utilized for access roads, sediment ponds, buffer areas, scales, office, leachate management, and other facilities designed to support the landfill activities.

Future cells will be constructed entirely within the current property limits and no new property will be required. The current property was previously studied and evaluated prior to original permit issuance. All requirements of Chapter 335-13-4-.01, Landfill Unit Siting Standards, have been previously met and reported in Volume 1 of 2 of the original Solid Waste Permit Application entitled, Site Analysis, Perry County Associates Landfill prepared by Jordan, Jones, & Goulding (JJ&G) Inc, and dated September 2005. This report also included the required Site Hydrogeologic Evaluation. This Site Analysis (referenced throughout this Application as the Hydrogeologic Evaluation) has been previously reviewed and approved by ADEM, and a copy can be found in Appendix E of this document. There have been no noted discrepancies between the above referenced report and actual field conditions encountered since development of the site began.

All location restrictions for landfill siting, as specified in the ADEM Rules, were addressed for this facility in the original permit application prepared by JJ&G, Inc. referenced above.

All jurisdictional wetland and stream areas were delineated and presented to the U. S. Army Corps of Engineers in a report by Ecological Solutions, Inc. dated June, 2001. This delineation was accepted by the Corps on May 13, 2003. Additionally, on March 7, 2008 Ecological Solutions, Inc. submitted an Individual Permit Application to the U.S. Army Corps of Engineers for impacts to wetlands, perennial and intermittent streams associated with the landfill expansion. Subsequently, the U.S. Army Corp of Engineers issued a Section 404 Clean Water Act Permit on October 18, 2010 for the impacts. All permitted wetland impacts have been made, including those associated with future tracts, as noted in the Notification of Project Completion letter submitted to the U.S. Army Corp of Engineers on April 6th,

2013. These impacts were permitted through the U.S. Army Corps of Engineers and all wetland documentation is kept in the facility operating record.

The information contained in Volumes 1 and 2 of this 2025 Major Modification Application Binder along with the Design and Operation Plans constitute the complete **2025 Major Modification Application**.

# 2.0 DESIGN AND OPERATIONS

In accordance with the Alabama Solid Waste Management Regulations prepared by the Alabama Department of Environmental Management (ADEM), Division 13, Solid Waste program, this document presents the information for the Arrowhead Landfill. This document is divided into sections which correspond to ADEM rules found in Chapter 4 of Division 335-13. Each paragraph is subdivided to correspond with the items listed for each rule part in the ADEM Permit Review List.

*2.1 General Design Standards for Disposal Facilities (335-13-4-.11)*

*(1) General Standards.*

*335-13-4-.12 through 335-13-4-.20 provides standards for establishing a landfill unit providing that the siting standards of 335-13-4-.01 have been fully complied with to the satisfaction of the Department. Certain requirements contained in 335-13-4-.01 through 335-13-4-.20 may be enhanced or reduced by the Department as deemed necessary to comply with the Act and this Division.*

**The landfill is designed at a minimum to the standards of the Alabama Department of Environmental Management (ADEM) Solid Waste Rules dated August 15, 2022. The landfill includes a composite liner system with a leachate collection system.**

**Where a liner with leachate collection system is placed on virgin earth, settlement and stability have been calculated using soil boring information.**

**Siting standards including the Hydrogeological Evaluation, were submitted in Volume 1 of 2 of the original Solid Waste Permit Application entitled, Site Analysis, Perry County Associates Landfill prepared by Jordan, Jones, & Goulding, Inc. (JJ&G) and dated September, 2005 (see Appendix E). This document is further referenced throughout this 2025 Major Modification Application as the Hydrogeologic Evaluation.**

*(2) Hydrogeology Standards.*

*(a) For purposes of designing the bottom elevation of cell, the applicant shall measure the ground water elevation at the location of the proposed cell or liner system. Such determinations shall be based on groundwater measurements taken in the area of the proposed cell or liner system as approved by the Department. At each measuring location, the applicant shall obtain a minimum of two measurements taken during each of the three consecutive months of February, March and April with no two measurements taken within any twelve-day period. Having obtained the*

*measurements, the applicant shall design the facility so that the bottom elevation of the liner shall be a minimum of five feet above the highest measured groundwater level. The applicant shall submit to the Department all data known to exist concerning groundwater elevations at the landfill site and shall submit to the Department a location map showing all monitoring wells or piezometers and drilling logs for all monitoring wells or piezometers used to obtain any groundwater elevation data that is submitted. Nothing herein shall prevent the Department from requiring additional groundwater measurements or from requiring an additional buffer as it may deem appropriate with respect to a particular site.*

**The Hydrogeologic Evaluation prepared by JJ&G is attached in Appendix E. The facility is designed to maintain a five foot vertical separation after settlement between the seasonal high water table, and the bottom elevation of the cell when measured as described above.**

*(b) When the geological and hydrological data so indicate, the Department may specify greater separation distances, a liner(s), or a leachate collection system, or combination of the above to protect the groundwater.*

**The required separation is shown and in most cases is much greater than that required by ADEM.**

*(c) When the geological and hydrological data so indicate, the Department may allow engineering controls to remove, divert, drain, or otherwise modify zones of saturation above the uppermost aquifer.*

**Any perched zones of water present on clay lenses will be drained during excavation of cells for landfill construction. The use of underdrains is not anticipated for this facility.**

*2.2 Plans and Operational Reports (335-13-4-.12)*

*(1) <u>Compliance.</u>*

*Plans and operational reports for construction, operation, maintenance, closure, and post-closure care of landfill units shall be prepared and kept on site and shall comply with 335-13-5-.02(1) and this Chapter.*

**The Regional Planning Commission Statement of Consistency and the Host Government Approval are included in Appendix H and I, respectively of this document.**

*(2) Plan Requirements.*

*These plans and reports shall include the following as determined necessary by the Department:*

*(a) Sufficient control points on-site to provide for accurate horizontal and vertical control for facility construction, operation and closure and post-closure.*

**Benchmarks and a system of coordinates have been established on the site to provide for accurate horizontal and vertical control for the facility during construction, operation, and closure. Benchmarks are shown on the Design and Operation Plans. Existing on-site control was established by Wellston Associates Land Surveyors, LLC and is based on state plane coordinates.**

*(b) Detail presentation of geological and hydrogeological units in the disposal site, with typical sections of disposal method and plan and profile sheets on all areas or trenches.*

**Refer to the Design and Operation Plans and Hydrogeologic Evaluation. Details and cross sections are provided therein.**

*(c) Boundary plat and legal property description prepared, signed, and sealed by a land surveyor of the proposed boundary of the facility and disposal area of the facility.*

**Refer to the Design and Operation Plans, Sheets 1 and 2 of 2, Boundary Survey.**

*(d) Initial and final topographical maps at contour intervals of five feet or as otherwise specified by the Department.*

**Refer to the Design and Operation Plans.**

*(e) Existing and proposed surface drainage pattern to include control structures designed to handle run-on and run-off. Design calculations for sediment control basins, etc. should be provided.*

**Refer to the Design and Operation Plans and the Stormwater, Erosion and Sediment Control Design Calculations attached in Section 9 of this document.**

*(f) Buffer zones, screening and other aesthetic control measures. Buffer zones around the perimeter of the landfill unit shall be a minimum of 100 feet in width measured in a horizontal plane. No disposal or storage practices for waste shall take place in the buffer zone. Roads, access control measures, earth storage, and buildings may be placed in the buffer zone.*

**A 100 foot minimum waste disposal buffer zone has been established around the perimeter of the site. Refer to the Design and Operation Plans for location of this buffer zone.**

*(g) Details of plans for permanent all weather access roads.*

**All access roads are shown on the Design and Operation Plans. The facility will be accessed from the North from Tayloe Road. There is an emergency/special use access on the South at Cahaba Road.**

*(h) A summary of 335-13-4-.01 standards and conclusions of action to be taken and implemented into facility design.*

**a. The waste footprints are not located within the 100-year floodplain. Please refer to the FEMA Flood Insurance Rate Map Information attached in Appendix G.**

**b. A threatened and endangered species evaluation was performed on site by Ecological Solutions, Inc. in June 2001. This evaluation included an office review and site reconnaissance. During this evaluation, no federally protected or state protected species were observed and no habitat was observed for any protected species of potential occurrence within the study corridor.**

**This MSWLF is sited at a distance greater than 10,000 feet to any airport runway end. Please see the Hydrogeologic Evaluation (Appendix E) and Site Location Map (Appendix D) showing the proximity of this facility to airports.**

**c. The disturbed portion of the facility is not located in an archaeologically or historically sensitive area as determined by the Alabama Historical Commission. In the original permit application, there were eight potentially historically sensitive areas identified and one potential cemetery. After further evaluations of these potentially historically sensitive areas were completed by the applicant, clearance was obtained by the Alabama Historical Commission. A copy of the letter from the Deputy State Historic Preservation Officer is attached in Appendix F verifying this condition. In addition, these nine historical areas were removed through a minor modification approved by ADEM on January 31, 2008.**

*(i) Location of any areas of the facility used for disposal of solid wastes.*

**Refer to the Design and Operation Plans.**

*(j) Presentation of special engineering features or considerations which must be included or maintained in facility construction, operation, maintenance and closure. Items required in 335-13-4-.12 through 335-13-4-.20 shall be included.*

**Refer to the Design and Operation Plans, Section 5.0 – Construction Quality Assurance Plan, Section 6.0 – Technical Specifications, Section 8.0 – Leachate Collection System Calculations, and Section 9.0 – Stormwater, Erosion and Sediment Control Design Calculations.**

**Specifically, the facility does perform waste solidification periodically. This process is defined in the Design and Operation Plans.**

*(k) Quality assurance/quality control (QA/QC) plan for all components of the liner, leachate collection, and cap systems.*

**See Section 5.0 - Construction Quality Assurance Plan.**

*(l) Location of all explosive gas wells and/or monitoring points.*

**An Environmental Monitoring Plan is included in Section 7.0 of this document for the site. An Environmental Monitoring Plan Sheet is included as part of the Design and Operation Plans which shows the location of existing and future sampling points.**

*2.3 Site Geology and Hydrology (335-13-4-.13)*

*(1) <u>Site Hydrogeology.</u>*

*The site hydrogeology shall be established to the upper most aquifer and subsequent interconnecting aquifers.*

**Refer to the Hydrogeologic Evaluation, prepared by JJ&G, attached in Appendix E.**

*(2) <u>Hydrogeological Evaluation.</u>*

*The hydrogeological evaluation for a specific site, as required by the Department, may be provided for as follows:*

*(a) A hydrogeological evaluation performed by a firm or individual having expertise in hydrogeology. The expense of this evaluation*

*shall be borne wholly by the applicant. The following shall be required on such evaluations made under this Rule:*

1. *The installation of a minimum of three exploration borings to include sampling and geologic logging and completion of these borings as piezometers. Subsequent establishment of the first saturated zone, the upper most aquifer and subsequent underlying and interconnected aquifers, piezometer measuring point elevations, water table elevations and an estimate of groundwater flow direction and rate will be required.*

2. *A report shall be submitted to the Department which includes all items, information and analyses contained in 335-13-4-.13(2)(a)1.*

3. *Resumes and references, as necessary, to establish the qualifications of the firm or individual preparing the evaluation.*

**Refer to the Hydrogeologic Evaluation, prepared by JJ&G, located in Appendix E. The report was furthermore performed under the direction of, and sealed by, a registered professional in Alabama.**

*(b) A review of the information submitted under 335-13-4-.13(2)(a) shall be conducted by the Department.*

**This document was reviewed and approved by the Department prior to original permit issuance.**

*(c) The requirement for a hydrogeological evaluation may be waived by the Department based on specific geology, hydrology, or waste types proposed for disposal.*

**Not applicable.**

*(3) <u>Department Action.</u>*

*The Department will conduct a site background hydrogeological evaluation and review all other related reports, plans or submittals.*

*(a) Expense for the background hydrogeological evaluation and reviews conducted by the Department shall be borne by the applicant in accordance with established procedures of the Department.*

**Not applicable.**

*(b) The expense for soil borings, soil tests, piezometers and other data as needed by the Department shall be borne by the applicant.*

**Not applicable.**

*2.4 Groundwater Resources (335-13-4-.14)*

*(1) Groundwater.*

*Groundwater resources in the vicinity of the landfill unit shall be determined as a basis for facility design, groundwater protection, and groundwater monitoring required under 335-13-4-.27.*

*(a) The depth to the groundwater and the direction of flow shall be established during the hydrogeological evaluation.*

**Refer to the Hydrogeologic Evaluation, prepared by JJ&G and dated September 2005, located in Appendix E.**

*(b) The groundwater in the first saturated zone below the landfill unit shall be evaluated as follows:*

*1. A minimum of one hydraulically upgradient monitoring well for background data and two hydraulically downgradient monitoring wells shall be required.*

**Refer to the Design and Operation Plans, Environmental Monitoring Plan Sheet. The facility plans to continue monitoring groundwater with upgradient and downgradient monitoring wells.**

*2. The location and design of the monitoring wells shall be approved by the Department prior to installation and the upgradient well shall be located so as not to be affected by the landfill unit.*

**The upgradient groundwater monitoring wells are located so that they will not be affected by the landfill unit. A detail of the groundwater monitoring well is shown on a Detail Sheet in the Design and Operation Plans.**

*3. The monitoring wells shall be installed well in advance of projected facility opening so as to provide an undisputed background water quality sample from each well. Background water quality shall be established using the sampling and analysis procedures described in 335-13-4-.27.*

**Groundwater monitoring wells will be installed in accordance with the Phasing Schedule listed in the Environmental Monitoring Plan attached in Section 7.0.**

4. *Additional monitoring wells above the minimum may be required by the Department based on site hydrology, geology, topographical features and waste characteristics.*

**If required by ADEM, these will be installed.**

5. *Groundwater monitoring wells shall be designed and constructed as described in 335-13-4-.27.*

**The applicant has and will install all groundwater monitoring wells as described in 335-13-4-.27.**

(c) *The groundwater sampling and analysis plan shall be prepared in accordance with 335-13-4-.27.*

**An Environmental Monitoring Plan Sheet is included as part of the Design and Operation Plans. A narrative Environmental Monitoring Plan is attached in Section 7.0 of this binder. This has been prepared in accordance with 335-13-4-.27.**

(2) *Soil Permeability.*

*The permeability of on-site soils, specifically those underlying the disposal site, shall be determined by laboratory testing at a qualified soils laboratory and followed up by pump testing or slug testing of monitoring wells.*

**Refer the Hydrogeologic Evaluation prepared by JJ&G and dated September 2005 located in Appendix E. Soil permeabilities beneath the site are described in this report.**

*2.5 Cover (335-13-4-.15)*

*Daily, weekly, or some other periodic cover shall be required at all landfill units, as determined by the Department.*

(1) *The suitability and volume of any soils for daily, intermediate and final cover requirements shall be determined by soil borings and analysis.*

**During previous construction activities, the suitability of on-site soil for daily, intermediate, and final cover has been verified through proper analyses. This facility currently has sufficient volumes of on-site soils to meet the sites needs for periodic cover requirements. A summary of estimated soil needs broken out by tract is included at the end of this section.**

*(2) Any proposal to use alternate cover systems shall be submitted to and approved by the Department prior to implementation.*

**Excavation within future disposal areas of the site and areas of the site not utilized for disposal operations will be used to obtain soil cover materials. A sufficient volume of soil material will be available on site to meet site requirements for liner construction, daily cover, intermediate cover, and final cover.**

**Any proposal to use alternate cover systems shall be submitted to and approved by ADEM prior to implementation. Currently, at this facility, the following Alternate Daily Cover (ADC's) are approved for use in place of soil: synthetic tarps, petroleum contaminated soils (PCS), Posi-Shell, and automotive shredder residue (ASR). All four of these ADC's were approved by minor modification on July 20, 2009.**

*(3) Alternative cover shall be approved by the Department in compliance with federal law and the USEPA rules for guidance to achieve a level of performance equal to or greater than earthen cover material.*

**Any proposal to use alternate cover systems shall be submitted to and approved by ADEM prior to implementation. Currently, at this facility, the following Alternate Daily Cover (ADC's) are approved for use in place of soil: synthetic tarps, petroleum contaminated soils (PCS), Posi-Shell, and automotive shredder residue (ASR). All four of these ADC's were approved by minor modification on July 20, 2009.**

## *2.6 Explosive Gases (335-13-4-.16)*

*The generation of explosive gases, especially methane ($CH_4$), at a landfill unit which accepts organic waste shall be considered in the design and operation of the facility. Special attention shall be given to control and monitoring of explosive gases as follows:*

*(1) <u>Control.</u>*

*(a) Explosive gases shall not exceed the lower explosive limit at the facility boundary.*

*(b) Explosive gases shall not exceed 25 percent of the lower explosive limit in facility structures except for gas control or recovery system components.*

*(c) Facility structures shall be designed and constructed so as not to allow explosive gases to collect in, under or around structures in concentrations exceeding the requirements of this Rule.*

**The facility will be monitored in accordance with the Design and Operation Plans and the Environmental Monitoring Plan attached in Section 7.0.**

**The landfill facility is subject to New Source Performance Standards (NSPS) since its design capacity is greater than 2.5 million cubic meters and 2.5 million megagrams and maintains a Part 70 Operating Permit (Title V Permit). A voluntary gas collection control system (GCCS) will be installed to collect landfill gas at the discretion of the owner. The collected landfill gas will be conveyed to a flare, a beneficial reuse facility, or a combination of both. A Renewable Natural Gas (RNG) Plant is proposed to be constructed to beneficially use landfill gas. If applicable per NSPS, a mandatory GCCS will be installed, operated, and maintained by the facility.**

*(2) Monitoring.*

*(a) Gas monitoring equipment as required by the Department shall be provided at the landfill unit by the operating agency.*

*(b) The Department upon review of waste type, facility structures, site geology and surrounding land use may require installation of permanent gas monitoring structures, gas vents, gas control or recovery systems.*

**Currently the facility is monitored through the use of methane probes and bar hole punches.**

*(c) An explosive gas monitoring and reporting plan shall be prepared and filed at the facility for all landfill units receiving organic wastes. All sites required to monitor for explosive gases shall submit a plan which indicates permanent monitoring points. The plan shall also include what measures shall be taken by the permittee, landfill supervisor, and any operators present on-site to protect human health and property should explosive gases be detected which exceed the lower explosive limit (LEL). The plan must be prepared by a registered professional engineer and include seal or signature and registration number in accordance with Rule 335-13-5-.02(1)(e)1. of the ADEM Administrative Code.*

**The locations of all existing and future methane monitoring points are included in the Design and Operation Plans. The Environmental Monitoring Plan in Section 7.0 details the sampling requirements and measures that will be taken should explosive gases be detected.**

1. *The type and frequency of monitoring must be determined based on the following factors:*

   *(i) Soil conditions;*
   *(ii) Hydrogeological conditions surrounding the landfill unit;*
   *(iii) Hydraulic conditions surrounding the landfill unit;*
   *(iv) Location of the facility structures and property boundaries;*
   *(v) Location of structures adjacent to facility.*

2. *The minimum frequency for monitoring shall be quarterly for MSWLF and yearly for C/DLF and ILF.*

   *(i) All monitoring reports shall be submitted to the Department and placed in the operating record of the facility within 30 days of the monitoring event.*
   *(ii) Levels of gas detected shall be expressed in percent LEL and percent volume.*

   **All items in this rule will continue to be complied with. The monitoring frequency for methane gas will be quarterly.**

3. *If explosive gas levels exceed the limits specified in this Rule, the permittee shall:*

   *(i) Immediately take all necessary steps to ensure protection of human health and property and notify the Department;*
   *(ii) Within 7 days of detection, place in the operating record of the facility the explosive gas levels detected and the immediate steps taken to protect human health and property;*
   *(iii) Within 20 days of detection, submit to the Department for approval a remedial plan for the explosive gas releases. This plan shall describe the nature and extent of the problem and the proposed remedy. The plan shall be implemented upon approval by the Department, but within 60 days of detection. Also within 60 days of detection, a copy of the plan shall be placed in the operating record of the facility and the Department notified that the plan has been implemented.*

   **Should a detection of methane gas be confirmed, the steps and requirements outlined herein will be followed.**

4. *Monitoring points shall be located every 300 feet along the landfill permit boundaries. In areas where a dwelling is within 1000 feet of the boundaries, the monitoring points shall be 100 feet apart or as otherwise directed by the Department.*

**Spacing of Methane Monitoring points is shown on the Design and Operation Plans.**

(i) *Monitoring shall be conducted in structures, culverts, under bridges, drop inlets, and any other place that is conducive to gas accumulation.*

**This is specified in the Environmental Monitoring Plan.**

(ii) *Permanent gas monitoring structures, or use of the bar hole punch method, are required by the Department.*

**The site currently utilizes methane probes and bar hole punches.**

(iii) *A minimum depth of six feet must be obtained for permanent monitoring structures and four feet when using the bar hole punch method.*

**A Methane Monitoring Plan complying with this rule is included in the Environmental Monitoring Plan attached in Section 7.0 of this Permit Application. Locations for the Methane Monitoring Points and bar hole punches are included in the Design and Operation Plans.**

*2.7 Drainage (335-13-4-.17)*

*Owners or operators of all facilities must design, construct and maintain:*

*(1) A run-on control system to prevent flow onto the active and/or closed portions of the landfill during the peak discharge from a 25-year storm;*

**Off-site drainage or stormwater run-on which enters the site is directed away from the active portions of the landfill during peak discharge from a 24-hour, 25-year storm by ditches, berms and piping systems.**

*(2) A run-off control system from the active and/or closed portions of the landfill to collect and control at least the water volume resulting from a 24-hour, 25-year storm.*

**Stormwater drainage berms, downdrain pipes, ditches, culverts and sediment ponds are designed to control and treat the volume of water from the 24-hour, 25-year storm event. Calculations confirming that the design of the ponds are adequate are attached in Section 9.**

*(3) On-site drainage structures to carry incident precipitation from the disposal site so as to minimize the generation of leachate, erosion and sedimentation. Run-off from the active and/or closed portions of the landfill unit must be handled in accordance with 335-13-4-.01(2)(a), and (b) and shall be routed to a settling basin or other sedimentation control structure to remove sediment prior to release onto adjacent properties or waters.*

**The on-site drainage from a 24-hour, 25-year rainfall will be controlled by the use of berms, downdrains, culverts, ditches, and sediment ponds. See Section 9 for detailed design information on all erosion and sediment control structures.**

**The ponds and ditch side slopes will be vegetated and stabilized. Prior to the vegetation being established, erosion will be controlled by the use of temporary vegetation, hay bales or rock check dams, siltation fences and erosion control blankets. Specific erosion controls have been designed and are included in the Design and Operation Plans and Section 9. The facility currently maintains coverage under NPDES Permit ALG160167 for stormwater discharges associated with this type of industrial activity.**

**Each sediment pond will be cleaned of sediment as required. Sediment shall also be removed when the sediment reaches the red stripe of the sediment gauge. When water levels prevent the visual inspection of sediment, the operator shall use the red stripe on the sediment gauge as an indicator. If the water level stays above the red stripe for more than 60 days, then sediment shall be removed.**

*2.8 Liners and Leachate Collection (335-13-4-.18)*

*(1) <u>Liners.</u>*

*Where natural hydrogeologic conditions may be determined by the Department to be insufficient to minimize the impact of leachate on waters, the use of an appropriate liner(s) shall be used as approved by the Department. New MSWLF units and lateral expansions, as a minimum, shall be constructed with a composite liner, as defined in 335-13-1-.03, or an alternate design as specified in 335-13-4-.18(3)(h). Multiple liners, including composite liners, may be required if determined necessary by the Department.*

**The facility plans to continue using a regulatory liner system. The regulatory liner system consists of a 24" thick Compacted Clay**

**Liner with a permeability (k) of ≤1x10$^{-7}$ cm/sec and a 60 mil minimum thick textured HDPE geomembrane liner. The facility will use a 12" thick protective cover system with a minimum hydraulic conductivity of 1 x 10$^{-2}$ cm/sec. This 12" thick protective cover material shall be placed on top of an 8 osy non-woven cushion geotextile fabric which will lay on top of the 60 mil FML. The 12" thick protective cover system was approved through a minor modification dated October 27, 2009 for any areas receiving coal ash waste material, and then extended to all areas of the landfill through a minor modification approved on October 25, 2010.**

*(2) Leachate Collection System.*

*A leachate collection system shall be required that is designed and constructed to maintain less than a 30 cm depth of leachate over the liner.*

**The facility will utilize a leachate collection system which has been demonstrated to maintain less than a 30 cm depth of leachate over liner. This demonstration is provided as part of the Leachate Collection System Calculations attached in Section 8.0.**

**The permeability of the leachate collection system will be in accordance with Section 8.0 of the Permit Application and will have a permeability k ≥ 1 x 10$^{-2}$ cm/sec.**

*(3) Specifications.*

*The composite liner(s) shall comply with the following minimum standards:*

*(a) The permeability shall be 1x10$^{-7}$ cm/sec or less for soil liners.*

*(b) The synthetic liner(s) shall be resistant to physical and chemical attack by leachate.*

*(c) The liner system shall be capable of maintaining integrity for the design life which must be determined on a site specific basis.*

*(d) The minimum allowable thickness of each layer of the composite liner shall be:*

*1. 40 mil for the flexible membrane liner component unless FML consists of HDPE which requires 60 mil, and*

*2. Two feet, measured after compaction, for the natural soil liner component meeting the permeability requirements of 335-13-4-.18(3)(a).*

*(e) The installation of synthetic liners shall be as recommended by the manufacturer providing that:*

*1. The installation recommendations of the manufacturer to be used are provided to the Department for review.*

*2. The Department finds that the recommended installation procedures are consistent with the intent of the Act and this Chapter.*

*3. The installation of the liner shall be under the supervision of an engineer who shall certify to the Department that the liner was installed and maintained in accordance with this Division, QA/QC plans, and approved design plans.*

**These items will be complied with. This is detailed in the CQA Plan and Technical Specifications which are located in Sections 5 and 6, respectively.**

*(f) The design and installation of soil liners and the properties of soils used in a soil liner shall meet the following minimum requirements:*

*1. Design of soil liner(s) shall be by a qualified soils engineer, or geotechnical engineer.*

**The soil liner component was designed by a qualified soils engineer registered in Alabama.**

*2. The soil liner must be compacted in lifts of 4 to 6 inches within 4 percent of optimum moisture content (or as approved by the Department) to a field density which correlates with a laboratory permeability of $1x10^{-7}$ cm/sec or less.*

**This compaction criteria is discussed in the Technical Specifications for the liner system.**

*3. The installation of soil liner(s) shall be under the supervision of a soils engineer, geotechnical engineer or geologist who shall certify to the Department that the liner(s) was installed and maintained in accordance with this Division, QA/QC plans, and approved design plans.*

**This is detailed in the CQA Plan which is included in this Permit Application in Section 5.0.**

*4. The soils used in soil liners shall meet the minimum following criteria:*

*(i) Free of oversize particles, such as rocks, roots, limbs and other foreign substances which would alter the design integrity of the liner;*
*(ii) Classified under the Unified Soil Classification System as CL, CH or SC (ASTM Standard D2 487-69);*
*(iii) Allow greater than 30 percent passage through a No. 200 sieve (ASTM Test D-1140);*
*(iv) Have a liquid limit equal to or greater than 30 units (ASTM Test D-423); and*
*(v) Have a plasticity greater than or equal to 15 units (ASTM Test D-424).*

**The soil requirements for the regulatory liner system are detailed in the CQA Plan and the Technical Specifications found in Sections 5.0 and 6.0 of this document.**

*(g) For a composite liner system, the synthetic liner shall be installed in direct contact with the soil liner.*

**For the 24" thick clay liner, the 60 mil textured liner will be installed in direct contact with the top of the 24" thick (k ≤ $1x10^{-7}$ cm/sec) compacted clay liner.**

*(h) An alternate liner design may be approved by the Department provided that:*

*1. The owner or operator demonstrates that the alternate design ensures the concentration values listed in Table 1 of this Rule will not be exceeded in the first saturated zone at the relevant point of compliance, as specified by the Department under 335-13-4-.27(2)(a)3.*

**Not applicable.**

*2. When approving a design that complies with subparagraph (a) of this paragraph, the Department shall consider at least the following factors:*

*(i) The hydrogeologic characteristics of the facility and surrounding land;*
*(ii) The climatic factors of the area; and*
*(iii) The volume and physical and chemical characteristics of the leachate.*

***TABLE 1***

| Chemical | MCL (mg/l) |
|---|---|
| Arsenic | 0.05 |
| Barium | 1.0 |

| Chemical | MCL (mg/l) |
|---|---|
| Benzene | 0.005 |
| Cadmium | 0.01 |
| Carbon tetrachloride | 0.005 |
| Chromium (hexavalent) | 0.05 |
| 2,4-Dichlorophenoxy acetic acid | 0.1 |
| 1,4-Dichlorobenzene | 0.075 |
| 1,2-Dichloroethane | 0.005 |
| 1,1-Dichloroethylene | 0.007 |
| Endrin | 0.0002 |
| Fluoride | 4 |
| Lindane | 0.004 |
| Lead | 0.015 |
| Mercury | 0.002 |
| Methoxychlor | 0.1 |
| Nitrate | 10 |
| Selenium | 0.01 |
| Silver | 0.05 |
| Toxaphene | 0.005 |
| 1,1,1-Trichloromethane | 0.2 |
| Trichloroethylene | 0.005 |
| 2,4,5-Trichlorophenoxy acetic acid | 0.01 |
| Vinyl Chloride | 0.002 |

**Not applicable.**

*2.9 Access (335-13-4-.19)*

*The owner or operator of the facility must control public access and prevent unauthorized vehicular traffic and illegal dumping of wastes by using artificial barriers, natural barriers, or both, as appropriate to protect human health and the environment.*

**The access road will be restricted by a gate which is opened and attended to during daily operating hours and locked at night and whenever the landfill is closed. Other fences and natural barriers prevent site access. Additional fencing may be added by the Owner at locations determined to be potential access points.**

*2.10 Closure and Post-Closure (335-13-4-.20)*

*(1) Submittal.*

*The owner or operator must submit a closure/post-closure plan to the Department and place in the operating record, no later than the effective date of these regulations or by the initial receipt of waste, whichever is later.*

**The Closure Plan is located in Section 3.0. The Post-Closure Plan is located in Section 4.0.**

*(2) Closure.*

*The requirements for closure of existing and proposed landfill units shall include the following unless otherwise noted.*

*(a) The owner or operator must prepare a written closure plan that describes the steps necessary to close all existing and proposed landfill units at any point during their active life in accordance with the cover design requirements in 335-13-4-.20(2)(b). The owner or operator must submit the closure plan as part of the Permit Application to the Department. The closure plan, at a minimum, must include the following information:*

*1. A description of the final cover, designed in accordance with 335-13-4-.20(2)(b) and the methods and procedures to be used to install the cover;*

*2. An estimate of the largest area of the landfill unit ever requiring a final cover as required under 335-13-4-.20(2)(b) at any time during the active life;*

*3. An estimate of the maximum inventory of wastes ever on-site over the active life of the facility; and*

*4. A schedule for completing all activities necessary to satisfy the closure criteria in this Rule.*

**A written Closure Plan meeting this criteria is included in Section 3.0.**

*(b) A final cover system must be installed which is designed to minimize infiltration and erosion. The final cover system must be comprised of an erosion layer(s) underlain by an infiltration layer(s) as follows:*

*1. The infiltration layer for MSWLF and ILF must be comprised of a minimum of 18 inches of earthen material and/or a synthetic layer that has a permeability less than or equal to the permeability of any bottom liner system or natural subsoils present, or a permeability no greater than 1 x $10^{-5}$ cm/sec, whichever is less. The infiltration layer for*

*C/DLF must be comprised of a minimum of 18 inches of compacted earthen material excluding sands, and*

2. *The erosion layer must consist of a minimum 6 inches of earthen material that is capable of sustaining native plant growth, as specified in 335-13-4-.20(2)(d).*

3. *The Department may approve an alternative final cover design that includes:*

   *(i) An infiltration layer that achieves an equivalent reduction in infiltration as the infiltration layer specified in 335-13-4-.20(2)(b)1., and*
   *(ii) An erosion layer that provides equivalent protection from wind and water erosion as the erosion layer specified in 335-13-4-.20(2)(b)2.*

**The final cap detail (previously approved) is found in the Design and Operation Plans which specifies the cap system as outlined in this rule section.**

*(c) Final soil cover shall be graded so that:*

1. *Surface water does not pond over the landfill unit.*

   **The minimum slope for the final grade will be 5%.**

2. *The maximum final grade of the final cover system shall not exceed 25 percent or as specified by the Department to minimize erosion.*

   **This Major Modification Application proposes to increase the maximum final grade of the final cover system to 33 percent (3H:1V). The Storm Water, Erosion and Sediment Control Design Calculations invluded in Section 9.0 and the Geotechnical Design Calculations invlucded in Section 12.0 demonstrate the effectiveness and stability of this design.**

3. *Slopes longer than 25 feet shall require horizontal terraces, of sufficient width for equipment operation, for every 20 feet rise in elevation or utilize other erosion control measures approved by the Department.*

   **Sideslope drainage berms are shown on the final drainage plan and are spaced every 40 vertical feet. Detail calculations provided by Golder and Associates, Inc. have been included in Section 3.0 which demonstrate the effectiveness of this berm spacing.**

**A variance was granted by ADEM to increase the vertical spacing on the sideslope drainage berms from 20' vertical to 40' vertical for the currently permitted facility. The calculations referenced above were used to support this request.**

4. *The minimum final grade of the final cover system shall not be less than 5 percent or as specified by the Department to minimize ponding.*

   **The minimum final grade shown on the Final Grading Plan is 5%.**

5. *For a permitted facility utilizing the area fill method or the trench method, final grading of the infiltration layer shall be completed within 90 days after the unit has received the last known receipt of waste.*

   **A final cover system meeting this criteria is proposed for this facility. The final cover system is detailed in the Design and Operation Plans Detail Sheets and Technical Specifications located in Section 6.0.**

(d) *A vegetative or some other appropriate cover must be established to minimize erosion and, when applicable, maximize evapotranspiration. Within 90 days after completion of final grading requirements on each phase or each trench as specified in 335-13-4-.20(2)(a), the Permittee or owner of a permitted landfill unit shall prepare the final cover for the establishment of a vegetative cover or alternative cover. Deep rooted vegetation (roots that may grow below the 6 inch erosion layer) shall be prohibited as vegetative cover. Preparation of a vegetative cover shall include, but not be limited to, the following:*

1. *Placement of appropriate species of grass seed, fertilizer and mulch; and*

2. *Watering and maintenance necessary such that germination of grass will occur.*

**A final vegetative cover meeting this requirement is shown in the Design and Operation Plans and detailed in the Technical Specifications located in Section 6.0. In addition to mulch, other measures such as matting, flexible growth media, or hydroseeding may be employed to assist with permanent vegetation.**

(e) *Prior to beginning closure of each landfill unit as specified in this Rule, an owner or operator must submit to the Department and*

*place in the operating record a notice of the intent to close the unit.*

**Prior to closure of any area, notice will be provided to ADEM of the intent to close. This notice will be placed in the Facility Operating Record.**

(f) *The owner or operator must begin closure activities of each LF unit no later than 30 days after the date of which the LF unit receives the known final receipt of wastes. If the LF unit has remaining capacity and there is reasonable likelihood that the LF unit will receive additional wastes, closure activities of each LF unit must begin no later than one year after the date of known final receipt of wastes. Extensions beyond the one-year deadline for beginning closure may be granted by the Department if the owner or operator demonstrates that the LF unit has the capacity to receive additional wastes and the owner or operator has taken and will continue to take all steps necessary to prevent threats to human health and the environment from the unclosed LF unit.*

**This schedule for closure will be complied with by this facility.**

(g) *The owner or operator of all LF units must complete closure activities of each LF unit in accordance with the closure plan within 180 days following the last known receipt of waste. Extensions of the closure period may be granted by the Department if the owner or operator demonstrates that closure will, of necessity, take longer than 180 days and he has taken and will continue to take all steps necessary to prevent threats to human health and the environment from the unclosed LF unit. Extensions granted for closure of each LF unit shall not exceed a total of 180 days.*

**This schedule for closure will be complied with by this facility.**

(h) *Following closure of each LF unit, the owner or operator must submit to the Department a certification, signed by an independent registered professional engineer verifying that closure has been completed in accordance with the closure plan, and a copy placed in the operating record. C/DLF and/or ILF owner or operator may submit certification signed by a registered professional engineer in lieu of an independent registered professional engineer.*

**This certification will be submitted to ADEM at the time of closure by an Alabama registered professional engineer.**

(i) *Within 90 days after permit expiration, revocation or when final closure requirements in 335-13-4-.20 are achieved as determined*

*by the Department, the permittee or owner of a facility must provide documentation of compliance with the requirements of the Uniform Environmental Covenants Program in ADEM Admin. Code Division 335-5 and shall record a notation onto the land deed containing the property utilized for disposal, and/or some other legal instrument that is normally examined during a title search, that will in perpetuity, notify any potential purchaser of the property that:*

1. *The land has been used as a solid waste disposal facility landfill unit;*

2. *Its use is restricted by the items contained in 335-13-4-.20(3)(c) and 335-13-4-.20(3)(d);*

3. *The locations and dimensions of the landfill unit with respect to permanently surveyed benchmarks and section corners shall be on a plat prepared and sealed by a land surveyor;*

4. *Contain a note, prominently displayed, which states the name of the Permittee or operating agency, the type of landfill unit and the beginning and closure dates of the disposal activity.*

5. *Certification by an Engineer or Land Surveyor that all closure requirements have been completed as determined necessary by the Department.*

**These documentation requirements will be met at the time the facility completes closure activities.**

(j) *For a permitted facility, the permittee or land owner shall submit a certified copy of the recording instrument to the Department and place a copy in the operating record within 120 days after permit expiration, revocation or as otherwise directed by the Department.*

**The requirement of submission of the recording instrument to ADEM will be met by this facility.**

(k) *Detail design for the closure of existing and proposed LF units shall be shown on a final contour and drainage plan. Items required in 335-13-4-.20(2)(b) through (d), (i), (j), and (3)(a), (d), and (f) shall be included.*

**This detail design is part of the facility design and it will be made part of any closure construction plans.**

*(3) Post-closure.*

*The requirements for post-closure of existing and proposed landfill units shall include the following unless otherwise noted.*

*(a) Following closure of each LF unit, the owner or operator must conduct post-closure care. Post-closure care must be conducted for a minimum of 30 years; or a minimum of 5 years if closed prior to October 9, 1993, or the effective date of § 258.1 of 40 CFR 258, Solid Waste Disposal Criteria, whichever is later; except as provided under 335-13-4-.20(3)(b), and consist of at least the following:*

*1. Eroded areas shall be filled with suitable soil cover, compacted, graded and appropriate cover established as described in 335-13-4-.20(2)(d).*

*2. Areas which provide for ponding of surface water shall be filled, graded and an appropriate cover established as described in 335-13-4-.20(2)(d).*

*3. Landfilled areas with extensive surface cracks in soil cover shall be corrected as necessary, or as determined by the Department, to prevent infiltration of surface water.*

*4. An appropriate cover shall be maintained on the facility at all times as described in 335-13-4-.20(2)(d).*

*5. Access control structures shall be maintained or erected and signs shall be posted stating that the facility is closed and giving the location of the nearest permitted landfill unit.*

*6. Any waste dumped at the landfill unit following closure shall be removed to an approved landfill unit by the permittee, operating agency, or owner.*

*7. Monitoring devices and pollution control equipment such as groundwater monitoring wells, explosive gas monitoring systems, erosion, and surface water control structures, and leachate facilities shall be maintained. Monitoring requirements shall continue in effect throughout the active life and post-closure care period as determined by the Department unless all solid waste is removed and no unpermitted discharge to waters has occurred.*

*8. Other deficiencies such as vector control which may be observed by the Department shall be corrected.*

**These requirements for 30 years of post-closure care will be met by this facility. The facility will be inspected monthly and**

**after major precipitation events to confirm the integrity of the site is being maintained.**

*(b) The length of the post-closure care period may be:*

*1. Decreased by the Department if the owner or operator demonstrates that the reduced period is sufficient to protect human health and the environment and this demonstration is approved by the Department; or*

*2. Increased by the Department if the Department determines that the lengthened period is necessary to protect human health and the environment.*

**This rule will be complied with during the post-closure period. The planned Post-Closure period for this facility is anticipated to be 30 years.**

*(c) The owner or operator of all LF units must submit to the Department and receive approval as part of the Permit Application, a written post-closure plan. A copy must also be placed in the operating record. The post-closure plan must include, at a minimum, the following information:*

*1. A description of the monitoring and maintenance activities required in 335-13-4-.20(3)(a) for each LF unit, and the frequency at which these activities will be performed;*

*2. Name, address, and telephone number of the person or office to contact about the facility during the post-closure period; and*

*3. A description of the planned uses of the property during the post-closure period.*

**The Post-Closure Care Plan for this facility is included in Section 4.0 of this 2025 Major Modification Application document.**

*(d) Post-closure use of the property used for the disposal operation must never be allowed to disturb the integrity of the final cover, liner(s), or any other component of the containment system, or the function of the monitoring systems necessary to comply with the requirements of these Rules. The Department may approve any other disturbance if the owner or operator demonstrates that the disturbance, including any removal of waste, complies with the following:*

*1. The activities will not increase the potential threat to human health or the environment; or*

*2. The activities are necessary to reduce a threat to human health or the environment.*

**This rule will be complied with during the post-closure period.**

*(e) Following completion of the post-closure care period for each LF unit, the owner or operator must submit to the Department a certification, signed by an independent registered professional engineer verifying that post-closure care has been completed in accordance with the post-closure plan, and a copy placed in the operating record. A C/DLF Owner or Operator may submit certification signed by a registered professional engineer in lieu of an independent registered professional engineer.*

**This certification will be provided by the facility at the conclusion of the post-closure care period.**

*(f) If the Permittee or owner, or any subsequent owner of the land upon which a landfill unit is located wishes to remove waste, waste residues, the liner, if any, or any contaminated soils, the owner must request approval from the Department. The owner may also ask permission to remove the notation from the recording instrument if all waste and contaminated soils are removed from the property and no unpermitted discharges to waters have occurred.*

**Should all waste be removed from this facility, this request will be made in a timely manner.**

*2.11 General Operational Standards for Landfill Units (335-13-4-.21)*

*Any person or agency operating or planning to operate a landfill unit shall operate and maintain the facility consistent with this Division. General requirements for operating and maintaining an acceptable landfill unit shall be:*

*(1) <u>General Operation</u>.*

*(a) The operation and use of the landfill unit shall be as stipulated in the permit.*

*(b) Waste accepted at the facility shall be strictly controlled so as to allow only waste stipulated on the permit or otherwise as may be approved by the Department. The permittee of any facility permitted under these Rules must have in the operating record a plan describing procedures the permittee will implement for detecting and preventing the disposal of free liquids, regulated*

*hazardous wastes, regulated medical wastes, and regulated PCB wastes at the facility. This plan must include at a minimum:*

1. *Random inspections of incoming loads to ensure that incoming loads do not contain free liquids, regulated hazardous wastes, regulated medical wastes, or regulated PCB wastes.*

2. *Inspection of suspicious loads.*

3. *Records of all inspections to include origin of waste suspected to be regulated hazardous, regulated medical, or regulated PCB waste if known; transporters, to include transfer stations and all handlers of the waste enroute to the disposal site; and any certifications from generators provided to the permittee or facility personnel. These records must be maintained on file in the operating record of the facility.*

4. *Training of facility personnel to recognize free liquids, regulated hazardous wastes, regulated medical wastes, and regulated PCB wastes.*

5. *Procedures for notifying the proper authorities if free liquids, regulated hazardous wastes, regulated medical wastes, or regulated PCB wastes are discovered at the facility.*

6. *Methods to identify all industrial users of the facility, producers of special wastes, and transporters of these wastes.*

**The facility will comply with these general operation requirements. Compliance will be demonstrated in the Facility Operating Record. A Prohibited Waste Exclusion Plan is attached in Section 11.0 which outlines these requirements.**

(c) *Prior to disposal of industrial waste and/or medical waste, the permittee shall obtain from each generator a written certification that the material to be disposed does not contain free liquids, regulated hazardous wastes, regulated medical wastes, or regulated PCB wastes.*

1. *This certification may be based on laboratory analysis of the waste on a case-by-case basis, or documentation supporting the generator's knowledge of the waste stream(s), or as may be required by the Department.*

2. *Copies of the certification shall be submitted to the Department for disposal approval and for any specific requirements prior to disposal. After submittal of the required certification, the Department shall have five (5) working days to respond. If no response is given, the permittee may dispose of the material as proposed.*

3. *In the case of one-time emergency disposal requests, the permittee shall submit the required certification no later that five (5) days after the disposal of waste.*

4. *Certification shall be renewed or revised biennially (every two years) or at such time that operational changes at the point of generation could render the waste hazardous, whichever is more frequent and submitted to the Department for approval.*

5. *Copies of these certifications and approvals shall be maintained on file in the operating record of the facility and shall be made available for the Department upon request.*

6. *The above requirements notwithstanding and, as may otherwise be required, pursuant to Division 13 rules, generators will not be required to submit certification to the Department provided that:*

   *(i) The waste will be disposed of at a non-commercial industrial waste landfill which has been permitted by the Department, and is owned either exclusively or mutually by the generator(s) of the waste, and which disposes of waste generated only by the owner(s);*
   *(ii) The wastestream(s) to be disposed of are specifically described in the Solid Waste Landfill Permit issued by the Department or in the final application as referenced by the permit for the site designated to receive the waste;*
   *(iii) The required certification, as described above, is maintained on-site by the owner(s) of the landfill; and*
   *(iv) The required certification, as described above, is made available for inspection by the Department upon request.*

**The facility will comply with the requirements for industrial and/or medical waste acceptance and appropriate demonstrations will be made in the Facility Operating Record.**

*(d) The landfill unit shall be operated in such a manner that there will be no water pollution or unauthorized discharge.*

1. *Any discharge resulting from a landfill unit or practice may require:*

   (i) *A National Pollutant Discharge Elimination System (NPDES) permit under the Alabama Water Pollution Control Act as issued by the Department.*
   (ii) *A dredge or fill permit from the Army Corps of Engineers as required under Section 404 of the Clean Water Act, as amended; or*
   (iii) *That a non-point source of surface waters does not violate an area wide or statewide water quality management plan that has been approved under the Alabama Water Pollution Control Act.*

   **All proposed Jurisdictional Wetland Impacts have been properly permitted through the U.S. Army Corps of Engineers. These impacts have been completed in accordance with the approved permit. The facility will continue to maintain coverage under NPDES Permit ALG160167 for this type of industrial activity.**

2. *The groundwater shall not be contaminated as specified by this Division.*

   **This rule will be complied with.**

(e) *The historic and certified disposal areas shall be identified with a sufficient number of permanent markers which are at least visible from one marker to the next.*

**Appropriate waste disposal unit boundary markers will be installed and maintained as required by this rule. As shown on the Design and Operation Plans, marker posts for waste disposal units will be placed on 300' centers at a minimum, and at all corners.**

(f) *Measuring or weighing devices shall be required for all municipal solid waste landfill units accepting solid waste. All solid waste shall be properly measured or weighed prior to disposal unless otherwise approved by the Department.*

**This facility will utilize certified truck scales for measuring incoming waste for disposal.**

(g) *Deep rooted vegetation (with roots that may grow below the six inch erosion layer) shall be prohibited as vegetative cover.*

**The facility will comply with the vegetative cover requirements, and vegetative cover will be installed in accordance with the closure plan.**

*(h) With the exception of very small quantity generator waste disposed of in municipal solid waste landfills, regulated hazardous waste, as defined by Division 14 of the ADEM Administrative Code, is prohibited from disposal in a non-hazardous landfill unit.*

**The facility will not accept regulated hazardous waste.**

*(i) Except as provided in paragraph 1. below, a landfill shall not dispose of whole tires after December 31, 2027. Whole tires shall at a minimum be shredded or cut into thirds or smaller pieces prior to disposal.*

*1. Incidental whole tires received in loads of solid waste may be disposed, provided the whole tires constitute a de minimis portion of the overall load of waste.*

*2. "De minimis" refers to a small amount of material or number of items, as applicable, commingled and incidentally disposed of with other solid waste.*

**This rule will be complied with.**

*(2) Open Burning.*

*(a) Open burning of solid waste at any landfill unit is prohibited unless approved by the Department as follows:*

*1. Clearing debris at the landfill unit such as trees and stumps may be burned if prior approval is received from the Department and the Alabama Forestry Commission.*

*2. Emergency clean-up debris resulting from catastrophic incidents may be burned at a permitted landfill unit if consistent with the intent of this Division and air pollution control requirements. Prior approval must be received from this Department and other appropriate agencies.*

*3. If approved, the burning shall not occur over previously filled areas or within 200 feet of existing disposal operations unless otherwise specified by the Department and such burning shall not cause a public nuisance or pose a threat to public health.*

**Appropriate approvals will be obtained prior to any open burning. Records of this activity will be maintained in the Facility Operating Record.**

*(b) The person or agency requesting permission to burn solid waste shall apply in writing to the Department, outlining why a burn request should be granted. This request should include, but not be limited to, specifically what areas will be utilized, types of waste to be burned, the projected starting and completion dates for the project, and the projected days and hours of operation.*

**Appropriate approvals will be obtained prior to any open burning. Records of this activity will be maintained in the Facility Operating Record.**

*2.12 Specific Requirements for Municipal Solid Waste Landfills (335-13-4-.22)*

*The following requirements in conjunction with 335-13-4-.21 shall be for operating and maintaining an acceptable MSWLF:*

*(1) Daily Operation.*

*(a) All waste shall be covered as follows:*

1. A minimum of six inches of compacted earth or other alternative cover material that is approved by the Department shall be added at the conclusion of each day's operation or as otherwise approved by the Department to control disease vectors, fires, odors, blowing litter, and scavenging.

   **A minimum 6 inches of clean compacted earth (or other alternative daily cover (ADC) material approved by ADEM) will be applied to the working face at the conclusion of each working day. A list of currently approved ADC's are listed below:**

   **1. Synthetic Tarps**
   **2. Petroleum Contaminated Soil (PCS)**
   **3. Posi-shell**
   **4. Automotive Shredder Residue (ASR)**

   **These ADC's were approved by minor modification on 7/20/09.**

2. *In the event that erosion develops on previously covered disposal areas, or when covered waste otherwise becomes exposed, cover must be re-applied to comply with the minimum cover requirements of subparagraph (1)(a)1. of this section.*

**Final grading, final cover and vegetative cover requirements are discussed in detail in Section 3.0 - Closure Plan.**

3. *Final closure shall be carried out in accordance with Rule 335-13-4-.20 of this Division.*

**Final grading, final cover and vegetative cover requirements are discussed in detail in Section 3.0 - Closure Plan.**

(b) *All waste shall be confined to as small an area as possible within a single working face and spread to a depth not exceeding two feet prior to compaction, and such compaction shall be accomplished on a face slope not to exceed 4 to 1 (25%) or as otherwise approved by the Department.*

**The operations at the site will be conducted in phases. Typically operations will be conducted by filling one area to a workable height prior to proceeding to the next area. The areas may be divided with berms. Exterior containment berms may be utilized. The outside slope of the exterior containment berm will be near final grade and direct stormwater run-off to the perimeter ditch.**

**Waste will be appropriately spread prior to compaction. Each working face slope will not exceed the slope of the permitted final grades and a maximum of 200 feet by 200 feet in size. Should waste receipt be less than 1,500 tons/day the working face size will be reduced to 150' x 100'. During the course of the day the active face will be constantly compacted.**

**This facility is currently approved to operate 3 working faces through variances dated 10/25/10 and 6/17/2013 which allows one for the placement of MSW / C&D waste, one for the placement of ash waste, and a third temporary working face for a fluff layer over the liner of newly constructed cells.**

**A modified variance is requested to operate 3 working faces: two (2) working faces may be utilized for disposal operations in two separate Tracts simultaneously, and a third for a fluff layer over the liner of newly constructed cells. Splitting waste volume between working faces allows for a safe management of permitted waste volumes as a Tract approaches closure grades. All working faces should be confined to as small an area as possible.**

(c) *All waste shall be thoroughly compacted with adequate landfill equipment before the daily cover is applied. A completed daily*

*cell shall not exceed eight feet in vertical thickness measured perpendicular to the slope of the preceding cell.*

**Waste will be thoroughly compacted with adequate landfill equipment before the daily cover is applied. A variance is being requested to remove the 8' vertical restriction. Due to the volume of waste accepted, a greater vertical thickness is required in order to appropriately manage the size of the working face. The initial "daily cell" will be evenly distributed over the entire daily cell area prior to placement of waste above this height. The following "daily cells" will be distributed over an area which will generate maximum final grades (exterior slopes) and therefore, reduce leachate generation. At the end of each day, 6 inches of soil cover (or an approved alternate daily cover) will be placed over the active "daily cell" and working face.**

(d) *The site shall be operated in accordance with approved plans and permits.*

**The site shall be operated in accordance with the Design and Operation Plans and permits.**

(e) *Adequate personnel shall be provided to ensure continued and smooth operation of the facility.*

**The following personnel will be provided to ensure smooth operation of this facility. A Landfill Manager will be on-site who is responsible to ensure that operations at the facility are performed in accordance with the Plans and ADEM regulations. A scalehouse attendant who will record both the origin and quantity of waste; equipment operators who will be responsible for the daily earthwork, fill placement and compaction, and cover operations, as well as the maintenance and operation of diversion and sediment structures, and the access road; laborers as needed to control litter, wash equipment, perform maintenance, and support, etc. Landfill personnel will be trained in municipal solid waste landfill techniques and spotting unauthorized waste materials in the inbound loads.**

**A Certified Landfill Operator in accordance with the ADEM regulations will be present at the site.**

(f) *Adequate equipment shall be provided to ensure continued operation in accordance with permit and regulations.*

**The landfill anticipates the following minimum equipment to be maintained on-site and utilized for various aspects of the landfill operations:**

**1 Steel Wheel Compactor**
**1 Bulldozer**
**1 Excavator**
**1 Off-Road Haul Truck**
**1 Small Farm Tractor for Maintenance**
**Miscellaneous Tools, Pumps, Pick-up Trucks, etc.**

**Substitutions and additions to the equipment listed above may occur. However, equipment capable of performing comparably to the listed equipment will always be maintained on-site or nearby.**

*(g) Provisions shall be made for disposal activities in adverse weather conditions.*

**By providing an all-weather access road to the working face, the landfill provides for waste disposal in all weather conditions. During saturation conditions, a dozer or scraper can remove the top saturated earthen material in the daily cover stockpile to uncover dry material for use as workable daily cover. The all weather access road detail is shown in the Design and Operation Plans.**

**The stormwater management system will facilitate disposal operations during periods of excessive rainfall by allowing for positive drainage to sediment ponds and temporary sediment traps.**

*(h) The site shall be adequately secured using artificial barriers, natural barriers, or both to prevent entry of unauthorized vehicular traffic.*

**The access road will be restricted by a gate which is opened during daily operating hours and locked at night and whenever the landfill is closed. Other natural barriers prevent site access. Additional fences may be added at points deemed necessary by the Owner.**

*(i) A sign outlining instructions for use of the site shall be posted at the entrance and shall include:*

*1. name of facility,*
*2. name of permittee and/or operating agency or person,*
*3. days and hours of operation,*
*4. disposal fees, and*
*5. types of waste accepted if the site is available to the general public or commercial haulers.*

**The informational sign at the entrance gate includes the name of the facility, name of permittee, days and hours of operation, disposal fees, types of waste accepted, restrictions (no hazardous, liquid or infectious wastes), and a telephone number for contact person in case of emergency or need after operating hours.**

*(j) Special provisions shall be made for handling large dead animals or highly putrescible waste. Immediately covering the waste with a minimum of 12 inches of cover in a designated area of the facility shall be included in these provisions.*

**All large dead animals and highly putrescible waste will be disposed of at the toe of the active working face immediately upon arrival. Immediately following, the waste will be covered with a minimum of 12 inches of soil or waste.**

*(k) Bulk or noncontainerized liquid waste, or containers capable of holding liquids, shall not be accepted at a landfill unit unless:*

*1. The liquid is household waste other than septic waste;*

*2. The liquid is leachate or gas condensate derived from the MSWLF unit, and the MSWLF unit is designed with a minimum composite liner and leachate collection system or approved equivalent liner and leachate collection system; or*

*3. The containers:*

*(i) Are similar in size to that normally found in household waste;*
*(ii) Are designed to hold liquids for use other than storage; or*
*(iii) Contain household wastes.*

**Liquid wastes not meeting the requirements of this section will be prohibited from disposal in this landfill. This facility does have an approved Waste Solidification Plan which requires that the solidification of liquid wastes be performed over the lined, constructed waste footprint. Liquid wastes that have been handled in accordance with the approved Waste Solidification Plan may be disposed in the landfill.**

*(l) Empty containers larger in size than normally found in household waste must be rendered unsuitable for holding liquids prior to disposal in the landfill unit unless otherwise approved by the Department.*

**This rule will be complied with.**

*(m) Unless otherwise provided by 335-13-4-.22(1)(k), free liquids are prohibited from disposal in the landfill unit.*

**This rule will be complied with.**

*(n) MSWLF units containing sewage sludge and failing to satisfy the criteria in this Division violate Sections 309 and 405(e) of the Clean Water Act.*

**This rule will be complied with.**

*(2) Routine Maintenance.*

*(a) Scavenging shall be prohibited and salvaging operations shall be controlled.*

**Scavenging and salvaging will be prohibited at this facility.**

*(b) Litter shall be controlled within the permitted facility.*

**Litter will be controlled along the entrance, access roads and within the confines of the facility by daily policing. Litter may be controlled as necessary with portable fencing. Any litter blowing onto adjoining properties will be cleaned up immediately by the landfill. The potential problem of wind blown litter will be reduced by limiting the size of the active working face and using daily cover over the active fill area. Also, litter control fences may be utilized.**

*(c) An all-weather access road shall be provided to the dumping face.*

**The landfill will construct and maintain an all-weather access road to the working face. Adequate crushed stone aggregate will be stockpiled on-site to provide materials for routine maintenance of the access road.**

*(d) Measures shall be taken to prevent the breeding or accumulation of disease vectors. If determined necessary by the Department or the State Health Department, additional disease vector control measures shall be conducted.*

**Vectors will be controlled by compaction and the use of daily cover, or approved ADC materials.**

*(e) Environmental monitoring and treatment structures shall be clearly marked and identified, protected and maintained in good repair and shall be easily accessible.*

**Environmental monitoring and treatment facilities will be protected and maintained in good condition throughout the life and post-closure period of this facility. They will either be replaced or repaired as the need arises. All monitoring points will be protected with appropriate bollards or other controls.**

(f) *Completed sites or portions of sites shall be properly closed as provided by this Division and approved facility plans.*

**Completed portions of the site shall be properly closed as provided by ADEM and the approved facility plan.**

(g) *The average daily volume of waste received at a MSWLF shall be calculated by dividing the total month's receipts by the total number of days in the reporting month. Records shall be maintained on the average daily volume of waste received at MSWLFs. A quarterly report which summarizes the daily volumes, with volumes received reported in a format specified and approved by the Department, shall be submitted to the Department and maintained on file in the operating record of the facility by the permittee. If the average daily volume is exceeded for two or more consecutive quarters, by 20 percent or 100 tons/day, whichever is less, a modification would be required to adjust the permitted average daily volume.*

**The landfill maintains records on the daily volume of waste received at the landfill. An automated management system is used in the scale house which enables the landfill to monitor all transactions through the use of truck scales. Quarterly reports summarizing daily volumes will be submitted to ADEM utilizing a format approved by ADEM.**

(3) *Additional Requirements*.

(a) *Owners or operators of all MSWLFs must ensure that the units do not violate any applicable requirements developed under a State Implementation Plan (SIP) approved or promulgated by the Administrator pursuant to Section 110 of the Clean Air Act, as amended.*

**This facility will comply with all Clean Air Act requirements. This facility submitted a Title V Application in July 2010 and an updated Title V Application in February 2012 to the ADEM Air Branch.**

(b) *Notwithstanding this Rule, additional requirements for operating and maintaining a MSWLF may be imposed by the Department, as deemed necessary, to comply with the Act and this Division.*

**No response necessary.**

*2.13 Septic Tank Pumpings and Sewage Sludge (335-13-4-.24)*

*The practice of accepting septic tank pumpings and sewage sludge shall not occur at landfill units unless specifically approved in writing by the Department.*

**Septic tank pumpings will not be accepted for disposal unless approved in writing by Department.**

**Sewage sludge will be treated before being transported to the landfill and will arrive in such condition that will provide for the best management practice at the solid waste facility and as approved by ADEM. The practice of accepting sewage sludge as described above shall not occur until approved in writing by the Department.**

*2.14 Requirements for Management and Disposal of Special Waste (335-13-4-.26)*

*(1) Exceptions.*

*(a) Requirements for the management and disposal of special waste at a landfill unit permitted by the Department shall meet the requirements of this Rule.*

*(b) Certain requirements may be modified by the Department as deemed necessary to comply with the Act and this Division.*

*1. Waste types for which specific rules and regulations under this Division have not been developed shall be managed and disposed of in a manner as determined by the Department to be consistent with the intent of the Act and this Division.*

*2. Generators of a special waste may be required by the Department to provide an analysis and certification that the waste is nonhazardous waste or treated medical waste.*

**This facility is currently approved to dispose of asbestos waste, foundry sand, petroleum contaminated waste, and municipal solid waste ash in accordance with Rule 335-13-4-.26.**

**The landfill will control the disposal of special waste at the facility by requiring written certification from the generator that the waste is nonhazardous or is treated medical waste. The generator will also be required to provide a description of the special waste, SDS data if available, a TCLP laboratory analysis of a representative sample of the special waste, and that approval has been granted by ADEM to accept and dispose of this special waste at the landfill.**

*(2)* *Disposal requirements for friable asbestos.*

*Any person who generates, processes, treats, or disposes of friable asbestos shall comply with the following practices:*

*(a)* *Friable asbestos shall be disposed of in a facility permitted by the Department. The friable asbestos shall arrive at the landfill unit in properly labeled, leak-tight containers as determined by the Department's Air Division.*

**Asbestos may be accepted at the landfill if properly packaged.**

*(b)* *Containers shall be placed intact in a specially prepared place and covered with a minimum of 12 inches of earth at the end of each working day. Asbestos waste may be landfilled in an excavation at the bottom of the operating face if no liner is present or the design depth restriction is not exceeded. The waste may also be placed in a separately designated area. If a separate area is utilized, it shall be clearly marked to prevent future excavation into the waste.*

**Asbestos must be delivered in properly labeled, leak-tight containers as determined by ADEM before acceptance for disposal. The material inside the containers should be in a form that it will not easily become airborne.**

*(c)* *Proper handling precautions shall be taken to ensure that containers are not ruptured prior to placing the required daily earth cover as noted in 335-13-4-.26(2) (b). No machinery shall be operated directly over uncovered containers.*

**The asbestos containers will be placed intact at the daily asbestos waste disposal area, and covered with a minimum of 12 inches of earth cover by the end of the work day. These areas will be established daily by the facility operator. Proper handling precautions for asbestos will be taken when unloading, disposing, and covering these containers to ensure that rupturing does not occur prior to being covered. No machinery will be operated over the uncovered containers.**

*(d)* *Final cover shall be as noted in 335-13-4-.20(2)(b).*

**A final cover system meeting the requirements of this rule will be utilized as specified in the Design and Operation Plans.**

*(3)* *Disposal requirements for foundry wastes.*

*Foundry waste which exhibits less than 50 percent of each of the TC Levels for metals as defined by the USEPA's Toxicity Characteristic Leaching Procedure (TCLP) may be managed in the following manner:*

*(a) Foundry waste may be managed in areas other than*

*1. Flood Plains;*
*2. Wetlands;*
*3. Residential zones; or*
*4. Areas less than 5 feet above the uppermost aquifer.*

*(b) Each foundry must maintain records at the manufacturing facility. These records must include:*

*1. A description of the site to within the ¼, ¼ Section of a specific Township and Range.*

*2. Volume of foundry waste disposed of at each location.*

*(c) The waste must be certified by the generator on a quarterly basis or whenever the process changes which would significantly alter the test results, whichever is more frequent. Certification of the foundry waste shall be accomplished by submitting the following:*

*1. A completed Solid/Hazardous Waste Determination Form.*

*2. A TCLP Analysis for metals.*

*(d) Each foundry must contact the Water Division of ADEM with regards to General Stormwater and/or NPDES permits.*

*(e) Foundry waste from two or more foundries may be managed at one location provided adequate documentation and record keeping is maintained for each foundry.*

*(f) Foundry waste not meeting the requirements of paragraph (2) of this Rule must be managed at an approved recycle/reuse facility or at a landfill unit approved for the disposal of foundry waste and permitted by the Department.*

**Foundry waste will only be managed at this landfill in accordance with ADEM requirements.**

*(4) <u>Disposal requirements for petroleum contaminated waste.</u>*

*Any person who disposes of petroleum contaminated waste shall comply with the following practices:*

*(a) Petroleum contaminated waste must be disposed of in a MSWLF and/or a synthetically lined facility having a solid waste disposal*

*permit issued by the Department and having groundwater monitoring wells.*

*(b) Prior to disposing of a petroleum contaminated waste in accordance with subparagraph (a) of this paragraph, the generator of the waste must provide the Department with a written certification that the waste is non-hazardous.*

*1. The generator of a petroleum contaminated waste may use his knowledge of the processes producing the waste to certify that the waste is non-hazardous; however the Department, on a case-by-case basis, may require additional information and/or laboratory analyses to support the generator's certification.*

*2. The written certification that the waste is non-hazardous must include laboratory analysis for metals if the source of the petroleum contamination is leaded gasoline, used automotive crank case oil, or if the generator has reason to believe that the source contains TCLP metals.*

**Prior to acceptance of petroleum contaminated waste, requirements of this rule section will be complied with and records kept in the Facility Operating Record.**

*(c) Small quantities of petroleum contaminated waste may be disposed in MSWLFs, C/DLFs, .or ILFs, and shall not require approval and/or testing, provided that the waste:*

*1. Contains less than twenty-five (25) gallons of petroleum; and*

*2. Total material (i.e., soil, rags, sorbent, etc.) is less than five (5) cubic yards per occurrence.*

**The facility will comply with this rule.**

*(5) Disposal requirements for municipal solid waste ash.*

*Municipal solid waste ash shall be disposed of at a MSWLF meeting at a minimum the design criteria established under 335-13-4-.18. Alternative disposal methods or uses must be approved by the Department prior to implementation.*

**Municipal Solid Waste Ash may be accepted at this MSWLF as approved by ADEM.**

*(6) Disposal requirements for wood ash waste. Wood ash waste which exhibits less than 50 percent of each of the TC Levels for metals as*

*defined by the USEPA's Toxicity Characteristic Leaching Procedure (TCLP) may be managed in the following manner:*

*(a) Wood ash waste may be managed in areas other than*

*1. Flood Plains;*
*2. Wetlands;*
*3. Residential zones; or*
*4. Areas less than 5 feet above the uppermost aquifer"*

*(b) Facilities managing wood ash waste in an area that is not a permitted landfill unit, not within the property boundaries of the generator, and meets the requirements of 335-13-4-.26 (6)(a) must maintain records at the facility that include the following:*

*1. A description of the site to within the ¼, ¼ Section of a specific Township and Range.*

*2. Volume of the wood ash waste disposed of at each location on a quarterly basis.*

*3. Certification of the wood ash waste on a quarterly basis or whenever the waste generating process changes which would significantly alter the test results, whichever is more frequent. Certification of the wood ash waste must be accomplished by submitting the following:*

*(i) A completed Solid/Hazardous Waste Determination Form.*

*(ii) A TCLP analysis for metals.*

*(c) Facilities managing wood ash waste in an area that is not a permitted landfill unit, within the property boundaries of the generator, and meets the requirements of 335-13-4-.26 (6)(a) must maintain records at the facility that include the following:*

*1. Certification of the wood ash waste on a two (2) year basis or whenever the waste generating process changes which would significantly alter the test results, whichever is more frequent. Certification of the wood ash waste must be accomplished by submitting the following:*

*(i) A completed Solid/Hazardous Waste Determination Form.*

*(ii) A TCLP Analysis for metals.*

*(d) Each facility managing wood ash waste in accordance with 335-13-4-.26(6) shall submit an annual report on or before January*

*31st of each year utilizing a format approved by the Department which contains the following:*

1. *Summary of the components of 335-13-4-.26(6)(b) and/or (c).*

2. *Documentation of the non-coal permitted fuel burned on a quarterly basis to include the type, quantity (mass input basis), and the percentage of total fuel, of each type of fuel burned.*

*(e) Facilities managing wood ash waste in an area that is not a permitted landfill unit and meets the requirements of 335-13-4-.26 (6)(a) must contact the Water Division of the ADEM with regards to NPDES requirements for waste management areas.*

*(f) Wood ash waste from two or more facilities may be managed at one location provided adequate documentation and record keeping is maintained for each generator.*

*(g) Wood ash waste not meeting the requirements of paragraph (6) of this rule must be managed at a landfill unit approved for the disposal of wood ash waste and permitted by the Department.*

**Wood Ash Waste will be managed at this landfill in accordance with ADEM requirements.**

*2.15 Recordkeeping Requirements (335-13-4-.29)*

*Recordkeeping shall be maintained as follows:*

*(1) <u>Operating Record.</u>*

*The owner or operator of a MSWLF, C/DLF or ILF unit must record and retain in an operating record at the facility, or in an alternative location approved by the Department, the following information as it becomes available:*

*(a) Solid Waste Disposal Facility Permit as issued by the Department.*

*(b) Permitted application, operational narrative, and engineering drawings. This may include, but is not limited to:*

1. *Any location restriction demonstration required under 335-13-4-.01 of this Division;*

2. *Any MSWLF unit design documentation for placement of leachate or gas condensate in a MSWLF unit as required under 335-13-4- .22(1)(k) of this Division;*

*3. Closure and post closure care plans as required by 335-13-4-.20 of this Division;*

*4. Explosive gas monitoring plans as required by 335-13-4-.16 of this Division;*

*5. Corrective action plan, if necessary, which includes detection in assessment monitoring;*

*6. Any other documentation submitted to the Department during the permitting process.*

*(c) Reports or documentation generated during the normal operation of the facility may include, but are not limited to:*

*1. Gas monitoring results from monitoring and any remediation plans required by 335-13-4-.16;*

*2. Inspection records, training procedures, notification procedures, and other information required in 335-13-4-.21(1)(b);*

*3. Any monitoring, testing, or analytical data as required by 335-13-4-.20 of this Division concerning closure;*

*4. Any demonstration, certification, finding monitoring, testing, or analytical data required by 335-13-4-.27 concerning groundwater monitoring and corrective action;*

*5. Quarterly volume reports as required in 335-13-4-.22(2)(g) or 335-13-4-.23(2)(f) of this Division;*

*6. Waste certifications as required by 335-13-4-.21(1)(c) of this Division;*

*7. Any other report or document generated in the normal operation of the facility which is submitted to the Department.*

*(d) Any cost estimates and financial assurance documentation required by 335-13-4-.28.*

**Each of the items listed above shall be placed in the Facility Operating Record which is maintained on site.**

*(2) <u>Department notification.</u>*

*The owner/operator must notify the Department when the documents from subparagraph (1)(b) of this Rule have been placed or added to the operating record, and all information contained in the operating record*

*must be furnished upon request to the Department or be made available at all reasonable times for inspection by the Department.*

**The Department will be notified when documents are placed in or added to the Facility Operating Record. The Facility Operating Record will be made available to the Department for inspection, as requested.**

*(3) Alternative schedules.*

*The Department can set alternative schedules for recordkeeping and notification requirements as specified in paragraphs (1) and (2) of this Rule, except for notification requirements in 335-13-4-.01(1)(c) and 335-13-4-.27 (4)(g)3.(iii).*

**If requested, by the Department, this rule will be complied with.**

# ARROWHEAD LANDFILL CAPACITY BREAKDOWN

# ARROWHEAD LANDFILL CAPACITY BREAKDOWN

# TRACT NO. 1

# TRACT NO. 1 – LANDFILL CAPACITY BREAKDOWN

## Waste Footprint:

| | |
|---|---|
| Permitted Area: | 117.6 acres |

## Airspace Estimates:

| | |
|---|---|
| Permitted Airspace | 16,828,041 CY |
| Addition in Airspace by Expansion: | 3,990,457 CY |
| Remaining Airspace (as of 10/11/24) | 11,669,913 CY |

NOTE: Airspace volumes represent estimated waste volume and are calculated from the top of protective cover to the base of the landfill final cover system.

## Anticipated Soil Requirements:

| | | |
|---|---|---|
| **Estimated Soil Needs for Tract No. 1:** | | |
| 1.0 | Structural Fill material required for landfill construction | 253,417 CY |
| 2.0 | 24" thick Clay Liner Material required | 64,211 CY |
| 3.0 | 12" thick Protective Cover Soil required | 32,105 CY |
| 4.0 | Daily & Intermediate Soil cover required—estimated to be 10% of Remaining Airspace | 1,166,991 CY |
| 5.0 | 12" thick Soil Cap Material required | 32,105 CY |
| 6.0 | 18" thick Final Cap Infiltration Layer Material required | 48,158 CY |
| 7.0 | Sideslope Drainage Berm Soil required | 62,935 CY |
| 8.0 | Internal Road Construction & Misc. Soil needs | 100,000 CY |
| **TOTAL SOIL REQUIREMENTS FOR TRACT NO. 1 =** | | 1,759,922 CY |
| **Estimated Soil Available for Tract No. 1** | | |
| 9.0 | Estimated Excavation through Cell Construction | 215,450 CY |
| 10.0 | Estimated Excavation Material suitable for Clay Liner | 96,316 CY |
| 11.0 | Estimated Excavation Material suitable for Protective Cover Soil | 0 CY |
| 12.0 | Remaining soil available—(suitable for structural fill, daily & intermediate cover, soil cap, infiltration layer, sideslope drainage berm, internal roads, and miscellaneous needs over the life of the site) | 119,134 CY |
| **TOTAL SOIL AVAILABLE IN THE TRACT NO. 1 AREA =** | | 215,450 CY |
| **ESTIMATED SOIL NEEDED FROM OTHER SOURCES ON SITE =** | | -1,544,472 CY |

NOTE: This Tract has a soil deficit of 1,544,472 CY. However, the soil requirements shown provide a conservative estimate since the use of approved alternate daily covers greatly reduces the sites dependence on soil for daily cover. Any soil deficit will ultimately by obtained through on-site and off-site borrow sources controlled by the facility Owner.

# TRACT NO. 2

# TRACT NO. 2 – LANDFILL CAPACITY BREAKDOWN

## Waste Footprint:

| | |
|---|---|
| Permitted Area: | 159.3 acres |

## Airspace Estimates:

| | |
|---|---|
| Permitted Airspace | 23,102,207 CY |
| Addition in Airspace by Expansion: | 9,874,592 CY |
| Remaining Airspace | 32,976,799 CY |

NOTE: Airspace volumes represent estimated waste volume and are calculated from the top of protective cover to the base of the landfill final cover system.

## Anticipated Soil Requirements:

| | | |
|---|---|---|
| **Estimated Soil Needs for Tract No. 2:** | | |
| 1.0 | Structural Fill material required for landfill construction | 681,658 CY |
| 2.0 | 24" thick Clay Liner Material required | 514,008 CY |
| 3.0 | 12" thick Protective Cover Soil required | 257,004 CY |
| 4.0 | Daily & Intermediate Soil cover required—estimated to be 10% of Remaining Airspace | 3,297,680 CY |
| 5.0 | 12" thick Soil Cap Material required | 257,004 CY |
| 6.0 | 18" thick Final Cap Infiltration Layer Material required | 385,506 CY |
| 7.0 | Sideslope Drainage Berm Soil required | 105,448 CY |
| 8.0 | Internal Road Construction & Misc. Soil needs | 750,000 CY |
| **TOTAL SOIL REQUIREMENTS FOR TRACT NO. 2 =** | | 6,248,308 CY |
| **Estimated Soil Available for Tract No. 2** | | |
| 9.0 | Estimated Excavation through Cell Construction | 4,564,084 CY |
| 10.0 | Estimated Excavation Material suitable for Clay Liner | 771,012 CY |
| 11.0 | Estimated Excavation Material suitable for Protective Cover Soil | 0 CY |
| 12.0 | Remaining soil available—(suitable for structural fill, daily & intermediate cover, soil cap, infiltration layer, sideslope drainage berm, internal roads, and miscellaneous needs over the life of the site) | 3,793,072 CY |
| **TOTAL SOIL AVAILABLE IN THE TRACT NO. 2 AREA =** | | 4,564,084 CY |
| **ESTIMATED SOIL NEEDED FROM OTHER SOURCES ON SITE =** | | -1,684,224 CY |

NOTE: This Tract has a soil deficit of 1,684,224 CY. However, the soil requirements shown provide a conservative estimate since the use of approved alternate daily covers greatly reduces the sites dependence on soil for daily cover. Any soil deficit will ultimately by obtained through on-site and off-site borrow sources controlled by the facility Owner.

# TRACT NO. 3

# TRACT NO. 3 – LANDFILL CAPACITY BREAKDOWN

## Waste Footprint:

| | |
|---|---|
| Permitted Area: | 148.4 acres |

## Airspace Estimates:

| | |
|---|---|
| Permitted Airspace | 26,324,659 CY |
| Addition in Airspace by Expansion: | 9,560,214 CY |
| Remaining Airspace | 35,689,631 CY |

NOTE: Airspace volumes represent estimated waste volume and are calculated from the top of protective cover to the base of the landfill final cover system.

## Anticipated Soil Requirements:

| | | |
|---|---|---|
| **Estimated Soil Needs for Tract No. 3:** | | |
| 1.0 | Structural Fill material required for landfill construction | 571,254 CY |
| 2.0 | 24" thick Clay Liner Material required | 478,837 CY |
| 3.0 | 12" thick Protective Cover Soil required | 239,419 CY |
| 4.0 | Daily & Intermediate Soil cover required—estimated to be 10% of Remaining Airspace | 3,588,487 CY |
| 5.0 | 12" thick Soil Cap Material required | 239,419 CY |
| 6.0 | 18" thick Final Cap Infiltration Layer Material required | 359,128 CY |
| 7.0 | Sideslope Drainage Berm Soil required | 97,895 CY |
| 8.0 | Internal Road Construction & Misc. Soil needs | 750,000 CY |
| **TOTAL SOIL REQUIREMENTS FOR TRACT NO. 3 =** | | 6,324,439 CY |
| **Estimated Soil Available for Tract No. 3** | | |
| 9.0 | Estimated Excavation through Cell Construction | 4,666,590 CY |
| 10.0 | Estimated Excavation Material suitable for Clay Liner | 718,256 CY |
| 11.0 | Estimated Excavation Material suitable for Protective Cover Soil | 0 CY |
| 12.0 | Remaining soil available—(suitable for structural fill, daily & intermediate cover, soil cap, infiltration layer, sideslope drainage berm, internal roads, and miscellaneous needs over the life of the site) | 3,948,334 CY |
| **TOTAL SOIL AVAILABLE IN THE TRACT NO. 3 AREA =** | | 4,666,590 CY |
| **ESTIMATED SOIL NEEDED FROM OTHER SOURCES ON SITE =** | | -1,657,849 CY |

NOTE: This Tract has a soil deficit of 1,657,849 CY. However, the soil requirements shown provide a conservative estimate since the use of approved alternate daily covers greatly reduces the sites dependence on soil for daily cover. Any soil deficit will ultimately by obtained through on-site and off-site borrow sources controlled by the facility Owner.

# 3.0 CLOSURE PLAN

*3.1 Closure and Post-Closure (335-13-4-.20)*

*(1) Submittal.*

*The owner or operator must submit a closure/post-closure plan to the Department and place in the operating record, no later than the effective date of these regulations or by the initial receipt of waste, whichever is later.*

**The Closure Plan included in this section of the 2025 Major Modification Application details each of these requirements.**

*(2) Closure.*

*The requirements for closure of existing and proposed landfill units shall include the following unless otherwise noted.*

*(a) The owner or operator must prepare a written closure plan that describes the steps necessary to close all existing and proposed landfill units at any point during their active life in accordance with the cover design requirements in 335-13-4-.20(2)(b). The owner or operator must submit the closure plan as part of the Permit Application to the Department. The closure plan, at a minimum, must include the following information:*

*1. A description of the final cover, designed in accordance with 335-13-4-.20(2)(b) and the methods and procedures to be used to install the cover;*

*2. An estimate of the largest area of the landfill unit ever requiring a final cover as required under 335-13-4-.20(2)(b) at any time during the active life;*

*3. An estimate of the maximum inventory of wastes ever on-site over the active life of the facility; and*

*4. A schedule for completing all activities necessary to satisfy the closure criteria in this Rule.*

**The Closure Plan meeting these requirements is included in this section of the 2025 Major Modification Application.**

*(b) A final cover system must be installed which is designed to minimize infiltration and erosion. The final cover system must be comprised of an erosion layer(s) underlain by an infiltration layer(s) as follows:*

1. *The infiltration layer for MSWLF and ILF must be comprised of a minimum of 18 inches of earthen material and/or a synthetic layer that has a permeability less than or equal to the permeability of any bottom liner system or natural subsoils present, or a permeability no greater than 1 x $10^{-5}$ cm/sec, whichever is less. The infiltration layer for C/DLF must be comprised of a minimum of 18 inches of compacted earthen material excluding sands, and*

2. *The erosion layer must consist of a minimum 6 inches of earthen material that is capable of sustaining native plant growth, as specified in 335-13-4-.20(2)(d).*

   **The closure final cover system required by the rule is shown on the Design and Operation Plans which is part of this 2025 Major Modification Application.**

3. *The Department may approve an alternative final cover design that includes:*

   *(i) An infiltration layer that achieves an equivalent reduction in infiltration as the infiltration layer specified in 335-13-4-.20(2)(b)1., and*

   *(ii) An erosion layer that provides equivalent protection from wind and water erosion as the erosion layer specified in 335-13-4-.20(2)(b)2.*

   **If the facility chooses to utilize an alternative final cover design, that demonstration will be made.**

*(c) Final soil cover shall be graded so that:*

1. *Surface water does not pond over the landfill unit.*

2. *The maximum final grade of the final cover system shall not exceed 25 percent or as specified by the Department to minimize erosion.*

3. *Slopes longer than 25 feet shall require horizontal terraces, of sufficient width for equipment operation, for every 20 feet rise in elevation or utilize other erosion control measures approved by the Department.*

4. *The minimum final grade of the final cover system shall not be less than 5 percent or as specified by the Department to minimize ponding.*

5. *For a permitted facility utilizing the area fill method or the trench method, final grading of the infiltration layer shall be completed within 90 days after the unit has received the last known receipt of waste.*

   **The final design included in this 2025 Major Modification Application meets the requirements of this rule, with the exception of the maximum final grade slope and the horizontal spacing of the horizontal terraces. The variances for these components are discussed in Section 2.10 Closure and Post Closure of Section 2.0 Design and Operations.**

(d) *A vegetative or some other appropriate cover must be established to minimize erosion and, when applicable, maximize evapotranspiration. Within 90 days after completion of final grading requirements on each phase or each trench as specified in 335-13-4-.20(2)(a), the Permittee or owner of a permitted landfill unit shall prepare the final cover for the establishment of a vegetative cover or alternative cover. Deep rooted vegetation (roots that may grow below the 6 inch erosion layer) shall be prohibited as vegetative cover. Preparation of a vegetative cover shall include, but not be limited to, the following:*

1. *Placement of appropriate species of grass seed, fertilizer and mulch; and*

2. *Watering and maintenance necessary such that germination of grass will occur.*

**Vegetative cover meeting this requirement can be found in Section 6.0 Technical Specification.**

(e) *Prior to beginning closure of each landfill unit as specified in this Rule, an owner or operator must submit to the Department and place in the operating record a notice of the intent to close the unit.*

**This item will be complied with at the time of MSWLF unit closure.**

(f) *The owner or operator must begin closure activities of each LF unit no later than 30 days after the date of which the LF unit receives the known final receipt of wastes. If the LF unit has remaining capacity and there is reasonable likelihood that the LF unit will receive additional wastes, closure activities of each LF unit must begin no later than one year after the date of known final receipt of wastes. Extensions beyond the one-year deadline for beginning closure may be granted by the Department if the owner*

*or operator demonstrates that the LF unit has the capacity to receive additional wastes and the owner or operator has taken and will continue to take all steps necessary to prevent threats to human health and the environment from the unclosed LF unit.*

**This item will be complied with at the time of MSWLF unit closure.**

(g) *The owner or operator of all LF units must complete closure activities of each LF unit in accordance with the closure plan within 180 days following the last known receipt of waste. Extensions of the closure period may be granted by the Department if the owner or operator demonstrates that closure will, of necessity, take longer than 180 days and he has taken and will continue to take all steps necessary to prevent threats to human health and the environment from the unclosed LF unit. Extensions granted for closure of each LF unit shall not exceed a total of 180 days.*

**This item will be complied with at the time of MSWLF unit closure.**

(h) *Following closure of each LF unit, the owner or operator must submit to the Department a certification, signed by an independent registered professional engineer verifying that closure has been completed in accordance with the closure plan, and a copy placed in the operating record. C/DLF and/or ILF owner or operator may submit certification signed by a registered professional engineer in lieu of an independent registered professional engineer.*

**The appropriate certification by an independent registered professional engineer verifying that closure has been completed in accordance with the approved Closure Plan included in this Section of the 2025 Major Modification Application will be provided at time of closure.**

**A Partial Closure Certification letter for Tract 1 Cells 2-5 was submitted to the Department on January 6, 2012 and an Environmental Covenant was established. ADEM approved the covenant on January 31, 2012.**

(i) *Within 90 days after permit expiration, revocation or when final closure requirements in 335-13-4-.20 are achieved as determined by the Department, the permittee or owner of a facility shall record a notation onto the land deed containing the property utilized for disposal, and/or some other legal instrument that is normally examined during a title search, that will in perpetuity, notify any potential purchaser of the property that:*

1. *The land has been used as a solid waste disposal facility landfill unit;*

2. *Its use is restricted by the items contained in 335-13-4-.20(3)(c) and 335-13-4-.20(3)(d);*

3. *The locations and dimensions of the landfill unit with respect to permanently surveyed benchmarks and section corners shall be on a plat prepared and sealed by a land surveyor;*

4. *Contain a note, prominently displayed, which states the name of the Permittee or operating agency, the type of landfill unit and the beginning and closure dates of the disposal activity.*

5. *Certification by an Engineer or Land Surveyor that all closure requirements have been completed as determined necessary by the Department.*

**This item will be complied with at the time of MSWLF unit closure.**

(j) *For a permitted facility, the permittee or land owner shall submit a certified copy of the recording instrument to the Department and place a copy in the operating record within 120 days after permit expiration, revocation or as otherwise directed by the Department.*

**This item will be complied with at the time of MSWLF unit closure.**

(k) *Detail design for the closure of existing and proposed LF units shall be shown on a final contour and drainage plan. Items required in 335-13-4-.20(2)(b) through (d), (i), (j), and (3)(a), (d), and (f) shall be included.*

**A final design and as-built plan showing final contours and drainage shall be prepared for each closure event.**

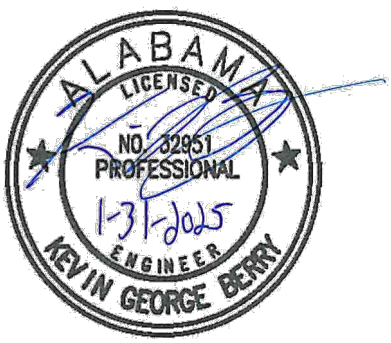
# CLOSURE PLAN

## 2025 MAJOR MODIFICATION APPLICATION
## ARROWHEAD LANDFILL

## ARROWHEAD ENVIRONMENTAL PARTNERS, LLC
## PERRY COUNTY, ALABAMA

## JANUARY 2025

HHNT
HODGES, HARBIN, NEWBERRY & TRIBBLE, INC.
*Consulting Engineers*

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# TABLE OF CONTENTS

1. PURPOSE ..... 1
2. FINAL COVER SYSTEM ..... 2
3. GRADE (5 PERCENT - 25 PERCENT) ..... 3
4. HORIZONTAL DRAINAGE BERMS ..... 4
5. FINAL GRADING WITHIN 90 DAYS ..... 5
6. VEGETATIVE COVER WITHIN 90 DAYS AFTER FINAL GRADING ..... 6
7. AREA AND WASTE ESTIMATES ..... 7
8. CLOSURE SCHEDULE ..... 8
9. TECHNICAL SPECIFICATIONS FOR CLOSURE ..... 10
10. TEMPORARY CLOSURE ..... 11

# 1. PURPOSE

The purpose of this closure plan is to meet the requirements of Rule 335-13-4-.20 and to provide the operator guidance on how closure will be carried out. Site closure can occur at any time during the life of the facility and the closure plan should recognize that. In order that this plan provides this detailed evaluation of the closure, a worst case closure is listed below. That worst case assumes that the facility is closed on the date when the effort to close would be the greatest. The closure plan includes:

- A description of the final cover system;
- Methods and procedures for installation and conformance specs;
- An estimate of the largest area ever requiring closing;
- An inventory of waste on-site;
- A schedule for completing the closure criteria.

# 2. FINAL COVER SYSTEM

The purpose of the final cover system is to minimize infiltration and erosion after closure. The final cover system for this landfill shall consist of the following components:

- 12” thick minimum cohesive soil layer with a permeability no greater than 1 x $10^{-5}$ cm/sec;
- 40 mil thick flexible membrane liner in direct contact with the 12 inch thick cohesive soil layer;
- Geocomposite Drainage Media (GDM) Layer above the 40 mil FML;
- A minimum thickness of 18 inches of protective soil cover and a 6" thick topsoil erosion layer capable of supporting vegetative cover which equates to a minimum cap thickness of 24” on top of the GDM.
- An active or passive gas system (as required by the regulations) will be installed independently of the final cover system.

The vegetative cover for this site will be a low maintenance plant species to control erosion of the final cover system, improve the aesthetics of the facility and promote evapotranspiration and shall be as specified in the "Grassing" Technical Specifications located in Section 6.0. The methods used for installation of the final cover system are covered in the Construction Quality Assurance Plan found in Section 5.0. An alternative final cover may be utilized if approved by ADEM.

# 3. GRADE (5 PERCENT - 33 PERCENT)

As different phases of the landfill are closed, contours will be developed according to the final grading plan. Final contours shown are approximations and are intended as a general guide. If any changes become necessary to the final grading plan, then further approval from ADEM may be required.

Intermediate and final soil cover will be graded so that surface water does not stand or birdbath on the landfill. The final cap side slopes will be graded to approximately 33 percent (3(H):1(V)) and not exceed 33 percent. The top slopes will not be less than 5 percent.

# 4. HORIZONTAL DRAINAGE BERMS

Horizontal drainage berms will be constructed for each ±40 feet rise in elevation to divert storm water run-off and provide erosion control. A variance request was previously approved for the facility allowing the increased berm spacing from 20' vertical to 40' vertical. Each berm will be constructed as shown in the Design and Operation Plans to slow and collect the run-off flow. The berms will route the run-off to downdrains which will carry the water from the slopes to the perimeter ditch or culverts and to the sediment ponds. Detailed design of this system is shown on the Design and Operation Plans.

# 5. FINAL GRADING WITHIN 90 DAYS

Final grading will be completed 90 days after the landfill has reached the final approved elevations or landfilling has permanently ceased.

# 6. VEGETATIVE COVER WITHIN 90 DAYS AFTER FINAL GRADING

The landfill will establish a vegetative cover to reduce erosion and maximize evapotranspiration. The final cover surface will be scarified, fertilized, limed, seeded, and mulched as soon as practical or within 90 days after completion of the final grading of each phase.

Appropriate species of grass seed, fertilizer, lime, sodding (if applicable), hydroseeding, and their rates of application will be consistent with the recommendations of the local Soil Conservation Service. The vegetative cover will be nurtured, protected, and maintained until it has established itself. Deep rooted vegetation (roots that may grow below the 6" erosion layer) shall be prohibited as vegetative cover. Preparation of a vegetative cover shall include but not be limited to placement of appropriate species of grass seed, fertilizer and mulch, and watering and maintenance such that germination of grass can reasonably be anticipated. Maintenance of the final cover system for mowing and fertilizer will be the responsibility of the Owner.

# 7. AREA AND WASTE ESTIMATES

Below is an explanation of the anticipated worst case closure condition for each Tract – or the condition in which closure of each tract would be the most expensive.

A partial closure event in Tract No. 1 was completed in mid-2011. This partial closure event closed approximately 31 acres of the 39 acre tract previously permitted. Therefore, the closure of Tract No. 1 will take place through 2 partial closure events at a minimum. Since construction of future cells will cause waste to overlay onto a portion of the previously closed Tract No. 1 area along the northern slope, only 22 acres of the previously closed 31 acres in Tract No. 1 will remain closed. Therefore the area requiring closure is expected to be roughly 95.6 acres to complete closure of Tract No. 1.

Due to the configuration of Tract 2, by the time Cell No. 6 is filled, a majority of Cells No. 1-5 will be at final grade. We assume that a partial closure event of Tract 2 will take place which will break this 159.3 acre tract into two smaller closure events of roughly 78.3 acres (Cells No. 1-5) and 81 acres (Cells No. 6-9).

We also assume that by the time Cell No. 8 is filled in Tract No. 3, a large portion of Cells No. 1-4 (western side) will be at final grade and that a partial closure event of Tract No. 3 will take place. This will break this 148.4 acre tract into two smaller closure events of roughly 63.2 acres (in Cells No. 1-8) leaving 85.2 acres remaining in this tract for a future closure event.

Therefore, the anticipated worst case condition for any of the 3 tracts of the landfill requiring closure at any time will occur immediately after construction of the last cell in Tract 1 (Cell No. 9) when approximately 95.6 acres will require final capping.

The total estimated airspace for the landfill is approximately 89,484,928 c.y. Approximately 10% of the total volume will be used by daily and intermediate cover materials. Therefore, the estimated amount of waste to be disposed on-site is approximately 80,536,435 c.y.

# 8. CLOSURE SCHEDULE

The following schedule shall be followed for completing all activities necessary for satisfactory closure of the MSWLF unit according to Rule 335-13-4-.20(1.c).

| Step No. | Action Required |
|---|---|

1. The owner or operator must place in the operating record a notice of intent to close all of, or a portion of the MSWLF unit.
2. The owner or operator must submit to the Department a notice of intent to close all of, or a portion of the MSWLF unit.
3. The owner or operator shall begin closure activities of the MSWLF unit no later than 30 days after the date on which the MSWLF unit receives the known final receipt of wastes. If the MSWLF unit has remaining capacity and there is a reasonable likelihood that the MSWLF unit will receive additional wastes, closure activities of the MSWLF unit must begin no later than one year after the most recent receipt of wastes. Extensions beyond the one-year deadline for beginning closure may be granted by the Department if the owner or operator demonstrates that the MSWLF unit has the capacity to receive additional wastes and the owner or operator has taken and will continue to take all steps necessary to prevent threats to human health and the environment from the unclosed MSWLF unit.
4. The owner or operator of all MSWLF units shall complete closure activities of the MSWLF unit in accordance with the closure plan within 180 days following the last known receipt of waste. Extension of the closure period may be granted by the Department if the owner or operator demonstrates that closure will, of necessity, take longer than 180 days and they have taken and will continue to take all steps to prevent threats to human health and the environment from the unclosed MSWLF unit. Extensions granted for closure of each MSWLF unit shall not exceed a total of 180 days.
5. Following closure of each MSWLF unit, the owner or operator shall notify the Department that a certification, signed by an independent registered professional engineer verifying that closure has been completed in accordance with the closure plan and has been placed in the operating record.
6. Within 90 days after permit expiration, revocation, or when final closure requirements in 335-13-4-.20 are achieved as determined by the Department, the permittee or owner of a facility shall record a notation onto the land deed containing the property utilized for disposal, and/or some other legal instrument that is normally examined during a title search, that will in perpetuity, notify any potential purchaser of the property that:
    a. The land has been used as a solid waste disposal facility landfill unit,
    b. Its use is restricted by the items contained in 335-13-4-.20(3)(c) and 335-13-4-.20(3)(d),

c. The locations and dimensions of the landfill unit with respect to permanently surveyed benchmarks and section corners shall be on a plat prepared and sealed by a land surveyor,

d. Contain a note, prominently displayed, which states the name of the Permittee or operating agency, the type of landfill unit and the beginning and closure dates of the disposal activity,

e. Certification by an Engineer or Land Surveyor that all closure requirements have been completed as determined necessary by the Department.

7. For a permitted facility, the permittee or land owner shall submit a certified copy of the recording instrument to the Department and place a copy in the operating record within 120 days after permit expiration, revocation, or as otherwise directed by the Department.

8. Detail design for the closure of existing and proposed LF units shall be shown on a final contour and drainage plan. Items required in 335-13-4-.20(2)(b) through (d), (i), (j), and (3)(a), (d), and (f) shall be included.

# 9. TECHNICAL SPECIFICATIONS FOR CLOSURE

See the following specifications in the Technical Specifications Section 6.0 of the Application for closure activities:

| | | |
|---|---|---|
| Section No. | 01000 - | Pre-Construction Conference |
| | 01050 - | Confirmation Surveys |
| | 01051 - | Construction Surveys |
| | 01300 - | Submittals |
| | 01400 - | Quality Control |
| | 01560 - | Erosion and Sediment Control |
| | 02210 - | Grading |
| | 02220 - | Trenching, Backfilling and Compaction |
| | 02252 - | Protective Soil Cover On Landfill Cap |
| | 02260 - | Compacted Clay Cap |
| | 02674 - | Gas Venting System |
| | 02720 - | Storm Sewer Systems |
| | 02744 - | High Density Polyethylene (HDPE) Pipe |
| | 02748 - | HDPE Fabrication |
| | 02754 - | Geocomposite Drainage Media (GDM) Cap System |
| | 02755 - | Geomembrane (FML) Cap |
| | 02930 - | Grassing |

# 10. TEMPORARY CLOSURE

Where areas of the landfill will be closed out in preparation of future work, either a cap installation, or a later liner installation, 12" of soil shall be placed over that area. This soil shall be graded to promote positive drainage, shall be smooth and uniform in appearance, and shall be vegetated. This area of temporary closure shall be maintained in a erosion free condition until that later work is commenced. Areas which are closed temporarily will be graded a minimum of 5% and a maximum of 33%.

# 4.0 POST-CLOSURE CARE PLAN

*4.1 Closure and Post-Closure (335-13-4-.20)*

*(3) Post-Closure.*

*The requirements for post-closure of existing and proposed landfill units shall include the following unless otherwise noted.*

*(a) Following closure of each LF unit, the owner or operator must conduct post-closure care. Post-closure care must be conducted for a minimum of 30 years; or a minimum of 5 years if closed prior to October 9, 1993, or the effective date of § 258.1 of 40 CFR 258, Solid Waste Disposal Criteria, whichever is later; except as provided under 335-13-4-.20(3)(b), and consist of at least the following:*

*1. Eroded areas shall be filled with suitable soil cover, compacted, graded and appropriate cover established as described in 335-13-4-.20(2)(d).*

*2. Areas which provide for ponding of surface water shall be filled, graded and an appropriate cover established as described in 335-13-4-.20(2)(d).*

*3. Landfilled areas with extensive surface cracks in soil cover shall be corrected as necessary, or as determined by the Department, to prevent infiltration of surface water.*

*4. An appropriate cover shall be maintained on the facility at all times as described in 335-13-4-.20(2)(d).*

*5. Access control structures shall be maintained or erected and signs shall be posted stating that the facility is closed and giving the location of the nearest permitted landfill unit.*

*6. Any waste dumped at the landfill unit following closure shall be removed to an approved landfill unit by the permittee, operating agency, or owner.*

*7. Monitoring devices and pollution control equipment such as groundwater monitoring wells, explosive gas monitoring systems, erosion, and surface water control structures, and leachate facilities shall be maintained. Monitoring requirements shall continue in effect throughout the active life and post-closure care period as determined by the Department unless all solid waste is removed and no unpermitted discharge to waters has occurred.*

8. *Other deficiencies such as vector control which may be observed by the Department shall be corrected.*

**The Post-Closure Plan included in this section of the 2025 Major Modification Application details each of these requirements.**

(b) *The length of the post-closure care period may be:*

1. *Decreased by the Department if the owner or operator demonstrates that the reduced period is sufficient to protect human health and the environment and this demonstration is approved by the Department; or*

2. *Increased by the Department if the Department determines that the lengthened period is necessary to protect human health and the environment.*

**This rule will be complied with during the post-closure care period. The planned post-closure period for this facility is anticipated to be 30 years.**

(c) *The owner or operator of all LF units must submit to the Department and receive approval as part of the Permit Application, a written post-closure plan. A copy must also be placed in the operating record. The post-closure plan must include, at a minimum, the following information:*

1. *A description of the monitoring and maintenance activities required in 335-13-4-.20(3)(a) for each LF unit, and the frequency at which these activities will be performed;*

2. *Name, address, and telephone number of the person or office to contact about the facility during the post-closure period; and*

3. *A description of the planned uses of the property during the post-closure period.*

**A Post-Closure Plan meeting these requirements is included as part of this section of the 2025 Major Modification Application.**

(d) *Post-closure use of the property used for the disposal operation must never be allowed to disturb the integrity of the final cover, liner(s), or any other component of the containment system, or the function of the monitoring systems necessary to comply with the requirements of these Rules. The Department may approve any other disturbance if the owner or operator demonstrates that the*

*disturbance, including any removal of waste, complies with the following:*

1. *The activities will not increase the potential threat to human health or the environment; or*

2. *The activities are necessary to reduce a threat to human health or the environment.*

**This rule will be complied with during the post-closure care period.**

(e) *Following completion of the post-closure care period for each LF unit, the owner or operator must submit to the Department a certification, signed by an independent registered professional engineer verifying that post-closure care has been completed in accordance with the post-closure plan, and a copy placed in the operating record. A C/DLF Owner or Operator may submit certification signed by a registered professional engineer in lieu of an independent registered professional engineer.*

**The appropriate certification by an independent registered professional engineer will be submitted to ADEM at the conclusion of the post-closure care period.**

(f) *If the Permittee or owner, or any subsequent owner of the land upon which a landfill unit is located wishes to remove waste, waste residues, the liner, if any, or any contaminated soils, the owner must request approval from the Department. The owner may also ask permission to remove the notation from the recording instrument if all waste and contaminated soils are removed from the property and no unpermitted discharges to waters have occurred.*

**Should all waste be removed from this facility, this request will be made in a timely manner.**

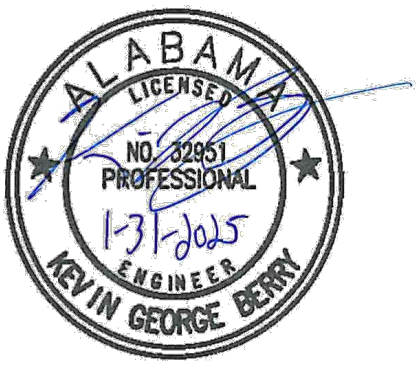
# POST-CLOSURE PLAN

## 2025 MAJOR MODIFICATION APPLICATION
## ARROWHEAD LANDFILL

## ARROWHEAD ENVIRONMENTAL PARTNERS, LLC
## PERRY COUNTY, ALABAMA

## JANUARY 2025

HHNT
HODGES, HARBIN, NEWBERRY & TRIBBLE, INC.
*Consulting Engineers*

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# TABLE OF CONTENTS

1. GENERAL ..... 1
2. CONTACT NAME ..... 2
3. DESCRIPTION OF USE ..... 3
4. MAINTENANCE ACTIVITIES ..... 4
5. ACCESS CONTROL STRUCTURES AND SIGNAGE ..... 5
6. WASTE DUMPED AFTER CLOSURE ..... 6
7. MONITORING DEVICES ..... 7
8. VECTOR CONTROL ..... 8
9. RECORD NOTATION ON LAND DEED ..... 9
10. CERTIFICATION ..... 10

# 1. GENERAL

The landfill operator will be responsible for 30 years of post-closure care of the Arrowhead Landfill after closure of the landfill facility. These post-closure care activities ensure the environmental integrity of the facility. The facility post-closure care will be carried out in a manner that promotes non-destructive use by wildlife. A copy of the approved Post-Closure Plan shall be placed in the operating record.

# 2. CONTACT NAME

The person or office to contact about the facility during the post closure period is as follows:

Mr. William Gay
Division Vice President
Arrowhead Environmental Partners, LLC
65 Challenger Road
Suite 312
Ridgefield Park, NJ 07660
Phone: (914) 671-7287 (business phone)

# 3. DESCRIPTION OF USE

The planned end use of this site is non-destructive on the various landfill closure systems. In particular, no activity is planned, nor will any activity be allowed, which disturbs the integrity of the cap system, base liner system, or any other components of the containment system, or the function of the monitoring systems unless necessary to comply with the requirements of the rules. Any disturbance must be approved by the Department. Only those disturbances which will not increase the potential threat to human health or the environment, as fully demonstrated by the operator, will be approved.

# 4. MAINTENANCE ACTIVITIES

Maintenance of the MSWLF unit during the post closure care period shall include quarterly inspections for areas which may be forming washes and gullies, ponding of water, or extensive surface cracking (desiccation). More frequent inspections immediately following closure activities or during adverse weather conditions may be necessary.

Eroded areas will be filled with suitable soil or re-worked, compacted, graded, and vegetated. Areas where ponding is occurring will be filled, graded, and vegetated. For those areas with extensive surface cracks, corrective measures shall include, but are not limited to: excavate and recompact the soil, vegetate, or other measures as necessary. An appropriate cover will be maintained on the landfill at all times.

Other elements of post-closure inspection are the gas management and monitoring system, ground water monitoring system, access roads, notification and warning signs, fencing, the surface water management system and leachate facilities. Inspection of the closed landfill will be performed by landfill personnel to ensure that all post-closure requirements are being met. Quarterly a registered engineer in Alabama will conduct an inspection and provide results to the Owner. Currently quarterly post-closure inspections and reporting are completed for the portion of Tract 1 that has been certified closed.

If an inspection indicates that corrective measures are required to repair or restore the landfill, maintenance will be performed as soon as practical but not less than 30 days from discovery of the deficiency.

# 5. ACCESS CONTROL STRUCTURES AND SIGNAGE

The erected fences, main gate, and the natural barriers will all be used to control access into the facility during the active operation. To protect and maintain the integrity of the closed landfill, these structures will be maintained and kept functional to control access and egress during the post-closure period.

A sign will be posted at the main entrance gate stating that the landfill is permanently closed. It shall identify the location of the nearest permitted and operating landfill disposal facility.

# 6. WASTE DUMPED AFTER CLOSURE

Any waste dumped at the MSWLF unit following closure shall be removed and disposed in an approved landfill unit by the permittee, operating agency or owner.

# 7. MONITORING DEVICES

The landfill will perform post-closure inspections to assure that the monitoring devices are functional throughout the post-closure care period. The inspection will include the gas management system, groundwater monitoring system, surface water management system, methane monitoring system, and leachate facilities.

If an inspection indicates that corrective measures are required to repair or restore a component, maintenance will be performed as soon as practical.

# 8. VECTOR CONTROL

During the routine post-closure maintenance inspection, the landfill will check for disease vectors. Vectors are not anticipated to be a problem during the post-closure period due to closure methods. However, should vectors become a problem, the landfill will take the appropriate measures to control them.

# 9. RECORD NOTATION ON LAND DEED

After post-closure, the area of the property used for the landfill shall never be used. Nor shall anyone be allowed to disturb the integrity of the final cover, liners, or any other component of the containment system, or the function of the monitoring systems, unless approved by the Department.

The Department may approve any other disturbances, if the owner or operator demonstrates that the disturbance, including any removal of waste, will not increase the potential threat to human health or the environment, or are necessary to reduce a threat to human health or the environment.

Within 90 days after the permit expiration, revocation, or when final closure requirements in 335-13-4-.20 are achieved as determined by the Department, the permittee or owner of the facility will record a notation onto the land deed containing the property utilized for disposal, and/or some other legal instrument that will normally be examined during a title search, that will in perpetuity, notify any potential purchaser of the property of the following:

1. The land has been used as a solid waste disposal facility.
2. The land use is restricted by the items contained in 335-13-4-.20(3)(c) and (d) of the Administrative Code of ADEM.
3. Locations and dimensions of the disposal facility with respect to permanently surveyed benchmarks and section corners will be contained on a plat prepared and sealed by an Alabama Registered Land Surveyor. The plat will be titled "Arrowhead Landfill." The following note will also be prominently displayed:

   Arrowhead Municipal Solid Waste Landfill
   Operated from (October 2007 to (closure date))

4. Provide certification by an Engineer or Land Surveyor that all closure requirements have been completed as determined necessary by the Department.
5. The landfill will submit a certified copy of the recording instrument to the Department and place a copy in the operating record within 120 days after permit expiration or as otherwise directed by the Department.

# 10. CERTIFICATION

Following completion of the post closure care period of the MSWLF unit, the owner or operator shall submit to the Department a certification, signed by an independent registered professional engineer, verifying that post closure care has been completed in accordance with the post closure care plan, and place a copy in the operating record.

# 5.0 CONSTRUCTION QUALITY ASSURANCE PLAN

# CONSTRUCTION QUALITY ASSURANCE (CQA) PLAN

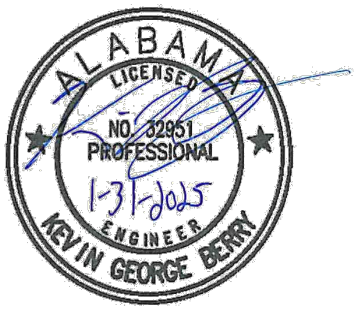
## 2025 MAJOR MODIFICATION APPLICATION
## ARROWHEAD LANDFILL

## PERRY COUNTY ASSOCIATES, LLC
## PERRY COUNTY, ALABAMA

## JANUARY 2025

*(CQA Plan is to be reviewed by Design Engineer for every construction project to determine if any improvements or changes are warranted. All changes will be appropriately approved by ADEM prior to implementation)*

HHNT
HODGES, HARBIN, NEWBERRY & TRIBBLE, INC.
*Consulting Engineers*

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# TABLE OF CONTENTS

1. GENERAL ..... 1
2. GRADING ..... 3
3. COMPACTED CLAY LINER ..... 6
4. TEXTURED HDPE GEOMEMBRANE LINER ..... 11
5. LEACHATE COLLECTION SYSTEM ..... 19
6. TESTING PIPING SYSTEMS ..... 21
7. PROTECTIVE COVER SOIL - ON LINER - SANDY SOIL ..... 24
8. GEOMEMBRANE FML CAP ..... 26
9. GEOCOMPOSITE DRAINAGE MEDIA (GDM) ..... 34
10. PROTECTIVE SOIL COVER ON LANDFILL CAP ..... 36
11. INTERFACE FRICTION - BASE LINER SYSTEM ..... 38
12. INTERFACE FRICTION - CAP LINER SYSTEM ..... 40
13. CERTIFICATION ..... 41

# 1. GENERAL

A. Construction Quality Assurance / Quality Control Plan (CQA Plan) for the construction of the liner, cap, and leachate collection system shall be provided by a third-party consulting engineering firm specializing in the inspection and testing of soils and geosynthetics. Resumes and qualifications including experience with projects of similar type, size, and complexity shall be provided to the OWNER for review and approval.

B. The services of the CQA firm shall be provided and paid for by the OWNER. The services of the CQA firm shall be required during construction of the compacted clay liner, reinforced geosynthetic clay liner, HDPE geomembrane liner, leachate collection system, protective cover gravel, geonet drainage media, compacted soil cap, protective soil cover, and geomembrane cap.

C. The project team providing the CQA services shall consist of the following:

1. ENGINEER OF RECORD: The OWNER's engineer for all landfill activities, who shall be a registered professional engineer licensed in Alabama.
2. DESIGN ENGINEER: Responsible for providing interpretations and clarifications of the Contract Documents, reviewing and approving shop drawings, authorizing minor variations in the work from the requirements of the Contract Documents, and rejecting defective work (duties and responsibilities are described in General Conditions as "ENGINEER"). The DESIGN ENGINEER shall be registered professional engineer licensed in Alabama.
3. CQA ENGINEER: Responsible for defining quality assurance, requirements compatible with the project objectives, verifying basic data as reasonable and complete, outlining procedures to process data, developing statistical procedures for the analysis of test data, and preparing quality assurance memoranda and quality control reports. The CQA ENGINEER shall report to the DESIGN ENGINEER. This CQA ENGINEER shall be a registered professional engineer licensed in Alabama. Reference to the CQA ENGINEER, for the purpose of this document, shall include the CQA ENGINEER or his representative.
4. Engineering Technicians: Responsible for field observations, testing and inspection. Technicians will be assigned to the project as deemed necessary by the CQA ENGINEER and will be responsible to the CQA ENGINEER. The CQA ENGINEER, Technician or the CQA ENGINEER's representative shall be on-site during construction activities.
5. CQA Testing Laboratory: The CQA Testing Laboratory will have experience in testing structural fills, soil liners, aggregates, and geosynthetics, and be familiar with ASTM, GRI, and other applicable test standards. Geosynthetics testing shall be performed by a laboratory accredited through the Geosynthetics Accreditation Institute's Laboratory Accreditation Program (GAI-LAP). Separate laboratories may be used for soils and geosynthetics testing.

5. AS BUILT SURVEYOR: As-built certification surveys shall be performed by a registered professional land surveyor licensed in Alabama on the components of the composite liner system. Drawings shall be prepared for the following:

    a. Base grades on top of prepared surface prior to installation of compacted clay liner and soil cap.

    b. Top of finished grade for the soil component of each liner system.

    c. Top of finished grade for protective cover layer of each liner system including cap.

D. This CQA Plan and the Technical Specifications must be reviewed by the Design Engineer and CQA Engineer before each cell construction or final cap construction project. Revised test methods, improvements in technologies, new products must be evaluated to determine if these minimum requirements are met. Changes to this CQA Plan or the Technical Specifications must be approved by the Design Engineer, CQA Engineer and ADEM prior to implementation.

# 2. GRADING

## A. GENERAL

The CQA ENGINEER shall test the grading, placement, and compaction of in-situ materials and structural fill. The CQA ENGINEER shall certify the materials and construction were in accordance with the plans, specifications, and this CQA Plan.

## B. RELATED WORK

The CQA ENGINEER should reference the grading section of the technical specifications for pertinent soil materials, physical properties and construction requirements.

## C. SUBGRADES

During construction, conformance and performance testing of the subgrade soil materials shall be performed by the CQA ENGINEER. The CQA ENGINEER shall monitor proofrolling of areas that are cut to achieve grade. Material placed to achieve grades indicated on the plans shall be tested by the CQA ENGINEER in accordance with the test methods and frequencies listed herein to verify that the compacted fill materials used by the CONTRACTOR complies with the technical specifications. Areas of proofrolling or compacted fill that do not conform to the technical specifications will be delineated and reported to the CONTRACTOR. These areas will be re-worked by the CONTRACTOR and re-tested until passing results are achieved.

The CQA ENGINEER shall monitor the repair and re-work of subgrade which is damaged by excess moisture (causing softening) and insufficient moisture (causing desiccation and shrinkage) or be freezing. If such conditions are found to exist, the CQA ENGINEER shall evaluate the suitability of the subgrade by the following methods as applicable:

- moisture / density testing;
- visual inspection during proof-rolling;
- other test methods identified herein.

## D. CONFORMANCE TESTING

It will be necessary for the CQA ENGINEER to observe and test the structural fill soils to ensure they are uniform and conform to the requirements of the technical specifications. For soil materials obtained from on-site or off-site borrow areas, visual inspections and conformance tests shall be performed by the CQA ENGINEER prior to the materials being used. Borrow area inspections may also be utilized by the CQA ENGINEER to ensure that only suitable soil materials are transported to the site. For both on-site and off-site borrow areas containing non-uniform materials, it shall be necessary for the CONTRACTOR and the CQA ENGINEER to coordinate excavation and monitoring of the segregation of substandard materials. All materials failing to comply with conformance standards shall be rejected for use.

Initial evaluation of various soil types by the CQA personnel during construction shall be largely visual; therefore, the CQA personnel must be experienced with visual-manual soil classification procedures. CQA personnel shall observe soils for deleterious materials (e.g., roots, stumps, rocks, and large objects). When necessary, the visual-manual procedure for the description and identification of soils shall be conducted by the CQA ENGINEER in accordance with test methods ASTM D2487 and ASTM D2488.

## E. TEST METHODS AND FREQUENCY

All testing shall be conducted in accordance with this CQA Plan or as directed by the DESIGN ENGINEER. The field testing methods, used to evaluate the suitability of soils during their installation, shall be performed by the CQA ENGINEER in accordance with current ASTM test procedures indicated in the table below. Documentation and reporting of the test results shall be the responsibility of the CQA ENGINEER.

The Standard Proctor Test (ASTM D698) shall be used for the determination of moisture / density relationships unless otherwise indicated. In-place moisture / density shall be determined by the nuclear test methods (ASTM D6938 or ASTM D8167), the sand cone test method (ASTM D1556), or drive cylinder test method (ASTM D2937). The Sand Cone Test Method (ASTM D1556) or Drive Cylinder Test Method (ASTM D2937) shall be used to establish correlations of moisture and density in cases of uncertainty, and as a check of the nuclear surface moisture / density gauge calibration. Any conflict regarding acceptance of test results shall be resolved by the DESIGN ENGINEER.

Testing shall be conducted during the course of the work. The minimum construction testing frequencies are presented in the table below. The frequency may be increased at the discretion of the CQA ENGINEER or if variability of the materials is observed by the CQA ENGINEER. Sampling locations shall be selected by the CQA ENGINEER. If necessary, the location of routine in-place density tests shall be determined using a non-biased sampling approach.

A special testing frequency shall be used at the discretion of the CQA ENGINEER when visual observations of construction performance indicate a potential problem.

**MINIMUM TESTING REQUIREMENTS FOR STRUCTURAL FILL**

| TEST | FREQUENCY |
|---|---|
| Laboratory Moisture-Density / ASTM D698 | 1 test per 20,000 c.y. |
| Liquid Limit, Plastic Limit, Plasticity Index / ASTM D4318 | 1 test per 20,000 c.y. |
| Moisture /<br>Oven, ASTM D2216<br>Microwave, ASTM D4643<br>Direct Heat, ASTM D4959 | 1 test per 20,000 c.y. |

| | |
|---|---|
| Particle Size Analysis of Soils / ASTM D6913 & D7928 | 1 test per 20,000 c.y. |
| Field Density and Moisture Content / Sand Cone, ASTM D1556 Drive Cylinder, ASTM D2937 Nuclear, ASTM D6938 or D8167 | 1 test per 2,000 c.y. of structural fill (site grading) |

**F. COMPACTION**

The CQA ENGINEER shall confirm that structural fill conforms to compaction requirements as follows:

| **Description** | **Standard Proctor Compaction** |
|---|---|
| Sediment Pond Embankments | 95% |
| Roadways* | 98% |
| Shoulders and Embankments | 95% |
| Utilities Under Structures | 95% |
| Other Areas | 95% |

**Below 12" is 95%*

**G. PROTECTION OF SUBGRADES AND FILL SURFACES**

The CQA ENGINEER shall monitor newly graded areas to verify the CONTRACTOR is protecting these areas from traffic and erosion until construction is complete.

# 3. COMPACTED CLAY LINER

## A. GENERAL

The CQA ENGINEER shall certify the materials and installation are in accordance with the plans, specifications, and this CQA Plan.

## B. MATERIAL

The compacted clay liner material shall consist of on-site cohesive soils, synthetically improved soils, or imported cohesive soils meeting the hydraulic conductivity criterion of $k \leq 1 \times 10^{-7}$ cm/sec. These soils shall be classified as MH, ML, CL, CH, or SC with > 30% passing the #200 sieve, LL ≥ 30%, and PI ≥ 15% as specified in the ADEM Rules.

## C. STOCKPILING AND MATERIAL APPROVAL

1. All material to be used as the compacted clay liner shall be approved in advance of construction by the CQA ENGINEER. Approval is based upon successful completion of CQA testing outlined herein. Such testing can be performed either during excavation and stockpiling or from existing stockpiles prior to use.

2. The procedure for testing during excavation and stockpiling is outlined below.

    a. Each load of soil will be examined either at the borrow source or the stockpile area. Any unsuitable material will be rejected or routed to separate stockpiles consistent with its end use.

    b. During stockpiling operations, one (1) bulk sample of material placed will be collected. The following tests will be performed prior to placement of any low permeability soil liner material:

        1. Method for Laboratory Determination of Water (Moisture) Content of Soil, Rock, and Soil-Aggregate Mixtures, ASTM D2216, or ASTM D4959.

        2. Method for Particle - Size Analysis of Soils, ASTM D6913 & D7928

        3. Test Method for Liquid Limit, and Plasticity Index of Soils, ASTM D4318.

    c. One (1) sample for every 5,000 cubic yards of material stockpiled will be selected for hydraulic conductivity testing (ASTM D5084 measurement of Hydraulic Conductivity of Saturated Porous Materials using a Flexible Wall Permeameter) and for determining the moisture-density relationship (ASTM D698), Moisture (ASTM D2216), Atterberg Limits (ASTM D4318), Particle Size (ASTM D6913 & D7928).

3. Reports for compacted clay liner will be prepared by the CQA ENGINEER and shall include:

    a. summary of laboratory test data, and

b. a summary of construction, sampling and testing method, and recommendations.

**D. SUBGRADE**

1. The CQA ENGINEER shall verify that the liner subgrade is constructed in accordance with the grading specifications.
2. The landfill cell shall be excavated to the lines and grades as indicated on the drawings. The subgrade shall be scarified to a depth of 6" and compacted to 95% as determined by the Standard Proctor Test, ASTM D698.
3. The subgrade shall be reasonably free of large rocks, large roots, stumps, and other debris.

**E. TEST PAD**

1. A test pad will be constructed using the same construction methods, equipment, and material to be used for the clay liner component. The test fill pad construction will be conducted prior to or coincide with the beginning of construction of the clay liner component.
2. Construction equipment and methods shall be reviewed by the CQA ENGINEER prior to test pad placement.
3. Construction methods, sampling and testing, including hydraulic conductivity testing, shall be specified by the CQA ENGINEER.

**F. CONSTRUCTION**

1. Compacted clay liner shall be placed to achieve a hydraulic conductivity of $k \leq 1 \times 10^{-7}$ cm/sec.
2. Only soil previously approved by the CQA ENGINEER shall be used in construction of the compacted clay liner. Unsuitable material will be removed prior to acceptance by the CQA ENGINEER.
3. All required field density and moisture content tests shall be completed before the overlying lift of soil is placed. The surface preparation (e.g., wetting, drying, scarification, etc.) shall be completed before the CQA ENGINEER will allow placement of subsequent lifts.
4. Moisture content will be monitored by the CQA ENGINEER or his representative prior to compaction. If the soil is drier or wetter than the specified moisture content range, water will be added and the lift will be disced to distribute the moisture evenly or the lift dried.

   The surface of each lift shall be scarified prior to placement of subsequent lifts. The final lift shall be sealed using a smooth drum roller.

5. The thickness of the loose lift shall be measured at random locations after spreading and leveling is completed. Loose lift thickness should not exceed 8" for a final 6" compacted lift thickness.

Each lift shall be checked visually for rocks, debris, plant materials, and other foreign material. The surface of the clay liner shall be reasonably free of material which will not pass through a screen. The remaining clay liner (below the surface) shall be free of material which will not pass through a 2" screen. This may require mechanical pulverizing of these soils.

6. The exposed surface of the clay liner shall be rolled with a smooth drum roller or equivalent at the end of each work day or as needed to protect the clay liner from adverse weather conditions.

7. The finished clay liner surface shall be reasonably free of all rock or rock fragments. Rock or rock fragments are defined as the material retained by a standard ¾" screen. Protrusions shall be removed and all cracks and voids shall be filled and the surface made uniform. Rock or other material protruding more than ¾" shall not be allowed. This shall be accomplished by final dressing of the clay liner with smooth drum rollers and hand raking.

   No rubber-tired vehicles are permitted on the final dressed surface unless authorized by the CQA ENGINEER.

8. The surface on which the geomembrane is to be placed shall be maintained in a firm, clean, dry, and smooth condition before and during the liner installation.

   Desiccation cracking shall be minimized. Minor desiccation cracking shall be repaired by the sprinkling of water. Desiccation cracks not accepted by the CQA project engineer shall require reconstruction of the affected area of the top lift.

9. The CQA ENGINEER shall inspect the compacted clay liner and certify that it is in accordance with the specifications and approved plans and receive concurrence of the State prior to the CONTRACTOR beginning installation of geomembrane. This may require separate certifications of liner sections. If this is required, surveys of each section shall be provided by the CONTRACTOR to define the limits of these sections. Placement of geomembrane on any portion of the soil liner surface by the geomembrane installer will constitute his acceptance of the surface.

**G. SAMPLING AND TESTING FOR COMPACTED CLAY LINER**

1. The CQA ENGINEER or his representative will perform field density tests to assure that the soil density and moisture content are within the prescribed limits. The frequency of testing is noted below.

2. Bottom and Side Slope of Cell

   a. Field density tests shall be performed at the rate of 4/AC/Lift of lined area for each lift of the clay liner base and the subgrade. Density shall achieve a minimum criteria of > 95% Standard Proctor. For any failing test, an area 100' x 100' shall be reworked and the area shall be retested. Moisture content must be within 4% of optimum moisture content (or as approved by the Department).

   b. The field density tests will be performed using a nuclear density gauge (ASTM D6938), sand cone (ASTM D1556) or drive cylinder (ASTM D2937) methods. The location of each test will be randomly determined by the CQA ENGINEER or his representative.

All holes shall be patched with sodium bentonite mixed with the clay liner soil, compacted and hydrated in the holes.

c. Two (2) bulk samples of the clay liner for each lift will be collected during placement or compaction. The following tests will be performed to confirm that the material properties specified in the ADEM Rules are met:

   1. Method for Laboratory Determination of Water (Moisture) Content of Soil, Rock, and Soil-Aggregate Mixtures (ASTM D2216 or ASTM D4959).
   2. Method for Particle - Size Analysis of Soils, ASTM D6913 & D7928
   3. Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils, ASTM D4318.

d. One (1) sample per acre per each lift of soil liner placed will be selected by the CQA ENGINEER for hydraulic conductivity testing (ASTM D5084) for $k \leq 1 \times 10\text{-}7$ cm/sec. For any failing test, the one acre area represented by the failing test shall be reworked and the area shall be retested.

e. Particle size screening of the clay liner material shall be performed in accordance with technical specifications.

**H. THICKNESS**

1. The clay liner shall be 24 inches thick across the bottom and side slopes of the cell. Thickness of the clay liner on the side slopes shall be measured perpendicular to the slope face.
2. The as-built thickness of the liner shall be determined by non-destructive survey methods as described below. Samples of the in-place compacted soil liner shall be tested and evaluated prior to acceptance.
3. After completion of a segment of clay liner, but before installation of the geomembrane (FML), the top of the clay shall be surveyed to ensure:

   a. The specified minimum thickness of clay liner has been achieved.

   b. The top of the clay liner slopes diagonally across the cell toward the collection assembly at grades specified on the contract drawings.

   c. The top of the clay liner in the collection assembly area is at the grades and elevations specified on the contract drawings.

   d. Clay liner placed beyond the limits of the lines and grades as shown on the contract drawings will not be accepted and must be removed at the CONTRACTOR's expense. Such material which has been determined suitable for clay liner construction may be re-incorporated into clay liner if needed.

   e. This survey work shall be performed by a surveyor registered in the State of Alabama the services of whom shall be provided by the OWNER.

**I. PROTECTION**

1. The CQA ENGINEER shall monitor protection of the clay liner during and after construction.

2. The clay liner surface shall be sprinkled with water as needed to prevent desiccation. Should excessive desiccation occur, or softening due to excessive moisture or from freeze-thaw, the impacted areas or the last lift shall be reconstructed in accordance with the specifications.
3. Completed lifts or sections shall be sealed by rolling with a smooth drum roller as needed to seal and maintain the clay surface to reduce potential erosion and/or desiccation from adverse weather conditions.

# 4. TEXTURED HDPE GEOMEMBRANE LINER

## A. GENERAL

The CQA ENGINEER shall certify the material and installation are in accordance with the plans, specifications, and the CQA Plan.

## B. MATERIAL

1. The geomembrane will be textured minimum 60 mil High Density Polyethylene (HDPE) supplied and installed by firms approved by the OWNER.
2. Seams for providing watertight joints will be extrusion or double hot wedge fusion seams using techniques approved by the CQA ENGINEER.
3. Construction Quality Assurance shall confirm the material meets the minimum physical properties of GRI Test Method GM-13 in Table 1.

**TABLE 1**
**REQUIRED PHYSICAL PROPERTIES**
**OF**
**GEOMEMBRANE LINER (HDPE) SHEET**

| Property | Test Method | Required Values 60 MIL | CQC Frequency |
|---|---|---|---|
| Thickness, Mil. (min.)[1] | ASTM D5994 (Textured) | 60 (lowest individual measurement) | Per Roll |
| Sheet Density, g/cm$^3$ (min. ave.) | ASTM D792 or ASTM D1505 | 0.940 | 200,000 lbs[2] |
| Tensile Properties (min. ave.) (Each Direction) | ASTM D6693, Type IV | | 20,000 lbs[3] |
| Strength at Yield (1 lbs/in) | | 126 | |
| Elongational Yield (%) | | 12 | |
| Strength at Break (1 lb/in) | | 90 | |
| Elongation at Break (%) | | 100 | |
| Tear Resistance, 1 lbs. (min. ave.) | ASTM D1004 | 42 | 45,000 lbs[3] |
| Stress Crack Resistance | ASTM D5397 | 500 hours | per GRI GMI 10 |
| Puncture Resistance, 1 lbs. (min) | ASTM D4833 | 90 | 45,000 lbs[3] |

| | | | |
|---|---|---|---|
| Carbon Black Content, (Allowable Range in %) | ASTM D4218 | 2.0 - 3.0 | 20,000 lbs[3] |
| Carbon Black Dispersion, (Acceptable Levels) | ASTM D5596 | GRI GM 13 | 45,000 lbs[3] |
| Asperity (textured only) (MARV) | ASTM D 7466 | 16 | every 2nd roll |

1 Thickness - value represents lowest individual value
2 pounds in resin
3 pounds of geomembrane

**C. GEOMEMBRANE MANUFACTURER AND INSTALLER**

1. The Geomembrane Installer will submit to the CQA Engineer the following as obtained from the Geomembrane Manufacturer:
    a. Production Certification including project references
    b. Testing Program of Compound Ingredients
    c. Material Certification
    d. Test Data for Material and Resin
    e. All of the above submittals will be reviewed and retained by the CQA ENGINEER
2. The Geomembrane Installer will submit the following to the CQA ENGINEER prior to the installation:
    a. Qualifications of Geomembrane Installer Superintendent and Foreman
    b. Resumes of each Geomembrane CONTRACTOR field welder
    c. Six (6) sets of geomembrane panel layout drawings
3. The CQA ENGINEER or his representative will sample rolls from each shipment of geomembrane at the manufacturing plant prior to shipment to the site. The minimum number of rolls to be sampled for each shipment will be determined by computing the cube root of the total number of rolls delivered in the shipment and rounding this value upward to the nearest integer with at least one sample per each manufacturer's lot. For instance, if 40 rolls of geomembrane are delivered in a shipment, at least four rolls will be sampled.

    The CQA ENGINEER or his representative will measure geomembrane thickness of each roll made for the project at the manufacturing plant prior to shipment. Material that does not fall within acceptable thickness criteria will be rejected.
4. The random samples must be representative of the material supplied and exclude the outer wrap of geomembrane if signs of scuffing or other damage is observed. Samples should be full roll width and at least 2 feet long.

5. The laboratory testing of the samples selected by the CQA representative shall be directed by the CQA ENGINEER and shall confirm conformance with the following properties:

    a. Thickness (ASTM D5994 for textured sheet)

    b. Density (ASTM D1505 or D792)

    c. Carbon Black Content (ASTM D4218)

    d. Tensile Properties (ASTM D6693 Type IV)

    e. Tear Resistance (ASTM D1004)

**D. DELIVERY AND STORAGE**

1. Upon delivery at the site, the CQA ENGINEER shall inventory all rolls and conduct a surface observation of each roll or factory panel for defects or damage. The inspection will be performed without unrolling rolls or unfolding factory panels unless defects or damages are found or suspected. The CQA ENGINEER will indicate those rolls with severe flaws that should be removed from the site and those rolls with minor flaws.
2. The CONTRACTOR will be responsible for the storage of the geomembrane on-site upon arriving at the site. The OWNER will provide storage space in a location (or several locations) such that on-site transportation and handling are minimized. Storage space should be protected from theft, vandalism, etc.
3. The CQA ENGINEER will verify that storage space selected is in a well-drained area and that cribbing techniques have been used as needed to ensure that the materials will not be sitting in ponded water in the event of rainfall.

**E. GEOMEMBRANE INSTALLATION**

1. An initial CQA meeting will be held prior to installation. The Geomembrane Installer, CQA ENGINEER or his representative, and a representative of the OWNER will be in attendance. The following issues will be discussed and agreed upon by all parties and shall be included in a report in the CQA documentation.

    a. Testing of welds

    b. Characteristics of "good" weld, and

    c. Repair procedures

2. The CQA ENGINEER or his representative will mark all areas where grinding is considered to be excessive. The location and repair method for the excessive grinding will be recorded in the daily field reports. The method or repair will be determined by the CQA ENGINEER.
3. Overheating of the geomembrane will be monitored by the CQA ENGINEER or his representative. At the discretion of the CQA ENGINEER, coupons will be cut from the end of the extrusion seams and the bottom side of the seam will be observed for visible warping or deformation. The location and repair method of overheated areas

will be recorded in the daily field reports. The method of repair will be determined in the field by the CQA ENGINEER.

4. During seaming, the CQA ENGINEER or his representative will observe the seams for the following:
    a. proper preparation,
    b. grinding technique, where applicable, and
    c. overheating
5. The CQA ENGINEER or his representative will observe the geomembrane during the coolest part of the day to check for trampolining. Any areas where excessive "trampolining" occurs will be marked by the Engineer for repair by the Geomembrane Installer.
6. The CQA ENGINEER or his representative will mark all areas where the geomembrane indicates a protrusion from the soil liner. The method of repair will be determined in the field by the CQA ENGINEER.

**F. TEST SEAMS**

1. The Geomembrane Installer will perform a test seam for each welding machine and crew in use. At a minimum, the test seams shall be made at the beginning of each seaming period; at changes of equipment, equipment settings, operator, weather, or sheet temperature; at the CQA ENGINEER's discretion, and at least once every four to six hours during continuous operation of each welding machine; or at change in material type (i.e., smooth-to-smooth seam versus smooth-to-textured seam). The test seam should be approximately five (5) feet long. The CQA ENGINEER will sample the test seam from the center three (3) feet of the test sample.
    a. The date, time, and equipment, as well as liner temperature, welding temperature, and seaming parameters will be recorded for each test seam.
    b. A minimum of three (3) specimens from each sample will be tested in peel and shear (ASTM D6392). Film Tear Bond type failures will be the criterion for qualification of the test seam. Testing will be performed in the field by the Geomembrane Installer under full-time observation by the CQA ENGINEER or his representative.

        Three (3) specimens from each sample shall be tested for Bonded Seam Strength (sheer) using ASTM D6392. The load at failure shall be in accordance with Table 2. Failures in grind areas of extrusion seams shall require resampling and retesting.

        At least three (3) specimens from each sample shall be tested for Peel Adhesion using ASTM D6392. The load at failure shall be in accordance with Table 2.
    c. Untested portions of the test seam will be retained by the CQA ENGINEER for the project record and future testing as required.

d. The test seam must pass the field testing before production seaming is performed by the RESPECTIVE SEAMING CREW.

**G. FIELD DESTRUCTIVE TESTING**

1. The Geomembrane Installer will obtain minimum 12" x 48" samples of field seams, suitable for testing, at an average frequency of one sample per 500 linear feet of weld. The date, time and equipment, seam number, and seaming parameters will be marked on each sample and recorded by the CQA ENGINEER. Each destructive sample is to be divided into three equal segments, one for field destructive testing, one for laboratory CQA Testing, and one archive.

2. Samples retained will be tested in the field by the Geomembrane Installer. A minimum of five (5) specimens from each sample will be tested in peel and shear (ASTM D6392) for the properties in Table 2.

   Five (5) specimens from each sample shall be tested for Bonded Seam Strength (shear) using ASTM D6392. The load at failure shall be at least 90 percent of the yield strength (in pounds per inch width) of the parent geomembrane. Failures in grind areas of extrusion seams may require resampling and retesting.

   At least five (5) specimens from each sample shall be tested for Peel Adhesion using ASTM D6392. The load at failure shall be in accordance with Table 2.

   The values of each set of five (5) specimens must meet the specifications to be considered a passing seam. A non-film tear bond failure is unacceptable even if the non-film tear bond specimen meets strength requirements. If unresolved discrepancies exist between the CQA ENGINEER's and CONTRACTOR's test results, the archived sample may be tested by the CQA ENGINEER. Samples which do not pass the shear and peel tests will be resampled from locations at least 10 feet on each side of the original location. These two (2) re-test samples must pass both shear and peel testing. If these two (2) samples do not pass, then additional samples will continue to be obtained until the questionable seam area is defined.

   The CQA ENGINEER or the OWNER may require additional random samples to be taken for testing in areas which visually appear defective and not in accordance with the project requirements.

   At the end of each double wedge welded field seam of 100' or more in length, a 1" wide coupon is to be cut from near the end of the seam. This coupon is to be tested in peel using a field tensiometer. The CQA ENGINEER will observe this test and FTB type failures will be the criteria for preliminary acceptance of the production seam. (Final seam acceptance is contingent on air and destructive testing).

**H. NON-DESTRUCTIVE TESTING**

1. The CQA ENGINEER shall confirm that the geomembrane installer has conducted non-destructible testing of the entire length of all field seams in accordance with Section 02750 of the specifications. The testing method shall be approved by the CQA ENGINEER in advance.

2. Non-destructive testing will be observed by the CQA ENGINEER or his representative on a full-time basis.

## I. DESTRUCTIVE LABORATORY TESTING

1. Destructive seam samples will be laboratory tested by the CQA ENGINEER. Testing frequency shall average one (1) sample per 500 linear feet of field seam.
    a. A minimum of five (5) peel specimens will be tested for each sample in accordance with ASTM D6392 for the properties listed in Table 2. At least five (5) specimens from each sample will be tested for bonded shear strength (shear) in accordance with ASTM D6392. These test samples shall be taken at the same locations as the CONTRACTOR's destructive testing samples.
    b. All laboratory specimens will be conditioned for a minimum of one (1) hour prior to testing at the Standard Atmosphere for Testing Geosynthetics, that is, air maintained at a relative humidity of 65 $\pm$5 percent and a temperature of 21 $\pm$2$^{o}$C (70 $\pm$4$^{o}$F).
2. The load and elongation at failure will be measured for each specimen. Film tear bond (FTB) is the qualifying criterion.
    a. The CQA ENGINEER will describe the type of failure for each specimen and record the presence of any disbonding, delamination, foreign material in the bond area, etc.
    b. The bonded shear strength (shear) should be in accordance with Table 2. If a shear specimen exhibits a failure within the grinding or preparation area adjacent to the seam that falls below 90 percent of the parent material strength, the CQA ENGINEER may require additional seam repair.
    c. The peel adhesion should be in accordance with Table 2. If a peel specimen fails in the grinding or preparation area, this should be clearly noted on the test report. Both sides of the double-wedge fusion seam must pass the testing requirements to constitute a passing test.
    d. All values of each set of five (5) specimens must meet the specifications to be considered a passing seam. A non-film tear bond failure is unacceptable even if the non-film tear bond specimen meets strength requirements. If unresolved discrepancies exist between the CQA ENGINEER's and CONTRACTOR's test results, the archived sample may be tested by the CQA ENGINEER. Samples which do not pass the shear and peel tests will be resampled from locations at least 10 feet on each side of the original location. These two (2) re-test samples must pass both shear and peel testing. If these two (2) samples do not pass, then additional samples will continue to be obtained until the questionable seam area is defined.
    e. Seams represented by a failing destructive field or laboratory test sample shall be cut out and replaced or covered with a cap strip and the seam bounded by supplemental passing field and laboratory destructive test samples.

**TABLE 2**
**SEAM STRENGTH AND RELATED PROPERTIES OF THERMALLY BONDED SMOOTH AND TEXTURED HIGH DENSITY POLYETHYLENE (HDPE) GEOMEMBRANE 60 MIL SHEET**

| Property | Units | Value |
|---|---|---|
| Hot Wedge Seams | | |
| shear strength (1) | lb/in | 120 |
| shear elongation at break (2) | % | 50 |
| peel strength (1) | lb/in | 91 |
| peel separation | % | 25 |
| Extrusion Fillet Seams | | |
| shear strength (1) | lb/in | 120 |
| shear elongation at break (2) | % | 50 |
| peel strength (1) | lb/in | 78 |
| peel separation | % | 25 |

(1) Value listed for shear and peel strengths are for all test specimens.
(2) Elongation measurements should be omitted for field testing
(3) Reference GRI GM 19a for Seam Strengths of HDPE Liner

## J. REPAIRS

Any portion of unsatisfactory geomembrane or seam area failing a destructive or non-destructive test shall be repaired. Damaged geomembrane shall be removed and replaced with acceptable geomembrane materials if damage cannot be satisfactorily repaired. Installer shall be responsible for repair of damaged or defective areas. Agreement upon the appropriate repair method shall be decided between the CQA ENGINEER and the Installer. Procedures available include the following:

- Patching - Used to repair large holes, tears, undispersed raw materials and contamination by foreign matter;
- Spot Welding - Used to repair pinholes, other localized flaws (minor) or where geomembrane thickness has been reduced;
- Capping - Used to repair large lengths of failed seams; and
- Replacement - Used to remove the unacceptable seam and replace with new material.

In addition, surfaces of the geomembrane which are to be repaired by extrusion welds shall be lightly abraded with disc grinder or equivalent to assure cleanliness. All geomembrane surfaces shall be clean and dry at the time of repair. Patches or caps shall be extended at least six inches for extrusion weld and four inches for wedge weld beyond the edge of the defect. All corners of patch material shall be rounded.

The CQA ENGINEER shall number and log each patch repair, and the Installer shall non-destructively test each repair using methods specified in this CQA Plan.

## K. FINAL INSPECTION

A final inspection shall be completed by the Installer, DESIGN ENGINEER, CQA ENGINEER and OWNER prior to the Installer demobilizing from the site. All identified problem areas shall be repaired by the Installer and accepted by the CQA ENGINEER prior to the Installer demobilizing from the site.

# 5. LEACHATE COLLECTION SYSTEM

## A. GENERAL

The CQA ENGINEER shall certify the materials and installation and in accordance with the plans, specifications, and this CQA Plan.

## B. MATERIALS

1. Leachate collection pipe shall be high density polyethylene pipe in accordance with the specifications.
2. Stone for encasing leachate pipe and for the leachate sump shall be clean washed gravel composed of a hard mineral such as quartz. Stone size shall be ASTM No. 57 and No. 78 as shown on the Design and Operation Plans.
3. Cushion Geotextile shall be a non-woven geotextile of polypropylene fibers or polyester yarns which is intended to be and shall be suitable for separation and cushioning. Geotextile shall be minimum 24 ounce per square yard cushioning fabric within Tracts 1 and 2 and 30 ounce per square yard cushioning fabric with Tract 3 under leachate collection pipes. A temporary, 4-ounce per square yard geotextile shall be placed on top of the Leachate Collection Stone, as show on the plans, for separation.
4. The CQA ENGINEER or his representative shall verify that all materials provided are those specified or are equal and are in accordance with the approved plans, specifications and this CQA Plan.

## C. INSTALLATION

1. The CQA ENGINEER will allow installation of the leachate collection system to proceed after he has provided complete certification of the installed HDPE geomembrane.
2. The CQA ENGINEER shall verify there is no damage to the geomembrane during the installation of the leachate collection system. Should damage occur the CQA ENGINEER shall direct the CONTRACTOR to make the required repairs.
3. The CQA ENGINEER or his representative shall be present during all phases of the leachate collection system construction and shall verify that all work is in accordance with the approved plans, specifications and this CQA Plan.

## D. QUALITY ASSURANCE

In order to assure conformance with the plans, specifications and the CQA Plan, the CQA ENGINEER shall:

1. High Density Polyethylene Pipe
   a. Receive CONTRACTOR's submittals on materials
   b. Review submittals on pipe for:

1. compliance with applicable ASTM standard
2. unit weight
3. diameter and SDR
4. physical dimensions
5. method of jointing with instructions
6. nominal pipe joint lengths
7. recommended bedding and installation details
8. instructions and tables or information on strength of each pipe type versus bury
9. conditions of depth and traffic loadings
10. Certification by manufacturer that material properties meet the values listed in the material properties sheet.
11. perforation diameter and spacing

c. Secure certification that pipe supplied is represented by the quality assurance data.

d. Reject pipe which does not meet appropriate ASTM Standards.

e. Review results of any samples taken for testing.

f. Witness and verify that jointing and installation is in accordance with manufacturer's recommendations and the specifications.

g. Shall verify leachate conduits external to the collection system are tested and demonstrated to be leakproof.

2. Stone

a. Receive CONTRACTOR's submittals on stone.

b. Review submittals for conformity to specifications including quarry's certification of gradation.

c. Reject material which does not meet specifications.

d. Review results of any samples collected for testing.

e. Verify that stone encasement is in accordance with the approved plans, specifications and this CQA Plan.

3. Geotextile

a. Receive CONTRACTOR's submittals on geotextile and review for conformity to specifications.

b. Reject material which does not meet specifications.

c. Verify that geotextile is in accordance with the approved plans, specifications and this CQA Plan.

d. Review results of any samples collected by the Engineer for testing.

# 6. TESTING PIPING SYSTEMS

## A. GENERAL

1. The CQA ENGINEER shall observe and document the leak testing of leachate manholes, force mains, and non-perforated gravity piping.
2. If the specified rate of leakage is exceeded on test, the Contractor shall locate the points of excessive leakage and institute appropriate measure of correction, whereupon there shall be a re-test and this procedure continued until test requirements are met.
3. Hydrostatic testing shall be performed on force mains and pressure leachate piping. Exfiltration testing shall be performed on manholes and gravity leachate piping.

## B. EXFILTRATION TESTING

1. The CQA ENGINEER shall require exfiltration tests on all manholes and gravity leachate piping.
2. Procedure for Exfiltration Testing
   a. Plug each end of section or all openings to manhole to be tested with watertight bulkheads.
   b. Insert in each bulkhead at the top of the pipeline a two (2") inch pipe with 90° elbow, that will extend four (4') feet vertically above the top of the pipeline or above the groundwater line, whichever is higher. Manhole shall be tested at full depth with the water level at the cover ring.
   c. The elevations of the top of the two (2") inch pipe at each bulkhead shall be the same.
   d. Fill the pipeline with clear water until the water level is at the top of the two (2") inch pipe at the upper end of section or at the manhole ring.
   e. Maintain the water level by adding accurately measured amounts of water for a period of thirty minutes, not allowing the lower pipe to overflow.
   f. The maximum length of a section of pipeline to be tested by means of an exfiltration test at one time shall be limited to 1,000 linear feet.
   g. The maximum permissible leakage determined by exfiltration shall be the rate of 25 gallons per interval. inside diameter of pipe, per 1,000 feet of pipe, per 24 hours, inclusive of all appurtenances within the section such as manholes, valves, etc. The length of pipe used in the computation shall be the horizontal distance between manhole centerlines of the section being tested. The maximum permissible leakage rate for manholes tested alone shall be 0.01 gallons per vertical foot per day.
   h. Once exfiltration is found to be within allowable limits, remove all bulkheads.

## C. Hydrostatic Testing

1. The following piping systems shall be Hydrostatically tested:
   a. All pressure leachate piping and force main.
   b. Do not test piping system with water where water testing will be harmful to the system operation, such as for air and gas piping systems.
2. After the pipe has been laid and backfilled between joints, and before any joints are covered, unless this requirement is waived by the CQA Engineer, all newly laid pipe, above-ground or below-ground, or any valved section thereof, shall be subjected to a hydrostatic gauge pressure as hereinafter tabulated.
   a. All piping that will be considered inaccessible or impossible to repair after the completion of all work shall be hydrostatically tested while still accessible.
   b. Examples of such piping are those near or under basins, paved roads, concrete structures, and concrete foundation.
   c. Note: All piping shall have reaction blocking (thrust blocks) in place before testing.
3. Tests shall be under the direction of the CQA ENGINEER. The CONTRACTOR shall furnish a pressure gauge for measuring the pressure on the pipeline, shall provide a corporation cock to attach gauge or pump connection, shall provide plugs to seal taps after use in testing, and shall also furnish a suitable pump, pipe, appliances, and other appurtenances necessary to make these tests.
4. Each section of pipe shall be filled slowly with water and the specified test pressure, measured at the point of the lowest elevation, shall be applied to the pipe in a satisfactory manner. The CONTRACTOR will furnish all test water.
5. Before applying the specified test pressure, all air shall be expelled from the pipe. To accomplish this, taps shall be made, as directed by the CQA ENGINEER, if necessary, at points of highest elevation, and afterward tightly plugged.
6. The test pressure shall be maintained for a sufficient length of time prior to the test to allow for thorough examination of joints and elimination of leakage where necessary. The pipe line shall be made watertight under the test pressure.
7. All exposed pipes, fittings, valves, hydrants, and joints will be carefully examined during the open trench test. Any cracked or defective pipes, fittings, valves, or hydrants discovered in consequence of this pressure test shall be removed and replaced by the CONTRACTOR with sound material and the test shall be repeated until satisfactory to the CQA ENGINEER.
8. Hydrostatic test pressures shall be as follows:

| System | Pressure Test Rating (psi) |
|---|---|
| Miscellaneous pressure pipe | 50 |
| Pressure leachate piping (force main) | 100 |
| Secondary Containment Piping | (max. elevation pressure head for the section of tested pipe, plus 5 psi) |

a. The test section shall be pressurized to the required test pressure.

b. The test shall be conducted for a minimum of one (1) hour.

c. The test section shall not be accepted if it has any observed leakage on the test pressure drops more than one (1) psi during the leakage test.

d. During testing of the secondary containment piping, the primary piping should be brought up to and held at the system test pressure to prevent damage to the primary piping.

# 7. PROTECTIVE COVER SOIL - ON LINER - SANDY SOIL

## A. GENERAL

The CQA ENGINEER shall certify the materials and installation are in accordance with the plans, specifications, and this CQA Plan.

## B. MATERIAL

1. Material for the protective sand shall be a natural or manufactured sand, shall be capable of 98% passage through a 2" screen and shall have no more than 5% by weight passing the No. 200 sieve. The protective cover material shall contain no aggregate rocks, debris, plant material, material with sharp edges, lignite, coal, ash, or carbonaceous material. By-products of industrial processes, with the exception of quarry grinding operations, shall not be accepted. The sand (protective cover) material shall have a permeability of k ≥ 1x10-2 cm/sec. Manufactured sand is allowable.
2. Construction Quality Assurance shall confirm the minimum requirements for the protective cover as follows:

| Test | Minimum Frequency | Criteria |
|---|---|---|
| Grain Size to No. 200 Sieve (ASTM D422) | 2,000 $yd^3$ | ≤ ½”<br>5% ≤ #200 sieve |
| Permeability (ASTM D2434) | 1 per acre | k ≥ 1 x $10^{-2}$ cm/sec |

3. The material shall have an interface friction meeting the minimum requirements listed in Section 11 – Interface Friction - Base Liner System. This test shall be conducted at a frequency of two (2) per cell.

## C. STOCKPILING AND MATERIAL APPROVAL

1. All material to be used as protective cover soil shall be approved in advance by the CQA ENGINEER. The CQA ENGINEER must verify the soil meets all the material requirements.
2. Verification can be accomplished during excavation and stockpiling or prior to use at existing stockpiles.
3. The CQA ENGINEER shall prepare reports of all testing, analysis, and verification.

## D. CONSTRUCTION

1. The CQA ENGINEER shall provide verification of the following:

a. Approved material was used to construct the cover.

b. The protective cover was constructed in accordance with the approved plans, specifications, and this CQA Plan.

c. The geomembrane was not damaged during the construction of the cover.

d. The required cover thickness (12” minimum) was achieved.

e. A non-woven cushion geotextile was placed on top of the geomembrane liner and not damaged during the placement of the 12” protective cover soil.

# 8. GEOMEMBRANE FML CAP

## A. GENERAL

Stringent quality assurance and careful documentation are required in the production and installation of all geosynthetic materials. The work addressed under this section shall facilitate proper construction of all geosynthetic components of the cap for the landfill. All work shall be constructed to the lines, grades, and dimensions indicated on the project plans, in accordance with the Construction Specifications, or as required by the OWNER or DESIGN ENGINEER.

The CQA ENGINEER shall issue a written daily report of activities to the DESIGN ENGINEER. These reports shall include, at a minimum, observations and test results as well as problems encountered and solutions achieved. Construction reports summarizing significant events, as well as addressing all problems encountered and their solutions, shall be issued to the DESIGN ENGINEER. The format of these reports and frequency shall be established at the pre-construction meeting.

The CQA ENGINEER shall certify the materials and installation are in accordance with the plans, specifications, and this CQA Plan.

## B. MATERIAL

1. The geomembrane will be 40 mil Linear Low Density Polyethylene (LLDPE) supplied and installed by firms approved by the OWNER. The required physical properties will be as specified in the Construction Bid Documents.
2. Seams for providing watertight joints will be extrusion or double hot wedge fusion seams using techniques approved by the CQA ENGINEER.
3. Construction Quality Assurance shall confirm the material meets the minimum physical properties and test frequencies of the Geosynthetic Research Institute GRI Test Method GM-17, as latest revised, for 40 mil Linear Low Density Polyethylene (LLDPE) Geomembrane.

**TABLE 3**
**REQUIRED PHYSICAL PROPERTIES**
**OF**
**GEOMEMBRANE LINER (LLDPE) SHEET**

| Property | Test Method | Required Values 60 MIL | CQC Frequency |
|---|---|---|---|
| Thickness, Mil. (min.)[1] | ASTM D5994 (Textured) | 40 (lowest individual measurement) | Per Roll |
| Sheet Density, g/cm$^3$ (min. ave.) | ASTM D792 or ASTM D1505 | 0.939 | 200,000 lbs[2] |

| | | | |
|---|---|---|---|
| Tensile Properties (min. ave.) (Each Direction) | ASTM D6693, Type IV | | 20,000 lbs[3] |
| Strength at Break (1 lb/in) | | 60 | |
| Elongation at Break (%) | | 250 | |
| Tear Resistance, 1 lbs. (min. ave.) | ASTM D1004 | 22 | 45,000 lbs[3] |
| Puncture Resistance, 1 lbs. (min) | ASTM D4833 | 44 | 45,000 lbs[3] |
| Axi-Symmetric Break Resistance Strain (min, %) | ASTM D5617 | 30 | Per formulation |
| Carbon Black Content, (Allowable Range in %) | ASTM D4218 | 2.0 - 3.0 | 45,000 lbs[3] |
| Carbon Black Dispersion, (Acceptable Levels) | ASTM D5596 | GRI GM 17 | 45,000 lbs[3] |
| Asperity (textured only) (MARV) | ASTM D 7466 | 16 | every 2nd roll |

1 Thickness - value represents lowest individual value
2 pounds in resin
3 pounds of geomembrane

4. The CQA ENGINEER or his representative will sample rolls from each shipment of geomembrane at the manufacturing plant prior to shipment to the site. The minimum number of rolls to be sampled for each shipment will be determined by computing the cube root of the total number of rolls delivered in the shipment and rounding this value upward to the nearest integer with at least one sample per each manufacturer's lot. For instance, if 40 rolls of geomembrane are delivered in a shipment, at least four rolls will be sampled.
5. The CQA ENGINEER or his representative will measure geomembrane thickness of each roll made for the project at the manufacturing plant prior to shipment. Material that does not fall within acceptable thickness criteria will be rejected.
6. The random samples must be representative of the material supplied and exclude the outer wrap of geomembrane if signs of scuffing or other damage are observed. Samples should be full roll width and at least 2 feet long.
7. The laboratory testing of the samples selected by the CQA representative shall be directed by the CQA ENGINEER and shall confirm conformance with the following properties:

   a. Thickness (ASTM D5994 for textured sheet)
   b. Density (ASTM D1505 or D792)
   c. Carbon Black Content (ASTM D1603 or D4218)
   d. Tensile Properties (ASTM D6693 or GRI GM-17)
   e. Tear Resistance (ASTM D1004)

f. Asperity Height (ASTM D7466)

**C. GEOMEMBRANE MANUFACTURER AND INSTALLER**

1. The Geomembrane Installer will submit the following as obtained from the Geomembrane Manufacturer to the CQA ENGINEER:
   a. Production Certification including project references
   b. Testing Program of Compound Ingredients
   c. Material Certification
   d. Test Data for Material and Resin
   e. All of the above submittals will be reviewed and retained by the CQA ENGINEER
2. The Geomembrane Installer will submit the following to the CQA ENGINEER prior to the installation:
   a. Qualifications of Geomembrane Installer Superintendent and Foreman
   b. Resumes of Geomembrane CONTRACTOR field crew
   c. Six (6) sets of geomembrane panel layout drawings

**D. DELIVERY AND STORAGE**

1. Upon delivery at the site, the CQA ENGINEER shall inventory all rolls and conduct a surface observation of each roll or factory panel for defects or damage. The inspection will be performed without unrolling rolls or unfolding factory panels unless defects or damages are found or suspected. The CQA ENGINEER will indicate those rolls with severe flaws that should be removed from the site and those rolls with minor flaws.
2. The CONTRACTOR will be responsible for the storage of the geomembrane on-site upon arriving at the site. The OWNER will provide storage space in a location (or several locations) such that on-site transportation and handling are minimized. Storage space should be protected from theft, vandalism, passage of vehicles, etc.
3. The CQA ENGINEER will verify that storage space selected is in a well-drained area and that cribbing techniques have been used as needed to ensure that the materials will not be sitting in ponded water in the event of rainfall.

**E. GEOMEMBRANE INSTALLATION**

1. An initial CQA meeting (pre-deployment meeting) will be held prior to installation. The Geomembrane Installer, CQA ENGINEER or his representative, and a representative of the OWNER will be in attendance. The following issues will be discussed and agreed upon by all parties and shall be included in a report in the CQA documentation.
   a. Testing of welds
   b. Characteristics of "good" weld, and

c. Repair procedures

2. The CQA ENGINEER or his representative will mark all areas where grinding is considered to be excessive. The location and repair method for the excessive grinding will be recorded in the daily field reports. The method or repair will be determined by the CQA ENGINEER.

3. Overheating of the geomembrane will be monitored by the CQA ENGINEER or his representative. At the discretion of the CQA ENGINEER, coupons will be cut from the end of the extrusion seams and the bottom side of the seam will be observed for visible warping or deformation. The location and repair method of overheated areas will be recorded in the daily field reports. The method of repair will be determined in the field by the CQA ENGINEER.

4. During seaming, the CQA ENGINEER or his representative will observe the seams for the following:

   a. proper preparation

   b. grinding technique, where applicable, and

   c. overheating

5. The CQA ENGINEER or his representative will observe the geomembrane during the coolest part of the day to check for trampolining. Any areas where excessive "trampolining" occurs will be marked by the CQA ENGINEER for repair by the Geomembrane Installer.

6. The CQA ENGINEER or his representative will mark all areas where the geomembrane indicates a protrusion from the compacted soil cap. The method of repair will be determined in the field by the CQA ENGINEER.

**F. TEST SEAMS**

1. Test seams shall be made each day prior to commencing field seaming. The seams shall be made on fragment pieces of geomembrane under the same surface and environmental conditions as the production seams to verify that seaming conditions are adequate. The test seams shall be made at the beginning of each seaming period; at changes of equipment, equipment settings, operator, weather, or sheet temperature; at the CQA ENGINEER's discretion, and at least once every four to six hours during continuous operation of each welding machine; or at change in material type (i.e., smooth-to-smooth seam versus smooth-to-textured seam).

2. The test seam sample shall be at least five feet long by one foot wide with the seam centered lengthwise. For dual track fusion welds nine, one-inch wide by six-inch long test strips shall be cut from the test seam. Quantitatively test three specimens for inside peel adhesion (peel), three for outside peel, and then three specimens for bonded seam strength (shear). For extrusion welds six, one-inch wide by six-inch long test strips shall be cut from the trial seam. Quantitatively test three specimens for peel and three specimens for bonded seam strength (shear).

3. A test seam sample shall pass when the results of the tests in both peel and shear achieve the strengths provided in the seam strength table in Section I and when the break can be described as a film tear bond. A film tear bond is defined as a failure in the ductile mode of one of the bonded sheets by tearing prior to complete separation to the bonded area.

   - Peel strength (fusion) – ASTM D6392
   - Peel strength (extrusion) – ASTM D6392
   - Shear strength (fusion & extrusion) – ASTM D6392

4. Test seams shall be repeated, in its entirety, when any of the test seam samples fail in either peel or shear. If additional test seams fail, the seaming apparatus or seamer shall not be accepted and shall not be used for seaming until the deficiencies are corrected and two consecutive successful full test seams are achieved. No welding equipment or welder shall be allowed to begin production welds until the equipment and welder has successfully completed a test seam. Seaming shall not proceed when ambient air temperature or adverse weather conditions jeopardize the integrity of the cap installation. Installer shall demonstrate that acceptable seaming can be achieved by completing passing trial seams.

5. The remainder of the successful test seam shall be assigned a number and marked accordingly by the CQA ENGINEER, who shall also log the date, hour, ambient temperature, number of seaming apparatus, name of seamer (welder), and pass or fail description. The sample itself should be archived until project completion.

**G. FIELD DESTRUCTIVE TESTING**

1. The Geomembrane Installer will obtain 12" x 60" samples of field seams, suitable for testing, at an average frequency of one sample per 500 linear feet of weld. The date, time and equipment, seam number, and seaming parameters will be marked on each sample and recorded by the CQA ENGINEER.

2. Samples retained will be tested in the field by the Geomembrane Installer. A minimum of five specimens from each sample will be tested in peel and shear (ASTM D6392).

   Five specimens from each sample shall be tested for Bonded Seam Strength (shear) using ASTM D6392. Failures in grind areas of extrusion seams may require resampling and retesting.

   At least five specimens from each sample shall be tested for Peel Adhesion using ASTM D6392.

   The criteria for determining passing welded seam shall be as stated in the “Seam Strength” table in this section. If unresolved discrepancies exist between the CQA ENGINEER’s and CONTRACTOR’s test results, the archived sample may be tested by the CQA ENGINEER. Samples which do not pass the shear and peel tests will be resampled from locations at least 10 feet on each side of the original location. These two re-test samples must pass both shear and peel testing. If these two samples do not pass, then additional samples will continue to be obtained until the questionable seam area is defined.

3. The CQA ENGINEER or the OWNER may require additional random samples to be taken for testing in areas which visually appear defective and not in accordance with the project requirements.

   At the end of each double wedge welded field seam of 100' or more in length, a 1" wide coupon is to be cut from near the end of the seam. This coupon is to be tested in peel using a field tensiometer. The CQA ENGINEER will observe this test and FTB type failures will be the criteria for preliminary acceptance of the production seam. (Final seam acceptance is contingent on air and destructive testing).

## H. NON-DESTRUCTIVE TESTING

1. The CQA ENGINEER shall confirm that the geomembrane installer has conducted non-destructive testing of the entire length of all field seams in accordance with Section 02750 of the Technical Specifications. The testing method shall be approved by the CQA ENGINEER in advance.
2. Non-destructive testing will be observed by the CQA ENGINEER or his representative on a full-time basis.

## I. DESTRUCTIVE LABORATORY TESTING

1. Destructive seam samples will be laboratory tested by the CQA ENGINEER. Testing frequency shall average one sample per 500 linear feet of field seam.
   a. Test samples will be at least 12" x 60". A minimum of five peel specimens will be tested for each sample in accordance with ASTM D6392 for the properties listed in the Seam Strength table in this section. At least five specimens from each sample will be tested for bonded shear strength (shear) in accordance with ASTM D6392. These test samples shall be taken at the same locations as the CONTRACTOR's destructive testing samples.
   b. All laboratory specimens will be conditioned for a minimum of one hour prior to testing at the Standard Atmosphere for Testing Geosynthetics, that is, air maintained at a relative humidity of 65 ±5% and a temperature of 21 ±2°C (70 ±4°F).
2. The load and elongation at failure will be measured for each specimen. FTB is the qualifying criterion.
   a. The CQA ENGINEER will describe the type of failure for each specimen and record the presence of any disbonding, delamination, foreign material in the bond area, etc.
   b. The criteria for determining passing welded seams shall be as stated in the “Seam Strength” table in this section.
   c. If a peel specimen fails in the grinding or preparation area, this should be clearly noted on the test report. Both sides of the double-wedge fusion seam must pass the testing requirements to constitute a passing test.
   d. If unresolved discrepancies exist between the CQA ENGINEER’s and CONTRACTOR’s test results, the archived sample may be tested by the CQA ENGINEER. Samples which do not pass the shear and peel tests will be

resampled from locations at least 10 feet on each side of the original location. These two re-test samples must pass both shear and peel testing. If these two samples do not pass, then additional samples will continue to be obtained until the questionable seam area is defined.

SEAM STRENGTH AND RELATED PROPERTIES OF THERMALLY BONDED SMOOTH AND TEXTURED LINEAR LOW DENSITY POLYETHYLENE (LLDPE) GEOMEMBRANE 40 MIL SHEET

| Property | Units | Value |
|---|---|---|
| Hot Wedge Seams (1) | | |
| shear strength (2) | lb/in | 60 |
| shear elongation at break (3) | % | 50 |
| peel strength (2) | lb/in | 50 |
| peel separation | % | 25 |
| Extrusion Fillet Seams | | |
| shear strength (2) | lb/in | 60 |
| shear elongation at break (3) | % | 50 |
| peel strength (2) | lb/in | 44 |
| peel separation | % | 25 |

(1) Value listed for shear and peel strengths are for 5 out of 5 test specimens. All 5 must meet minimum specified value
(2) Elongation measurements should be omitted for field testing
(3) All failures must demonstrate film tear bond (FTB) for all 5 tests to be considered acceptable.

## J. REPAIRS

Any portion of unsatisfactory geomembrane or seam area failing a destructive or non-destructive test shall be repaired. Damaged geomembrane shall be removed and replaced with acceptable geomembrane materials if damage cannot be satisfactorily repaired. Installer shall be responsible for repair of damaged or defective areas. Agreement upon the appropriate repair method shall be decided between the CQA ENGINEER and the Installer. Procedures available include the following:

- Patching - Used to repair large holes, tears, undispersed raw materials and contamination by foreign matter;
- Spot Welding - Used to repair pinholes, other localized flaws (minor) or where geomembrane thickness has been reduced;
- Capping - Used to repair large lengths of failed seams; and

- Replacement - Used to remove the unacceptable seam and replace with new material.

  In addition, surfaces of the geomembrane which are to be repaired by extrusion welds shall be lightly abraded with disc grinder or equivalent to assure cleanliness. All geomembrane surfaces shall be clean and dry at the time of repair. Patches or caps shall be extended at least six inches for extrusion weld and four inches for wedge weld beyond the edge of the defect. All corners of patch material shall be rounded.

  The CQA ENGINEER shall number and log each patch repair, and the Installer shall non-destructively test each repair using methods specified in this CQA Plan.

## K. FINAL INSPECTION

A final inspection shall be completed by the Installer, DESIGN ENGINEER, CQA ENGINEER and OWNER prior to the Installer demobilizing from the site. All identified problem areas shall be repaired by the Installer and accepted by the CQA ENGINEER prior to the Installer demobilizing from the site.

# 9. GEOCOMPOSITE DRAINAGE MEDIA (GDM)

## A. GENERAL

The CQA ENGINEER shall certify the materials and installation are in accordance with the plans, specifications, and this CQA Plan.

## B. MATERIAL

1. The geocomposite shall be a composite consisting of a HDPE geonet sandwiched between two (2) layers of 8 ounce geotextile fabric. The composite shall meet the physical properties detailed in the table of required geocomposite drainage media properties in this section and be approved by the CQA ENGINEER.
2. During shipment and storage, the geocomposite shall be protected from ultraviolet light exposure, precipitation, contamination or other damaging conditions. Geocomposite rolls shall be shipped and stored in relatively opaque and watertight wrappings. The CQA ENGINEER shall verify that rolls of geocomposite have been shipped and are stored in accordance with the specifications.
3. All handling on-site is the responsibility of the Installer. The CONTRACTOR or Manufacturer is responsible for submittal of shipping manifests and all other relevant documents to the CQA ENGINEER.
4. The CQA ENGINEER or his representative shall take random samples from each shipment of geocomposite delivered to the site. The minimum number of rolls to be sampled for each shipment will be determined by computing the cube root of the total number of rolls delivered in the shipment and rounding this value up to the nearest integer with at least one sample per each manufacturer's lot. The 3' x 3' samples shall be retained as part of the project records. The ENGINEER shall at the OWNER's expense, take a minimum of two samples and have them tested for the properties listed below; should visual inspection by the CQA ENGINEER reveal any apparent deficiencies in the material additional testing may be performed.

**REQUIRED GEOCOMPOSITE DRAINAGE MEDIA PROPERTIES AND MANUFACTURER'S QUALITY CONTROL TEST DATA**

| Property | Test Method | Units | Value | Test Frequency |
|---|---|---|---|---|
| Thickness (geonet only) | ASTM D5199 | mil | 250 | Every roll |
| Resin Density (geonet only) | ASTM D 1505 | $g/cm^3$ | 0.94 | 50,000 $ft^2$ |
| Ply Adhesion | ASTM D 7005 or GRI GC7 | lb/inch | 1.0 Min. Avg. | 50,000 $ft^2$ |

| | | | | |
|---|---|---|---|---|
| Transmissivity [1] | ASTM D4716 | $m^3/m^2/s$ | $4.7 \times 10^{-4}$ Min. | 100,000 $ft^2$ |
| Mass Per Unit Area (unit weight) Geotextile Only | ASTM D5261 | $oz/yd^2$ | 8[2] | 100,000 $ft^2$ |
| Interface Friction | ASTM D5321 | degrees | See Section on Cap Liner Interface Friction | 2 per cap project |

Notes: [1] Conduct test for transmissivity at a normal compressive load of 500 psf and at a hydraulic gradient of 0.3 after a seating period of at least 24 hours. Boundary conditions are the site protective soil cover interface on the upper filter Geotextile and textured geomembrane against the lower filter Geotextile. Site boundary conditions should be used in the MQC testing for transmissivity.
[2] Nominal value.

**C. GEONET MANUFACTURER AND INSTALLER**

1. The CONTRACTOR shall submit the following as obtained from the Geonet Manufacturer to the CQA ENGINEER to review:
   a. Production Certification
   b. Material Certification
   c. Test Data for Material
2. The CONTRACTOR shall submit the following to the CQA ENGINEER prior to installation:
   a. Qualifications of installer superintendent, foreman and field crew.
   b. Six sets of field installation drawings.

**D. INSTALLATION**

1. The CQA ENGINEER will allow installation of the GDM to proceed after he has provided certification of the geomembrane cap or a section thereof.
2. The CQA ENGINEER shall monitor the installation of the GDM to verify there is no damage to the geomembrane cap. Should the cap be damaged the CQA ENGINEER shall direct the CONTRACTOR to make the necessary repairs.
3. The CQA ENGINEER or his representative shall be present during all placement operations and shall verify that all work is in accordance with the plans and technical specifications.
4. At the conclusion of this activity, the CQA ENGINEER shall provide a written certification that the work has been installed according to plans and technical specifications.

# 10. PROTECTIVE SOIL COVER ON LANDFILL CAP

## A. GENERAL

The CQA ENGINEER shall certify the materials and installation are in accordance with the plans, specifications and this CQA Plan.

## B. MATERIAL

1. Soil that meets all of the following requirements shall be classified as select soil fill for use in construction of the protective soil cover.
    a. Soil shall be classified according to the Unified Soil Classification System (USCS) as ML, MH, CH, SC, or CL (ASTM D2487). Liquid limit, plasticity index (PI), and percent passing the No. 200 sieve will be considered for proper classification.
    b. Select soil fill materials shall be reasonably free of gypsum, ferrous, and/or calcareous concretions and nodules, refuse, roots, or other deleterious substances.
    c. The lower 18” of protective soil cover on landfill cap shall be uniform, smooth, and free of debris, rock, plant materials, and other foreign material larger than 3" in diameter. The material should contain no sharp edges.
2. The top 6" of protective soil cover on landfill cap must be capable of supporting growth of vegetative cover. The top 6" may consist of the soils listed in VI.B.1.a, expanded to include SM.

## C. STOCKPILING AND MATERIAL APPROVAL

1. All material to be used as protective soil cover on landfill cap shall be approved in advance by the CQA ENGINEER. The CQA ENGINEER must verify the soil meets all the material requirements.
2. Verification can be accomplished during excavation and stockpiling or prior to use at existing stockpiles.
3. The CQA ENGINEER shall prepare reports of all testing, analysis and verification.

## D. CONSTRUCTION

1. The CQA ENGINEER shall provide verification of the following:
    a. Approved stockpiled material was used to construct the protective cover on landfill cap.
    b. The protective soil cover on landfill cap was constructed in accordance with the approved plans, specifications, and this CQA Plan.
    c. The geomembrane and GDM were not damaged during the construction of the protective soil cover.

d. After the protective soil cover on landfill cap thickness of 24" has been achieved, the layer thickness shall be measured by the test excavation or hard auger boring.

e. Landfill sideslope berms shall be compacted to a density of 95% or more of the Standard Proctor (ASTM D-698) maximum dry density. In-place testing shall be performed by the CQA ENGINEER to confirm the required compaction is achieved.

f. At least one (1) sample for every 40,000 in-place square feet will be taken and tested in accordance with ASTM D6913 (Grain Size) by the CQA ENGINEER.

g. Tested samples will meet or exceed the requirements outlined in the specifications.

h. If tests indicate that the in-place material does not meet the required specifications, the material will be removed, replaced, and retested.

i. The final lift of the protective soil cover on landfill cap grades will be measured to plus or minus two-tenths of a foot measured across any 10-foot section.

j. Placement of soils on the slope must begin at the base of the slope and be pushed upward or cross slope. Placement of soils from the top of the slope down, will not be allowed due to potential damage to the underlying geosynthetics.

# 11. INTERFACE FRICTION - BASE LINER SYSTEM

## A. GENERAL

This section is based on recommendations from the design geotechnical report titled Report of Geotechnical Evaluation – Major Modification Support prepared by Bunnell-Lammons Engineering and dated January 30, 2025

Prior to construction of each landfill waste cell, interface testing shall be performed for the geosynthetic/soil or geosynthetic/geosynthetic interfaces within the liner system. Representative samples of the materials to be supplied for construction shall be used in the tests. Each interface between adjacent soil or geosynthetic components should be tested in accordance with ASTM D5321 (soil/geosynthetic or geosynthetic/geosynthetic) or ASTM D6243 (GCL interface friction or GCL internal shear).

The minimum average interface shear and internal shear strength values required to achieve the slope stability factors of safety provided in the Report are provided in the Table below. For each landfill waste cell construction project, a minimum of two (2) tests should be performed for each interface, including the soil liner to the lowermost geosynthetic component and internal GCL strength (if being used), and should cover the normal loads listed in the Table below. Test results shall be reviewed by a geotechnical engineer specializing in solid waste landfills and experienced in interface friction testing. The average of the two (2) test results shall exceed the recommended minimum values presented, with none of the test results being less than 80% of the listed value.

| Base Liner Interface Friction Testing Requirements | | |
|---|---|---|
| **Normal Load (psf)** | **Peak Shear Strength, Secant Friction Angle** | **Large-Displacement Shear Strength Secant Friction Angle** |
| 1,000 | 510 (27°) | 250 (14.0°) |
| 8,000 | 2069 (14.5°) | 1125 (8.0°) |
| 15,000 | 3188 (12.0°) | 1842 (7.0°) |
| 20,000 | 4069 (11.5°) | 2279 (6.5°) |

Notes:

1. Compacted soil liner material is to be compacted to 95% maximum dry density ( as determined by ASTM D 698) at least 2% to 4% wet of optimum moisture content, or higher based on the results of construction test fill pad
2. Protective cover soil is to be “tamped in place” for testing.
3. Interface test shearing rates should be determined based on the interface components for each test.
4. The large displacement interface shear strength corresponding to the minimum peak strength interface should meet the recommended large displacement shear strength values presented.

If the minimum listed strengths are not achieved, the slope stability analysis can be reviewed and updated to conform with the constructed conditions of the landfill cell on a case-by-case

basis. This should be performed by a geotechnical engineer specializing in solid waste landfills and experienced in interface friction testing.

# 12. INTERFACE FRICTION - CAP LINER SYSTEM

## A. GENERAL

This section is based on recommendations from the design geotechnical report titled Report of Geotechnical Evaluation – Major Modification Support prepared by Bunnell-Lammons Engineering and dated January 30, 2025

Prior to each cap construction event, interface testing shall be performed for the geosynthetic/soil and geosynthetic/geosynthetic interfaces within the liner system. Representative samples of the materials to be supplied for construction shall be used in the tests. Each interface between adjacent soil or geosynthetic components should be tested in accordance with ASTM D5321 (soil/geosynthetic or geosynthetic/geosynthetic).

The minimum average interface shear and internal shear strength values required to achieve the slope stability factors of safety provided in the Report are provided in the Table below. For each cap construction project, a minimum of two (2) tests should be performed for each interface, including the soil liner to the lowermost geosynthetic component and should cover the normal loads listed in the Table below. Test results shall be reviewed by a geotechnical engineer specializing in solid waste landfills and experienced in interface friction testing. The average of the two (2) test results shall exceed the recommended minimum values presented in the table, with none of the test results being less than 80% of the listed value.

| Cap Liner Interface Friction Testing Requirements | |
|---|---|
| **Normal Load (psf)** | **Peak Shear Strength, Secant Friction Angle** |
| 1,000 | 510 (27°) |
| 8,000 | 2069 (14.5°) |
| 15,000 | 3188 (12.0°) |
| 20,000 | 4069 (11.5°) |

Notes:

1. Interface test shearing rates should be determined based on the interface components for each test.
2. The large displacement interface shear strength corresponding to the minimum peak strength interface should meet the recommended large displacement shear strength values presented.

If the minimum listed strengths are not achieved, the slope stability analysis can be reviewed and updated to conform with the constructed conditions of the cap on a case-by-case basis. This should be performed by a geotechnical engineer specializing in solid waste landfills and experienced in interface friction testing.

# 13. CERTIFICATION

A. The CQA ENGINEER will provide certification that the liner and cap systems and the leachate collection system, and other associated ancillary facilities for the particular landfill area are constructed according to the approved plans, specifications, and this CQA Plan. Said certification shall have the CQA ENGINEER's seal as a professional engineer registered in the State of Alabama. The report shall be submitted as each cell or section is constructed.

B. A copy of all test reports and field notes outlined in this CQA Plan will be submitted to the Alabama Department of Environmental Management for their review and approval within 45 days of completion of a cell or section. In addition, the construction certification report shall contain as-built drawings prepared and sealed by a land surveyor registered in Alabama noting any deviations from the approved engineering plans. The construction certification report must include a narrative by the engineer.

C. The project will not be deemed complete and acceptable until the Alabama Department of Environmental Management has accepted the construction certification and all supplement reports and data as complete. The CONTRACTOR and the CQA ENGINEER should completely familiarize themselves with the Rules and Regulations of the Alabama Department of Environmental Management (ADEM) concerning composite liner and closure cap systems.

# 6.0 TECHNICAL SPECIFICATIONS

# TECHNICAL SPECIFICATIONS

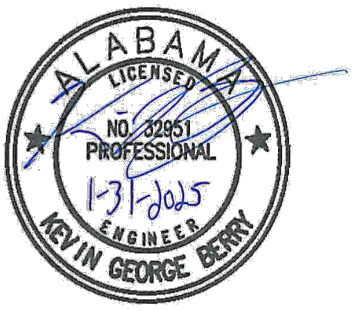
## 2025 MAJOR MODIFICATION APPLICATION
## ARROWHEAD LANDFILL

## PERRY COUNTY ASSOCIATES, LLC
## PERRY COUNTY, ALABAMA

## JANUARY 2025

*(Technical Specifications are to be reviewed by Design Engineer for every construction project to determine if any improvements or changes are warranted. All changes will be appropriately approved by ADEM prior to implementation)*

HHNT
HODGES, HARBIN, NEWBERRY & TRIBBLE, INC.
*Consulting Engineers*

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# TABLE OF CONTENTS

| | |
|---|---|
| SECTION 01000 | PRECONSTRUCTION CONFERENCE |
| SECTION 01050 | CONFIRMATION SURVEYS |
| SECTION 01051 | CONSTRUCTION SURVEYS |
| SECTION 01300 | SUBMITTALS |
| SECTION 01400 | QUALITY CONTROL |
| SECTION 01560 | EROSION AND SEDIMENT CONTROL |
| SECTION 01666 | TESTING PIPING SYSTEMS |
| SECTION 02110 | CLEARING AND GRUBBING |
| SECTION 02210 | GRADING |
| SECTION 02220 | TRENCHING, BACKFILLING AND COMPACTION |
| SECTION 02250 | COMPACTED CLAY LINER |
| SECTION 02252 | PROTECTIVE SOIL COVER ON LANDFILL CAP |
| SECTION 02255 | PROTECTIVE COVER SOIL – ON LINER – SANDY SOILS |
| SECTION 02260 | COMPACTED CLAY CAP |
| SECTION 02674 | GAS VENTING SYSTEMS |
| SECTION 02720 | STORM SEWER SYSTEMS |
| SECTION 02732 | FORCE MAIN AND RELATED APPURTENANCES |
| SECTION 02744 | HIGH DENSITY POLYETHYLENE (HDPE) PIPE |
| SECTION 02747 | LEACHATE COLLECTION SYSTEM |
| SECTION 02748 | HDPE FABRICATION |
| SECTION 02750 | TEXTURED HDPE GEOMEMBRANE LINER |
| SECTION 02754 | GEOCOMPOSITE DRAINAGE MEDIA (GDM) CAP SYSTEM |
| SECTION 02755 | GEOMEMBRANE (FML) CAP |
| SECTION 02757 | CUSHION GEOTEXTILE |
| SECTION 02930 | GRASSING |
| SECTION 11311 | SUBMERSIBLE LEACHATE SUMP PUMP |

# SECTION 01000 PRECONSTRUCTION CONFERENCE

## PART 1 GENERAL

### 1.1 DESCRIPTION

**PRECONSTRUCTION CONFERENCE**

Prior to beginning excavation activities, a pre-construction conference will be held on-site with representatives of:

Owner / Operator
Design Engineer
ADEM
Contractor
CQA Engineer

The purpose of the meeting will be to discuss issues relating to the proper prosecution of the work effort. The CONTRACTOR shall have a schedule of work effort on either a CPM or Gannt format which defines all major work events, target dates, time of completion, and the interrelationship of work effort.

Special attention shall be given to who can make field changes, approve change orders, stop the work, or otherwise make changes in either the project design or the construction sequence. Attention shall also be given to the relationship with the State Regulatory Agency.

An agenda should be prepared for the meeting which specifically lists each item in the Rules for discussion.

The pre-construction conference will be the first of several project conferences or meetings. A schedule for meetings after the pre-construction conference will be established at the pre-construction conference.

Detailed Minutes of this meeting shall be kept and copies distributed to all parties in attendance.

-- END OF SECTION --

# SECTION 01050 CONFIRMATION SURVEYS

## PART 1 GENERAL

### 1.1 GENERAL

This section covers the confirmation surveys required for the project. Landfill confirmation surveys are required for the cell subgrade, compacted clay liner, protective cover, flexible membrane liner (FML), all underground pipelines and electrical, structures, roads and other improvements. This will require four (4) separate topographic surveys of the cell area and an overall construction site survey.

### 1.2 QUALITY ASSURANCE

The confirmation surveys shall be sealed by a registered land surveyor licensed in this State.

### 1.3 SHOP DRAWINGS

Grade Stakes Numbering System: Provide grid numbering methodology for review. Provide method to number and log individual stakes to assure no stakes remain in compacted soil liner.

## PART 2 PRODUCTS

N/A

## PART 3 EXECUTION

### 3.1 GRID OVERLAY

The Surveyor shall establish a grid pattern for control over the entire landfill cell area. The grid dimensions for the landfill cell shall be 50 foot by 50 foot. The grid pattern shall remain in the same location for each land survey described below. The Surveyor shall develop and utilize a numbering system for grid points. The Surveyor shall coordinate the establishment of the grid pattern with the grading Contractor and this grid pattern will be used in the construction staking.

### 3.2 EXISTING CONDITIONS SURVEY

The Surveyor shall provide a 2 foot contour map of existing conditions of the excavation area (cell) only. The survey shall represent the elevations after clearing, grubbing and topsoil stripping but prior to any mass excavation.

## 3.3 CELL SUBGRADE SURVEY

The Surveyor shall provide a 2 foot contour map with grid elevations shown for the landfill cell(s) subgrade. The survey shall represent as-built elevations immediately prior to placement of the compacted soil liner. The survey shall confirm the correct slopes and grades with those given on the drawings.

## 3.4 COMPACTED CLAY LINER SURVEY

The Surveyor shall provide a 2 foot contour map with grid elevations shown for the landfill compacted soil liner and subgrade. The grid elevations shall be presented to facilitate confirmation of the required thickness (see Figure 1). The land survey shall represent as-built elevations immediately prior to placement of the geomembrane liner. The survey shall confirm the correct layer thickness, slopes, and grades with those given on the Drawings. The survey shall include limits of the compacted soil liner.

## 3.5 GEOSYNTHETICS SURVEY

The Surveyor shall provide a map locating the anchor trench, edge of liner, panels, repairs, and limits of each layer of geosynthetics and locations of all unique structures. The survey shall represent as-built final surface area(s) of the geosynthetics.

## 3.6 PROTECTIVE COVER / LEACHATE COLLECTION SYSTEM SURVEY

The Surveyor shall provide a 2 foot contour map with grid elevations shown for the landfill protective cover layer, compacted soil liner, and subgrade. The grid elevations shall be presented to facilitate confirmation of the required thickness (see Figure 1). The survey shall represent as-built final elevations. The survey shall confirm the correct layer thickness, slopes, and grades with those given on the Drawings. This survey should include the location of rain flaps and all leachate system piping.

## 3.7 OVERALL CONSTRUCTION SITE SURVEY

The Surveyor shall provide a 2 foot contour map of the entire construction site outside of the cells. This survey can be shown on one of the cell confirmation surveys or as a separate survey. This survey shall locate all improvements in this project including structures, underground pipelines, electrical and roads.

## 3.8 GRADE STAKES

The Surveyor shall remove all grade stakes prior to placement of subsequent layer. The Surveyor shall develop and utilize a grade stake numbering system to log and number individual stakes.

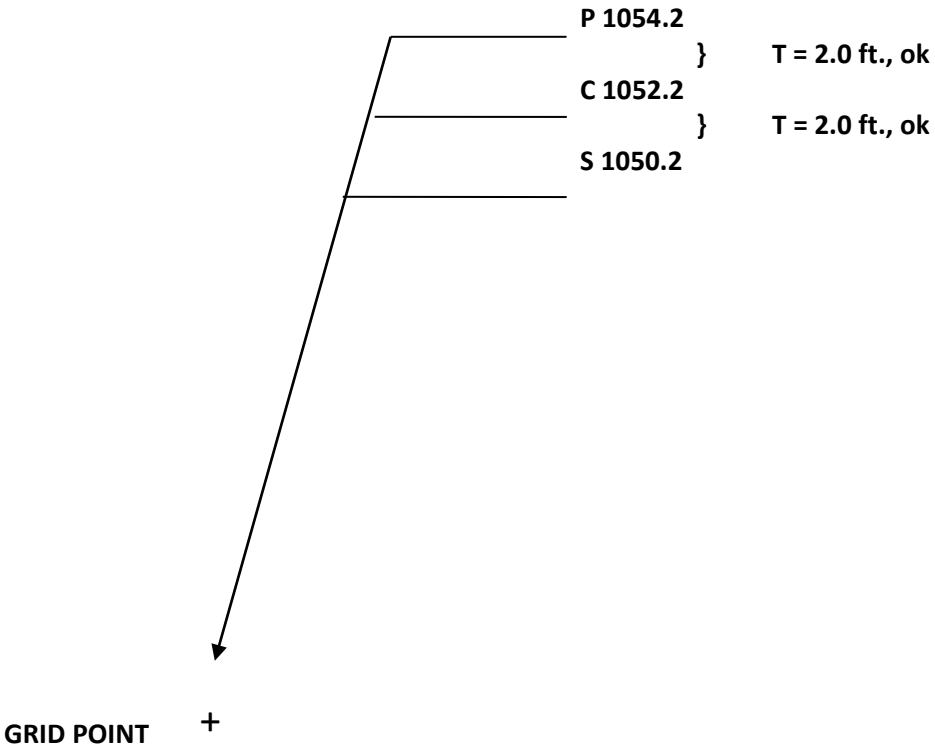
## 3.9 LAND SURVEYS

The Surveyor shall provide seven (7) sealed and signed prints of each survey and an electronic data file, on computer diskette (3½ inch) compatible with AutoCad 2004. The surveys shall include the data of surveys, vertical control utilized, and horizontal control utilized. The surveys shall be at a scale not less than 1" - 50'.

## 3.10 SCHEDULE

The Surveyor shall provide the confirmation surveys within two (2) days of the completion of the particular portion of the work to which they pertain.

**FIGURE 1**
**DATA PRESENTATION EXAMPLE**




* The specified minimum thickness is measured perpendicular to surface. A greater difference in elevation will be required on slopes in order to obtain the specified minimum thickness.

**Key**

| | |
|---|---|
| **P** | **PROTECTIVE COVER LAYER ELEVATION** |
| **C** | **COMPACTED CLAY LINER ELEVATION** |
| **S** | **COMPACTED SUBGRADE** |
| **T** | **THICKNESS** |

-- END OF SECTION --

# SECTION 01051 CONSTRUCTION SURVEYS

## PART 1 GENERAL

### 1.1 GENERAL

This section covers construction staking and quantity surveys provided by the Contractor. Construction staking is required for horizontal and vertical location of all site improvements including grading, compacted soil liner, and protective cover. Quantity surveys are required for the purpose of determining quantities of excavation.

### 1.2 QUALITY ASSURANCE

Quantity surveys shall be performed under the direction of a registered land surveyor licensed in this State. Reports of quantity surveys shall be signed and sealed by a registered land surveyor licensed in this State.

### 1.3 SHOP DRAWING

A. Grade Stakes Numbering System

Provide grid numbering methodology (in cells) for review. This shall be coordinated with the confirmation surveying. Provide method to number and log individual stakes to assure no stakes remain within the cell(s).

### 1.4 PAYMENT

All payment for construction surveying shall be included in the lump sum price bid in the Proposal for Construction Surveying.

## PART 2 PRODUCTS

### 2.1 GENERAL

The CONTRACTOR shall furnish all such stakes, spikes, steel pins, templates, platforms, equipment, instruments, tools, and other materials as may be required for staking and quantity surveys.

## PART 3 EXECUTION

### 3.1 CONSTRUCTION STAKING

A. General

1. The ENGINEER will provide benchmarks for vertical and dimensional data for horizontal location.

2. The CONTRACTOR shall complete the layout of the work and shall be responsible for all measurements that may be required for the execution of the work prescribed in the specifications or on the Drawings, subject to such modifications as may be required to meet changed conditions or as a result of necessary modifications to the work.

3. It shall be the responsibility of the CONTRACTOR to maintain and preserve all benchmarks shown on the plans and any other benchmarks provided by the DESIGN ENGINEER.

4. All survey data shall be recorded in accordance with standard and approved methods. All field notes, sketches, records, and computations made by the CONTRACTOR in laying out the work shall be available at all times during the progress of the work for the ready examination by the DESIGN ENGINEER or his duly authorized representative.

5. The DESIGN ENGINEER may make checks as the work progresses to verify lines and grades established by the CONTRACTOR and to determine the conformance of the completed work as it progresses with the requirements of the Contract Documents and Drawings. Such checking by the DESIGN ENGINEER or his representative shall not relieve the CONTRACTOR of his responsibility to perform all work in accordance with the Contract Documents and Drawings and the lines and grades given therein. In the event that location marks as established by the CONTRACTOR are found to be inaccurate or inadequate, work shall be suspended until corrections have been made.

B. Landfill Cell(s)

The CONTRACTOR shall establish a grid pattern for control over the entire landfill cell area. The grid dimensions shall be 50 foot by 50 foot. The grid pattern shall remain in the same location for subgrade, compacted soil liner, and protective cover construction. The CONTRACTOR shall develop and utilize a numbering system for grid points. The CONTRACTOR shall coordinate the establishment of the grid pattern with the Confirmation Surveyor so that the same grid pattern may be used for the confirmation surveys.

## 3.2 QUANTITY SURVEYS

The CONTRACTOR's surveyor shall develop topographic surveys for the purpose of determining quantities of excavation. Quantities of excavation and fill shall be calculated by the average end

area method or utilizing digital terrain modeling software. The CONTRACTOR's surveyor shall develop topographic surveys after completion of clearing, grubbing and stripping topsoil and again after completion of grading. Additional cross surveys may be required depending on sequencing of construction. The OWNER may survey portions of the work for confirmation of quantities.

## 3.3 GRADE STAKES

The CONTRACTOR shall remove all grade stakes prior to placement of subsequent layers during cell construction. The CONTRACTOR shall develop and utilize a grade stake numbering system to log and number individual stakes.

--END OF SECTION--

# SECTION 01300 SUBMITTALS

## PART 1 GENERAL

### 1.1 DESCRIPTION

A. CONTRACTOR shall prepare and furnish the following submittals as required for the Work.

1. Construction Progress Schedules
2. Shop Drawings and Data on all Products and Materials
3. Operation and Maintenance Data
4. Application for Payment Format

B. Type or neatly letter the following identifying title on all submittals:

NAME OF OWNER
PROJECT NAME

### 1.2 CONSTRUCTION PROGRESS SCHEDULES

A. Submit construction progress schedules for the work to DESIGN ENGINEER, with sub-schedules of related activities which are essential to progress of the Work.

B. Prepare schedules in the form of a horizontal bar chart.

1. Provide separate horizontal bar for each sequence of construction by activity clearly referenced to the corresponding specification section number.

2. Show the chronological order, duration and projected percentage completion of each sequence of construction.

3. Horizontal time scale: Maximum unit - one (1) month.

4. Sheet size 24" x 36".

5. Show time frame for submittal of shop drawings, product data, samples, operation and maintenance data, and other pertinent submittals.

6. Show dates of applications for progress payments at the bottom of the bar chart, indicate payment number, amount of payment request and cumulative

payment to date.

C. Submissions Requirements

1. CONTRACTOR shall submit schedules as provided in Article 2.6 of the General Conditions.

2. Submit revised Progress Schedule with each application for payment.

## 1.3 SHOP DRAWINGS

A. General

1. CONTRACTOR shall submit shop drawings, product data and samples required by the Contract Documents.

2. Designate in the construction progress schedule the dates for submission and the dates that reviewed shop drawings, product data and samples will be needed to cause no delay in the construction progress.

B. Shop drawings

1. Drawings shall be presented in a clear and thorough manner:

a. Details shall be identified by reference to sheet and detail number shown on Contract Drawings and applicable specification section(s).

b. Minimum sheet size: 8 ½" x 11"; maximum sheet size 24" x 36".

2. Product data:

a. Clearly mark each copy to identify pertinent products or models.
b. Show performance characteristics and capacities.
c. Show dimensions and clearance capacities.
d. Show wiring or piping diagrams and controls.

3. Manufacturer's standard schematic drawings and diagrams:

a. Modify drawings and diagrams to delete information which is not applicable to the work.

b. Supplement standard information to provide information specifically applicable to the work.

4. Samples

   a. Office samples shall be of sufficient size and quantity to clearly illustrate:

      1. Functional characteristics of the product, with integrally related parts and attachment devices.

      2. Full range of color, texture and pattern.

C. CONTRACTOR Responsibilities

1. Review shop drawings, product data and samples prior to submission.

2. Determine and verify:

   a. Field measurements.
   b. Field construction criteria.
   c. Catalog numbers and similar data.
   d. Conformance with specifications.

3. Coordinate each submittal with requirements of the Work and of the Contract Drawings.

4. Notify the DESIGN ENGINEER in writing, at time of submission, of any deviations in the submittals from requirements of the Contract Documents.

5. Begin no fabrication or work which requires submittals until return of submittals with DESIGN ENGINEER review stamp.

D. Submission requirements

1. Make submittals for all items prior to ordering or fabrication, and in such sequence as to cause no delay in the Work or in the work of any other CONTRACTOR.

2. Number of submittals required:

   a. Shop Drawings: Submit a minimum of five (5) copies as required by General Conditions, plus additional copies which CONTRACTOR requires.

   b. Samples: Submit the number stated in each Specification Section.

3. Submittals shall contain:

   a. The date of submission, submission number (in consecutive order) and dates of any previous submissions.

   b. Contract identification as specified in Article 1.01, paragraph B.

   c. The name of:

      1. CONTRACTOR
      2. Supplier
      3. Manufacturer

   d. Identification of the product with the specification section number.

   e. Field dimensions clearly identified as such.

   f. Relation to adjacent or critical features of the work or materials.

   g. Applicable standards, such as ASTM or Federal specification numbers.

   h. Identification of deviations from Contract Documents.

   i. Identification of revisions on re-submittals.

   j. CONTRACTOR's review stamp.

4. All shop drawings shall be coordinated between trades prior to submission for review and approval.

   a. Manufacturer's equipment submittals with statements such as "Field Wiring by Others", "Control Wiring by Others", or "Not by Manufacturer" (referring to related fittings, control or interlock wiring, etc.) will be "REJECTED" unless specifically noted as having been coordinated with all related trades.

5. CONTRACTOR's stamp initialed or signed, certifying to review of submittal, verification of products, field measurements and field construction criteria, and coordination of the information within the submittal with requirements of the work and of Contract Documents.

E. Re-submission requirements

1. CONTRACTOR shall make any corrections or changes in the submittals required by the DESIGN ENGINEER and resubmit.

2. Drawings and Product Data:

   a. Revise initial drawings or data, and resubmit as specified for the initial submittal.

   b. Indicate any changes which have been made other than those requested by the DESIGN ENGINEER.

3. Samples: Submit new samples as required for initial submittal.

F. Distribution

CONTRACTOR shall distribute reproductions of Shop Drawings which carry the DESIGN ENGINEER's review stamp to:

a. Job site file,
b. Record documents file, and
c. Others as required.

G. DESIGN ENGINEER will return three (3) reviewed and appropriately stamped copies of submittals to CONTRACTOR for distribution, or for re-submission, unless CONTRACTOR requests and submits additional copies as provided in paragraph D of this Article 1.04.

## 1.4 OPERATION AND MAINTENANCE DATA

A. General

1. CONTRACTOR shall compile product data and related information appropriate for OWNER's maintenance and operation of products furnished under the Contract.

   a. Prepare operating and maintenance data as specified in this Section and as referenced in other pertinent sections of specifications.

2. Instruct OWNER's personnel in the maintenance of products and in the operation of equipment and systems as provided in paragraph E of this section and the pertinent sections of the Specifications.

B. Quality Assurance

1. Preparation of data shall be done by personnel:

   a. Trained and experienced in maintenance and operation of the described products.

   b. Completely familiar with requirements of this Section.

C. Form of Submittals

1. Prepare data in the form of an instructional manual for use by OWNER's personnel.

2. Format:

   a. Size: 8 ½ " x 11"

   b. Text: Manufacturer's printed data, or neatly typewritten.

3. Binders:

   a. Commercial quality three-ring binders with durable and cleanable plastic covers.

   b. Maximum ring size: two (2") inch.

D. Content of Manual

The Manual shall contain the following information arranged in a systematic order:

1. Product data
2. Drawings
3. Written text as required to supplement product data.
4. Copy of each warranty, bond or service contract.
5. Information on materials and finishes.
6. Descriptions and operating and maintenance procedures on equipment and systems.

E. Instruction of OWNER's personnel.

1. Prior to final inspection or acceptance, fully instruct OWNER's designated personnel in the operation, adjustment and maintenance of all products,

equipment and systems.

2. Operating and Maintenance Data Booklet shall constitute the basis for instruction.

## 1.5 APPLICATION FOR PAYMENT FORMAT

A. The CONTRACTOR shall submit a sample Application for Payment for approval by the OWNER prior to submittal of the first progress payment. This document should be similar to the Engineers Joint Documents Committee EJCDC No. 1910-8-E, attached.

B. The schedule of values required by paragraph 1.03 will serve as the basis for progress payments on lump sum work. Progress payments on account of unit price work will be based on the number of units completed. An application for payment worksheet, similar to the attached document, shall accompany the application for payment. The CONTRACTOR shall submit a sample worksheet for approval by the OWNER prior to submittal of the first progress payment.

C. Receipts are required for all materials and equipment incorporated into the cell construction which were subject to scales tax paid by the CONTRACTOR. Copies of receipts shall be submitted with each pay request.

**APPLICATION FOR PAYMENT NO. _____**

To: _____ (Owner)
From: _____ (Contractor)
Contract: _____
Project: _____
OWNER's Contract No. _____ ENGINEER'S Project No. _____
For Work accomplished through the date of: _____

| | | |
|---|---|---|
| 1. | Original Contract Price: | $ |
| 2. | Net change by Change Orders and Written Amendments (+ or -): | $ |
| 3. | Current Contract Price (1 plus 2): | $ |
| 4. | Total completed to date: | $ |
| 5. | Retainage (per Agreement) | $ |
| 6. | Total Completed to Date Less Retainage | $ |
| 7. | Stored Materials | $ |
| 8. | Total completed to Date and Stored Materials | $ |
| 9. | Less Previous Application for Payments: | $ |
| 10. | **DUE THIS APPLICATION (8 MINUS 9)** | **$** |

Accompanying Documentation:

CONTRACTOR's Certification:

The undersigned CONTRACTOR certifies that (1) all previous progress payments received from OWNER on account of Work done under the Contract referred to above have been applied on account to discharge CONTRACTOR's legitimate obligations incurred in connection with Work covered by prior Applications for Payment numbered 1 through ____ inclusive; (2) title of all Work, materials and equipment incorporated in said Work or otherwise listed in or covered by this Application for Payment will pass to OWNER at time of payment free and clear of all Liens, security interests and encumbrances (except such as are covered by a Bond acceptable to OWNER indemnifying OWNER against any such Lien, security interest or encumbrance); and (3) all Work covered by this Application for Payment is in accordance with the Contract Documents and not defective.

Dated _____ _____
CONTRACTOR

By: _____

State of _____
County of _____
Subscribed and sworn to before me this _____
day of _____, _____

Notary Public
My Commission expires: _____

Payment of the above AMOUNT DUE THIS APPLICATION is recommended.

Dated _____ _____
ENGINEER

By: _____

EJCDC No. 1910-8-E (1996 Edition)
Prepared by the Engineers Joint Contract Documents Committee and endorsed by The Associated General Contractors of America and the Construction Specification Institute.

**APPLICATION FOR PAYMENT**
**WORKSHEET**

TO: (Owner's Name and Address)

FROM: (Contractor's Name and Address)

PROJECT:
PAY REQUEST #:
PERIOD TO:

| | | CONTRACT | | | WORK COMPLETED THIS PERIOD | | WORK COMPLETED TO DATE | | STORED MATERIALS | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Item No. | Description of Work | Qty. | Unit Price | Total Amount | Qty. | Total Amount | Qty. | Total Amount | Qty. | Unit Price | Amount Presently Stored |
| 1 | | | | | | | | | | | |
| 2 | | | | | | | | | | | |
| 3 | | | | | | | | | | | |
| 4 | | | | | | | | | | | |
| 5 | | | | | | | | | | | |
| 6 | | | | | | | | | | | |
| 7 | | | | | | | | | | | |
| 8 | | | | | | | | | | | |
| 9 | | | | | | | | | | | |
| 10 | | | | | | | | | | | |
| | TOTALS | | | | | | | | | | |
| CHANGE ORDER NO. 1 (etc.) | | | | | | | | | | | |
| 1 | | | | | | | | | | | |
| 2 | | | | | | | | | | | |
| 3 | | | | | | | | | | | |
| | TOTALS | | | | | | | | | | |

-- END OF SECTION --

# SECTION 01400 QUALITY CONTROL

## PART 1 GENERAL

### 1.1 DESCRIPTION

A. The OWNER shall employ and pay for the services of a third-party CQA firm and a geotechnical engineering firm to confirm the installation of the geomembrane and clay liners, perform soils, concrete and other required testing. The CONTRACTOR shall coordinate his work with the third-party firms. The third-party CQA firm shall use the CQA Plan for this project which is included as a part of these specifications.

1. Employment of the third-party CQA firm and geotechnical firm shall in no way relieve CONTRACTOR's obligations to perform the Work of the Contract.
2. The CONTRACTOR shall provide Quality Control on the HDPE geomembrane liner in accordance with the specifications.

B. Related requirements in other parts of the Project Manual:

1. Inspections and testing required by laws, ordinances, rules, regulations, orders or approvals of public authorities: Condition of the Contract.

C. Related requirements specified in other sections:

1. Certification of Products: The respective sections of Specifications.
2. Test, adjust and balance of equipment: The respective section of Specifications.
3. Laboratory tests required, and standards for testing: The respective section of the Specifications.

D. Testing laboratory inspection, sampling and testing is required for, but not limited to, the following:

1. Section 02210 - Grading
2. Section 02220 - Trenching, Backfilling and Compaction
3. Section 02744 - High Density Polyethylene (HDPE) Pipe
4. Section 02748 - HDPE Fabrication
5. Section 02250 - Compacted Clay Liner
6. Section 02255 - Protective Cover - On Liner – Sandy Soils
7. Section 02747 - Leachate Collection System

8. Section 02750 - Textured HDPE Geomembrane Liner

## 1.2 QUALIFICATION OF LABORATORY

A. Meet "Recommended Requirements for Independent Laboratory Qualifications", published by American Council of Independent Laboratories.

B. Meet basic requirements of ASTM E 329, “Standards of Recommended Practice for Inspection and Testing Agencies for Concrete and Steel as Used in Construction.”

C. Authorized to operate in the State in which Project is located.

D. Submit copy of report of inspection of facilities made by Materials Reference Laboratory of National Bureau of Standards during the most recent tour of inspection, with memorandum of remedies of any deficiencies reported by the inspection.

E. Testing Equipment

1. Calibrated at reasonable intervals by devices of accuracy traceable to either:

   a. National Bureau of Standards
   b. Accepted values of natural physical constants.

## 1.3 LABORATORY DUTIES

A. Cooperate with DESIGN ENGINEER and CONTRACTOR: provide qualified personnel after due notice.

B. Perform specified inspections, sampling and testing of materials and methods of construction:

1. Comply with specified standards.
2. Ascertain compliance of materials with requirements of Contract Documents.

C. Promptly notify DESIGN ENGINEER and CONTRACTOR of observed irregularities or deficiencies of work or products.

D. Promptly submit written report of each test and inspection; two (2) copies each to DESIGN ENGINEER, and one copy to CONTRACTOR and record documents file. Each report shall include:

1. Date issued.
2. Project title and number.
3. Testing laboratory name, address and telephone number.

4. Name and signature of laboratory inspector.
5. Date and time of sampling or inspection.
6. Record of temperature and weather conditions.
7. Date of test.
8. Identification of product and specification section.
9. Location of sample or test in the Project.
10. Type of inspection or test.
11. Results of tests and compliance with Contract Documents.
12. Interpretation of test results, when requested by DESIGN ENGINEER.

E. Perform additional tests as required by DESIGN ENGINEER or the OWNER if initial tests are not conclusive to merit acceptance.

## 1.4 LIMITATIONS OF AUTHORITY OF TESTING LABORATORY

A. Laboratory is not authorized to:

1. Release, revoke, alter or enlarge on requirements of Contract Documents.
2. Approve or accept any portion of the work.
3. Perform any duties of the CONTRACTOR.

## 1.5 CONTRACTOR'S RESPONSIBILITIES

A. Cooperate with laboratory personnel, provide access to work, to manufacturer's operations.

B. Secure and deliver to the laboratory adequate quantities of representational samples of materials proposed to be used and which require testing.

C. Provide to the laboratory the preliminary design mix proposed to be used for concrete, and other material mixes which require control by the testing laboratory.

D. Furnish copies of product test reports as required.

E. Furnish incidental labor and facilities:

1. To provide access to work to be tested.
2. To obtain and handle samples at the Project site or at the source of the product to be tested.

3. To facilitate inspections and tests.
4. For storage and curing of test samples.

-- END OF SECTION --

# SECTION 01560 EROSION AND SEDIMENT CONTROL

## PART 1 GENERAL

### 1.1 WORK INCLUDED

A. Installation of soil erosion control devices.

B. Maintenance of soil erosion devices during construction.

C. Removal of temporary soil erosion control devices after stabilization of disturbed areas.

D. Temporary grassing for soil erosion control.

### 1.2 QUALITY CONTROL

A. After installing the soil erosion control devices as called for on the Drawings, the Contractor shall assure himself that all reasonable measures possible have been taken to prevent the siltation of nearby water courses.

B. The erosion and sediment control shall conform with the rules and regulations of the Alabama Department of Environmental Management.

### 1.3 MEASUREMENT AND PAYMENT

A. Silt Fence

1. Measurement shall be from end-to-end along its base of each separate installation.

2. Payment shall be by the linear foot actually installed.

B. Rip-Rap

1. Rip-Rap for outlet protection, ditches, and other areas as called for on the Drawings shall be measured by the square yard of rip-rap surface area at the appropriate thickness shown on the plans.

2. Payment shall be by the square yard for quantities actually installed. Filter fabric will be included in the cost of rip-rap and supplied by the Contractor. Payment for stone shall include shaping of areas as shown on the plans and placement of the stone.

C. Inlet Protection

1. Measurement shall be by the actual quantity installed, complete as detailed in the plans.

2. Payment shall be at the unit price bid in the Proposal.

D. Excelsior Matting Ditches

1. Measurement for installed excelsior matting shall be of the centerline of the ditch.

2. Payment shall be at the unit price in linear feet bid in the Proposal. Unit Price shall include shaping and placement of excelsior matting and matting overlap.

E. Temporary Grassing

1. Measurement shall be made horizontally.

2. Payment shall be by the acre for areas actually seeded.

F. Hay Bale and Stone Check Dam

1. Measurement shall be by the actual quantity installed, complete as described in the plans.

2. Payment shall be at the unit price bid in the Proposal for Hay Bale and Stone Check Dams.

G. Excelsior Slope Matting

1. Measurement for installed excelsior slope matting shall be of the surface area of the slope in square yards.

2. Payment shall be at the unit price in square yards bid in the Proposal for Excelsior Slope Matting. Payment shall include shaping of slope and placement of excelsior matting on slope.

# PART 2 PRODUCTS

## 2.1 SILT FENCE AND INLET PROTECTION

A. Posts

Silt fence posts shall be 2" x 4" pressure treated pine, or steel posts, a minimum of four (4') feet long and spaced a maximum of six (6') feet apart.

B. Woven Wire Fence

Wire fence reinforcement shall be a minimum of 14-gauge 4" x 4" hogwire.

C. Filter Fabric

Filter fabric shall be woven synthetic geotextile of polypropylene, nylon, polyester, or polyethylene material, which is certified by the manufacturer as conforming to the requirements shown in the Table below.

The filter fabric shall be listed on the Alabama Department of Transportation approved list of geotextiles for Type "B" silt fence.

| Physical Property | Requirements |
|---|---|
| Grab Tensile (ASTM D4632) | MD 120 lbs, CD 100 lbs |
| Apparent Opening Size (ASTM D4751) | 30 (US Sieve) |
| Flow Rate (ASTM D4491) | 25 gpm/ft$^2$ |
| UV Resistance (ASTM D4355) | 80% |

## 2.2 RIP-RAP

A. Stone

Stone for rip-rap shall be durable, dense, specifically selected and graded, quarried stone. The $d_{50}$ size shall be 6, 9, or 12 inches as called for on the plans.

B. Gravel

Gravel for filter blanket shall be Size No. 57 in accordance with ASTM D 448-86.

C. Filter Fabric

Filter fabric for filter blanket shall be a non-woven geotextile suitable for filtration and separation. The fabric weight shall be a minimum of 6.0 ounces per square yard.

## 2.3 TEMPORARY GRASSING

A. Temporary seed

Temporary seed shall be annual ryegrass and browntop millet at the planting rates specified herein.

B. Mulch

Mulch for temporary grassing shall consist of grain straw or other acceptable material, and shall have been approved by the Design Engineer before being used. All mulch shall be reasonably free from mature seedbearing stalks, roots, or bulblets of Johnson Grass, Nutgrass, Sandbur, Wild Garlic, Wild Onion, Bermuda Grass, Crotalaria, and Witchweed, and free from an excessive amount of noxious weeds at the time of use of the mulch, and also there shall be compliance with all applicable State and Federal domestic plant quarantines. Straw mulch that is matted or lumpy shall be loosened and separated before being used.

Material for holding mulch in place shall be an approved binding material. No asphalt tacking material will be allowed.

### 2.4 TEMPORARY DITCH LINER

A. Excelsior Matting

Excelsior matting shall be an erosion control blanket consisting of an excelsior mat with a synthetic netting on one side similar and equal to Curlex as manufactured by American Excelsior Company.

## PART 3 EXECUTION

### 3.1 GENERAL

Construct temporary and permanent erosion control measures as shown on the Drawings, as required by site conditions, regulatory agency or Design Engineer. All permanent erosion control work shall be incorporated into the project at the earliest practicable time. Temporary erosion control measures shall be coordinated with permanent erosion control measures and all other work on the project to assure economical, effective, and continuous erosion control throughout the construction and post construction period and to minimize siltation of rivers, streams, lakes, reservoirs, other water impoundments, ground surfaces, or other property. If active construction ceases for more than 30 days, all disturbed areas shall be seeded and mulched using the temporary seed type and planting rates specified herein.

The Contractor shall be liable for all damages to public or private property and fines as may be placed on the project by the local regulatory agencies due to soil erosion from the project site. Clear only those areas required to install the soil erosion control devices, request an inspection by the local agency having jurisdiction.

All erosion control devices shall be inspected by the Contractor after each rainfall. Any required repairs shall be made immediately. Sediment deposits shall be removed when deposits reach approximately one-half of the capacity of the erosion control.

## 3.2 SILT FENCE

A. Silt fence shall be installed in accordance with the details in the plans.

B. Should the filter fabric deteriorate or become ineffective prior to the end of the construction as determined by the Design Engineer, the fabric shall be replaced immediately at no additional cost to the Owner.

## 3.3 RIP-RAP

A. Prepare subgrade to the required lines and grades as shown or indicated on the contract drawings. Place any fill required in the subgrade to a density equal to that of the surrounding area. Please filter fabric on the finished subgrade.

B. Place rip-rap by mechanical methods, augmented by hand placing where necessary to prevent damage to permanent works, provided that when the rip-rap is completed it forms a properly graded, dense, neat layer of stone. The completed rip-rap shall have a thickness as shown on the plans.

## 3.4 TEMPORARY GRASSING

Temporary grassing procedures will be implemented only under the direction of the Design Engineer, a cease of construction in excess of 15 days, or as required by the soil erosion inspector.

Seeding for temporary grassing shall be applied to all shoulders, side ditches, cut slopes, fill slopes, and any other area disturbed by the Contractor and not designated for pavement or structures. Temporary seeding shall occur immediately following final land disturbing activities. Any unseeded area which erodes shall be repaired to the satisfaction of the Design Engineer at no additional cost to the Owner. Temporary seeding shall be applied at the following rates:

| Temporary Seeding | LBS / Acre | Depth of Cover | Date of Planting |
|---|---|---|---|
| Annual Ryegrass | 40 | ¼" - ½" | 8/15 - 3/31 |
| Browntop Millet | 50 | ¼" - ½" | 5/1 - 8/15 |

Areas not receiving permanent cover that will be exposed for more than one (1) month shall receive temporary grassing. Temporary grassing shall consist of rye grass. Other cereal grass (i.e., millet) may also be used. Other grassing methods which have proved effective by the operator may be substituted for these.

## 3.5 INLET PROTECTION

A sump shall be constructed around the drop inlet and silt fence installed in accordance with the details in the plans for Drop Inlet Protection.

## 3.6 TEMPORARY DITCH LINER

A. After installation of the utilities, the ditches shall be reconstructed as near as possible to the original configuration.

B. Apply lime, fertilizer, and seed to the ditch and adjoining areas in accordance with the grassing specifications.

C. Place the excelsior mat in accordance with the detail and table in the erosion control plan.

D. Start laying the mat from the top of the upstream end of the channel and unroll it downgrade. Do not stretch netting.

E. Bury the upslope end and staple the mat every 12" across the top end, every three (3) feet around the edges and across the mat so that it is held closely against the soil. However, do not stretch the mat when stapling.

F. To join ends of strips, insert the new roll of mat in a trench as with upslope end and overlap it 18" with the previously laid upper roll. Turn under 6" of the 18" overlap and staple every 12" across the end.

## 3.7 REMOVAL OF TEMPORARY EROSION DEVICES

The Contractor shall remove all sedimentation and erosion control devices upon the approval of permanent seeding and stabilization by the agency having jurisdiction of the area and the Design Engineer. All sediment deposits remaining in place after the erosion control devices are removed shall be dressed to conform with the existing grade, prepared, and seeded. The cost of removal and cleanup shall be included in the cost of the installation of the device or in the cost for maintenance.

## 3.8 CLEAN OUT PERMANENT EROSION CONTROL DEVICES

The Contractor shall clean out permanent sediment and erosion control devices upon approval of permanent seeding and stabilization by the agency having jurisdiction of the area and the Design Engineer. The devices shall be cleaned out to the original condition. The cost of cleanup shall be included in the cost of installation or in the cost of maintenance of the device.

---END OF SECTION---

# SECTION 01666 TESTING PIPING SYSTEMS - LANDFILL

## PART 1 GENERAL

### 1.1 DESCRIPTION

A. This section covers the requirements for CONTRACTOR's testing gravity and pressure piping systems not specified under other Sections.

B. Tests shall be performed on but not limited to the following:

1. Pressure Leachate Collection Pipes
2. Force Mains
3. Gravity Manholes

C. All tests require the presence of the CQA ENGINEER.

D. If the installation fails to meet test requirements, the CONTRACTOR shall, at his expense, determine the source of leakage and make repairs as necessary to eliminate leakage and retest as directed.

E. All costs for the testing shall be borne by the CONTRACTOR.

F. Advise the CQA ENGINEER at least 48 hours before tests are to be conducted.

## PART 2 PRODUCTS

### 2.1 GENERAL

A. All equipment shall be the best of their particular class and suited for the intended use.

## PART 3 EXECUTION

### 3.1 GENERAL

A. If the specified rate of leakage is exceeded, on test, the CONTRACTOR shall locate the points of excessive leakage and institute appropriate measure of correction, whereupon the length of pipeline shall be retested and this procedure continued until test requirements are met.

B. Unless specified otherwise the following tests shall be performed as directed by CQA ENGINEER.

1. Exfiltration Testing

a. All HDPE manholes and other fabricated structures.

2. Hydrostatic Testing

a. Pressure Leachate Pipes
b. Force Mains

## 3.2 EXFILTRATION TESTING

A. The CQA ENGINEER shall require exfiltration tests on all HDPE manholes and on gravity piping.

B. The section to be tested and the manner of test will be determined by the CQA ENGINEER.

C. Procedure for Exfiltration Testing:

1. Plug each end of section or all openings to manhole to be tested with watertight bulkheads.

2. Insert in each bulkhead at the top of the pipeline a two (2") inch pipe with 90 elbow, that will extend four (4") feet vertically above the top of the pipeline or above the groundwater line, whichever is higher. Manholes shall be tested at full depth with the water level at the cover ring.

3. The elevations of the top of the two (2") inch pipe at each bulkhead shall be the same.

4. Fill the pipeline with clear water until the water level is at the top of the two (2") inch pipe at the upper end of section or at the manhole ring.

5. Maintain the water level by adding accurately measured amounts of water for a period of thirty minutes, not allowing the lower pipe to overflow.

D. The maximum length of a section of pipeline to be tested by means of an exfiltration test at one time shall be limited to 1,000 linear feet.

E. The maximum permissible leakage determined by exfiltration shall be the rate of 25 gallons per inch interval diameter of pipe per 1,000 feet of pipe line per 24 hours,

inclusive of all appurtenances within the section such as manholes, house connections, etc. The length of pipe used in the computation shall be the horizontal distance between manhole centerlines of the section being tested. The maximum permissible leakage for manholes shall be 0.01 gallons per vertical foot per day.

F. Once infiltration is found to be within allowable limits, remove all bulkheads.

## 3.3 HYDROSTATIC TESTING

A. The following piping system shall be Hydrostatically tested:

1. All other pressure piping systems not specifically requiring testing under other Sections; and

2. Do not test piping systems with water where water testing will be harmful to the system operation, such as for air and gas piping systems.

B. After the pipe has been laid and backfilled between fittings, and before any fittings are covered, unless this requirement is waived by the CQA ENGINEER, all newly laid pipe, above ground or below ground, or any valved section thereof, shall be subjected to a hydrostatic gauge pressure as hereinafter tabulated.

1. All piping that will be considered inaccessible or impossible to repair after the completion of all work shall be hydrostatically tested while still accessible.

2. Examples of such piping are those near or under basins, paved roads, concrete structures and concrete foundations.

3. Note: All piping shall have reaction blocking (thrust blocks) in place before testing, as required.

C. Tests shall be under the direction of the CQA ENGINEER. The CONTRACTOR shall furnish a pressure gauge for measuring the pressure on the pipeline, shall provide a corporation cock to attach gauge or pump connection, and shall provide plugs to seal taps after use in testing, and shall also furnish a suitable pump, pipe, appliances, and other appurtenances necessary to make these tests.

D. Each section of pipe shall be filled slowly with water and the specified test pressure, measured at the point of lowest elevation, shall be applied to the pipe in a satisfactory manner. The CONTRACTOR will furnish all test water.

E. Before applying the specified water test pressure, all air shall be expelled from the pipe. To accomplish this, taps shall be made, as directed by the CQA ENGINEER, if necessary, at points of highest elevation, and afterward tightly plugged.

F. The test pressure shall be maintained for a sufficient length of time prior to the test to allow for thorough examination of joints and elimination of leakage where necessary. The pipe line shall be made watertight under the test pressure.

G. All exposed pipes, fittings, valves, hydrants, and joints will be carefully examined during the open trench test. Any cracked or defective pipes, fittings, valves, or hydrants discovered in consequence of this pressure test shall be removed and replaced by the CONTRACTOR with sound material and the test shall be repeated until satisfactory to the CQA ENGINEER.

H. Hydrostatic test pressures shall be as follows:

| System | Pressure Test Rating (psi) |
|---|---|
| Miscellaneous pressure pipe | 50 |
| Water mains | 150 |
| Pressure leachate piping (force main) | 100 |
| Secondary Containment Pipe | Actual Maximum Pressure plus 5 psi |

1. The pressure shall be maintained within a maximum variation of five (5%) percent during the entire leakage test.

2. Leakage measurements shall not be started until a constant test pressure has been established.

3. The test shall be conducted for a minimum of one (1) hour.

4. The tested section will not be accepted if it has any observed leakage or test pressure drops more than one (1) psi during the leakage test.

5. During testing of the secondary containment piping, the primary piping should be brought up to and held at the system test pressure to prevent damage to the primary piping.

--END OF SECTION--

# SECTION 02110 CLEARING AND GRUBBING

## PART 1 GENERAL

### 1.1 DESCRIPTION OF WORK

A. Extent of site clearing is shown on Drawings.

B. Site clearing work includes, but is not limited to:

1. Protection of trees outside of clearing limits.
2. Removal of trees and other vegetation within site clearing limits.
3. Grubbing within the clearing limits.
4. Stripping topsoil.
5. Removal of debris on the site.

### 1.2 RELATED DOCUMENTS

A. Section 02930 - Grassing

B. Drawings and general provisions of Contract, including General and Supplementary Conditions, and Detailed Specification sections, apply to work of this section.

### 1.3 JOB CONDITIONS

A. Examine areas for conditions under which work is to be performed. Report to the DESIGN ENGINEER all conditions contrary to those shown on the contract drawings or specified herein and all other conditions that will affect satisfactory execution of the work. Do not proceed with work until unsatisfactory conditions have been corrected and authorization has been given by OWNER's representative.

B. Conduct site clearing operations to ensure minimum interference with roads, streets, walks, and other adjacent occupied or used facilities. Do not close or obstruct streets, walks, or other occupied or used facilities without permission from authorities having jurisdiction.

C. Provide protection necessary to prevent damage to existing improvements indicated to remain in place on adjoining properties and on OWNER's. Restore damaged improvements to their original condition, as acceptable to parties having jurisdiction, without additional cost to the OWNER.

D. Keep dirt, dust, noise, and other objectionable nuisances to a minimum. Use temporary enclosures, coverings, and sprinkling, or a combination thereof, as necessary to limit

dust to lowest practicable level, except do not use water to the extent of causing flooding, contaminated runoff, or icing.

E. Protect existing trees and other vegetation indicated to remain in place, against unnecessary cutting, breaking or skinning of roots, skinning and bruising of bark, smothering of trees by stockpiling construction materials or excavated materials within drip line, access foot or vehicular traffic, or parking of vehicles within drip line. Provide temporary guards to protect trees and vegetation to be left standing.

1. Water trees and other vegetation to remain within limits of the contract work as required to maintain their health during course of construction operations.

2. Repair or replace trees and vegetation indicated to remain which are damaged by construction operations, in a manner acceptable to OWNER, without additional cost to OWNER. Employ licensed arborist to repair damages to trees and shrubs.

3. Replace trees which cannot be repaired and restored to full-growth status, as determined by arborist.

F. Property corners, iron pipe and/or monuments, shall be located and protected before beginning clearing operations.

## 1.4 QUALITY ASSURANCE

A. Obtain a copy of Land Disturbing Permit and maintain at the site.

B. Obtain the required permits and conform to applicable codes for disposal of debris off-site and burning of debris on-site.

C. Perform all work in accordance with requirements of OSHA and the Environmental Protection Agency in addition to State and local requirements.

## 1.5 MEASUREMENT AND PAYMENT

Measurement shall be made of the area Cleared, Grubbed and Stripped of Topsoil in acres. The cost of all required work and all costs incidentals thereto shall be included in the unit prices in the Proposal for “Clearing, Grubbing and Stripping Topsoil”.

# PART 2 PRODUCTS

## 2.1 TOPSOIL

A. Topsoil is defined as natural, friable soil, characteristic of representative soils that produce heavy growth of crop, grass, or other vegetation is generally that soil strata found on the site of 6 to 12 inches depth.

B. Topsoil for placement on graded areas shall be free from roots, stones, and other materials that may hinder grading, planting, and maintenance operations, and shall be free from objectionable weed seeds and toxic substances.

# PART 3 EXECUTION

## 3.1 CLEARING

A. Clearing shall consist of the cutting, removal, and satisfactory disposal of all trees and shrubs within the clearing limits as designated on the plans and/or within easements and right-of-ways which will require construction work during the project.

B. Clear only those areas required to install the soil erosion control devices as shown on the plans and outlined in Section 01560 - Erosion and Sediment Control of these specifications prior to starting overall clearing operations.

C. Repair and maintain erosion control devices during construction in order to always assure their efficiency.

D. Trees to remain shall be trimmed of branches which will obstruct the new construction or as directed by the DESIGN ENGINEER or CQA ENGINEER. Branches to be trimmed shall be neatly cut close to the bole of the tree or main branch. Cuts more than 1 ½" in diameter shall be painted with a tree wound paint formulated for use on damaged plant tissues.

## 3.2 GRUBBING

A. Grubbing shall consist of the removal and disposal of stumps, roots larger than three (3) inches in diameter and matted roots from the designated clearing limits to a depth of 18 inches below the original surface level of the ground.

B. For trees to remain, provide protection for roots over 1 ½" in diameter which are cut during grubbing. Coat cut faces with a tree wound paint formulated for use on damaged plant tissues. Temporarily cover exposed roots with wet burlap to prevent roots from drying out, cover with earth as soon as possible.

C. Depressions made by grubbing shall be filled with suitable material and compacted to make the surface conform with the original adjacent surface of the ground, unless further excavation is indicated.

D. Use only hand methods for grubbing inside drip line of trees indicated to be left standing.

## 3.3 TOPSOIL STRIPPING, STOCKPILING AND SPREADING

A. All topsoil within the clearing limits shall be stripped and stockpiled as directed by the OWNER.

B. Topsoil shall be placed on all shoulders, slopes, ditches, and other earth areas graded under this contract, unless otherwise specified on the plans. Topsoil shall be uniformly placed on these areas to a compacted depth of not less than 4 inches or more than 6 inches. Topsoil depth on landscape areas shall be no less than 6 inches. The material shall be placed, leveled, and lightly compacted with at least one pass of a cultipacker, or other approved equipment weighing 100 to 160 pounds per linear foot of roller, to required cross sections.

## 3.4 REMOVAL OF DEBRIS

A. Removal of debris shall consist of the satisfactory disposal of any garbage or rubble within the clearing limits, easements, right-of-way or as specifically designated on the Drawings.

## 3.5 DISPOSAL OF MATERIAL

A. All vegetation and debris within the areas to be cleared shall become the property of the CONTRACTOR upon the start of work and shall be removed from the site and properly disposed.

B. Burning of combustible materials removed by clearing and grubbing operations will be allowed providing the CONTRACTOR obtains such permits and approvals required by local authorities, if available. The CONTRACTOR will be responsible for controlling fires in compliance with all Federal, State, and Local laws and regulations. The securing of necessary burning permits shall be the responsibility of the CONTRACTOR. All burning shall be under the constant care of competent watchmen. All materials resulting from clearing and grubbing operations and disposed of by burning on the site shall be thoroughly and completely reduced to ashes.

--END OF SECTION--

# SECTION 02210 GRADING

## PART 1 GENERAL

### 1.1 DESCRIPTION OF WORK

A. Excavation, fill, and preparation of sub-grade for landfill, roadways, embankments, building foundations, and detention basins.

B. All excavation shall conform with the lines and grades as shown on the plans or established by the DESIGN ENGINEER.

### 1.2 RELATED WORK

Drawings and general provisions of Contract, including General and Supplementary Conditions, and Detailed Specification sections, apply to work specified in this section.

### 1.3 QUALITY ASSURANCE

A. Perform excavation work in compliance with applicable requirements of governing authorities having jurisdiction.

B. OWNER will engage soil testing and inspection service, for quality control testing during earthwork operations.

C. Test reports for the following items shall be given to the DESIGN ENGINEER and will be available for the CONTRACTOR directly responsible for earthwork being tested:

1. Field Density Test Reports

2. One (1) optimum moisture-density curve for each type of soil encountered.

3. Other field inspection reports as deemed appropriate.

### 1.4 APPLICABLE STANDARDS

The most recent publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.
American Society for Testing and Materials (ASTM) Publications (Latest Version):

D6913 or D7928 — Method of Particle-Size Analysis of Soils

| | |
|---|---|
| D698 | Moisture Density Relations of Soils and Soil Aggregate Mixtures Using 5.5 lb. Rammer/12 inch drop |
| D1556 | Density and Unit Weight of Soil in Place by the Sand-Cone Method |
| D6938 or D8167 | Density of Soil in Place by the Nuclear Gage |
| D2937 | Density of Soil in Place by the Drive Cylinder Method |
| D4318 | Test Method For Liquid Limit, Plastic Limit and Plasticity Index of Soils |

## 1.5 SUBMITTALS

Submittals are required for proposed technique for rock excavation (Blasting not allowed), road construction materials including graded aggregate and geotextiles.

## 1.6 MEASUREMENT AND PAYMENT

A. General

Measurement shall be in accordance with Section 01051 – Construction Surveys.

B. Unclassified Excavation

1. Unclassified Excavation shall consist of all the excavated material to (1) compacted clay liner subgrade, (2) road subgrade, or (3) other structure subgrade. Unclassified excavation shall also include the subsequent placement of all material above the subgrades whether into embankments, disposal, or stockpiling in designated areas of all material, regardless of its nature of the manner in which it is removed from existing grade to the subgrades. For the landfill cell, unclassified excavation is defined as all materials to the depth indicated below the FML to accommodate the clay liner. For roadways the subgrade is defined as the subsurface prepared to receive sand clay base or aggregate base. Suitable and designated unclassified excavation materials only shall be used for all embankments fills, roadways, sediment basin embankments and other structural uses on the job site wherever such used are indicated or required.

2. Payment for unclassified excavation shall be included in the unit price per cubic yard stated in the Proposal for “Unclassified Excavation”.

C. Unsuitable Material

Areas requiring undercutting due to being unstable as determined by the CQA ENGINEER shall be measured in the presence of the CQA ENGINEER. Undercut excavation shall include the subsequent placement of all fill material required to replace undercut material. Payment shall be for the cubic yard unit price stated in the proposal for "unsuitable material". No payment will be made for undercut excavation performed prior to approval by the CQA ENGNIEER. Additionally, no payment shall be made for over excavation of unsuitable materials and no payments shall be made for excavation of unsuitable material volumes filled prior to inspection by the CQA ENGINEER.

D. Rock Excavation

Areas requiring rock excavation shall be measured in the presence of the CQA ENGINEER. Only non-rippable rock will be considered rock. Non-rippable rock is defined as rock that cannot be ripped using a single tooth ripper mounted on a D-8 dozer, making three (3) passes in perpendicular direction and producing at least 0.5 C.Y. of loosened rock. Payment shall be by the cubic yard price established in the proposal. No payment will be made for rock overexcavation or boulders. Boulders shall be defined as rock if more than 1.0 C.Y. in volume.

E. Compacted Clay Liner Subgrade

There shall be no measurement of compacted clay liner subgrade. Payment for construction of compacted clay liner subgrade shall be included in the unit price in the proposal for "Compacted Clay Liner".

F. Fine Grading

Payment for fine grading shall be included in the unit prices bid in the Proposal for "Unclassified Excavation".

G. All Weather Access Road

1. Measurement shall be of the horizontal area of the improved surface in square yards.

2. Payment shall be made at the unit price per square yard in the Proposal for "All Weather Access Road" and shall include graded aggregate, and geotextile fabric.

H. Payments shall be full compensation for all work covered by this section, including but not limited to: excavating and hauling anywhere within the property lines; removal of

unsuitable material; embankment placement; disposal (including disposal of boulders); or stockpiling of materials; and formation / compaction of embankments, road or landfill subgrades, and shoulders.

# PART 2 PRODUCTS

## 2.1 SUITABLE MATERIAL

A. Shall be free from construction material, debris, frozen material, organic matter or unstable material.

B. Shall be suitable for the formation of embankments, subgrades, backfill, shoulders and other places requiring structural fill as may be indicated on the contract drawings or directed by the CQA ENGINEER.

C. No rock greater than 6 inches in diameter shall be placed in any portion of the landfill embankment except as allowed in Section 3.5, C.5. Small rock less than 6 inches, if used, shall be incorporated into the embankment in such a fashion to completely avoid bridging or voids.

## 2.2 UNSTABLE MATERIAL

The CQA ENGINEER will designate whether or not a material is unstable for the formation of embankments and sub-grades. Unstable material may also be referred to as unsuitable. Moisture content of material alone shall not render material unstable or unsuitable. It is CONTRACTOR's responsibility to raise or lower material moisture content to achieve specified compaction densities or remove and replace at CONTRACTOR's expense.

## 2.3 UNSUITABLE MATERIAL

Material deemed unsuitable by the CQA ENGINEER for embankment formation operations or other operations shall be removed, replaced, and compacted using a suitable material.

## 2.4 BORROW EXCAVATION

Borrow material is available on site which is suitable for formation of embankment and subgrades as determined by the CQA ENGINEER, and shall be obtained from areas designated on the contract drawings.

## 2.5 SOIL LINER SUBGRADE

This area includes the designated thickness of compacted material to the limits indicated below the low permeability soil liner.

## 2.6 SELECT SOILS FOR MUNICIPAL SOLID WASTE LANDFILL

The CQA ENGINEER shall classify soils suitable for low permeability liner construction, drainage blanket (protective cover) and daily waste cover during the site excavation. The CONTRACTOR shall stockpile the materials at stockpile areas designated by the CQA ENGINEER.

### 2.7 GRADED AGGREGATE

Graded aggregate for access road construction shall comply with State Department of Transportation specifications for graded aggregate base.

### 2.8 GEOTEXTILE FABRIC

The geotextile fabric for access road construction shall be a high modulus, six (6 o.s.y.) ounce per square yard, woven geotextile suitable for road base stabilization, soil separation, and reinforcement. The fabric shall be Propex GEOTEX 3155T, Ten Cate Mirafi 600X, or equal.

## PART 3 EXECUTION

### 3.1 PREPARATION OF GROUND SURFACE FOR FILL

Before embankment and roadway construction are begun, all vegetation and rubbish shall be removed from the area within the limits of the embankment and roadway.

Following stripping, those areas at grade or designated to receive fill or subsequent materials placement shall be PROOF ROLLED in the presence of the CQA ENGINEER with a loaded dump truck or similar piece of heavy equipment to identify those areas needing repair due to pumping or yielding. Any area which ruts or pumps excessively in the opinion of the CQA ENGINEER shall be UNDERCUT to firm bearing and backfilled with properly compacted soil fill.

Topsoil shall be stockpiled and utilized in areas to be seeded after completion of grading. Excess topsoil shall be hauled to designated areas.

### 3.2 DETERMINATION OF IN-PLACE SOIL PROPERTIES

A. Determination of Density

Testing shall be provided by the CQA ENGINEER for the OWNER. Testing shall be performed by an approved commercial testing laboratory. The number of laboratory moisture-density tests and field density tests shall be in accordance with Paragraph Number of Density Tests to insure the specified density is obtained. Laboratory tests for moisture-density relations shall be performed in accordance with ASTM D698. Field tests for density and moisture content shall be performed in accordance with ASTM D1556, ASTM D2937, ASTM D6938 or ASTM D8167. Copies of all tests results will be furnished to the CONTRACTOR and the DESIGN ENGINEER. All testing shall comply with minimum construction quality assurance requirements of the State.

B. Classification Tests:

Liquid Limit, Plastic Limit, and Plasticity Index will be determined in accordance with ASTM D4318. Particle size analysis will be performed as specified in ASTM D6913 or D7928.

C. Number of Density Tests:

The following tests will be performed and are considered to be the number of tests. Additional tests may be required contingent upon weather and/or soil conditions.

1. One (1) laboratory moisture-density relation test and companion classification test for each type of soil encountered.

2. A minimum of one (1) density test shall be performed per 1,000 cubic yards of fill subgrade and other embankment fills.

## 3.3 DRAINAGE

Satisfactory methods for dewatering during construction shall be installed as required. Cost of dewatering shall be included in the unit (or) lump sum price in the proposal for unclassified excavation. The disposal of water after removal shall be in keeping with the intents of the soil erosion control plan.

## 3.4 ROCK EXCAVATION

N/A

## 3.5 GENERAL COMPACTION/FILL REQUIREMENTS

Excavation, fill and compaction requirements for this project vary as to the respective subgrade being constructed. Any subgrade not specifically detailed herein or any subgrade requirements that references this section shall meet the requirements of this section.

A. COMPACTION

1. When tested, embankment and fill material shall be compacted to not less than 95% Standard Proctor (ASTM D698) of the maximum dry density, or as specified in the schedule below. All subgrades will be proof-rolled prior to acceptance of subgrade by the CQA ENGINEER. Proof-rolling will be in accordance with procedures in section 3.1 of this specification. The number of tests shall be in accordance with Section 3.2, C.

| DESCRIPTION | STANDARD PROCTOR COMPACTION |
|---|---|
| Sediment Pond Embankments | 95% |
| Roadways | 95% (98%, Top 12 inches) |
| Shoulders & Embankments | 95% |
| Utilities Under Structures | 95% |
| Other Areas | 95% |

2. If, in the opinion of the CQA ENGINEER (based upon testing reports, or inspection), subgrade or fills which have been placed are below specified density, the CONTRACTOR shall then provide additional compaction or repairs at no additional cost to OWNER. Retests may be charged to the CONTRACTOR as determined by the CQA ENGINEER.

3. Subgrade materials shall be compacted at a moisture content within plus or minus 4% of optimum unless more or less moisture is allowed by the CQA ENGINEER. The CONTRACTOR shall dry or add moisture to the subgrade material when required to provide a uniformly compacted subgrade.

B. PROTECTION OF SUBGRADES

Ditches and drains shall be provided and maintained when required to satisfactorily drain the subgrade. Where previously approved subgrade is damaged by natural causes, by hauling equipment, or by other traffic, the CONTRACTOR shall restore the subgrade to the required lines, grades, and typical sections and to the required density at no additional cost to the OWNER.

C. EMBANKMENT FORMATION:

1. Areas to receive embankment formations or fill shall be stripped to suitable base material as required in Section 02110 - Clearing and Grubbing.

2. The material shall be deposited and spread in successive, uniform, approximately horizontal layers of not more than ten (10") inches in depth, loose measurement, for the full width of the cross section, and shall be kept approximately level by the use of effective spreading equipment. Each layer of the embankment shall be satisfactorily compacted as hereinafter specified.

3. Hauling shall be distributed over the full width of the embankment, and in no case will deep ruts be allowed to form during the construction of the embankment. The embankment shall be properly drained at all times.

4. Where embankments are to be constructed across ground which will not support the weight of trucks or other hauling equipment, the first layer of the embankment may be constructed by dumping successive truck or other equipment loads in a uniform distributed layer of a thickness not greater than that necessary to support the trucks or hauling equipment while placing subsequent layers. The remainder of such embankments shall then be constructed in layers as above specified.

5. When embankments are being constructed principally of rock, the depth of each layer shall be no greater than 36 inches. The rock shall be carefully distributed throughout the embankment and all voids shall be filled with fine material. The rock shall have a maximum particle size of no more than two (2') feet. No rock lifts shall be placed within three (3') feet vertically of the soil liner subgrade or roadway subgrade and shall only be placed in fill sections totaling greater than 6 feet nor shall rock be placed in proposed underground utility locations.

D. EMBANKMENT COMPACTION:

1. All embankment material shall be compacted to 95% Standard Proctor compaction unless otherwise provided in the Contract Documents or directed by the CQA ENGINEER. Compaction equipment used by the CONTRACTOR shall be adequate to produce the required compaction and produce a uniformly constructed embankment with all layers uniformly bound to all preceding layers.

2. Embankment materials shall be compacted at a moisture content within plus or minus four (4%) percent of optimum. The CONTRACTOR shall dry or add moisture to the embankment material when required to provide a uniformly compacted and stable embankment.

## 3.6 GENERAL GRADING TOLERANCES

Grading tolerances shall be as specified below:

LANDFILL(S)

Liner Subgrade (- 0.1' - 0)

Compacted Clay Liner
- A. Rough Grading (+ 0 to 0.2')
- B. Fine Grading (+ 0 to 0.1')

Embankment (± 0.1')

Protective Cover Gravel (+ 0.1')

ROADWAYS AND STRUCTURES

Roadway Subgrade
- A. Rough Grading (± 0.12')
- B. Fine Grading (± 0.04')

Other
- A. Rough Grading (± 0.12')
- B. Fine Grading (± 0.04')

## 3.7 ROADWAY SUBGRADE

A. Preparation of Subgrade

The roadway subgrade shall be shaped to the lines, grades and typical sections shown on the plans. Where the CQA ENGINEER directs that areas of the subgrade are to be stabilized, the subgrade surface in such areas may be left uniformly below grade to provide for the addition of the stabilizer material.

All unsuitable material, boulders, and all vegetative matter shall be removed and replaced with suitable material. Suitable material, when not available from the subgrade work, shall be taken from general excavation or borrow sources.

Material excavated in preparing the subgrade shall be stored or stockpiled in such a manner as to not interfere with the proper drainage or any of the subsequent of placing base or pavement.

B. Compaction of Subgrade

When tested, fill material shall be compacted to not less than the following percent of the maximum dry density:

1. Under paved roads 95%; top 12 inches to 98%.

2. Under shoulders and stoned road 95%.

The subgrade shall be compacted at a moisture content which is approximately that required to produce the maximum density indicated. The CONTRACTOR shall dry or add moisture to the subgrade when required to provide a uniformly compacted and acceptable subgrade.

C. Protection of Subgrade

Ditches and drains shall be provided and maintained when required to satisfactorily drain the subgrade. Where previously approved subgrade is damaged by natural causes, by hauling equipment, or by other traffic, the CONTRACTOR shall restore the subgrade to the required lines, grades, and typical sections and to the required density at no cost to the OWNER.

D. Rough Grading

The roadway subgrade surface shall to within the specified tolerance of the grades indicated on the contract drawings. The final rough grade surface shall meet the

compaction requirements and be graded and sealed to properly drain storm water prior to acceptance by the CQA ENGINEER.

E. Fine Grading

CONTRACTOR shall fine grade all roadway surfaces to within the specified tolerance of the grades indicated on the contract drawings. Compaction requirements shall be as described in Section 3.5.

## 3.8 LANDFILL CELL

The landfill cell shall be excavated to achieve the subgrade elevations equal to the specified liner thickness below the lines and grades indicated on the drawings as the top of clay elevation. The subgrade then shall be scarified to a depth of six (6") inches and compacted to 95% Standard Proctor before acceptance and subsequent placement of the low permeability soil liner.

Fine Grading:

CONTRACTOR shall fine grade the subgrade prior to placement of the soil liner.

## 3.9 STOCKPILE AREAS

Surplus and unsuitable excavation shall be hauled, placed and sloped to drain for each material classification.

Material stockpile areas are indicated on the contract drawings. All excavation material shall be placed or stockpiled by one of the means listed below. All material types and classifications shall be subject to the interpretation of the CQA ENGIEER and shall be stockpiled or used for fill as directed by the CQA ENGINEER. All stockpiles remaining over 14 days shall be stabilized with grass.

- Used for structural fill
- Stockpiled as topsoil
- Stockpiled as soil liner material
- Stockpiled as daily cover
- Stockpiled as drainage blanket (protective cover) material

## 3.10 MOISTURE CONTROL

Where subgrade or layer of soil material must be moisture conditioned before compaction, uniformly apply water to surface of subgrade or layer of soil material to prevent free water appearing on surface during or subsequent to compaction operations.

The CONTRACTOR shall furnish equipment for modifying the moisture content of the fill material and at times when the moisture content is not within the specified range, shall operate such equipment so as to achieve the necessary correction with minimum loss of time.

The addition of water shall be accomplished by methods which will distribute the added water evenly and in a controlled manner over the fill. Reduction in water content shall be accomplished by methods which are effective for promoting aeration of the fill material. No fill shall be placed until approved types of equipment for aeration and for addition of water are on the job and are demonstrated to be satisfactory of watering and/or dewatering operations.

During placement operations, CONTRACTOR shall keep surfaces from drying by addition of water or placement of additional materials.

Remove and replace, or scarify and air dry, soil material that is too wet to permit compaction to specified density.

Soil material that has been removed because it is too wet to permit compaction may be stockpiled or spread and allowed to dry. Assist drying by discing, harrowing or pulverizing until moisture content is reduced to a satisfactory value.

## 3.11 PROTECTION OF SUBGRADES AND FILL SURFACES

Newly graded areas shall be protected from traffic and erosion, and all settlement or washing away that may occur from all causes, prior to acceptance, shall be repaired and grades re-established to the required elevations and slopes. Embankments and excavations shall be kept shaped and drained. Ditches and drains along subgrade shall be maintained in such a manner as to drain effectively at all times. The finished subgrade shall not be disturbed by traffic or other operations and shall be protected and maintained by the CONTRACTOR in a satisfactory condition until compacted soil liner or road base materials are placed. The storage or stockpiling of materials on the finished subgrade will not be permitted.

## 3.12 WORK ON EXISTING ROADWAY RIGHT-OF-WAY

All dirt spilled from the CONTRACTOR's trucks on existing pavements over which it is hauled or which has otherwise been deposited thereon shall be removed by the CONTRACTOR. Whenever, in the opinion of the CQA ENGINEER, the accumulation is sufficient to cause the formation of mud, dust, interference with traffic, or create a hazard, the CONTRACTOR will be directed to remove such accumulations without delay.

Shoulders of roadways shall be left in good, acceptable condition and all topsoil and grass that is disturbed shall be replaced.

--END OF SECTION--

# SECTION 02220 TRENCHING, BACKFILLING AND COMPACTION

## PART 1 GENERAL

### 1.1 DESCRIPTION

The work under this Section includes all excavation, backfill, compaction, pavement removal, site restoration and cleanup for the construction of underground pipelines, and their related structures.

### 1.2 RELATED WORK

A. Section 02720 - Storm Sewer Systems
B. Section 02744 - High Density Polyethylene (HDPE) Pipe
C. Section 02747 - Leachate Collection System

### 1.3 DEFINITIONS

A. Pipeline Embedment:

1. Backfill material encasement extending from the full depth of bedding to a distance of twelve (12") inches above the top of the pipe.

2. Embedment is composed of bedding, initial backfill and foundation.

B. Foundation:

1. The load bearing portion of the embedment which underlines the bedding material.

2. Normally the excavated trench bottom except where unstable conditions exist and then alternate methods of foundation stabilization are required.

C. Bedding: Backfill material between a pipe and the foundation on which it rests.

D. Initial Backfill: Backfill placed from the top of the bedding and along the sides of the pipe to a distance of twelve (12") inches above the top of the pipe.

E. Final Backfill: Backfill placed from a distance of twelve (12") inches above the top of the pipe to the finished grade.

F. Embankment: Fill material placed above original ground surface to provide cover over a conduit which is fully or partially exposed.

G. Rock: Where "Rock" is used as the name of an excavated material, it shall mean boulders or pieces of rock, concrete or masonry measuring one (1) cubic yard or more, hard shale or solid ledge rock and masonry which, in the opinion of the CQA ENGINEER, requires for its removal the continuous use of pneumatic tools.

### 1.4 QUALITY ASSURANCE

A. Tests required by this section shall be performed by a qualified independent testing laboratory meeting the requirements of Section 01400.

B. The CONTRACTOR shall insure that all testing laboratory personnel contact the project representative prior to conducting tests to mutually select the test site. No testing shall commence without this contact.

C. All work shall comply with local development standards and state department of transportation specifications.

D. Regulatory Requirements:

1. Comply with applicable requirements of federal, state, and local laws, regulations and codes having jurisdiction at project site.

E. Reference Standards: Applicable requirements of standards and specifications referenced herein apply to the work of this Section.

### 1.5 SUBMITTALS

A. A minimum of two (2) copies of all test results shall be submitted to the CQA ENGINEER.

## PART 2 PRODUCTS

### 2.1 BACKFILL MATERIAL

A. The requirements of this Article shall apply to all backfill materials unless otherwise specified.

B. All material shall be suitable and free from roots, wood, scrap material, and other vegetable matter and refuse.

C. Acceptable material shall generally be a natural or artificial mixture of soil types normally found in natural deposits in the project vicinity or material obtained from the CONTRACTOR's excavations.

D. All material shall be sufficiently dry for compaction and shall not contain excessive amounts of soft or highly plastic clays.

E. Maximum size of stone shall not exceed four (4") inches.

## 2.2 BEDDING MATERIAL

A. Fine Granular Bedding:

1. Materials for fine granular bedding shall consist of well graded fine to course sands or gravel meeting the gradation requirements of ASTM C 33 for fine aggregates.

2. Natural materials or artificial mixtures, consisting largely of a mixture of sand and clay, found in natural deposits in the project vicinity may be utilized as long as the material meets the proper proportions and gradation requirements.

3. The material shall generally pass a 3/8" sieve with no more than 10% passing a No. 100 sieve, and shall be non-plastic.

B. Gravel Bedding:

1. Materials used for gravel bedding shall consist of natural rounded or angular, graded stone or crushed rock, with little or no fines.

2. Generally, the aggregate size shall range from 1½" to 3/8".

3. ASTM classification shall be No. 57 stone.

## 2.3 UNSUITABLE MATERIALS

A. General: Any material, which in the opinion of the CQA ENGINEER, contains vegetable matter, muck, roots, and rubbish shall be considered unsuitable.

B. The following, as defined in the United Soils Classification System, shall be considered the basis for classifying unsuitable material unless specifically noted in other sections of the specifications:

1. Highly plastic clay soils of the CH and MH descriptions.
2. Border line soils of the SC-CH description.
3. Organic soils of the OL and OH description.
4. Highly organic soils of the PT description.

# PART 3 EXECUTION

## 3.1 SITE PREPARATION

A. Clearing and Care of Surface Materials:

1. In areas where pipelines are constructed through established lawns and other improved grass areas, the sod shall be carefully removed, kept alive and replaced after backfilling is finished.

2. Topsoil so removed shall be stockpiled at a suitable location so that it can be replaced.

B. Trees, plants, and existing structures and utilities shall be protected with appropriate barriers prior to construction.

## 3.2 GENERAL TRENCH EXCAVATION

A. The requirements of this Article shall apply to all trench excavation unless otherwise specified.

B. Trench excavation shall be of such depth to enable proper installation of embedment materials that will result in construction of the pipeline to the alignment and grade, or depth of cover, as shown on the Drawings.

1. Over-excavation and replacement of materials with proper bedding material shall be required where specified by the CQA ENGINEER.

2. If during the course of construction, the trench is inadvertently over-excavated, that area shall be backfilled with fine granular bedding material, unless gravel bedding is required where unsuitable materials are encountered in the subgrade or where specified by the CQA ENGINEER.

C. All such related structures and appurtenances shall be constructed to the alignment, grade, and position as shown on the Drawings.

D. In all cases where materials are deposited along open excavation they shall be placed so that in the event of rain, no damage will result to the work or adjacent property.

E. Unstable trench bottom:

1. Where an unstable trench bottom condition is encountered due to the presence of muck, quicksand, or other unsuitable materials, the unstable soil

material shall be removed to a depth which is sufficient to produce a firm foundation.

2. The unstable soil material shall then be replaced with Class B embedment for the full depth of unstable material excavation.

3. The depth of unstable soil excavation and bedding replacement will be dependent upon the severity of the trench bottom soil conditions.

4. Depths of bedding shall be as a minimum those specified for Class B embedment, contained in Article 3.7 (c) of this Section.

5. Alternate foundations shall be used where required as specified in Article 3.8 of this Section.

F. Regardless of the type of embedment used, all bell holes for bell and spigot pipe shall be excavated at proper intervals so that the barrel of the pipe will rest for its entire length upon the bottom of the trench or bedding material.

G. All bedding materials shall achieve the required densities by tamping with suitable tools and shaped to receive the pipe and support it at the exact elevation and line as shown on the Drawings.

H. Wet excavation:

1. Where the excavation area shown on the Drawings falls under the water surface near the banks of a flowing stream or other body of water or in high ground water areas, the CONTRACTOR may adopt and carry out any method he may deem feasible for the performance of the excavation work and for the protection of the work thereafter; provided the method and equipment to be used has received prior approval of the CQA ENGINEER.

2. During the selected method of construction, the excavation area shall be effectively protected from damage during the excavation period and until all contemplated construction work therein has been completed to the satisfaction of the CQA ENGINEER.

3. The cost of all temporary construction work necessary or incidental thereto, including the cost of installing and removing sand bags, coffer dams, sheet piling, excavation and backfill, pumping and dewatering, shall be considered as an integral part of the cost of excavation and no separate payment therefore shall be allowed or made.

I. Disposal of materials:

1. Disposal of waste materials and smoothing of disturbed material during trenching operations shall be performed as the pipe is laid and shall not be allowed to lag more than 500 feet behind the pipe laying operations.

2. All materials removed by excavation which are suitable for the purpose shall be used whenever practicable for backfilling pipe trenches, foundations and footings, and for such other purposes as may be shown on the Drawings or directed by the CQA ENGINEER.

3. All materials not used for backfilling, foundations, or footings shall be considered as waste materials and disposed of by the CONTRACTOR in an approved manner.

4. Waste materials may be deposited in spoil banks at locations designated by the CQA ENGINEER.

5. If no disposal areas are shown on the Drawings, the CONTRACTOR shall provide at his own expense disposal areas satisfactory to the CQA ENGINEER.

6. Waste materials shall not be left in unsightly piles, but shall be spread in uniform layers and neatly leveled and shaped.

7. Spoil banks shall be provided with adequate openings to permit surface drainage of adjacent lands.

8. On completion of any part of the work proper disposal shall be made of all surplus or unused materials left within the construction limits of such work and the surface of the work left in a neat and workmanlike condition.

## 3.3 WATER IN TRENCHES

A. Trenches shall be reasonably free from water while the pipes are being laid.

1. The CONTRACTOR shall remove and dispose of any water (including storm water), sewage, or any other liquid which may be found or may accumulate in the excavations.

2. This may be done by pumping an adequate well point system, or other means of dewatering approved by the CQA ENGINEER.

B. The CONTRACTOR shall examine the site after excavating, and before proceeding with the work he shall notify the CQA ENGINEER of any evidence of water rising in such areas.

C. Static water levels shall be drawn down below the bottom of the excavation sufficiently to allow for placement of bedding and backfill.

1. Under certain conditions, the CQA ENGINEER may permit the CONTRACTOR to remove the water with the use of trenchside pumps through the use of an approved bedding.

2. The depth of bedding material will depend upon the amount of water, but care shall be taken to ensure that the trench wall soil material is such that it will not be removed from the area adjacent to the bedding.

D. The CONTRACTOR shall not open up more trench than the available pumping facilities are able to dewater.

E. The CONTRACTOR shall assume responsibility of disposing of all water so as not to injure or interfere with the normal drainage of the territory in which he is working.

F. In no case shall the pipe lines be used as drains for such water, and the ends of the pipe shall be kept properly and adequately blocked during construction by the use of approved stoppers and not by improvised equipment.

G. All necessary precautions shall be taken to prevent the entrance of mud, sand, or other obstructing matters into the pipe lines, and on completion of the work, any such material which may have entered the pipe lines must be cleaned out so that the entire system will be left clean and unobstructed.

H. Release of groundwater to its static level shall be performed in a manner to maintain undisturbed state of natural foundation soils, prevent disturbance of compacted backfill or bedding, and prevent flotation of pipelines.

I. The CONTRACTOR shall at all times have on hand sufficient pumping equipment and machinery in good working condition for all ordinary emergencies, and shall have available at all times competent workmen for operation of pumping equipment.

J. Dewatering systems shall be designed and operated to prevent removal of natural soils and to prevent excessive reductions in the groundwater outside the excavation to the extent that it would damage or endanger adjacent structures or property.

## 3.4 TRENCH SIZE

A. Gravity piping:

1. As soil conditions will permit, the sides of trenches shall be cut in vertical, parallel planes from the bottom of the trench to the top of the pipe and have maximum width of two (2') feet plus the outside diameter of the pipe as shown on the Drawings.

2. The width of the remaining depth of the trench may be as wide as necessary except as restricted by limits of right-of-way or existing improvements that are to be protected; the sides, however, shall be as nearly vertical as practicable or allowable.

3. If the trench width from the bottom of the trench to the top of the pipe is over-excavated in excess of that specified, sewers shall be laid on a gravel bedding at no extra cost to the OWNER.

B. Pressure Piping:

1. Trenches for pressure piping shall provide a minimum of 30 inches cover over the barrel of the pipe, except as otherwise shown.

2. Width of trench at and below top of the pipe shall not exceed twelve (12") inches on either side of pipe.

3. Width of trench above top of pipe may be as wide as necessary within limits of right-of-way, with banks as nearly vertical as practicable or allowable, and except as restricted by existing improvements, that are to be protected.

## 3.5 EXCAVATION FOR APPURTENANCES AND STRUCTURES

A. Excavation for appurtenances shall be made to a size that will allow at least twelve (12") inches between the outer surfaces of the appurtenance and the excavation wall or shoring.

B. Excavation for precast manholes and other precast structures shall be undercut six (6") inches below the bottom of the precast structure and shall be backfilled with gravel bedding as specified under the bedding material in this section.

C. Undercutting and providing a bedding for structures shall be considered as an integral part of the work and no separate payment shall be allowed or made.

## 3.6 EMBEDMENT OF PIPE

A. Pipeline embedment shall consist of all bedding materials, including concrete, foundation and initial backfill as shown on the Drawings.

B. Class A Embedment:

1. Concrete Cradle: The pipe shall be embedded in a monolithic cradle of plain or reinforced concrete.

   a. The minimum thickness shall be one-fourth (1/4) the inside pipe diameter or a minimum of four (4") inches under the barrel and extending up the sides for a height equal to one-fourth (1/4) the outside diameter.

   b. The cradle shall have a width at least equal to the outside diameter of the pipe barrel plus eight (8") inches or poured to the full width of the trench.

2. Concrete arch: The pipe shall be embedded in carefully compacted gravel bedding with a monolithic plain or reinforced concrete arch.

   a. The gravel bedding shall have a thickness of one-fourth (1/4) the outside diameter or three (3") inches minimum between the barrel and bottom of trench excavation extending to the springline of the pipe.

   b. The concrete arch shall have a minimum thickness of one-fourth (1/4) the inside diameter at the crown and have a minimum width equal to the outside pipe diameter plus eight (8") inches or poured to the full width of the trench.

C. Class B Embedment:

1. Class B embedment shall be used where an unstable trench bottom condition is encountered or where established by the DESIGN ENGINEER or where shown on the Drawings.

2. The pipe shall be laid on gravel bedding placed on a flat trench.

3. The gravel bedding shall have a minimum thickness of one-fourth (1/4) the outside pipe diameter.

4. The gravel bedding shall extend to the springline of the pipe barrel, or one-half (2) the outside diameter of the pipe.

D. Class C Embedment:

1. Class C embedment shall be used as the normal or ordinary embedment and shall be used unless unstable trench conditions are present or where otherwise shown on the Drawings.

2. The pipe shall be embedded in fine granular material on a trench bottom which shall be level in cross-section except that a continuous trough shall be

shaped in the bedding which will fit the pipe barrel with reasonable closeness.

3. The bedding shall have a minimum thickness beneath the pipe of six (6") inches or one-eighth (1/8) of the outside diameter of the pipe, whichever is greater.

4. The bedding shall extend up the sides of the pipe one-sixth (1/6) of the outside diameter of the pipe.

E. Initial backfill material, which is from the bedding to one (1') foot above the pipe:

1. Shall be carefully deposited in successive horizontal layers of not more than twelve (12") inches in loose depth on each side of the pipe.

2. Shall be thoroughly and carefully tamped or rammed around the pipe with approved tools until reaching a minimum cover of not less than one (1') foot over the top of the pipe.

## 3.7 ALTERNATE FOUNDATIONS

A. Where the bottom of the trench is found to consist of material which is unstable to such a degree that, in the opinion of the CQA ENGINEER, it cannot be removed and replaced with an adequate bedding material, alternative foundations methods may be required.

B. The CQA ENGINEER may require, depending upon the severity of the unstable soil, to provide special foundations such as piling, concrete mats (or a combination thereof), sheeting with keyed-in plank foundation, or other means of stabilization.

C. The type of alternative foundation methods shall be constructed in accordance with the Drawings or as approved by the CQA ENGINEER.

## 3.8 BACKFILLING TRENCHES

A. The backfilling of sewer or other pipe line trenches shall be started immediately after the pipe work and embedment preparation has been inspected by the CQA ENGINEER.

B. Final backfill material, which if from a height of one (1') foot above the pipeline upward:

1. Shall be backfilled in well compacted layers.

2. If the trench extends along or across streets, roadways, useable alleys, or sidewalks or any areas to be paved in new construction, the remainder of the trench shall be backfilled and tamped to its full depth in the manner specified for initial backfill.

3. Shall be backfilled in the manner specified for initial backfill where indicated on the Drawings.

C. Placement of backfill material in layers greater than twelve (12") inches loose fill shall require prior approval of compaction methods and equipment.

D. All backfilling shall be done in such manner as will not disturb or injure the pipe or structure over or against which it is being placed.

E. Any pipe or structure injured, damaged or moved from its proper line or grade during backfilling operations shall be opened up and repaired and then re-backfilled as herein specified.

F. Where excavation has been made, the top one (1') foot of backfill material shall consist of fine, loose earth free from large clods, vegetable matter, debris, stone, or other objectionable materials.

G. Temporary surfaces:

1. Where pipe trenches are cut across or along existing pavement, the CONTRACTOR shall construct a temporary surface over the cut by filling and tamping the upper six (6") inches of the cut with selected gravel, crushed stone or reef which will not disintegrate under traffic and which shall be maintained in good condition under traffic until the permanent pavement has been constructed.

2. No specific payment will be allowed for temporary surfacing.

## 3.9 COMPACTION AND TESTING

A. Compaction and testing for quality control shall be in conformance with Section 01400 and the Specific requirements of this Section.

B. Minimum tests required on all materials to prove compliance with the specifications shall be as follows:

1. A determination of soil classification, sieve analysis, maximum dry density as per ASTM D-698 and optimum moisture content shall be made from each material source.

2. In-place density test shall be made on all materials under roadways, streets, useable alleys, or other similar areas as required by the CQA ENGINEER.

C. Compaction requirements:

1. Unless otherwise specifically noted elsewhere in these Specifications or on the Drawings, material shall meet the following compaction requirements.
   a. Bedding and initial backfill material shall be well compacted.

   b. Final backfill and embankments shall be compacted to a density equal to or greater than the surrounding undisturbed soil.

   c. Compaction on total (initial & final) backfill and base material under roadways shall meet density requirements as indicated on the Drawings.

   d. Embedment shall be well compacted.

2. The theoretical maximum density shall be arrived at in the manner prescribed under applicable documents.

3. Material containing excessive moisture shall not be placed.

4. Its placement may be delayed until it has dried out to the proper moisture content, or it may be thoroughly mixed with a drier material to obtain the desired water content.

5. Material with insufficient moisture shall be wetted sufficiently before compaction to obtain the desired moisture content.

6. Adequate equipment for furnishing and sprinkling water shall be kept available at all times during the progress of the work.

## 3.10 SURFACE RESTORATION AND CLEAN-UP

A. CONTRACTOR shall properly restore to the satisfaction of the CQA ENGINEER all surfaces, pavements and drives, sidewalks and curbs, or whatever construction and irrespective of the type, which may be required to be removed or disturbed in the progress of work required under this Contract.

B. Surface Restoration:

1. Once backfilling has been completed and all objectionable material has been removed, surface restoration shall be conducted.

2. The CONTRACTOR shall fine grade all disturbed areas within the construction limits, unless otherwise directed by the CQA ENGINEER.

3. Upon completion of fine grading the CONTRACTOR shall seed all disturbed areas, unless otherwise shown on the Drawings in accordance with Section 02930 - Grassing.

4. Shrubbery or trees shall be properly heeled-in and replanted.

C. Clean-up and Maintenance:

1. All excavated areas, backfills, embankments, trenches and access road grading and ditches shall be maintained by the CONTRACTOR in good condition at all times until final acceptance by the OWNER.

2. Any settlement or washing that may occur prior to acceptance of the work, shall be repaired and grades re-established to the required elevations and slopes.

3. All debris and construction material and equipment shall be removed from the job site as soon as the work is completed.

4. All rights-of-way shall be left in a clean, neat and serviceable condition.

--END OF SECTION--

# SECTION 02250 COMPACTED CLAY LINER

## PART 1 GENERAL

### 1.1 SCOPE OF WORK

The Contractor shall furnish all labor, material, supervision, and equipment to complete the Compacted Clay Liner for the cell, including hauling, discing, compacting, drying, removal of rainfall and removal of all previously placed material unsuitable due to weather conditions, final grading and sealing and all necessary and incidental items as detailed or required to complete the compacted liner, all in accordance with the plans and specifications.

### 1.2 MEASUREMENT AND PAYMENT

A. Measurement shall be made by survey or field measurement and computed by the DESIGN ENGINEER in cubic yards with the quantity for payment being the product of the surface area and the required thickness (24") of the clay liner. This quantity shall not include the volume required for normal benching as detailed on the Construction Drawings. This quantity shall not include replacement volumes for areas that have become unsuitable due to weather or the overfill thickness required for erosion protection.

B. Clay liner placed beyond the limits of the lines and grades as shown on the Drawings will not be accepted and must be removed, if directed by the CQA ENGINEER, at the Contractor's expense.

C. The entire Compacted Clay Liner must meet or exceed the specified thickness, density and permeability requirements prior to payment.

D. Payment for work shall be made on the unit price bid per cubic yard of in-place Compacted Clay Liner.

### 1.3 QUALITY ASSURANCE

A. Quality assurance shall be in accordance with the requirements of Section 01400 Quality Control, the CQA Plan and the testing program requirements of this section.

B. A representative of the CQA firm or geotechnical firm shall be present at all times during clay liner construction activities.

# PART 2 PRODUCTS

## 2.1 CLAY LINER MATERIAL

A. Clay that meets all of the following requirements shall be classified as select clay fill for use in construction of the secure cell compacted clay liner.

1. Clay shall be classified according to the Unified Soil Classification System (USCS) as CL, CH, or SC (ASTM D2487-83). Liquid limit, plasticity index (PI), and percent passing the No. 200 sieve must meet the requirements specified in the ADEM Rules for proper classification.

2. Select clay fill materials shall be reasonably free of gypsum, ferrous, and/or calcareous concretions and nodules, refuse, roots, or other deleterious substances.

3. Continuous and repeated visual inspection of the materials being used will be performed by the CONTRACTOR to ensure proper soils are being used. In addition, the CQA ENGINEER shall make frequent inspections of the liner placement operations and materials, and will consult with the site personnel on suitable liner materials and locations of such.

4. The compacted clay liner material shall be compact, uniform, smooth, and reasonably free of debris, rock, plant materials, and other foreign material. It shall meet the qualification shown below.

   A one (1) square foot section of clay liner for every 20,000 square feet of liner shall be screened with an acceptance of the liner based on the following criteria:

   LOWER 18" CLAY LINER

| Percentage of Material Passing | Screen Size |
|---|---|
| 100% (avg. of all tests) | 2.0" |

   UPPER 6" CLAY LINER

| Percentage of Material Passing | Screen Size |
|---|---|
| 100% (avg. of all tests) | 3/4" |

   Should any sample fail the 100% passing requirement of 3/4" for the upper 6" and 2.0” for the lower 18", then four (4) additional test areas within the 20,000 square foot test area shall be selected by the CQA ENGINEER and tested in like manner. If the four (4) areas pass, then all test areas shall be

repaired and the 20,000 square foot area accepted. If any one of the four (4) areas fail, then the 20,000 square foot area shall be re-worked and re-tested. Rocks or roots remaining on or protruding through the surface shall be removed and the surface repaired.

5. Acceptance of the compacted clay liner surface must be made by the CQA ENGINEER. Decisions on smoothness shall be totally within the CQA ENGINEER's discretion.

# PART 3 EXECUTION

## 3.1 TEST PAD

A test pad shall be constructed using the same construction methods, equipment and material to be used for the Compacted Clay Liner. The test pad surface is considered integral to completion of an acceptable test pad. The test pad construction must proceed the beginning of placement of the Compacted Clay Liner. Samples from the test pad must exhibit a permeability of $K \leq 1x10^{-7}$ cm/sec.

## 3.2 SUBBASE PREPARATION

A. The 6" in-situ composite liner subbase for the composite liner clay base shall be compacted to 95% as determined by the Standard Proctor Test, AASHTO-T180. The composite liner subbase shall be reasonably free of rocks, roots, stumps, and other debris.

## 3.3 CONSTRUCTION OF COMPACTED CLAY LINER

A. Select clay fill lift thickness (after compaction) shall be no greater than six (6") inches. Thinner lifts are permissible to achieve design grade.

B. Prior to compaction, each lift of select clay fill material shall be thoroughly disced. Equipment or truck trafficking of the surface shall not be permitted during the period between scarifying and placement of the following lift.

C. After scarifying, representative samples will be taken by the CQA ENGINEER and tested for moisture content prior to any compactive efforts. If the moisture content is within the range specified in F below, compaction may begin. If the moisture content is outside of this range, the select clay fill will be wetted or dried and reworked accordingly. The select fill should be sprinkled or sprayed with water (from a water truck) and dozed, wind-rowed, and/or disc-plowed to uniformly increase the moisture content of the clay if the material is below Optimum Moisture Content (OMC). The select clay fill should be dozed, wind-rowed, and/or disc-plowed to help air dry the clay if the moisture content is too high.

D. Each lift will be thoroughly compacted and must satisfy moisture and density controls through field testing before a subsequent lift is placed.

E. Compaction of lifts shall be as follows:

1. Compaction of lifts shall be performed with an appropriately heavy, properly ballasted penetrating-foot compactor (such as a CAT 815 or equivalent) subject to approval of the CQA ENGINEER. A minimum of six (6) passes will be required on each lift regardless of whether the lift meets density specifications. A pass is defined as one trip of the compacting equipment over the lift and back to the starting point by a single drum roller or one trip across the lift surface from one side to the other if the compacting equipment has front and back compacting rollers. This requirement is to allow thorough remolding of the clay by kneading action and to reduce clod size. Clod size (after compaction) shall not exceed 3/4 inches.

2. The daily work area shall extend a distance no greater than necessary to maintain moist soil conditions (facilitate bonding) and continuous operations. Desiccation and crusting of the lift surface shall be avoided as much as possible.

3. If excessive desiccation and crusting of the lift surface occurs before placement of the next lift, this area shall be sprinkled with water and then scarified and tested for water content to ensure uniform moisture before placement of a subsequent lift.

4. Transition from full depth liner to beginning of adjacent new section shall be accomplished by sloping (cutting back) the end of a full depth section at 5H:1V (horizontal to vertical) or flatter for tying in a new lift.

5. The cell bottom shall be constructed initially and completed over the width of the base before beginning the slope. The transition between the bottom and side slopes shall be accomplished by compacting parallel to the slope by running up and down the slope.

6. Dozer or scraper equipment shall not be used for primary compaction efforts, except as specified in (C.) above.

F. During compaction, the placement soil moisture content and dry density shall be maintained within the limits specified below.

1. To confirm that the moisture content and dry density requirements of the compacted soil are being satisfied, field and laboratory tests on shelby tube samples shall be made at locations designated by the CQA ENGINEER.

2. Compaction moisture content shall be within four (4) percent wet of OMC.

G. The select fill shall be compacted to a minimum dry density of 95 percent (or as determined by test pad) of the maximum dry density determined by the Standard Proctor Test, ASTM D698. Densities less than 95 percent of the maximum dry density determined from the Standard Proctor Test shall be recompacted and/or removed and reworked to meet density objectives. In addition, the compacted materials dry density/moisture content shall lie within the 90 percent saturation line, to be established from tested specific gravities.

H. The compacted clay liner shall have a permeability of $K \leq 1 \times 10^{-7}$ cm/sec as determined by ASTM D5084.

I. No select fill shall be placed or compacted during sustained period of temperatures below 30°F. Select fill may be placed and compacted during periods of early morning and evening freezing temperatures with warming trends above freezing during the day.

J. During construction, finished lifts or sections of compacted clay liner must be sprinkled with water as needed to prevent drying and desiccation.

K. At the end of each construction day's activities, completed lifts or sections of compacted clay liner shall be sealed by rolling with a rubber tired or smooth drum rollers and sprinkled with water as needed.

L. The compacted clay liner shall be at least 24 inches thick across the bottom and up the sideslopes of the cell. Thickness of the clay liner on the sideslopes shall be measured perpendicular to the slope face.

M. The as-built thickness of the compacted clay liner shall be determined by non-destructive survey methods as described below. An individual lift may be sampled upon completion (but prior to subsequent lift placement) with an approved sampler or other investigative tool, but the resulting penetration shall be properly backfilled with hand tamped select clay fill or bentonite pellets. Samples of the in-place compacted clay liner shall be tested and evaluated prior to acceptance.

N. After completion of a segment of compacted clay liner, but before installation of the geomembrane liner, the top of the clay shall be surveyed to ensure:

1. The specified thickness of compacted clay liner has been achieved.

2. The top of the clay liner slopes diagonally across the cell toward the collection assembly at grades specified on the Drawings.

3. The top of the clay liner in the collection assembly area is at the grades and elevations specified on the Drawings.

4. Clay liner placed beyond the limits of the lines and grades as shown on the Drawings will not be accepted and must be removed at the Contractor's expense. Such material which has been determined suitable for liner construction may be re-incorporated into liner if needed.

5. This work shall be performed by a surveyor registered in this State the services of whom shall be provided by the OWNER.

--END OF SECTION--

# SECTION 02252 PROTECTIVE COVER ON LANDFILL CAP

## PART 1 GENERAL

### 1.1 SCOPE OF WORK

The CONTRACTOR shall furnish all labor, material, supervision, and equipment to install the Protective Soil Cover on the Landfill Cap, including hauling, spreading and final grading and all necessary and incidental items as detailed or required to complete the cover, all in accordance with the plans and specifications.

### 1.2 MEASUREMENT AND PAYMENT

A. Measurement shall be made by survey or field measurement and computed by the ENGINEER based on the horizontal area of the Geomembrane (FML) Cap installed. This quantity shall not include the volume required for normal benching as detailed on the Drawings. This quantity shall not include replacement volumes for areas that have become unsuitable due to weather or the overfill thickness required for erosion protection.

B. Soil cover placed beyond the limits of the lines and grades as shown on the Construction Drawings will not be accepted and must be removed, if directed by the ENGINEER, at the Contractor's expense.

C. The entire Soil Cover must meet or exceed the specified thickness, and quality requirements prior to payment.

D. Payment for work shall be made on the unit price bid per square foot of in-place Protective Soil Cover.

## PART 2 PRODUCTS

### 2.1 SOIL COVER MATERIAL

A. Soil that meets all of the following requirements shall be classified as select soil fill for use in construction of the secure cell soil cap.

1. Soil shall be classified according to the Unified Soil Classification System (USCS) as SC, ML, MH, CH, or CL (ASTM D2487). Liquid limit, plasticity index (PI), and percent passing the No. 200 sieve will be considered for proper classification.

2. Select soil fill materials shall be reasonably free of gypsum, ferrous, and/or

calcareous concretions and nodules, refuse, roots, or other deleterious substances.

3. Continuous and repeated visual inspection of the materials being used will be performed by the CONTRACTOR to ensure proper soils are being used. In addition, the CQA ENGINEER shall make frequent inspections of the placement operations and materials, and will consult with the site personnel on suitable materials and locations of such.

4. The lower 18” of protective soil cover shall be uniform, smooth, and free of debris, rock, plant materials, and other foreign material larger than 3 inches in diameter. The material should contain no sharp edges.

5. The top 6" of soil cover must be capable of supporting growth of vegetative cover.

# PART 3 EXECUTION

## 3.1 CONSTRUCTION OF PROTECTIVE SOIL COVER

A. Soil for the cover shall be placed and spread with light weight rubber tired or track equipment. When spreading the soil shall be stockpiled at depths of a minimum four feet and thence spread to the thickness indicated by pushing up the slope, utilizing light weight rubber tired or track equipment so as not to damage the geocomposite or geomembrane. Placement of soil for cover from the top, down the slope will not be allowed.

B. The soil cover shall be a total of 24” thick. On slopes the thickness shall be measured perpendicular to the slope of face.

C. After completion of the soil cover the cap shall be surveyed, or measured with on-site GPS to ensure the specified thickness has been achieved.

D. Soil berms should be compacted to 95% dry density standard proctor.

E. After the specified soil cover thickness has been achieved and verified the CONTRACTOR shall proceed immediately with the grassing.

F. Any damage to the geomembrane and/or GDM shall be repaired in accordance with Section 02755 – Geomembrane (FML) Cap, Section 02754 Geocomposite Drainage Media (GDM), and under the direction of the CQA ENGINEER.

--END OF SECTION--

# SECTION 02255 PROTECTIVE COVER – ON LINER – SANDY SOILS

## PART 1 GENERAL

### 1.1 SCOPE OF WORK

This section covers the material and placement of the protective cover system for liner systems utilizing a sandy soil drainage blanket with a permeability of $k \geq 1x10^{-2}$ cm/sec.

### 1.2 QUALITY ASSURANCE

A. Quality assurance shall be in accordance with the requirements of Section 01400 Quality Control and the testing program requirements of this section.

B. A representative of the CQA firm or geotechnical firm shall be present at all times during protective cover construction activities.

### 1.3 RELATED WORK

A. Section 02747 - Leachate Collection System

### 1.4 MEASUREMENT AND PAYMENT

A. Measurement shall be made by survey or field measurement and computed by the DESIGN ENGINEER in cubic yards with the quantity for payment being the product of the surface area and the required thickness (12") of the protective cover.

B. Protective cover placed beyond the limits of the lines and grades as shown on the Construction Drawings will not be accepted and must be removed, if directed by the CQA ENGINEER, at the Contractor's expense.

C. The entire Protective Cover must meet or exceed the specified thickness requirements prior to payment.

D. Payment for work shall be made on the unit price bid per cubic yard for 12" Thick Protective Cover in the Proposal.

# PART 2 PRODUCTS

## 2.1 SANDY SOIL COVER MATERIAL

Material for the sandy soil (protective cover) shall be a loose granular material resulting from the disintegration of rocks, shall be capable of 98% passage through a ¼" screen and shall have no more than 5% by weight passing the No. 200 sieve. The protective cover material shall contain no aggregate rocks, debris, plant material, material with sharp edges, lignite, coal, ash, or carbonaceous material. By-products of industrial processes, with the exception of quarry grinding operations, shall not be accepted. The sandy soil (protective cover) material shall have a permeability of $k \geq 1x10^{-2}$ cm/sec.

Construction Quality Assurance for the Granular Drainage Media shall be as follows:

| Test | Minimum Frequency | Criteria |
|---|---|---|
| Grain size to No. 200 sieve (ASTM D 422) | 2,000 $yd^3$ | ≤1/2" 5% ≤ #200 Sieve |
| Permeability (ASTM D 2434) | 3,000 $yd^3$ | $k \geq 1x10^{-2}$ cm/sec |

# PART 3 EXECUTION

## 3.1 CONSTRUCTION OF PROTECTIVE COVER

A. Sandy soils for the protective cover shall be placed and spread with light weight rubber-tired or tracked equipment. All tracked equipment used in placement of the protective cover shall be low ground pressure equipment having a ground contact pressure less than six (6) psi. Tracked equipment must be operated in such a manner that sharp turns that cause dragging of the tracks over the protective cover are minimized. When spreading, the material shall be stockpiled at depths of a minimum four feet and thence spread to the thickness indicated utilizing light weight rubber-tired or track equipment so as not to damage the geomembrane liner.

B. The sandy soils on the floor and side slopes shall be 12 inches thick minimum. The thickness shall be measured perpendicular to the slope of face.

C. After completion of the protective cover, the liner system shall be surveyed to ensure the specified thickness has been achieved.

D. Any damage to the geomembrane shall be repaired in accordance with Section 02750 HDPE Geomembrane Liner and under the direction of the CQA ENGINEER.

--END OF SECTION--

# SECTION 02260 COMPACTED CLAY CAP

## PART 1 GENERAL

### 1.1 SCOPE OF WORK

The CONTRACTOR shall furnish all labor, material, supervision, and equipment to construct the Compacted Clay Cap (infiltration layer) for the cell, including hauling, discing, compacting, drying, removal of rainfall and removal of all previously placed material unsuitable due to weather conditions, final grading and sealing and all necessary and incidental items as detailed or required to complete the compacted clay cap, all in accordance with the plans and specifications.

### 1.2 QUALITY ASSURANCE

A. Quality assurance shall be in accordance with the requirements of Section 01400 Quality Control and the testing program requirements of this section.

B. A representative of the CQA ENGINEER shall be present at all times during the clay cap construction activities.

### 1.3 MEASUREMENT AND PAYMENT

A. Measurement of all areas, including replacement areas will be made by survey or field measurement and computed by the ENGINEER based on the horizontal area of the Geomembrane (FML) Cap installed. This quantity shall not include the volume required for normal benching as detailed on the Construction Drawings. This quantity shall not include replacement volumes for areas that have become unsuitable due to weather.

B. Compacted clay cap placed beyond the limits of the lines and grades as shown on the Construction Drawings will not be accepted and must be removed, if directed by the ENGINEER, at the Contractor's expense.

C. The entire compacted clay cap must meet or exceed the specified thickness, and quality requirements prior to payment.

D. Payment for work shall be made on the unit price bid per square foot of in-place compacted clay cap.

# PART 2 PRODUCTS

## 2.1 CLAY CAP MATERIAL

A. Soil that meets all of the following requirements shall be classified as select soil fill for use in construction of the secure cell compacted clay cap.

1. Soil shall be classified according to the Unified Soil Classification System (USCS) as SC, ML, MH, CH, or CL (ASTM D2487-83). Liquid limit, plasticity index (PI), and percent passing the No. 200 sieve will be considered for proper classification.

2. Select soil fill materials shall be reasonably free of gypsum, ferrous, and/or calcareous concretions and nodules, refuse, roots, or other deleterious substances.

3. Continuous and repeated visual inspection of the materials being used will be performed by the CONTRACTOR to ensure proper soils are being used. In addition, the CQA ENGINEER shall make frequent inspections of the cap placement operations and materials, and will consult with the site personnel on suitable cap materials and locations of such.

# PART 3 EXECUTION

## 3.1 TEST PAD

A test strip may be constructed using the same construction methods, equipment and material to be used for the compacted clay cap. The test fill construction must precede the beginning of placement of the compacted clay cap by a minimum of two (2) weeks. Samples from the test strip must exhibit a permeability of $k \leq 1.0 \times 10^{-5}$ cm/sec.

## 3.2 CONSTRUCTION OF COMPACTED CLAY CAP

A. Select soil fill lift thickness (after compaction) shall be no greater than six (6") inches. Thinner lifts are permissible to achieve design grade after first lift.

B. Prior to compaction, each lift of select soil fill material shall be thoroughly disced. Equipment or truck trafficking on the surface shall not be permitted during the period between scarifying and placement of the following lift.

C. After scarifying, representative samples will be taken by the CQA ENGINEER and tested for moisture content prior to any compactive efforts. If the moisture content is within the range specified in subparagraph F below, compaction may begin. If the

moisture content is outside of this range, the select soil fill will be wetted or dried and reworked accordingly. The select fill should be sprinkled or sprayed with water (from a water truck) and dozed, wind-rowed, and/or disc-plowed to uniformly increase the moisture content of the soil if the material is below Optimum Moisture Content (OMC). The select soil fill should be dozed, wind-rowed, and/or disc-plowed to help air dry the soil if the moisture content is too high.

D. Each lift will be thoroughly compacted and must satisfy moisture and density controls through field testing before a subsequent lift is placed.

E. Compaction of lifts shall be as follows:

1. Compaction of lifts shall be performed with an appropriately heavy, properly ballasted penetrating-foot compactor (such as a CAT 815 or equivalent) subject to approval of the CQA ENGINEER. A minimum of six (6) passes will be required on each lift regardless of whether the lift meets density specifications. A pass is defined as one (1) trip of the compacting equipment over the lift and back to the starting point by a single drum roller or one trip across the lift surface from one side to the other if the compacting equipment has front and back compacting rollers. This requirement is to allow thorough remolding of the soil by kneading action.

2. The daily work area shall extend a distance no greater than necessary to maintain moist soil conditions (facilitate bonding) and continuous operations. Desiccation and crusting of the lift surface shall be avoided as much as possible.

3. If desiccation and crusting of the lift surface occurs before placement of the next lift, this area shall be sprinkled with water and then scarified and tested for water content to ensure uniform moisture before placement of a subsequent lift.

4. Transition from full depth cap to beginning of adjacent new section shall be accomplished by sloping (cutting back) the end of a full depth section at 5H:1V (horizontal to vertical) or flatter for tying in a new lift.

5. Dozer or scraper equipment shall not be used for primary compaction efforts, except as specified in subparagraph C above.

F. During compaction, the placement soil moisture content and dry density shall be maintained within the limits specified below.

1. To confirm that the moisture content and dry density requirements of the compacted soil are being satisfied, field and laboratory tests on shelby tube

samples shall be made at locations designated by the CQA ENGINEER and at the frequency specified in the CQA Plan.

2. Compaction moisture content shall be within four (4%) percent wet of OMC.

G. The select fill shall be compacted to a minimum dry density of 95 percent (or as determined by test strip) of the maximum dry density determined by the Standard Proctor Test, ASTM D698. Densities less than 95 percent of the maximum dry density determined from the Standard Proctor Test shall be recompacted and/or removed and reworked to meet density objectives. In addition, the compacted materials dry density/moisture content shall lie within the 90 percent saturation line, to be established from tested specific gravities.

H. The compacted clay cap shall have a maximum permeability of $k \leq 1.0 \times 10^{-5}$ cm/sec as determined by ASTM D5084.

I. No select fill shall be placed or compacted during sustained period of temperatures below $30^{o}$ F. Select fill may be placed and compacted during periods of early morning and evening freezing temperatures with warming trends above freezing during the day.

J. During construction, finished lifts or sections of compacted clay cap must be sprinkled with water as needed to prevent drying and desiccation.

K. At the end of each construction day's activities, completed lifts or sections of compacted clay cap shall be sealed by rolling with a rubber tired or smooth drum rollers and sprinkled with water as needed.

L. The compacted clay cap shall be 12” thick.

M. Perforations in the compacted clay cap resulting from sampling or testing procedures, survey stakes or other activities shall be identified and backfilled by the CQA ENGINEER. The perforations shall be filled with a soil-bentonite mix consisting of 10% minimum by weight bentonite powder or granules mixed with clay cap material. The perforations shall be backfilled with the soil-bentonite mixture in 3-inch loose lifts and thoroughly compacted by hand tamping by the CQA ENGINEER.

N. The as-built thickness of the compacted clay cap shall be determined as described below. Samples of the in-place compacted clay cap shall be tested and evaluated prior to acceptance.

O. After completion of the compacted clay cap, but before installation of the Geomembrane FML Cap, the cap shall be surveyed or measured with on-site GPS to ensure:

1. The specified thickness of compacted clay cap has been achieved. This will also be confirmed through a number of hand auger borings to be completed by the CQA ENGINEER.

2. The top of the compacted clay cap slopes at grades specified on the Construction Drawings.

-- END OF SECTION --

# SECTION 02674 GAS VENTING SYSTEMS

## PART 1 GENERAL

### 1.1 SCOPE OF WORK

The Contractor shall furnish all labor, material, supervision, and equipment to complete the installation of the gas collection and venting system as shown on the Construction Drawings, including HDPE piping and gravel.

### 1.2 RELATED WORK

A. Section 02220 – Trenching, Backfilling and Compaction

B. Section 02744 – High Density Polyethylene (HDPE) Pipe

C. Section 02754 – Geocomposite Drainage Media (GDM) Cap System

### 1.3 MEASUREMENT AND PAYMENT

A. Gas Collection Ridge Vent

1. Measurement of the gas venting system shall be along the centerline of the ridge.

2. Payment shall be made by the unit price bid for the gas collection ridge vent and shall include pipe, gravel, geocomposite, waste removal and haul to working face, and re-compacted clay cap.

B. Methane Gas Vent

1. Measurement shall be made from the ground surface to the bottom cap

2. Payment shall be made on the unit price bid per vertical foot of point construction as stated in the proposal and shall include all fittings, marker posts, and re-compacted clay cap.

C. Methane Gas Solar Flare – (as needed)

1. Measurement shall be by the number actually installed

2. Payment shall be by the unit base bid and shall include all fittings and

connection to existing gas vent.

### 1.4 QUALITY

A. The CONTRACTOR shall employ and pay for the service of the third-party geotechnical firm to supervise and certify the installation of the vents.

B. Each vent will be certified as being constructed according to this plan.

C. The methane gas vents and gas collection ridge vent shall be constructed at the locations shown on the Construction Drawings and according to the detail shown on those same plans. The system shall be installed under the supervision of and certified by a geologist or geotechnical engineer registered in Alabama. Documentation and certification that the system was installed according to the approved plan shall be submitted to the ENGINEER and to the OWNER within 30 days from completion of the installation. The documentation will include "as-built" logs of each gas event.

## PART 2 PRODUCTS

### 2.1 GAS VENT PIPING

A. Gas vent piping shall be in accordance with Section 02744 - High Density Polyethylene (HDPE) Pipe.

### 2.2 GRAVEL

Gravel for encasing the gas collection pipe shall be a clean washed hard non-carbonaceous mineral such as quartz. Gravel size shall be ASTM No. 57.

### 2.3 GEOCOMPOSITE DRAINAGE MEDIA (GDM)

A. GDM shall be in accordance with Section 02754 Geocomposite Drainage Media (GDM) Cap System. GDM for gas collection ridge vent will be placed as a standard roll width along the ridge as shown in the Construction Drawings.

### 2.4 12 OZ / S.Y. NON-WOVEN GEOTEXTILE

A. 12 oz. / S.Y. Non-Woven Geotextile shall be in accordance with SKAPS Industries GT-112, or approved equal.

# PART 3 EXECUTION

## 3.1 INSTALLATION

A. The gas collection and venting system shall be installed in accordance with the construction details in the construction drawings. All gas vents shall be installed and screened to the depths shown on the attached table. Vents shall be installed to depth no greater than the bottom of the waste. Soil material and disposal of waste removed from the boreholes shall be disposed of at the active working face.

--END OF SECTION--

# SECTION 02720 STORM SEWER SYSTEMS

## PART 1 GENERAL

### 1.1 WORK INCLUDED

A. Installation of storm sewer lines, flared end sections and other appurtenances.

### 1.2 RELATED WORK

A. Section 02220 - Trenching, Backfilling and Compaction

B. Drawings and General Provisions of Contract, including General and Supplementary Conditions, Special Conditions, and Detailed Specification Sections, apply to Work specified in this Section.

### 1.3 MEASUREMENT AND PAYMENT

A. Storm Pipe

1. Measurement shall be from center to center of structures measured along the centerline of the pipe, without regard to depth.

2. Payment shall be per linear foot for each size and type of material.

B. Headwalls / Drop Inlet

1. Measurement shall be by the number actually installed.

2. Payment shall be by the unit price.

C. Payment for the above items shall constitute full compensation for furnishing of all materials, labors, tools, equipment, services, and incidentals necessary to complete the work as required in this Section of the Specifications.

D. Payment for work covered by this Section of the Specifications will be made under the following item designations as indicated in the agreement:

RCP .....Linear Foot
Headwall ..... Each
CMP .....Linear Foot

# PART 2 PRODUCTS

## 2.1 REINFORCED CONCRETE PIPE (RCP)

Reinforced concrete pipe used for the drainage system shall conform to AASHTO Specification M-170 and ASTM C76. Diameter of pipe shall be as indicated on the drawings, and class of pipe shall be as required for the particular installation. Joints shall be bell and spigot with rubber gasket in accordance with ASTM C443.

## 2.2 JOINT MATERIAL

Joint material shall be as manufactured by Ram-Nek or equal, and which meets or exceeds all requirements of Federal Specifications SS-S-00210 "Sealing Compound, Preformed Plastic for Pipe Joints, Type I, Rope Form".

## 2.3 CORRUGATED METAL PIPE (CMP)

Corrugated metal pipe shall be of the diameter indicated and shall be bituminous coated corrugated steel pipe conforming to the requirements of AASHTO:M190 for the specified sectional dimensions, plate thickness and type of bituminous coating. Coupling bands shall be fully coated with bituminous material

## 2.4 DROP INLETS AND HEADWALLS

Drop inlets and headwalls shall be in accordance with the details in the Construction Drawings.

# PART 3 EXECUTION

## 3.1 PIPE INSTALLATION

Pipe shall be protected during handling against impact shocks and free fall. The pipe shall be laid so as to produce a straight line of pipe on a uniform grade, each pipe laid to form a close joint with the preceding pipe and so as to form a smooth inside flow line.

--END OF SECTION--

# SECTION 02732 FORCE MAIN AND RELATED APPURTENANCES

## PART 1 GENERAL

### 1.1 DESCRIPTION OF WORK

A. This section covers the materials and the installation of all force mains and related appurtenances as required on the contract drawings.

### 1.2 RELATED WORK

A. Section 01666 - Testing Piping Systems
B. Section 02744 – High Density Polyethylene Pipe
C. Section 02220 - Trenching, Backfilling & Compaction

### 1. 3 SUBMITTALS

A. Submittals are required for all products specified in this section.

### 1.4 QUALITY ASSURANCE

A. Quality Assurance shall be in accordance with the requirements of Section 01400 – Quality Control and the testing requirements of Section 01666 – Testing Piping Systems.

## PART 2 PRODUCTS

### 2.1 PIPE

A. Force Main piping shall be in accordance with Section 02744 – High Density Polyethylene Piping.

### 2.2 VALVES

A. CHECK VALVES

Check valves shall be ASAHI or equal.

### 2.3 PRECAST CONCRETE MANHOLES

A. Precast Concrete Manholes for air release valves and leachate manholes shall meet ASTM C478. The standard joint shall be sealed with a plastic cement putty meeting

Federal Specification SS-S-00210, such as Ram-Nek or a butyl rubber sealant. All lift holes, pipe entrances, and inside joints shall be plugged with grout after installation.

B. Manhole shall have 30”x30” aluminum access hatch, as shown on detail in contract drawings.

C. Manhole Steps shall be placed at 12 inches O.C. and composed of composite neoprene-steel as manufactured by Dewey Brothers (MH-ST-18A), Oliver Tire and Rubber or M.A. Industries or equal.

D. All manholes shall have 6 inch precast bottoms resting on a minimum of 24 inches of #57 stone.

# PART 3 EXECUTION

## 3.1 TRENCHING, BACKFILLING AND COMPACTION

A. Trenching, backfilling and compaction shall be in accordance with applicable requirements of Section 02220.

## 3.2 PIPE INSTALLATION

A. Pipe Installation shall be in accordance with applicable requirements of Section 02744 – High Density Polyethylene Pipe (HDPE).

B. ALIGNMENT AND GRADE

1. All pipe shall be laid to maintain grade on force main so that low and high points do not exist.

C. PIPE HANDLING

1. Pipe handling shall be in accordance with applicable requirements of Section 02744 – High Density Polyethylene Pipe (HDPE).

D. CONCRETE THRUST BLOCKING

Concrete having compressive strength of not less than 2500 psi shall be used as backing. Bends exceeding 223 degrees and all tees shall be backed with concrete as a thrust backing. Backing shall be placed between solid ground and the fitting to be anchored; the area of bearing on the pipe and on ground in each instance shall be that required by the ENGINEER or as shown on the plans. The backing shall be so

placed that the pipe fitting joints will be accessible for repair. No extra payment will be made for the concrete backing.

## 3.3 PRESSURE AND LEAKAGE TESTS

Pressure and leakage tests shall be in accordance with applicable requirements of Section 01666 - Testing Piping Systems.

-- END OF SECTION --

# SECTION 02744 HIGH DENSITY POLYETHYLENE (HDPE) PIPE

## PART 1 GENERAL

### 1.1 DESCRIPTION OF WORK

A. This section covers the materials and the installation of all HDPE piping.

### 1.2 RELATED WORK

A. Section 02220 - Trenching, Backfilling and Compaction
Section 02747 - Leachate Collection System

B. Drawings and general provisions of Contract, including General and Supplementary Conditions, and Detailed Specification Sections, apply to work specified in this section.

### 1.3 QUALITY ASSURANCE

Quality Assurance shall be in accordance with Section 01400, Quality Control and the Construction Quality Assurance Manual.

### 1.4 APPLICABLE PUBLICATIONS AND STANDARDS

American Society for Testing and Materials (ASTM Publications)

| | |
|---|---|
| ASTM D256 | Test Methods For Impact Resistance of Plastics and Electrical Insulating Materials |
| ASTM D638 | Test Method For Tensile Properties of Plastics |
| ASTM D696 | Test Method For Coefficient of Line at Thermal Expansion of Plastics |
| ASTM D746 | Test Method For Brittleness Temperature of Plastics and Elastomers By Impact |
| ASTM D1238 | Test Method For Flow Rates of Thermoplastics By Extrusion Plastometer |
| ASTM D1248 | Polyethylene Plastics Molding and Extrusion Materials |
| ASTM D1505 | Test Method For Density of Plastics By The Density-Gradient Technique |

| | |
|---|---|
| ASTM D1525 | Test Method For Vicat Softening Temperature of Plastics |
| ASTM D1693 | Test Method For Environmental Stress Cracking of Ethylene Plastics |
| ASTM D2240 | Test Method For Rubber Property - Durometer Hardness |
| ASTM D2321 | Underground Installation of Flexible Thermoplastic Sewer Pipe |
| ASTM D2412 | External Loading Properties of Plastic Pipe by Parallel - Plate Loading |
| ASTM D2837 | Obtaining Hydrostatic Design Basis For Thermoplastic Pipe Materials |
| ASTM D3350 | Polyethylene Plastics Pipe and Fittings Materials also Gasket for push-on Joints |

## 1.5 SUBMITTAL REQUIREMENTS

A. All submittals shall be clearly marked as to what is being provided. Submittals not so marked shall be returned. Contractor shall submit shop drawings with the following information on each of the pipe types provided:

1. indicate compliance with applicable ASTM standard
2. unit weight
3. SDR
4. diameter
5. physical dimensions
6. method of jointing with instructions
7. nominal pipe joint lengths
8. recommended bedding and installation details
9. instructions and tables or information on strength of each pipe type versus bury conditions of depth and traffic loadings

B. Manufacturer's certificate of compliance.

The DESIGN ENGINEER requires certified lab data from the manufacturer to verify the physical properties of the materials supplied under this specification and at the Owner's expense may take random samples for testing by an independent laboratory. The DESIGN ENGINEER REQUIRES CERTIFICATION that the pipe produced is represented by the quality assurance data.

### 1.6 MEASUREMENT AND PAYMENT

A. General

Payment shall constitute full compensation for furnishing of all products, tools, equipment, dewatering services, testing and all incidentals necessary to complete the work as required in this Section of the Specifications.

B. Perforated Leachate Collection Pipe

See Section 02747 – Leachate Collection System

C. Solid Leachate Collection Pipe

1. Measurement shall be along the centerline of the piping. No deductions shall be made for space occupied by valves, manholes, or fittings.

2. Payment will be made for piping at the Contract unit price per linear foot (LF) for the various types and sizes of the piping, complete.

D. Pipe Cleanout

1. Pipe cleanouts including caps, and grading shall be measured by each actually installed.

2. Payment shall be made by the unit price in the Proposal for each actually installed.

## PART 2 PRODUCTS

### 2.1 PIPE SCHEDULE

| Function | SDR | Diameter | Type | Minimum Pipe Length |
|---|---|---|---|---|
| Perforated Leachate Collection Pipe | 9.0 | 8" | HDPE Smooth Wall | 40 Feet |
| Solid Leachate Collection Pipe | 9.0 | 8" | HDPE Smooth Wall | 40 Feet |
| Force Main | 11.0<br>17 | 4” Carrier<br>8” Container | HDPE<br>Dual Containment | 40 Feet |
| Force Main | 11.0 | 2” Carrier | HDPE | 40 Feet |

| | | | | |
|---|---|---|---|---|
| | 17 | 4" Carrier | Dual Containment | |
| Sump Riser | 11.0 | 24" | HDPE Smooth Wall | 40 Feet |
| Miscellaneous Piping | As Noted on Drawings | | | |

## 2.2 HIGH DENSITY POLYETHYLENE (HDPE) PIPE

A. Pipe and Fittings Resin

The pipe supplied under this specification shall be high performance, very high molecular weight, high density polyethylene pipe. All pipe and fitting resins shall be manufactured by the same company which manufactures the pipe itself in accordance with these specifications to ensure complete resin compatibility and total product accountability. The fittings supplied under this specification shall be molded or manufactured from a polyethylene compound having a cell classification equal to or exceeding the compound used in the pipe.

B. Resin physical properties shall comply with the Plastic Pipe Institute (PPI) recommended material Designation PE 3608 and conform to Material Cell Classification (ASTM D3350) or 345464C.

C. Standards

Polyethylene pipe and fittings shall meet all the requirements of NSF listed pipe but are not required to be NSF listed.

D. Quality Control

The resin used for the manufacture of the pipe shall be manufactured by the pipe manufacturer, thus maintaining complete control of the pipe quality. The pipe shall contain no recycled compound except that which is generated in the manufacturer's own plant from the same raw material. The pipe shall be homogenous throughout and free of visible cracks, holes, foreign inclusions, or other deleterious defects, and shall be identifiable in color, density, melt flow and other physical properties throughout.

The polyethylene resin used shall have all ingredients precompounded prior to extrusion of pipe. In-plant blending is not acceptable.

The DESIGN ENGINEER REQUIRES CERTIFICATION that the pipe produced is represented by the quality assurance data. Additionally, test results from the manufacturer's testing which show the pipe does not meet appropriate ASTM standards of manufacturer's representation, will be cause for rejection of the pipe represented by the testing. These tests may include density and flow rate measurements form samples taken at selected

locations within the pipe wall and thermal stability determinations according to ASTM 3350, 10.1.9.

E. The CQA ENGINEER requires certified lab data from the manufacturer to verify the physical properties of the materials supplied under this specification and at Owner's expense may take random samples for testing by an independent laboratory.

F. Rejection

Polyethylene pipe and fittings which do not meet the requirements of this specification shall be rejected.

G. Perforations shall be as detailed, factory machined and trimmed by the manufacturer or pipe supplier in the shop under controlled conditions. No pipe perforating will be allowed in the field. All perforated pipe shall be free of trimmings and debris when delivered and prior to installation.

### 2.3 VALVES

A. Gate valves shall be ASAHI, or equal. All seals shall be VITON.

## PART 3 EXECUTION

### 3.1 PIPE INSTALLATION

A. All pipe shall be installed in accordance with the manufacturer's recommendations and the requirements of these specifications.

B. Perforations shall be constructed by the manufacturer as detailed in the Contract Drawings no field perforating will be allowed. Perforated leachate pipe shall be laid in the trench as detailed in the Contract Drawings. The CQA ENGINEER shall be allowed to review the perforated leachate pipe prior to backfill and prior to acceptance for payment.

C. The pipe interior shall be kept clean before and after laying. Pipe shall be kept clean before installation by proper storage and handling. After installation by proper storage and handling, pipe shall be covered with stone. Any open pipe ends shall be plugged and covered with clean fabric.

### 3.2 HANDLING OF PIPE

A. Pipe shall be stored on clean, level ground to prevent undue scratching and gouging of the pipe. Polyethylene pipe shall be protected from direct sunlight. If the pipe must be stacked for storage, such stacking shall be done in accordance with the pipe

manufacturer's recommendations. The handling of polyethylene pipe shall be done in such a manner that it is not damaged by dragging over sharp objects or cut by chokers or lifting equipment.

## 3.3 REPAIR OF DAMAGED SECTIONS

A. Polyethylene Pipe (HDPE)

Sections of polyethylene pipe having cuts or gouges in excess of 10% of the wall thickness of the pipe shall be removed. New polyethylene pipe section shall be rejoined using the butt fusion joining method. It is the DESIGN ENGINEER's intent to reduce the number of joints. The CQA ENGINEER shall reject pipe installations where in his opinion installation methodology of Contractor does not meet this objective.

## 3.4 PIPE JOINING

A. Perforated and Non-Perforated Leachate Pipe (HDPE)

Sections of polyethylene pipe and fittings shall be joined into continuous lengths on the job site above ground. The joining method shall be the butt fusion method and shall be performed by qualified persons and in strict accordance with the pipe manufacturer's recommendations. The butt fusion equipment used in the joining procedures shall be capable of meeting all conditions recommended by the pipe manufacturer, including, but not limited to, temperature requirements, alignment and fusion pressures. Pipe will be fused at approximately 500$^{o}$F with 150 psi fusion pressure.

## 3.5 HANDLING OF FUSED PIPE

Fused segments of polyethylene pipe shall be handled so as to avoid damage to the pipe. When lifting fused sections of pipe, chains or cable type chokers must be avoided. Nylon slings are required. Spreader bars are recommended when lifting long fused sections. Care shall be exercised to avoid cutting or gouging the pipe.

## 3.6 TRENCHING AND BACKFILL

Leachate collection pipe shall be laid as detailed in the construction drawings. Force main and gravity pipe (outside the cell) shall be laid in accordance with Section 02220 - Trenching, Backfill and Compaction.

## 3.7 HDPE PIPE CLEANOUTS

HDPE pipe cleanouts shall be installed as detailed on the contract drawings.

## 3.8 INSPECTION AND ACCEPTANCE

All work shall be subject to inspection and approval prior to final acceptance and payment. Final acceptance shall be contingent upon the following:

A. Owner accepts polyethylene pipe installation when the installation is finished, all testing results are satisfactory, installation documentation and site inspection is completed, and pipes have been flushed. Non-perforated pipe shall be tested in accordance with Section 01666 - Testing Piping Systems.

B. Contractor shall clean by water flushing all HDPE pipe beginning at cleanouts. Lines shall be flushed until completely free of debris. Contractor shall recover and remove all debris from system and dispose of in an environmentally safe manner.

C. Final cleanup shall meet the approval of the CQA ENGINEER and the Owner.

--END OF SECTION--

# SECTION 02747 LEACHATE COLLECTION SYSTEM

## PART 1 GENERAL

### 1.1 SCOPE OF WORK

The Contractor shall furnish all labor, material, supervision, and equipment to complete the perforated leachate piping collection systems for the cells including collection piping penetration assembly, gravel, geotextile and sand.

### 1.2 RELATED WORK

A. Section 02744 – High Density Polyethylene (HDPE) Pipe
B. Section 02255 - Protective Cover Soil - On Liner - Sandy Soils

### 1.3 MEASUREMENT AND PAYMENT

A. Measurement of the leachate collection system shall be along the centerline of the piping.

B. Payment shall be made by the unit price bid for the stated size of perforated leachate pipe and shall included pipe, gravel, transition media, and geotextile fabric.

### 1.4 QUALITY ASSURANCE

A. Quality assurance shall be in accordance with the requirements of Section 01400 Quality Control and the testing program requirements of this section.

## PART 2 PRODUCTS

### 2.1 LEACHATE COLLECTION PIPING

A. Leachate collection piping shall be in accordance with Section 02744 – High Density Polyethylene (HDPE) Pipe.

### 2.2 GRAVEL

Gravel for encasing leachate pipe shall be a clean washed hard non-carbonaceous mineral such as quartz. Gravel size shall be ASTM No. 57. The transition media shall be ASTM No. 78 or sand with a permeability of $K \geq 1x10^{-1}$ cm/sec.

### 2.3 30 O.S.Y. NON-WOVEN CUSHION GEOTEXTILE

Geotextile shall be a non-woven geotextile of polypropylene fibers or polyester yarns which are intended to be and shall be suitable for separation and cushioning. Geotextile shall be 30 ounce per square yard cushioning fabric and shall be placed under the ASTM No. 57 stone as called for on the plans.

### 2.3 24 O.S.Y. NON-WOVEN CUSHION GEOTEXTILE

Geotextile shall be a non-woven geotextile of polypropylene fibers or polyester yarns which are intended to be and shall be suitable for separation and cushioning. Geotextile shall be 24 ounce per square yard cushioning fabric and shall be placed under the ASTM No. 57 stone as called for on the plans.

### 2.4 8 O.S.Y. NON-WOVEN GEOTEXTILE FABRIC

Geotextile shall be a non-woven geotextile of polypropylene fibers or polyester yarns which are intended to be and shall be suitable for separation and cushioning. Geotextile shall be 8 ounce per square yard cushioning fabric and shall be placed under the protective cover soil material when a 12” thick protective cover soil material thickness is used.

### 2.5 4 O.S.Y. NON-WOVEN GEOTEXTILE FABRIC

Geotextile shall be a non-woven geotextile of polypropylene fibers or polyester yarns which are intended to be and shall be suitable for separation. Geotextile shall be 4 ounce per square yard filter fabric and shall be placed on top of the ASTM No. 57 stone temporarily as called for on the plans. This fabric shall be removed prior to waste disposal.

## PART 3 EXECUTION

### 3.1 INSTALLATION

A. The leachate collection system shall be installed in accordance with the construction details in the contract drawings. The leachate pipe shall be embedded in gravel with the gravel providing separation of the pipe from the sand.

B. Gravel for the transition filter shall be placed uniformly on the (angle of repose) surface of the protective cover material to achieve the filter depth required in the plans.

C. The OWNER shall provide the services of a Registered Land Surveyor to certify that the thickness of the material required by the plans and specifications is actually in place. This surveyor shall also prepare "As-Built" drawings of the site which show the in-place thickness of the collection system.

--END OF SECTION--

# SECTION 02748 HIGH DENSITY POLYETHYLENE (HDPE) FABRICATION

## PART 1 GENERAL

### 1.1 SCOPE OF WORK

This section cover the materials and fabrication of HDPE sump risers, base plate, and manholes.

### 1.2 RELATED WORK

A. Section 02744 – High Density Polyethylene (HDPE) Pipe

### 1.3 QUALITY ASSURANCE

The resin used for the manufacture of the pipe and plate products shall be manufactured by the producer of the products, thus maintaining complete control of the quality. The products shall contain no recycled compound except that which is generated in the manufacturer's own plant from the same raw material. The products shall be homogenous throughout and free of visible cracks, holes, foreign inclusions or other deleterious defects, and shall be identifiable in color, density, and other physical properties throughout.

The manufacturer shall provide certification that the products produced are represented by the quality assurance data.

### 1.4 APPLICABLE PUBLICATIONS AND STANDARDS

American Society for Testing and Materials (ASTM Publications)

| | |
|---|---|
| ASTM D256 | Test Methods For Impact Resistance of Plastics and Electrical Insulating Materials |
| ASTM D638 | Test Method For Tensile Properties of Plastics |
| ASTM D696 | Test Method For Coefficient of Line at Thermal Expansion of Plastics |
| ASTM D746 | Test Method For Brittleness Temperature of Plastics and Elastomers By Impact |
| ASTM D1238 | Test Method For Flow Rates of Thermoplastics By Extrusion Plastometer |

| | |
|---|---|
| ASTM D1248 | Polyethylene Plastics Molding and Extrusion Materials |
| ASTM D1505 | Test Method For Density of Plastics By the Density-Gradient Technique. |
| ASTM D1525 | Test Method For Vicat Softening Temperature of Plastics |
| ASTM D1693 | Test Method For Environmental Stress Cracking of Ethylene Plastics |
| ASTM D2240 | Test Method For Rubber Property - Durometer Hardness |
| ASTM D2321 | Underground Installation of Flexible Thermoplastic Sewer Pipe |
| ASTM D2412 | External Loading Properties of Plastic Pipe by Parallel - Plate Loading |
| ASTM D2837 | Obtaining Hydrostatic Design Basis For Thermoplastic Pipe Materials |
| ASTM D3350 | Polyethylene Plastics Pipe and Fittings Materials also Gasket for push-on Joints |

## 1.5 SUBMITTAL REQUIREMENTS

Submittals on fabricated products shall be clearly marked as to what is being provided. CONTRACTOR shall submit fabricator's shop drawings with the following information on each product provided:

1. indicate compliance with applicable ASTM Standard
2. unit weight of material
3. physical dimensions including material thickness
4. method of joining
5. recommended bedding and installation details
6. anti-flotation anchor requirements

## 1.6 MEASUREMENT AND PAYMENT

A. No measurement shall be made for "HDPE Fabrication".

B. Payment for work or products required in this section shall be included in the unit/lump sum price bid in the Proposal for the item to which the work in this section applies.

# PART 2 PRODUCTS

## 2.1 BASIC MATERIALS

A. Pipe: The pipe shall be in accordance with Section 02744 – High Density Polyethylene Pipe (HDPE). The pipe shall be made of high density, high molecular weight polyethylene pipe material meeting the requirements of Type III, Class C, Category 5, Grade P34, as defined in ASTM D-1248 Standard Specification for Polyethylene Plastics Molding and Extrusion Materials. Clean rework material generated by the manufacturer's own production may be used so long as the pipe or fittings produced meet all the requirements of this specification.

B. HDPE Plate: Plate used for fabrication shall be made of the same high density, high molecular weight polyethylene material used for pipe to insure compatibility of polyethylene resins in the fabrication process.

## 2.2 FABRICATION

A. Experience: Products shall be constructed by a fabricator or manufacturer with at least five (5) years experience in the construction of products similar to those being provided.

B. Joining: Pipe and plate material shall be joined by the extrusion weld method or the butt fusion method in strict accordance with the manufacturer's recommendations. The equipment used in the joining procedures shall be capable of meeting all conditions of the pipe or plate material manufacturer.

C. Stub-outs: Products shall have HDPE pipe penetrations and stub-outs for flange or butt fusion connections as shown in the construction plans. Penetrations shall be extrusion welded to the wall of the product. All stub-outs and penetrations shall be installed by the manufacturer or fabricator.

D. Testing: Structures shall be tested in accordance with Section 01666 - Testing Piping Systems, and certification shall be provided OWNER.

# PART 3 EXECUTION

## 3.1 INSTALLATION

Fabricated products shall be installed in accordance with the fabricator's / manufacturer's recommendations and as shown in the plans.

--END OF SECTION--

# SECTION 02750 TEXTURED HDPE GEOMEMBRANE LINER

## PART 1 GENERAL

### 1.1 SCOPE OF WORK

A. The CONTRACTOR shall furnish all labor, materials, supervision and equipment to complete the installation of the Textured HDPE Geomembrane Liner, including, but not limited to, liner layout, seaming, patching, and all necessary and incidental items required to complete the Work, in accordance with the Contract Drawings and these Specifications.

B. Sufficient liner and fabric material shall be furnished to cover all lined areas shown on the Drawings, including overlaps at field seams and anchor trenches.

C. It is the intent of these Specifications to ensure a quality finished product. It shall be the responsibility of the CONTRACTOR to ensure that this requirement is met.

### 1.2 QUALITY

A. The CONTRACTOR will be required to submit a quality control program to the CQA ENGINEER prior to initiating field work.

B. The OWNER shall employ and pay for the services of a third-party CQA Firm, in accordance with Section 01400 - Quality Control, to confirm the installation of the liners.

C. All installation procedures and testing shall be in accordance with these Specifications and OWNER's Independent Construction Quality Assurance (CQA) Plan (attached).

D. All field destructive and non-destructive testing will be performed by the CONTRACTOR. Samples for laboratory testing will be taken by the CONTRACTOR for testing at the CONTRACTOR's laboratory as well as the CQA ENGINEER's laboratory.

### 1.3 SUBMITTALS

A. The geomembrane and geotextile fabric manufacturers shall submit certification that all sheets manufactured for the Project have been produced in accordance with these Specifications along with results from a quality control program. This information must be submitted for review prior to material delivery. The CQA ENGINEER reserves the right to halt delivery and/or installation until proper certification is submitted and determined acceptable for use.

B. The CONTRACTOR shall submit to the CQA ENGINEER, six (6) full sets of panel layout construction drawings. Field welds and panels shall have an identification system. Drawings shall be submitted to the CQA ENGINEER at least two (2) weeks prior to installation.

C. The manufacturer of the geomembrane used in this work shall approve all shop drawings and a proposed liner layout to cover the lined area shown on the Drawings.

D. Details shall be included to show the termination of the liner at the perimeter of lined areas, the methods of sealing around penetrations and methods of anchoring.

E. The CONTRACTOR shall submit to the CQA ENGINEER a physical sample of the liner and fabric to be used. The samples shall be labeled with the manufacturer's name, product identification, lot number and roll number.

F. The CONTRACTOR shall also submit to the CQA ENGINEER inventory tickets, roll numbers or batch identifications, packing papers and invoices for the liner and fabric used.

G. The CONTRACTOR shall provide personnel resumes demonstrating compliance with the following requirements:

1. A minimum of one (1) field superintendent per shift shall be designated by the CONTRACTOR and approved by the CQA ENGINEER. Each field superintendent shall have a minimum of three years and five million square feet of field experience in installing HDPE geomembranes. Any change or replacement of superintendent during the Project must be approved by the CQA ENGINEER.

2. The weld technicians shall have a minimum of one year and one million square feet HDPE geomembrane welding experience.

## 1.4 WARRANTY

A. Material

The MANUFACTURER is responsible for guaranteeing its product. The warranty shall include all that is listed below:

1. Shall begin at the time of issuance of CQA ENGINEER's Certification of Substantial Completion.

2. The material shall be free from defects and be able to withstand normal weathering and use from the date of installation for a period of 20 years under normal uses and services for which it is designed and manufactured.

3. This limited warranty does not include damages or defects resulting from acts of God, casualty or catastrophe such as, but not limited to earthquake, flood, piercing hail, and tornado.

4. "Normal Use" excludes: exposure to harmful chemicals, mechanical abuse by machinery, equipment, or people, excessive pressure beyond that indicated by the final overburden or municipal refuse and cover indicated on the drawings.

### 1.5 MEASUREMENT AND PAYMENT

A. Payment for work shall be made on the Unit Price Bid per square foot of in-place geomembrane liner. Pay limits shall be measured to the upper inside corner of all anchor trenches or the limit of geomembrane liner runout (edge of liner) where no anchor trench is shown.

B. All testing, patches, repairs, material in the anchor trenches, waste, overlap, and material beyond the required pay limits will be considered incidental to the construction and will be excluded from payment. All materials and work required of the CONTRACTOR for excavation, backfill, and compaction of the anchor trench are also considered incidental to the installation and will also not be included as pay items.

C. Payment quantities will be determined by the DESIGN ENGINEER. No payment shall be made until liner is actually installed and the state accepts the certification of the CQA Firm.

## PART 2 PRODUCTS

### 2.1 GEOMEMBRANE LINER

A. The geomembrane shall comprise HDPE material manufactured of new, first-quality products designed and manufactured specifically for the purpose of municipal waste leachate containment in sanitary landfills.

B. The geomembrane material shall be so produced as to be free of holes, blisters, undispersed raw materials or any sign of contamination by foreign matter. Any such defect shall be repaired in accordance with the manufacturer's recommendations. The DESIGN ENGINEER or CQA ENGINEER may reject all or portions of units (or rolls) of geomembrane if significant quantities of production flaws are observed.

C. The geomembrane material shall meet the material properties as specified in Table 1.

D. The geomembrane liner shall be the required nominal liner thickness as shown on the drawings.

E. If natural colored, the manufacturer shall add carbon black per ASTM D 1248 Specifications, Section 3.1.2.3, Class C.

F. The manufacturer's quality control program shall include the following inspections and tests:

1. Inspection for: Appearance on both sides, manufacturing defects, and thickness at 10 random locations across each sample strip. Thickness measured shall be within ±0.006 inches of the average thickness of the strip.
2. Testing shall be conducted in accordance with Table 1 and the results reported.

### 2.2 PACKAGING AND STORAGE

A. The geomembrane shall be shipped rolled. Folded or otherwise creased liner will not be accepted. The liner shall be marked and tagged with the following information:

1. Serial Number
2. Resin Type
3. Roll Length
4. Gross Weight
5. Inspected By
6. Date of Manufacture
7. Resin Lot Number
8. Roll Width
9. Net Weight

B. Liner which has been delivered to the Project site shall be stored in a dry area and protected from precipitation and direct sunlight.

C. Care shall be taken to keep the materials clean and free from debris prior to installation.

## PART 3 EXECUTION

### 3.1 GENERAL

The geomembrane liner shall be constructed as soon as practical after completion of the compacted clay liner and after certification in writing of the compacted clay liner by the CQA ENGINEER and the CONTRACTOR. The geomembrane liner shall be installed following the manufacturer's printed recommendations, using sound, accepted engineering practices. All

liner installation shall be completed by one crew and shall be installed in no more than 30 calendar days from the date of initiation of installation. The installing crew shall be approved by the manufacturer/fabricator for installation of 60 mil HDPE synthetic liners.

A manufacturer's technical representative shall be at the Preconstruction Conference and on site at the time of installation.

A. Geomembrane Liner

1. No horizontal seams are allowed within five (5) feet of the toe of the slope.

2. Unroll only those factory-packaged sections which are to be anchored or seamed together in one day. Panels should be positioned with the overlap recommended by the manufacturer, but not less than two (2) inches.

3. After panels are initially in place, remove as many wrinkles as possible. Unroll several panels and allow the liner to "relax" before beginning field seaming. The purpose of this is to make the edges which are to bonded as smooth and free of wrinkles as possible.

4. Once panels are in-place and smooth, commence field seaming operations.

5. No support equipment used by any CONTRACTOR shall be allowed on the geomembrane. Personnel working on the geomembrane shall not smoke, wear damaging shoes or engage in any activity which damages the geomembrane.

6. The anchor trench shall be excavated, backfilled and compacted. Care should be taken when backfilling the trench to prevent any damage to the geomembrane.

7. Damaged and sample coupon areas of geomembrane shall be repaired by the CONTRACTOR. Any damage to the soil / clay Liner Component while coupons are open is the responsibility of the CONTRACTOR. Repaired areas will be tested for seam integrity by the CONTRACTOR. Damaged materials are the property of the CONTRACTOR and will be removed from the site at the CONTRACTOR's expense. The CONTRACTOR will retain all ownership and responsibility for the geomembrane until acceptance by the OWNER.

## 3.2 SEAMING

A. Geomembrane Liner

1. Field Seaming

a. All foreign matter (dirt, water, oil, etc) shall be removed from the area to be bonded. If the seam is to be bonded by the extrusion process, the bonding surfaces must be thoroughly cleaned by mechanical abrasion or alternate methods approved by the CQA ENGINEER to remove surface cure and prepare the surfaces for bonding. No solvents shall be used to clean the geomembrane liner.

b. As much as practical, field seaming shall start in the middle and work toward an open end in order to minimize cutting and patching of large wrinkles that become trapped. When seaming the side slopes, seaming should start at the toe of the slope and work up the slope. Tack welds, if used, shall use heat only; no double-sided tape, glue or other method will be permitted. The geomembrane should be seamed completely to the ends of all panels to minimize the potential of tear propagation along the seam. Seaming of the bottom membrane to the sidewall membrane shall be conducted when conditions minimize thermal expansion effects. The completed liner shall not exhibit "trampolining" and shall be in full contact with the underlying soil liner.

c. At the end of each day or installation segment, all unseamed edges shall be anchored by sand bags or other approved device. Sand bags shall weigh approximately 20 pounds and shall be placed no further apart than 20 foot spacing along the open end of the geomembrane. Sand bags securing the geomembrane on the side slopes should be connected by a rope fastened at the top of the slope by a temporary anchor. If high winds are expected, boards along the edge of unseamed panels, with weighted sand bags on top, should be used to anchor the geomembrane on the bottom of the cell. Sand bags fastened by rope should be used to secure unseamed edges on the side slopes. Staples, U-shaped rods, or other penetrating anchors shall not be used to secure the geomembrane. The temporary anchoring of the geomembrane is fully the responsibility of the CONTRACTOR. Any material damaged as the result of weather effects, shall be repaired or replaced at no cost to the OWNER.

d. It is imperative to keep surface water runoff from beneath the geomembrane at all times during installation. The CONTRACTOR's panel placement and seam welding technique and welding schedule shall minimize or eliminate the accumulation of water beneath the geomembrane. Any water found ponded beneath the geomembrane after the geomembrane has been installed shall be removed by the CONTRACTOR at no cost to the OWNER. Any underlying liner that has become excessively moist, soft or unsuitable to perform its intended function shall be replaced at no cost to the OWNER.

e. After field seaming is complete in a given area, liner edges in the anchor trench should be buried. Do not bury the liner edge in the anchor trench within 30 feet of an incomplete or unbounded field seam.

2. Field seaming may be extrusion or fusion welding or a combination of these methods. Solvent welding is not acceptable. The DESIGN ENGINEER or CQA ENGINEER reserves the right to reject any proposed seaming method believed unacceptable.

a. Extrusion welding applies a molten bead of material to preheated sheets of geomembrane. The sheets are then joined by pressure.

b. The fusion welding process heats the area to be joined to the melting point and then applies pressure to join the melted surfaces.

c. The sheets to be joined shall be overlapped at least two (2) inches after the necessary aligning and cutting.

d. In general, seams should be oriented parallel to the line of maximum slope, i.e., oriented up and down, not across, the slope. In corners and odd shaped geometric locations, the number of field seams should be minimized.

e. No horizontal seams should be within five (5) feet from the toe of the slope.

f. No seaming should be attempted above 40 degrees C (104 degrees F) ambient air temperature. Below five degrees C (41 degrees F) ambient air temperature, preheating of the geomembrane may be required. It shall be the responsibility of the CONTRACTOR to demonstrate that conditions are favorable for seaming by acceptable test (start-up) seams which duplicate, as closely as possible, actual field conditions. Preheating may be achieved by natural and/or artificial means (shelters and heating devices).

g. A moveable protective layer of plastic may be required, as recommended by the CQA ENGINEER, to be placed directly below each overlap of geomembrane that is to be seamed. This is to prevent any moisture build-up between the sheets to be welded.

h. Seaming will extend to the outside edge of panels to be placed in anchor trenches.

i. If required, a firm substrata should be provided by using a flat board, a conveyor belt, or similar hard surface directly under the seam overlap to achieve proper support.

j. Grinding prior to welding shall be as recommended by the geomembrane manufacturer and shall be done perpendicular to the sheet edge. Overground or improperly ground areas shall be replaced at the CONTRACTOR's expense.

k. No folds, wrinkles or "fish-mouths" shall be allowed within the seam area. Where wrinkles or folds occur, the material shall be cut, overlapped and an extrusion-weld shall be applied. During wrinkle or fold repairs, adjacent geomembrane may not necessarily be required to meet the two (2) inch minimum overlap, if approved by the CQA ENGINEER. All welds on completion of the work shall be tightly bonded and sealed.

## 3.3 TESTING OF HDPE GEOMEMBRANE

A. General

1. Samples of the field seams shall be taken and tested in accordance with ASTM D6392 ensure that tensile strength at yield and break, elongation at yield and break meet the minimum specifications. A quality control certificate shall be issued with the material.

2. The CONTRACTOR shall employ on-site physical non-destructive testing on all welds.

3. A quality control technician employed by the CONTRACTOR shall inspect each sheet and seam. Any area showing a defect shall be marked and repaired in accordance with HDPE repair procedures.

B. Test Seams: Test seams will be made each day prior to commencing field seaming. These seams will be made on fragment pieces of geomembrane liner to verify that seaming conditions are adequate. Such test seams will be made at the beginning of each seaming period and, at the CQA ENGINEER's discretion, at least once every four (4) hours, for each seaming apparatus used that day. Also, each seamer will make at least one (1) test seam each day. The test seam shall be made using the same geomembrane used in production seaming.

1. The test seam sample will be at least 1.5 m (5 feet) long by 0.3 m (1 foot) wide with the seam centered lengthwise. Ten (10) adjoining specimens 25 mm (1-inch) wide each will be die cut from the test seam sample. These specimens,

which will be tested with a tensiometer in the field for shear (five samples) and peel (five samples) by the CONTRACTOR and witnessed by the CQA ENGINEER, should not fail in the seam. If a test seam fails, the entire operation will be repeated. If the additional test seam fails, the seaming apparatus or seamer will not be accepted and will not be used for seaming until the deficiencies are corrected and two (2) consecutive successful full test seams are achieved. Test seam failure is defined as failure of any one of the specimens tested in shear or peel.

2. The CQA ENGINEER will observe all test seam procedures. The remainder of the successful test seam sample will be assigned a number and marked accordingly by the CQA ENGINEER, who will also log the date, hour, ambient temperature, number of seaming unit, name of seamer and pass or fail description. At least one (1) tested specimen from each test as selected by the CQA ENGINEER will be retained by the CQA ENGINEER. The CQA ENGINEER will transmit these specimens to the OWNER following acceptance of the geomembrane materials and installation by the OWNER.

3. The criteria for determining a passing seam shall be the properties shown in Table 3 of the attached CQA Plan.

C. Field Seams: Field seams will be tested by the CONTRACTOR continuously using non-destructive techniques and at specified intervals using destructive tests. Requirements for non-destructive and destructive testing are as follows:

1. Single Weld Seams: The CONTRACTOR shall maintain and use equipment and personnel at the site to perform continuous vacuum box testing on all single weld production seams or when the geometry of the weld makes pressure testing impractical.

a. Equipment for Vacuum Testing:

1. Vacuum box assembly consisting of a rigid housing, a transparent viewing window, a soft neoprene gasket attached to the bottom, port hole or valve assembly, and a vacuum gauge.
2. Vacuum pump assembly equipped with a pressure controller and pipe connection.
3. A rubber pressure/vacuum hose with fittings and connections.
4. A bucket and means to apply a soapy solution.

b. Procedure for Vacuum Testing:

1. Trim excess overlap from seam, if any.

2. Turn on the vacuum pump to reduce the vacuum box to approximately five (5) inches of mercury, i.e., three (3) psi gauge.

3. Apply a generous amount of solution of strong liquid detergent and water to the area to be tested.

4. Place the vacuum box over the area to be tested and apply sufficient downward pressure to "seat" the seal strip against the liner.

5. Close the bleed valve and open the vacuum valve.

6. Apply a minimum of three inches Hg. vacuum to the area as indicated by the gauge on the vacuum box.

7. Ensure that a leak tight seal is created.

8. For a period of not less than five (5) seconds, examine the composite liner FML through the viewing window for the presence of soap bubbles.

9. If no bubbles appear after 15 seconds, close the vacuum valve and open the bleed valve, move the box over the next adjoining area with a minimum three (3) inch overlap, and repeat the process.

10. Mark all areas where soap bubbles appear and repair the marked areas. After repairs are made, retest these areas.

2. Double Weld Seams: The CONTRACTOR shall maintain and use equipment and personnel to perform air pressure testing of all double weld seams. The system shall be capable of applying a pressure of at least 30 psi for not less than five minutes. The CONTRACTOR shall perform all pressure and vacuum testing under the supervision of the CQA ENGINEER. Pressure loss tests shall be conducted in accordance with the procedures outlined in "Pressurized Air Channel Test for Dual Seamed Geomembranes", Geosynthetic Research Institute Test Method GM-6. As outlined by the test method, following a two minute pressurized stabilization period, pressure losses over a measurement period of five (5) minutes shall not exceed the following: 40 mil - 4 psi, 60 mil - 3 psi, 80 mil - 2 psi.

3. Destructive testing will be performed on an average of every 500 linear feet of field seam. The locations will be selected by the CQA ENGINEER. Sufficient size samples will be obtained by the CONTRACTOR to provide one sample to the archive, one sample to the CQA ENGINEER for laboratory testing, and two samples to be retained by the CONTRACTOR for both field and laboratory testing. Testing requirements are as follows: Each sample shall be large enough to test five (5) specimens in peel and five specimens in shear. The criteria for passing seams is shown in Table 2 of the attached CQA Plan. If unresolved discrepancies exist between the CQA ENGINEER's and CONTRACTOR's test results, the archived sample may be tested by the CQA ENGINEER. Samples which do not pass the shear and peel tests will be re-sampled from locations at least 10 feet on each side of the original location. These two re-test samples must pass both shear and peel testing. If these two samples do not pass, then additional samples will continue to be obtained until the questionable seam area is defined.

   The CQA ENGINEER will observe all production seam field test procedures. The remainder of the successful test seam sample will be assigned a number and marked accordingly by the CQA ENGINEER, who will also log the date, seam number, approximate location in the seam, and field test pass-or-fail description, if applicable. The CQA ENGINEER will be responsible for the archive specimen.

## 3.4 REPAIRS

A. Repair of failing test seams, damage from pressure testing and sample coupons: Damaged and sample coupon areas, and other damaged areas of geomembrane shall be repaired by the CONTRACTOR by construction of a cap strip. No repairs shall be made to seams by application of an extrusion bead to a seam edge previously welded by integrity. Damaged materials are the property of the CONTRACTOR and will be removed from the site at the CONTRACTOR’s expense.

B. Make repairs as follows:

   1. Abrade surfaces of the geomembrane that are to be repaired no more than 20 minutes prior to the repair,

   2. Clean and dry all geomembrane surface immediately prior to repair,

   3. Only use approved seaming equipment,

   4. Extend patches or caps at least 6 inches beyond the edge of the defect, and round corners of patches to a radius of at least 3 inches, and

5. Cut the geomembrane below large caps to avoid potential for water and gas collection between the two sheets.

## 3.5 ANCHOR TRENCH BACKFILLING

The anchor trench will be backfilled and compacted to a dry density not less than 90 percent of the maximum dry density determined by the Standard Proctor (ASTM D-698). Care should be taken when backfilling the trench to prevent any damage to the geomembrane. Anchor trench spoil shall be used as backfill material, wherever possible.

## 3.6 PROTECTION OF LEADING EDGES

Between construction of partial sections of the membrane liner, leading edges of the membrane may be exposed or buried for extended periods of time prior to their joining to adjacent, subsequent membrane sections. The combined action of abrasive soil and equipment impact stresses may "etch" unprotected membrane surfaces sufficiently to affect seam strengths. Therefore, it is necessary to protect leading edges in high activity areas with sacrificial layers of HDPE sheet until they are ready for final seaming. As a minimum, each leading edge to be seamed that must be buried or which must be exposed for periods of one (1) month or longer shall be continuously covered by a layer of geotextile overlain by a layer of HDPE sheet. The geotextile shall be non-woven and have a minimum weight of 6 oz. per square yard. The sacrificial HDPE sheet shall have a minimum thickness equal to that of the membrane liner to be protected. Both protective cover sheets layers shall have a minimum width of two feet. The protective cover sheets shall be either covered with soil or weighted with sand bags to prevent displacement by wind. The edge of the sheet to be protected shall be approximately centered beneath the overlying protective layers prior to burial or weighing with sandbags. Leading edges located in areas expected to receive direct traffic from construction equipment shall be buried under a minimum thickness of three feet of buffer soil.

## 3.7 HDPE LINER ACCEPTANCE

The CONTRACTOR shall retain ownership and responsibility for the geosynthetic lining system until acceptance by the OWNER.

The lining system shall be accepted by the OWNER when:

- The installation is complete as determined by the CQA ENGINEER;
- Verification of the adequacy of all seams and repairs, including associated testing, is complete;
- All documentation of installation is completed, including all CQA reports;

- The CONTRACTOR provides the OWNER with record drawings of the panel layout and seam locations with reference numbers for test locations;

- The CONTRACTOR, the Manufacturer and the CQA ENGINEER provide written certification that the installation was in accordance with the manufacturer's general recommendations, the OWNER's CQA plan, and specifications, with exceptions noted.

**TABLE 1**

**REQUIRED PHYSICAL PROPERTIES**
**OF**
**GEOMEMBRANE LINER (HDPE) SHEET**

| PROPERTY | TEST METHOD | REQUIRED VALUES 60 MIL | CQC FREQUENCY |
|---|---|---|---|
| Thickness, Mil. (min.)[1] | ASTM D5994 (Textured) | 60 (lowest individual measurement) | Per Roll |
| Sheet Density, g/cm$^3$ (min. ave.) | ASTM D792 or ASTM D1505 | 0.940 | 200,000 lbs.[2] |
| Tensile Properties (min. ave.) (Each Direction) | ASTM D6693, Type IV | | 20,000 lbs. [3] |
| Strength at Yield (1 lb/in)<br>Elongational Yield (%)<br>Strength at Break (1 lb/in)<br>Elongation at Break (%) | | 126<br>12<br>90<br>100 | |
| Tear Resistance, 1 lbs. (min. ave.) | ASTM D1004 | 42 | 45,000 lbs.[3] |
| Stress Crack Resistance | ASTM D5397 | 500 hrs.<br>GM - 13 | per GRI GM 10 |
| Puncture Resistance, lbs. (min.) | ASTM 4833 | 90 | 45,000 lbs.[3] |
| Carbon Black Content, (Allowable Range in %) | ASTM D4218 | 2.0 - 3.0 | 20,000 lbs.[3] |
| Carbon Black Dispersion, (Acceptable Levels) | ASTM D5596 | GRI GM13 | 45,000 lbs.[3] |
| Asperity (textured only) | ASTM D7466 | 16 | every 2nd roll |

1. Thickness - value represents lowest individual value.
3. pounds of resin
4. pounds of geomembrane

-- END OF SECTION--

# SECTION 02754 GEOCOMPOSITE DRAINAGE MEDIA (GDM) CAP SYSTEM

## PART 1 GENERAL

### 1.1 DESCRIPTION OF WORK

A. The Contractor shall furnish all labor, materials, tools, supervision, transportation, and installation equipment necessary for the installation of the geocomposite drainage media (GDM), as specified herein, as shown on the Drawings, and in accordance with the Construction Quality Assurance (CQA) Plan.

B. The Contractor shall be prepared to install the GDM in conjunction with the geomembrane cap and other components of the cap system

### 1.2 REFERENCES

The latest revision of the following standards of the American Society of Testing and Materials (ASTM) are hereby made a part of these specifications.

| | |
|---|---|
| ASTM D 413 | Standard Test Methods for Rubber Property - Adhesion to Flexible Substrate |
| ASTM D 792 | Standard Test Methods for Density and Specific Gravity of Plastic by Displacement. |
| ASTM D 1505 | Standard Test Method for Density of Plastics by the Density-Gradient Technique. |
| ASTM D 1777 | Standard Test Method for Measuring Thickness of Textile Materials. |
| ASTM D 4716 | Standard Test Method for Constant Head Hydraulic Transmissivity (In-Plane Flow) of Geotextiles and Geotextiles Related Products. |
| ASTM D 5199 | Standard Test Method for Measuring Nominal Thickness of Geotextiles and Geomembrane |
| ASTM F904 | Standard Test Method for Measuring Ply Adhesion |

### 1.3 CONSTRUCTION QUALITY ASSURANCE (CQA) TESTING

A. The Contractor shall comply with all terms and requirements of the Construction Quality Assurance Plan (contained in this document).

B. GDM that is rejected upon testing shall be removed from the project site and replaced at Contractor's cost. Sampling and quality assurance testing of GDM supplied as replacement for rejected material shall be performed by the CQA Engineer at Contractor's cost.

### 1.4 SUBMITTALS

A. Prior to shipping to the site, the Contractor shall submit to the Engineer two (2) copies of a mill certificate or affidavit signed by a legally authorized official of the Manufacturer. The Contractor shall also submit two samples, one yard square in size each, with the mill certificate. The mill certificate or affidavit shall attest that the GDM meets the required properties stated in these Specifications. The samples shall be labeled with the Manufacturer's lot or batch number, machine directions, date of sampling, project number, and Manufacturer and product names.

B. For GDM delivered to the site, quality control certificates, signed by the Manufacturer's quality assurance manager shall be provided for every 50,000 square feet of GDM. Each certification shall have roll identification number(s), sampling procedures, frequency, and test results.

C. The Contractor shall furnish the Engineer a copy of delivery tickets or other approved receipts as evidence for materials received that will be incorporated into the construction.

### 1.5 MEASUREMENT AND PAYMENT

A. Payment for work shall be made on the Unit Price bid per square foot of in-place GDM**.** Pay limits shall be measured to the limits of geomembrane cap (FML)**.**

B. All testing, patches, repairs, waste, overlap, and material beyond the required pay limits will be considered incidental to the construction and will be excluded from payment.

C. Payment quantities will be determined by the Engineer.

## PART 2 PRODUCTS

### 2.1 MATERIALS

A. The Geonet shall be manufactured by extruding two (2) sets of polyethylene strands to

form a three dimensional structure to provide planer water flow.

B. A non-woven filter geotextile shall be heat bonded to both sides of the Geonet. Heat bonding shall be performed by the Manufacturer prior to shipping to the site. The filter geotextile shall have a minimum weight of 6 oz/sy on top of the Geonet and 6 oz/sy on the bottom of the Geonet.

C. The Geonet shall contain UV inhibitors to prevent ultraviolet light degradation.

D. T□□ GDM □□□□□□□□□□r□ □□ □□□ □□□□□□ □□□ □ □□□□ □□ □r□□□r□□□:

| PROPERTY | TEST METHOD | UNITS | VALUE |
|---|---|---|---|
| Thickness (geonet only) | ASTM D5199 | mil | 250 |
| Resin Density (geonet only) | ASTM D1505 | $g/cm^3$ | 0.94 |
| Mass per Unit Area (Unit Weight) (geotextile only) | ASTM D5261 | $oz/yd^2$ | 8 (bottom & top) |
| Ultraviolet Resistance (500 hrs) (geotextile only) | ASTM D4355 | % | 70 |
| Apparent Opening Size (AOS) (geotextile only) | ASTM D4751 | U.S. Sieve | 70 |
| Permittivity (geotextile only) | ASTM D4491 | $sec^{-1}$ | 0.5 |
| Strength Class[2] (geotextile only) | AASHTO M288 | Class | 2 |
| Ply Adhesion | ASTM D7005 or GRI GC 7 | lb/inch | 1.0 Min. |
| Transmissivity[3] | ASTM D4716 | $m^3/m^2/sec$ | $4.7 \times 10^{-4}$ Min. (500 psf) |

Notes:
1. Minimum Average Roll Value (MARV), except where noted
2. AASHTO M288 includes requirements for the following properties:
   - Grab Tensile Strength (ASTM D4632) (160 lbs)
   - Grab Tensile Elongation (ASTM D4632) (∃50%)
   - Trapezoidal Tear Strength (ASTM D4533) (55 lbs)
   - Puncture Resistance (ASTM D4833) (55 lbs)
   - Burst Strength (ASTM D3786) (200 psi)
3. Conduct test for transmissivity at the normal compressive load indicated and at a minimum hydraulic gradient of 0.30 after a seating period of at least 24 hours. Boundary conditions are site protective cover soil (sand) interface on the upper geotextile and the textured FML against the lower geotextile.

In addition, the minimum interface properties for each of the geosynthetic / geosynthetic and geosynthetic / soil interfaces shall be confirmed using direct shear testing (ASTM D5321). The minimum interface friction angle or equivalent shear strength (Ø and c) between all components of the composite cap as determined by direct shear testing shall be $\geq 20.5°$. The test shall be conducted at a frequency of two (2) tests per project using a normal load of 500 psf.

E. Each roll of GDM delivered shall have the following identification information:

1. Manufacturer's name
2. Product identification
3. Thickness
4. Roll number
5. Lot number
6. Roll dimensions

# PART 3 EXECUTION

## 3.1 SHIPPING, HANDLING AND STORAGE

A. During periods of shipment and storage, all GDM shall be protected from direct sunlight, temperature greater than 140° F, water, mud, dirt, dust, and debris. To the extent possible, the GDM shall be maintained wrapped in heavy-duty protective covering until use. GDM delivered to the project site without protective wrapping shall be rejected.

B. GDM that is damaged during shipping or storage shall be rejected and replaced at Contractor expense.

## 3.2 INSTALLATION

A. GDM shall be placed to the lines and grades shown on the Contract Drawings. At the time of installation, the GDM shall be rejected, if it has defects, rips, holes, flaws, evidence of deterioration, or other damage.

B. The GDM shall be placed only on Geomembrane that has been accepted by the Engineer.

C. The Contractor shall provide temporary anchorage of the GDM during installation to prevent movement during construction. Such anchorage may include sandbags and the like, as approved by the Engineer. Permanent bonding to the Geomembrane shall be prohibited.

D. In general, seams shall be oriented parallel to the line of maximum slope, i.e., oriented

up and down the slope.

E. Adjacent rolls of GDM shall be overlapped a distance of at least three (3) inches and the overlapping geonet secured using polyethylene ties. Tie spacing shall be every ten (10) feet.

The overlaying filter geotextile, where applicable, shall extend at least six (6) inches past the geonet joint and shall be permanently bonded by heat bonding or sewing as approved by the Engineer.

F. Any GDM that is torn, crushed, or punctured shall be repaired or replaced by the Contractor at no additional cost to the Owner. The repair shall consist of a patch of the same type of material, placed over the failed area and shall overlap the existing material a minimum of twelve (12) inches from any point of the rupture. The patch shall be connected to the Geonet using polyethylene ties at a five (5) foot spacing with a minimum of two (2) ties.

--END OF SECTION--

# SECTION 02755 GEOMEMBRANE (FML) CAP

## PART 1 DESCRIPTION

### 1.1 SCOPE OF WORK

A. The CONTRACTOR shall furnish all labor, materials, supervision and equipment to complete the installation of the Linear Low Density Polyethylene (LLDPE) Geomembrane Cap, including, but not limited to, layout, seaming, patching, and all necessary and incidental items required to complete the Work, in accordance with the Construction Drawings and these specifications.

B. Sufficient material shall be furnished to cover all lined areas shown on the Construction Drawings, including overlaps at field seams and welding to the existing anchor trench.

C. It is the intent of these specifications to ensure a quality finished product. It shall be the responsibility of the CONTRACTOR to ensure that this requirement is met.

### 1.2 QUALITY

A. The CONTRACTOR will be required to submit a quality control program to the CQA ENGINEER prior to initiating field work.

B. The OWNER shall employ and pay for the services of a third-party CQA ENGINEER, in accordance with Section 01400 - Quality Control, to confirm the installation of the liners.

C. All installation procedures and testing shall be in accordance with these specifications and OWNER's independent Construction Quality Assurance (CQA) Plan. A copy of this plan is enclosed.

D. All field destructive and non-destructive testing will be performed by the CONTRACTOR. Samples for laboratory testing will be taken by the CONTRACTOR for testing at the CONTRACTOR's laboratory as well as the CQA ENGINEER's laboratory.

### 1.3 SUBMITTALS

A. The geomembrane manufacturer shall submit certification that all materials manufactured for the project have been produced in accordance with these specifications along with results from a quality control program. This information must be submitted for review prior to material delivery. The CQA ENGINEER reserves the right to halt installation until proper certification is submitted and determined acceptable for use.

B. The CONTRACTOR shall submit to the CQA ENGINEER, six full sets of panel layout construction drawings. Field welds and panels shall have an identification system. Construction Drawings shall be submitted to the CQA ENGINEER at least two weeks prior to installation.

C. The manufacturer of the geomembrane used in this work shall approve all shop drawings and a proposed cap layout to cover the cap area shown on the Construction Drawings.

D. Details shall be included to show the termination of the geomembrane at the perimeter of capped areas, the methods of sealing around penetrations and methods of anchoring.

E. The CONTRACTOR shall submit to the CQA ENGINEER a physical sample of the geomembrane to be used. The samples shall be labeled with the manufacturer's name, product identification, lot number and roll number.

F. The CONTRACTOR shall also submit to the CQA ENGINEER inventory tickets, roll numbers or batch identifications, packing papers and invoices for the geomembrane used.

G. The CONTRACTOR shall provide personnel resumes demonstrating compliance with the following requirements:

1. A minimum of one field superintendent per shift shall be designated by the CONTRACTOR and approved by the CQA ENGINEER. Each field superintendent shall have a minimum of three years and five million square feet of field experience in installing geomembranes. Any change or replacement of superintendent during the Project must be approved by the CQA ENGINEER.

2. The weld technicians shall have a minimum of one year and one million square feet geomembrane welding experience.

## 1.4 WARRANTY

A. Material

The MANUFACTURER is responsible for guaranteeing it's product. The warranty shall include all that is listed below:

1. Shall begin at the time of issuance of CQA ENGINEER's Certification of Substantial Completion.

2. The material shall be free from defects and be able to withstand normal weathering and use from the date of installation for a period of 20 years under normal uses and services for which it is designed and manufactured.

3. This limited warranty does not include damages or defects resulting from acts of God, casualty or catastrophe such as, but not limited to earthquake, flood, piercing hail, or tornado.

4. "Normal Use" excludes: exposure to harmful chemicals, mechanical abuse by machinery, equipment, or people, excessive pressure beyond that indicated by the final overburden or municipal refuse and cover indicated on the drawings.

### 1.5 MEASUREMENT AND PAYMENT

A. Payment for work shall be made on the Unit Price bid per square foot of in-place geomembrane liner. Pay limits shall be measured to the welded seam along the existing anchor trench or the limit of geomembrane liner runout (edge of liner) where no welded seams are required.

B. All testing, patches, repairs, waste, overlap, and material beyond the required pay limits will be considered incidental to the construction and will be excluded from payment. All materials and work required of the CONTRACTOR for exposing the existing base liner, cleaning, and welding to the existing base liner are also considered incidental to the installation and will also not be included as pay items.

C. Payment quantities will be determined by the ENGINEER. No payment shall be made until liner is actually installed and the state accepts the certification of the CQA Firm.

## PART 2 PRODUCTS

### 2.1 GEOMEMBRANE CAP

A. The geomembrane shall comprise linear low density polyethylene material manufactured of new, first-quality products designed and manufactured specifically for the purpose of capping in landfills.

B. The geomembrane material shall be so produced as to be free of holes, blisters, undispersed raw materials or any sign of contamination by foreign matter. Any such defect shall be repaired in accordance with the manufacturer's recommendations. The CQA ENGINEER may reject all or portions of units (or rolls) of geomembrane if significant quantities of production flaws are observed.

C. The geomembrane material shall meet the material properties and testing frequencies as specified in the Geosynthetic Research Institute GRI Test Method GM-17, as latest revised, for 40 mil Linear Low Density Polyethylene (LLDPE) geomembrane.

D. The geomembrane cap shall be the required minimum liner thickness as shown on the Construction Drawings.

E. If natural colored, the manufacturer shall add carbon black per ASTM D 1248 Specifications, Section 3.1.2.3, Class C.

F. The manufacturer's quality control program shall include the following inspections and tests:

1. Inspection for: Appearance on both sides, manufacturing defects, and thickness at 10 random locations across each sample strip.

2. Testing shall be conducted in accordance with the Geosynthetic Research Institute GRI Test Method GM-17, as latest revised, for 40 mil Linear Low Density Polyethylene (LLDPE) geomembrane.

3. A quality chart of each roll of sheet shall be prepared and a copy attached to the roll. Information plotted on the chart shall include the location and type of defect, if any.

G. The textured material shall have an interface friction angle with contiguous cap components of Ø > 26.6°. Interface friction testing shall be conducted between all components of the cap suing normal loads of 200, 500 and 1,000 psf at a frequency of two (2) tests per project.

H. The geomembrane shall be shipped rolled. Folded or otherwise creased material will not be accepted. The material shall be marked and tagged with the following information:

1. Serial Number
2. Resin Type
3. Roll Length
4. Gross Weight
5. Inspected By
6. Date of Manufacture
7. Resin Lot Number
8. Roll Width
9. Net Weight

I. Material which has been delivered to the project site shall be stored in a dry area and protected from precipitation and direct sunlight.

J. Care shall be taken to keep the materials clean and free from debris prior to installation.

# PART 3 EXECUTION

## 3.1 GENERAL

The geomembrane cap shall be constructed as soon as practical after filling of the cell. The cap shall be installed following the manufacturer's printed recommendations, using sound, accepted engineering practices. The entire geomembrane cap installation shall be completed by one crew. The installing crew shall be approved by the manufacturer/fabricator for installation of 40 mil geomembrane.

A manufacturer's technical representative shall be at the Pre-Deployment Meeting and on site at the time of installation.

A. Geomembrane

1. No horizontal seams are allowed within five feet of the toe of the slope.

2. Unroll only those factory-packaged sections which are to be anchored or seamed together in one day. Panels should be positioned with the overlap recommended by the manufacturer, but not less than 2-inches.

3. After panels are initially in place, remove as many wrinkles as possible. Unroll several panels and allow the geomembrane to "relax" before beginning field seaming. The purpose of this is to make the edges, which are to be bonded, as smooth and free of wrinkles as possible.

4. Once panels are in-place and smooth, commence field seaming operations.

5. No support equipment used by any CONTRACTOR shall be allowed on the geomembrane. Personnel working on the geomembrane shall not smoke, wear damaging shoes or engage in any activity which damages the geomembrane.

6. Damaged and sample coupon areas of geomembrane shall be repaired by the CONTRACTOR. Repaired areas will be tested for seam integrity by the CONTRACTOR. Damaged materials are the property of the CONTRACTOR and will be removed from the site at the CONTRACTOR's expense. The CONTRACTOR will retain all ownership and responsibility for the geomembrane until acceptance by the OWNER.

7. The CONTRACTOR shall use extreme care when uncovering the in-place 60 mil HDPE base liner. Once uncovered, the 60 mil base liner shall be cleaned and the 40 mil LLDPE shall be welded to the 60 mil HDPE base liner within 12” of the existing based liner anchor trench. Any damage to the existing 60 mil HDPE base liner shall be repaired prior to protective cover soil placement.

## 3.2 SEAMING

A. Geomembrane

1. Field Seaming

a. All foreign matter (dirt, water, oil, etc) shall be removed from the area to be bonded. If the seam is to be bonded by the extrusion process, the bonding surfaces must be thoroughly cleaned by mechanical abrasion or alternate methods approved by the CQA ENGINEER to remove surface cure and prepare the surfaces for bonding. No solvents shall be used to clean the geomembrane.

b. Tack welds, if used, shall use heat only; no double-sided tape, glue or other method will be permitted. The geomembrane should be seamed completely to the ends of all panels to minimize the potential of tear propagation along the seam. The completed cap shall not exhibit "trampolining" and shall be in full contact with the underlying soil cap.

c. At the end of each day or installation segment, all unseamed edges shall be anchored by sand bags or other approved device. Sand bags shall weigh approximately 20 pounds and shall be placed no further apart than 20 foot spacing along the open end of the geomembrane. Sand bags securing the geomembrane on the side slopes should be connected by a rope fastened at the top of the slope by a temporary anchor. If high winds are expected, boards along the edge of unseamed panels, with weighted sand bags on top, should be used to anchor the geomembrane. Sand bags fastened by rope should be used to secure unseamed edges on the side slopes. Staples, U-shaped rods or other penetrating anchors shall not be used to secure the geomembrane. The temporary anchoring of the geomembrane is fully the responsibility of the CONTRACTOR. Any material damaged as the result of weather effects, shall be repaired or replaced at no cost to the OWNER.

d. It is imperative to keep surface water runoff from beneath the geomembrane at all times during installation. The CONTRACTOR's panel placement and seam welding technique and welding schedule shall minimize or eliminate the accumulation of water beneath the geomembrane. Any water found ponded beneath the geomembrane after the geomembrane has been installed shall be removed by the CONTRACTOR at no cost to the OWNER. Any soil subgrade beneath installed geomembrane that has become excessively moist, soft or unsuitable to perform its intended function shall be replaced at no cost to the OWNER.

2. Field seaming may be extrusion or fusion welding or a combination of these methods. Solvent welding is not acceptable. The CQA ENGINEER reserves the right to reject any proposed seaming method believed unacceptable.

   a. Extrusion welding applies a molten bead of material to preheated sheets of geomembrane. The sheets are then joined by pressure.

   b. The fusion welding process heats the area to be joined to the melting point and then applies pressure to join the melted surfaces.

   c. The sheets to be joined shall be overlapped at least 2-inches after the necessary aligning and cutting.

   d. In general, seams should be oriented parallel to the line of maximum slope, i.e. oriented up and down, not across, the slope. In corners and odd shaped geometric locations, the number of field seams should be minimized.

   e. No horizontal seams should be within 5 feet from the toe of the slope.

   f. No seaming should be attempted above 40 degrees C (104 degrees F) ambient air temperature. Below five (5) degrees C (41 degrees F) ambient air temperature, preheating of the geomembrane may be required. It shall be the responsibility of the CONTRACTOR to demonstrate that conditions are favorable for seaming by acceptable test (start-up) seams which duplicate, as closely as possible, actual field conditions. Preheating may be achieved by natural and/or artificial means (shelters and heating devices).

   g. A moveable protective layer of plastic may be required, as recommended by the CQA ENGINEER, to be placed directly below each overlap of geomembrane that is to be seamed. This is to prevent any moisture build-up between the sheets to be welded.

   h. Seaming will extend to the outside edge of panels.

   i. If required, a firm substrata should be provided by using a flat board, a conveyor belt, or similar hard surface directly under the seam overlap to achieve proper support.

   j. Grinding prior to welding shall be as recommended by the geomembrane manufacturer and shall be done perpendicular to the sheet edge. Overground or improperly ground areas shall be replaced at the CONTRACTOR's expense.

k. No folds, wrinkles or "fish-mouths" shall be allowed within the seam area. Where wrinkles or folds occur, the material shall be cut, overlapped and an extrusion-weld shall be applied. During wrinkle or fold repairs, adjacent geomembrane may not necessarily be required to meet the 2-inch minimum overlap, if approved by the CQA ENGINEER. All welds on completion of the work shall be tightly bonded and sealed.

## 3.3 TESTING OF GEOMEMBRANE

A. General

1. Samples of the field seams shall be taken and tested in accordance with ASTM D6392 to ensure that tensile strength at yield and break, elongation at yield and break meet the minimum specifications. A quality control certificate shall be issued with the material.

2. The CONTRACTOR shall employ on-site physical non-destructive testing on all welds.

3. A quality control technician shall inspect each sheet and seam. Any area showing a defect shall be marked and repaired in accordance with geomembrane repair procedures.

B. Test Seams: Test seams will be made each day prior to commencing field seaming. These seams will be made on fragment pieces of geomembrane to verify that seaming conditions are adequate. Such test seams will be made at the beginning of each seaming period and, at the CQA ENGINEER's discretion, at least once every four hours, for each seaming apparatus used that day. Also, each seamer will make at least one test seam each day.

1. The test seam sample will be at least 1.5 m (5 feet) long by 0.3 m (1 foot) wide with the seam centered lengthwise. Six adjoining specimens 25 mm (1-inch) wide each will be die cut from the test seam sample. These specimens, which will be tested with a tensiometer in the field for shear (three samples) and peel (three samples) by the CONTRACTOR and witnessed by the CQA ENGINEER, should not fail in the seam. If a test seam fails, the entire operation will be repeated. If the additional test seam fails, the seaming apparatus or seamer will not be accepted and will not be used for seaming until the deficiencies are corrected and two consecutive successful full test seams are achieved. Test seam failure is defined as failure of any one of the specimens tested in shear or peel.

2. The CQA ENGINEER or his representative will observe all test seam procedures. The remainder of the successful test seam sample will be assigned a number and marked accordingly by the CQA ENGINEER, who will also log the date, hour,

ambient temperature, number of seaming unit, name of seamer and pass or fail description. At least one tested specimen from each test as selected by the CQA ENGINEER will be retained by the CQA ENGINEER. The CQA ENGINEER will transmit these specimens to the OWNER following acceptance of the geomembrane materials and installation by the OWNER.

3. The criteria for determining passing welded seams shall be as stated in the "Seam Strength" table in the Geomembrane FML Cap Section of the CQA Plan.

C. Field Seams: Field seams will be tested by the CONTRACTOR continuously using non-destructive techniques and at specified intervals using destructive tests. Requirements for non-destructive and destructive testing are as follows:

1. Single Weld Seams: The CONTRACTOR shall maintain and use equipment and personnel at the site to perform continuous vacuum box testing on all single weld production seams or when the geometry of the weld makes pressure testing impractical.

a. Equipment for Vacuum Testing:

1. Vacuum box assembly consisting of a rigid housing, a transparent viewing window, a soft neoprene gasket attached to the bottom, port hole or valve assembly, and a vacuum gauge.

2. Vacuum pump assembly equipped with a pressure controller and pipe connection.

3. A rubber pressure/vacuum hose with fittings and connections.

4. A bucket and means to apply a soapy solution.

b. Procedure for Vacuum Testing:

1. Trim excess overlap from seam, if any.

2. Turn on the vacuum pump to reduce the vacuum box to approximately 5 in. of mercury, i.e. 3 psi gauge.

3. Apply a generous amount of solution of strong liquid detergent and water to the area to be tested.

4. Place the vacuum box over the area to be tested and apply sufficient downward pressure to "seat" the seal strip against the liner.

5. Close the bleed valve and open the vacuum valve.

6. Apply a minimum of 3 psi vacuum to the area as indicated by the gauge on the vacuum box.

7. Ensure that a leak tight seal is created.

8. For a period of not less than 5 seconds, examine the geomembrane through the viewing window for the presence of soap bubbles.

9. If no bubbles appear after 15 seconds, close the vacuum valve and open the bleed valve, move the box over the next adjoining area with a minimum 3 inch overlap, and repeat the process.

10. Mark all areas where soap bubble appear and repair the marked areas. After repairs are made, retest these areas.

2. Double Weld Seams: The CONTRACTOR shall maintain and use equipment and personnel to perform air pressure testing of all double weld seams. The system shall be capable of applying a pressure of at least 30 psi for not less than five minutes. The CONTRACTOR shall perform all pressure and vacuum testing under the supervision of the CQA ENGINEER. Pressure loss tests shall be conducted in accordance with the procedures outlined in "Pressurized Air Channel Test for Dual Seamed Geomembranes", Geosynthetic Research Institute Test Method GM-6. As outlined by the test method, following a two minute pressurized stabilization period, pressure losses over a measurement period of five minutes shall not exceed the following: 40 mil - 4 psi.

3. Destructive testing will be performed on a maximum of every 500 linear feet of field seam. The locations will be selected by the CQA ENGINEER. Sufficient size samples will be obtained by the CONTRACTOR to provide one sample to the archive, one sample to the CQA ENGINEER for laboratory testing, and two samples to be retained by the CONTRACTOR for both field and laboratory testing. Testing requirements are as follows: Each sample shall be large enough to test five specimens in peel and five specimens in shear. The criteria for determining passing welded seams shall be as stated in the “Seam Strength” table in the Geomembrane FML Cap Section of the CQA Plan.

   a. Tests shall be conducted in peel and shear using a tensiometer. No strain measurements from field tests of seams will be accepted. Field tests will be evaluated for the criteria described above in paragraph B. 3. or 4.

b. The CQA ENGINEER will observe all production seam field test procedures. The remainder of the successful test seam sample will be assigned a number and marked accordingly by the CQA ENGINEER, who will also log the date, seam number, approximate location in the seam, and field test pass-or-fail description, if applicable. The CQA ENGINEER will be responsible for the archive specimen.

## 3.4 REPAIRS OF DAMAGED AND SAMPLED AREAS

A. Damaged and sample coupon areas of geomembrane shall be repaired by the CONTRACTOR by construction of a cap strip. No repairs shall be made to seams by application of an extrusion bead to a seam edge previously welded by integrity. Damaged materials are the property of the CONTRACTOR and will be removed from the site at the CONTRACTOR's expense. The CONTRACTOR will retain all ownership and responsibility for the geomembrane until acceptance by the OWNER.

## 3.5 PROTECTION OF LEADING EDGES

Between construction of partial sections of the geomembrane cap, leading edges of the geomembrane may be exposed or buried for extended periods of time prior to their joining to adjacent, subsequent geomembrane sections. The combined action of abrasive soil and equipment impact stresses may "etch" unprotected geomembrane surfaces sufficiently to affect seam strengths. Therefore, it is necessary to protect leading edges in high activity areas with sacrificial layers of geomembrane sheet until they are ready for final seaming. As a minimum, each leading edge to be seamed that must be buried or which must be exposed for periods of one month or longer shall be continuously covered by a layer of geotextile overlain by a layer of geomembrane sheet. The geotextile shall be nonwoven and have a minimum weight of 6 oz. per square yard. The sacrificial geomembrane sheet shall have a minimum thickness equal to that of the geomembrane liner to be protected. Both protective cover sheet layers shall have a minimum width of 2 feet. The protective cover sheets shall be either covered with soil or weighted with sand bags to prevent displacement by wind. The edge of the sheet to be protected shall be approximately centered beneath the overlying protective layers prior to burial or weighing with sandbags. Leading edges located in areas expected to receive direct traffic from construction equipment shall be buried under a minimum thickness of three feet of buffer soil.

## 3.6 CAP ACCEPTANCE

The CONTRACTOR shall retain ownership and responsibility for the geomembrane cap system until acceptance by the OWNER.

The cap system shall be accepted by the OWNER when:

- The installation is complete as determined by the CQA ENGINEER;

- Verification of the adequacy of all seams and repairs, including associated testing, is complete;

- All documentation of installation is completed, including all CQA reports;

- The CONTRACTOR provides the OWNER with record drawings of the panel layout and seam locations with reference numbers for test locations;
- The CONTRACTOR, the Manufacturer and the CQA ENGINEER provide written certification that the installation was in accordance with the manufacturer's general recommendations, the OWNER's CQA plan, and specifications, with exceptions noted.

- The cap system has been accepted by the Alabama Department of Environmental Management.

--END SECTION--

# SECTION 02757 CUSHION GEOTEXTILE (NON-WOVEN)

## PART 1 GENERAL

### 1.1 SCOPE OF WORK

A. The CONTRACTOR shall furnish all labor, materials, tools, supervision, transportation, and installation equipment necessary for the installation of the geotextile layer, as specified herein, as shown on the Engineering Plans, and in accordance with the Construction Quality Assurance (CQA) Plan.

B. The CONTRACTOR shall be prepared to install the geotextile in conjunction with the earthwork and other components of the liner system.

### 1.2 REFERENCES

(Note: For geotextile test standards please refer to the current ASTM Annual Book of ASTM Standards, Volume 04.13 Section 4 for the Latest version of the American Society for Testing and Materials (ASTM) Standards.)

### 1.3 MEASUREMENT AND PAYMENT

A. Leachate Collection Pipe Cushion Geotextile

1. No separate measurement shall be made.

2. Payment shall be included in the perforated leachate collection unit price in the Proposal.

B. Cushion Fabric Under Stone Protective Cover

1. No separate measurement shall be made.

2. Payment shall be included in the perforated leachate collection unit price in the Proposal.

## PART 2 PRODUCTS

### 2.1 MATERIALS

A. This section sets forth the requirements for geotextiles.

B. Physical Properties

The geotextile shall be manufactured using a spunbonded process in which continuous polypropylene filaments are mechanically needled to produce a non-woven geotextile. Manufacturer's certification shall be required stating the geotextile has been inspected for broken needles. This inspection shall be via metal detectors permanently installed on-line at the production facility.

The geotextile shall meet or exceed the properties listed in Table 1. Unless noted otherwise, all numerical values indicate minimum average roll values (i.e., test results from any sampled roll in the lot, when tested in accordance with ASTM D 4759-88 shall meet or exceed the minimum average roll value listed). All strength values are for the weaker principle direction.

**TABLE 1**

| **Physical Property** | **Test Method** | **Unit Value** | **Minimum** |
|---|---|---|---|
| Mass Per Unit Area | ASTM D 3776 | oz/sy | 8.0/16.0* |
| Puncture Resistance | ASTM D6241 – 04(2009)e1 | lbs. | 600 |

ASTM - American Society for Testing and Materials

* As shown on the Drawings

C. Submittals

Prior to bid, the CONTRACTOR shall submit the geotextile manufacturer's specification sheet(s) which indicate the property values of the product(s) that are submitted for use on the project. A swatch (12" x 12") of each geotextile shall be submitted along with the specification sheets.

Prior to arrival of the geotextile(s) on site, upon request the geotextile manufacturer shall supply quality control/quality assurance documents to the OWNER's representative.

Quality control/quality assurance sampling and testing shall be conducted in accordance with ASTM D 4354 and applicable test standards as found in Table 1. Recommended tests and test frequencies are found in Table 2.

**TABLE 2**

| Property | Minimum Frequency |
|---|---|
| Mass Per Unit Area | every 100,000 $ft^2$ |
| Puncture Resistance | every 400,000 $ft^2$ |

Additional Supporting Documentation: CONTRACTOR shall supply additional documentation which shall include: supporting test date and EPA 9090 test data which will assist the DESIGN ENGINEER in determining the suitability of the geotextile for the intended application.

D. Plant Inspection

A representative of the OWNER may visit the manufacturing plant at any time during the project to observe and inspect the manufacturing process and quality control monitoring, sampling and testing. The OWNER will notify the CONTRACTOR at least forty-eight (48) hours in advance of the intended visit. The CONTRACTOR shall be responsible for making all necessary arrangements for the visit with the manufacturer. All costs of travel, lodging and meals incurred by the OWNER's representative will be borne by the OWNER.

## 2.2 SHIPPING, STORAGE AND HANDLING

A. General

Geotextile shall be shipped, stored and handled in accordance with ASTM D 4873, and as specified herein. CONTRACTOR shall be completely responsible for shipping, storage and handling of all geotextiles.

B. Roll Identification

Each roll shall be labeled (by printing directly on the geotextile) or tagged with roll identification number, lot identification number, name of manufacturer, product type and grade, and physical dimensions. The label or tag information shall be affixed or attached to the roll at all times during deployment of the roll. The roll identification number and manufacturer name shall also be marked on the protective covering.

C. Shipping

Geotextile shall be shipped and stored in opaque protective covering. CONTRACTOR shall notify the CQA ENGINEER at least 24 hours prior to schedule delivery. No materials shall be unloaded without the presence of the OWNER's representative. Geotextile(s) delivered to the site shall be inspected for damage, unloaded and stored with minimal handling. CONTRACTOR shall assist the OWNER's representative in conducting inventory, handling and sampling of geotextile at no additional cost to the OWNER.

D. Handling

No hooks, tongs or other sharp tools or instruments shall be used for handling geotextile roll(s). CONTRACTOR shall use slings or a pole which extends a minimum of 1 foot beyond each end to unload or handle individual rolls. Geotextile shall not be dragged along the ground.

E. Site Storage

Geotextile roll(s) whose protective covering has been damaged during handling shall be protected from ultraviolet light exposure, precipitation or other inundation, soil, mud, dirt, debris, puncture, cutting or other damaging or deleterious conditions. Geotextile shall not be stored directly on the ground.

## 2.3 CONFORMANCE TESTING

A. Sampling Procedures

Upon delivery to the site, samples of the geotextile(s) shall be removed and sent to a laboratory, chosen by the OWNER, for testing to ensure conformance to these specifications. Samples shall be selected by the OWNER's representative in accordance with these specifications. Conformance testing, as detailed, in Article 2.1 MATERIALS, C., Table 2.

B. Interpretation of Conformance Test Results

Test specimens will be obtained from each conformance sample. The minimum number of specimens tested per conformance sample for each tested geotextile property will be determined in accordance with the respective ASTM Standard. The average value will be calculated from the specimen test values of each conformance sample and compared to the minimum average roll value of the tested geotextile property. A conformance sample that yields an average number which is less than the specified minimum average roll property, will be recorded as a failure. If two conformance samples fail, all rolls within the sampled 100,000 square feet or lot will be rejected for use on the project unless the manufacturer would like to have additional testing performed at no cost to the OWNER. If only one (1) conformance test fails, the roll that yielded the failure will be rejected and a subsequent conformance sampled from the same 100,000 square feet or lot will be tested. All rolls within the sampled 100,000 square feet or lot will be rejected for use on the project if the subsequent conformance test fails. Only the roll which yielded a failure will be rejected from use on the project if the subsequent conformance test passes.

### 2.4 GEOTEXTILE INSPECTION

A. Material Inspection

The CONTRACTOR shall visually inspect all geotextile rolls for imperfections, faulty areas and possible damage prior to installation. All defective rolls shall be marked and repaired in accordance with approved methods.

## PART 3 EXECUTION

### 3.1 INSTALLATION

A. Placement

Geotextile(s) shall be installed as shown on the Engineering Plans, approved installation drawings, and as specified herein or in accordance with the approved installation procedures. No geotextile roll shall be installed without approval of the CQA ENGINEER. Geotextile rolls shall be placed in such a manner as to minimize field sewing.

Geotextile shall be cut only with an approved geotextile cutter.

All changes to approved installation drawings and procedures shall be approved by the CQA ENGINEER prior to implementation.

The CONTRACTOR shall exercise extreme care during geotextile installation to prevent damage to the prepared supporting subgrade surface or to other installed geosynthetics. The CONTRACTOR shall exercise care to prevent the entrapment of rocks, clods of earth or other matter which could damage the geotextile or other geosynthetic, clog the geotextile or hamper seaming. Any geotextile surface showing damage to penetration by foreign objects or distress shall be replaced or repaired.

No foot traffic shall be allowed on the geotextile except with approved smooth - sole shoes. No vehicular traffic shall be allowed on the geotextile. The CONTRACTOR shall not use the geotextile as a work area or storage area for tools and supplies.

The CQA ENGINEER shall have the authority to order the immediate stoppage of work as a result of improper installation procedures or for any reason which may result in defective and improper installation.

Cleanup within the work area shall be an ongoing responsibility of the CONTRACTOR. Particular care shall be taken to ensure that no trash, tools or other materials are trapped beneath the geotextile.

B. Repairs

Geotextile repairs shall be made with patches of the same geotextile material, using approved sewing systems, equipment and techniques. The patch size shall be 24" larger in all directions than the area to be repaired. All corners shall be rounded. All stitches shall be located no closer than 1 inch from the edge of the patch.

C. Joining Methods

Thread used to sew panels of geotextiles together shall be UV stabilized polypropylene. The tread color shall contrast with the geotextile color to assist in inspection of the seam.

Geotextile seams shall be prayer or flat seams for non-woven geotextiles. All seams shall be formed by mating the edges of the geotextile panels, and sewn together with continuous stitches located a minimum of 3 inches from the mated edges. A two - thread, type 401k double - locked stitch shall be used for all sewing work. Sewing procedures shall conform to the latest procedures recommended by the geotextile manufacturer. Thermal welding can also be performed on geotextiles with mass per unit area greater than 7.9 ounces per square yard. For both forms of seaming the CONTRACTOR shall demonstrate that the seam efficiency meets requirements found in Table 1.

D. Cover

All geotextile should be covered within 14 days. If the geotextile will be left exposed for more than 14 days, the manufacturer, prior to shipping, shall provide field U.V. test data and written recommendations for the maximum time of U.V. exposure. Geotextiles which will be left exposed for more than 14 days shall be routinely sampled and tested for tensile strengths every 4 weeks. Samples should be taken from the exposed geotextile and these areas properly repaired. If within the time frame of recommended exposure the tensile strength of the geotextile falls below 80% of the original values, the manufacturer shall replace the defective material assuming all cost for removal of the defective material and installation of the replacement material.

E. Socks

Geotextile fabric socks for wrapping pipe shall be constructed with the fabric specified in this section. The sock shall be constructed by forming a cylinder and stitching the seam in accordance with the joining methods specified in this section. The sock diameter shall be sufficient size to slip easily over the pipe and connecting sleeve.

-- END OF SECTION --

# SECTION 02930 GRASSING

## PART 1 GENERAL

### 1.1 WORK INCLUDED

Provide seedbed preparation, liming, fertilizing, seeding, and mulching of all newly graded finish earth surfaces, unless indicated otherwise, and all areas inside or outside the limits of construction that are disturbed by the Contractor's operation. Areas shall be hydroseeded, except small areas that are inaccessible to the hydroseeding equipment, which shall be drilled seedbed.

### 1.2 SUBMITTALS

A. Contractor shall furnish Certificates of Conformance from manufacturers or agencies.

1. Seed
2. Fertilizer
3. Lime
4. Soil Testing Recommendation - County Extension Service

B. Manufacturer's Literature

Including physical characteristics, application and installation instructions, and recommendations:

1. Hydraulic Mulch Material
2. Erosion Control Material

### 1.3 DELIVERY

A. Fertilizer and Lime

Deliver materials to the site in the original, unopened containers bearing the manufacturer's chemical analysis, name, trade name, trademark, and indication of conformance to state and federal laws. In lieu of containers, furnish fertilizer and lime in bulk with a certificate indicating the above information accompanying each delivery.

B. Seed

Deliver seed to the site in original sealed packages bearing the producer's guaranteed analysis for percentages of mixtures, purity, germination, weedseed content, and inert material. Label in conformance with USDA Federal Seed Act 53 Stat. Rules and

Regulations and applicable state seed laws. Wet, moldy, or otherwise damaged seed will be rejected.

### 1.4 STORAGE AND HANDLING

Store lime, fertilizer, and seed in dry locations away from contaminants. Protect seed from drying out. When handling materials, do not drop or dump from vehicles.

### 1.5 MEASUREMENT AND PAYMENT

A. Grassing shall include all labor, equipment, tools, seed, transportation, services, and any associated construction for complete installation. Measurement shall be made horizontally.

B. Payment shall be by the unit price bid per acre in the Proposal for "Permanent Grassing", only upon delivery of a complete stand of grass.

## PART 2 PRODUCTS

### 2.1 SEED

Permanent seeding shall be in accordance with the following schedule:

| SEEDS | LBS/ ACRE | DEPTH OF COVER | DATE OF PLANTING |
|---|---|---|---|
| BERMUDA GRASS-HULLED | 10 | ¼" - ½" | 3/15 - 7/15 |
| BERMUDA GRASS-UNHULLED | 10 | ¼" - ½" | 10/1 - 2/28 |
| BAHIA, PENSACOLA | 30 | ¼" - ½" | 3/1 - 6/15 |

Temporary seeding shall be used for spoil piles standing less than six (6) months. Long-term spoil piles shall be permanently seeded.

Mulch shall be applied to seeded areas within 24 hours after temporary and permanent seeding operations. Mulch shall be essentially free of noxious weeds and applied at a rate of approximately 70 lbs/1,000 square feet (3,000 lbs/acre).

On areas where ground surface exceeds approximately five (5%) slopes, the mulch shall be tacked using a sufficient amount of binding material to hold mulch in place.

Seedbed Preparation

1. Work lime and fertilizer into the soil where conventional equipment can be used. Use disk or similar equipment to prepare to depth of 3-4 inches. Use ripper if necessary.

2. Lime and fertilizer may be applied with seed mixture when hydroseeding is used and where mulch will be applied. Seedbed preparation may not be necessary where hydroseeding equipment is used.

3. Slopes that are too steep for conventional equipment (2:1 or steeper) should be seeded with hydroseeding equipment.

   Where hydroseeding equipment is not available for use on steep slopes, scarify the soil surface with a chain harrow, pick chain, grader blades with chisels, hand tools, or other equipment that will pit the soil or make trenches approximately 1-2 inches deep, 6-12 inches apart across the slope in which the seed can lodge and germinate.

## 2.2 LIME

ASTM C 602, commercial agricultural limestone containing a minimum of 94 percent of total carbonates, 52 percent calcium, and 42 percent magnesium. Provide the following ASTM E 11 gradation: minimum 100 percent passing the No. 20 sieve and 75 percent passing the No. 100 sieve. Application rates shall be as recommended by the Cooperative Extension Service through standard soil testing procedures.

## 2.3 FERTILIZER

Commercial grade, free flowing, uniform in composition and bearing the manufacturer's guaranteed statement of analysis. Analysis of fertilizer and application rates shall be as recommended by the Cooperative Extension Service through soil testing procedures, and in accordance with this schedule:

**FERTILIZER REQUIREMENTS**

| TYPE OF SPECIES | YEAR | ANALYSIS OR EQUIVALENT N-P-K | RATE | N TOP DRESSING RATE |
|---|---|---|---|---|
| 1. Cool season grasses | First | 6-12-12 | 1,500 lbs/ac | 50-100 lbs/ac[1,2] |
| 2. Cool season grasses and legumes | First | 6-12-12 | 1,500 lbs/ac | 0-50 lbs/ac[1] |
| 3. Ground covers | First | 10-10-10 | 1,300 lbs/ac[3] | - |

| | | | | |
|---|---|---|---|---|
| 4. Temporary cover crops seeded alone | First | 10-10-10 | 500 lbs/ac | 30 lbs/ac[3] |
| 5. Warm season grasses | First | 6-12-12 | 1,500 lbs/ac | 50-100 lbs/ac[2,4] |

1. Apply in spring following seeding.
2. Apply in split applications when high rates are used.
3. Apply to grass species only.
4. Apply when plants grow to a height of 2 to 4 inches.

### 2.4 MULCH

Free from noxious weeds, mold, or other deleterious material. Provide wood cellulose fiber when hydroseeding.

A. Straw

Stalks from oats, wheat, rye, barley, or rice. Furnish air-dry condition and of proper consistency for placing with commercial mulch-blowing equipment.

B. Wood Cellulose Fiber

Processed to contain no growth or germination-inhibiting factors and dyed an appropriate color to facilitate visual metering of materials application. Composition on air-dry weight basis: 9-15 percent moisture, pH range 3.5 to 5.0.

### 2.5 WATER

Suitable quality for irrigation.

## PART 3 EXECUTION

### 3.1 SEEDBED PREPARATION

Areas required to be seeded shall have been brought to the required subgrade. New areas to be seeded shall be thoroughly tilled to a minimum depth of four (4) inches by scarifying, disk harrowing, or other approved methods. Remove debris and stones larger than one inch remaining on the surface after tillage.

A. Fertilizer and Lime

Apply fertilizer and lime at the rates recommended by Cooperative Extension Service Tests.

B. Drill Seeding For New Seeding

Incorporate fertilizer and lime into the soil to a minimum depth of four (4) inches. Application may be performed as part of the tillage operations.

C. Hydroseeding

Apply liquid fertilizer in amounts recommended by the Cooperative Extension Service. Apply lime manually.

## 3.2 SEEDING

A. Seeding Conditions

Immediately before seeding, restore soil to the proper grade. Do not seed when the ground is muddy or in any unsatisfactory condition for seeding.

B. Seeding Method

Apply seed within 24 hours after seedbed preparation. Sow seed with approved sowing equipment using one or a combination of the following methods. Sow one-half the seed in one direction and sow remainder at right angles to the first sowing.

C. Drill Seeding

Use cultipacker seeders or grass seed drills. Drill seed uniformly to maximum depth of ¼" clay soils and ½" in sandy soils. Cover seed by spike-tooth harrow, cultipacker, or other approved devices.

D. Hydroseeding

Mix seed, fertilizer, and wood cellulose fiber in required amount of water to produce a homogenous slurry. After seed, water, and fertilizer have been thoroughly mixed, add 1,500 pounds of wood cellulose fiber per acre (dry weight) and apply the slurry. Seed shall not remain in water containing fertilizer for more than one (1) hour prior to application and shall be agitated during application.

## 3.3 PROTECTION OF SEEDED AREAS

Immediately after seeding, protect the area against traffic and other use by erecting barricades, as required, and placing approved signs at appropriate intervals until final acceptance.

## 3.4 RESTORATION

Restore to original condition existing lawn areas which have been damaged during seeding operations. Clean paving when work in adjacent areas is complete.

## 3.5 TURF

A. Duration

Turf establishment period will be in effect until final acceptance.

B. Maintenance

During turf establishment period, mow the seeded area to an average height of two (2") inches whenever the average height of grass becomes four (4") inches. Remove excess clippings, eradicate weeds, apply water and/or fertilizer, overseed, and perform other operations necessary to promote turf growth.

## 3.6 FINAL ACCEPTANCE

A. Final Inspection and Acceptance

At the end of the turf establishment period, final inspection will be made upon written request at least 10 days prior to the anticipated date. Final acceptance will be based upon a satisfactory stand of turf, defined as 95 percent ground cover of the established species.

B. Replanting

In areas which do not have a satisfactory stand of turf, replant as directed.

--END OF SECTION--

# SECTION 11311 SUBMERSIBLE LEACHATE SUMP PUMP

## PART 1 GENERAL

### 1.1 SCOPE OF WORK

A. The work under this section shall include the installation of a leachate pumping station. It shall consist of a carriage mounted pump and motor with discharge hose assembly, front exit fittings, control panel, and level sensor, per the operating conditions as shown on specifications and drawings.

B. System shall be designed for primary leachate removal.

### 1.2 QUALITY ASSURANCE

A. All equipment listed in this section shall be provided by a single supplier who has complete responsibility for the system.

B. The supplier of the leachate removal system will provide all warranty services, which shall be one year from date of installation.

C. All components of the system shall be suitable for the application and the warranty shall include suitability of use.

### 1.3 SUBMITTALS

A. The submittal package shall include a complete list of all components provided, pump curves, motor data, layout drawing, control electrical schematic, complete bill of materials, and warranty statement. Manufacturer data sheets shall be provided for each item listed on the bill of control panel material.

B. Submittals shall be for the specified application and “typical” data sheets will not be acceptable.

C. Any deviation from the project specification shall be clearly listed on a submittal package cover sheet. Should any exception be taken the reason for the exception shall be provided.

D. A complete operations and maintenance manual for the system shall be provided. Information shall include installation and removal procedures, system operation explanation, equipment lists, bill of materials, parts information, service contact

information, instructions for each component provided. The manual shall have an index to reference location of each document.

### 1.4 MEASUREMENT AND PAYMENT

Lump sum payment shall be made for work required in this Specification. The cost of all required work and all costs incidental thereto shall be included in the amount bid in the Proposal for Submersible Leachate Sump Pump.

## PART 2 PRODUCTS

### 2.1 PUMPS

A. The Owner shall furnish and install a complete leachate pumping system as manufactured by Sidesloper, GunnCo, Cumming, GA, or approved equal.

B. Pumps shall be centrifugal, submersible design, and suitable to handle primary landfill leachate. The pumps will be coupled to a submersible motor which is non-overloading throughout the operating curve of the pump.

C. The pump shall be selected and specified in each set of cell construction documents.

D. Pump design shall include the following features:

1. Integral check valve of 300 series stainless steel.

2. All series 300 stainless steel construction shall include impellars, bowls, guide vanes, and inlet screen.

3. Each impellar shall have a Teflon seal ring to reduce hydraulic losses.

4. All shaft bearings shall be Teflon or 316 SS.

5. A stainless steel flow inducer shall be provided at the pump inlet.

### 2.2 MOTOR DESIGN

The motor shall be selected and specified in the cell construction documents.

A. The motor shall be a squirrel-cage induction motor for submersible operation and conform to NEMA standards and shall be U.L. 778 recognized.

B. Motor shall be of corrosion resistance stainless steel construction.

C. The motor shall not use any oils or greases for lubrication.

D. The motor shall have a Kingsbury type thrust bearing capable of handling the maximum thrust load of the pump operating range.

E. A properly sized jacketed power cable suitable for submerged leachate service shall be provided. Splices of the cable are not allowed.

## 2.3 CARRIAGE

A. The pump shall be mounted in a 300 series stainless steel carriage for use in an 24" SDR 11 HDPE riser pipe.

B. The carriage shall provide a low center of gravity and all wheel shall remain in contact with the contour of the riser pipe. The wheels shall be of non-corrosive materials with self-lubricating qualities and able to travel over welding beads as typically found in riser pipe fabrications. A stainless steel inlet suction screen with round holes shall be provided to prevent debris from entering inlet.

C. The level sensor shall be carriage mounted and capable of removable / replacement without disassembly of the pump assembly.

D. A 0.25" safety / retrieval cable assembly with properly sized cable clips, snap hooks (at each end), and anchor eye bolt of 300 series stainless steel shall be provided.

## 2.4 DISCHARGE HOSE ASSEMBLY

A. Discharge hose shall be 2" EPDM wire reinforced materials with full vacuum rating and rated at a minimum working discharge pressure of 250 psi.

## 2.5 DISCHARGE HOSE FITTINGS

A. All hose fittings shall be 300 series stainless steel. Hose fittings shall be suitable for the application. All hose bands shall be hi-torque 300 series stainless steel.

B. The exit connection will penetrate the riser sidewall. A stainless steel tee with a ¼" NPT gauge port with plug and female stainless steel cam and groove disconnect shall be provided. The disconnect fitting shall be positive locking type. A properly sized stainless / liquid filled pressure gauge shall be provided for testing and maintenance use.

C. A mating stainless steel male cam and groove fitting shall be provided for mounting to the force main valve system.

D. A 2@ PVC ball type check valve shall be provided. Seats / seals shall be Viton. Each end connection shall be a true union design with F-NPT ends. Fittings shall be stainless steel to connect valve to system.

E. A 2@ PVC full port ball type isolation valve shall be provided. Seats / seals shall be Viton. Each end connection shall be a true union design with F-NPT ends. Fittings shall be stainless steel to connect valve to system.

## 2.6 CONTROL PANEL

A. The control panel shall be GunnCo Series 101 to provide level control, pump operation, and motor protection. The design shall provide pump motor protection, protect operator personnel, and allow check of status without entering the enclosure.

B. Control panel shall consist of a NEMA 4X stainless steel enclosure with lockable outer cover with dead front door and glass viewing window with stainless steel frame.

C. Operator controls shall be mounted on the interior door.

D. Operator accessible components mounted on the front door shall include the following for each pump:

1. H-O-A switch
2. RUN indicating light (green)
3. OVERLOAD indicating light (red)
4. HIGH LEVEL indicator (red)
5. HIGH LEVEL indicating beacon-top mounted (red)
6. Digital read out level indicator
7. Elapsed run time meters (mechanical non-reset type)
8. MAIN breaker with operator handle
9. MOTOR breaker
10. CONTROL circuit breaker
11. RECEPTACLE breaker
12. MOTOR MONITOR device
13. Overload reset button
14. Duplex Receptacle (side mounted)

E. The back plate shall consist of a sheet steel and finished with a primer coat and two coats of baked on enamel. All hardware mounted to the subpanel shall be accomplished with machine thread tapped holes. Sheet metal screws are not acceptable. All devices shall be permanently identified.

F. The panel power distribution shall include all necessary components and shall be completely wired with standard copper conductors. Control wiring shall be properly sized and installed in Panduit type wiring trays.

G. An individual circuit breaker shall be provided for main and control circuit. Motor starter shall be equipped with a motor off switch and be rated to the horse power and amperage of the motor.

H. Individual surge arrestors shall be provided in the control panel for incoming power, pilot circuit (110 volt), and the 4 to 20 mA instrument circuit.

1. The incoming power shall be equipped with a primary side surge arrestor. The units shall be mounted in the control panel and shall be field wired to incoming power. The unit shall provide protection against surge to the pump and panel.

2. A 110 volt surge suppressor shall be provided. The unit shall provide a automatic recovery, failure indication, be internally fused, and capable of a peak clamping voltage of 315V L-N and 350V L-G with less than a 5 nanosecond response time.

3. A 4-20mA signal surge suppressor shall be provided. The unit shall provide a crow bar effect to protect the panel and sensor and shall be capable with the sensor mounted surge suppressor in the sump.

I. A plug in type phase monitor shall be provided. The unit shall be equipped with a status indicating light. The unit shall monitor both high and low voltage and loss of phase and reversal of phase. Phase monitor shall be fused on all legs.

J. A fused type transformer shall be provided. Transformer shall be rated a minimum of .750 kVA.

K. A enclosure space heater with an adjustable thermostat shall be provided.

L. A motor monitor device shall provide NO FLOW protection and automatic cycle time operation for the pump. It shall be fully programmable to for time intervals (2 minutes to 8 hours), trip point settings, re-starts, and low and high voltage. The unit shall have separate time programming capacity for undercurrent conditions which shall be independent of time restarts for other fault conditions. A diagnostic alphanumeric code shall be displayed for normal and each fault condition. The unit shall provide ground fault protection for the pump. The monitor device will inhibit pump operate only when the HOA switch is in the A position.

M. A corrosion inhibitor shall be provided within the enclosure.

N. A 120 VAC duplex receptacle shall be provided with weather proof backbox and stainless steel cover. The receptacle shall be ground fault interrupter type.

O. The panel will have plug in type 10 amp relays with indicating lights for energizing of motor starter coil, top high level alarm light, and overload lights and remote status contacts.

P. All fuses shall be in enclosed fuse blocks with blown indicating light.

Q. Control Panel Total / Rate Indicator

1. The control panel shall include a total / rate microcontroller-based transmitter / indicator. The device shall provide LCD display simultaneous rate of flow to 6 digits ½" characters height and total gallons pumped to eight digits 5/16" character height. The display shall be manufactured using a cast aluminum body and electronics shall be urethane potted within. The display shall be NEMA 4X rated and mounted in the interior door of the pump control panel and clearly visible without entering the enclosure. The display shall provide a 4-20 mA analog signal and pulse outputs.

2. A panel mounted 24V power supply shall be provided. The power supply shall be fused separately from the control circuit using enclosed type fuse block with blown fuse indication.

3. A paddle wheel sensor shall be provided which is compatible with the indicator as manufactured by the indicator manufacturer. The sensor shall be provided with a minimum of 12' of cable.

4. A PVC Schedule 80 rated flow sensor tee or saddle shall be provided by the pump and control supplier.

## 2.7 LEVEL CONTROL

A. A panel mounted controller digital readout display shall provide level indication of the side slope sump with 3 digits to 1/10$^{th}$ of an inch. The pump “ON-OFF-HIGH LEVEL” selection shall be user friendly and accomplished through adjustable set point located on the face of the indicator. Adjustment of the level and alarm set points shall require only the use of a screwdriver without keyboard programming. The controller unit will accept a 4 to 20 signal from the transducer and provide a level indication readout of 0 to 138.6 inches of liquid.

B. Should a HIGH LEVEL condition occur, the display will flash until the condition is corrected.

C. A submersible transducer shall be provided with an adequate sized cable. The transducer shall be all 316 stainless steel and shall be mounted to the pump carriage. The unit shall provide a 4-20 ma signal output to the control unit. Static accuracy rating shall be no less than 1.0%. Cable shall be the same length as the pump power cable.

D. A surge suppressor shall be incorporated as part of the submersible transducer to provide additional protection from lightning transients. The transducer shall be fully warranted against failure due to lightning damage.

E. A permanent bellow type breather device shall be mounted in the control panel or junction box to prevent moisture in the vent tube.

F. A panel mounted intrinsically safe barrier shall be provided for the transducer signal

### 2.8 BACKBOARD

Mount control enclosure using (2) - 2" x 10' Schedule 40 steel pipe anchored a minimum of 3' below grade with poured concrete anchor and galvanized unit-strut cross members and galvanized mounting hardware. The lower edge of the control panel shall be 32" to 34" above final grade. An earth driven copper ground rod shall be installed with ground wire to the enclosure back-plate.

## PART 3 EXECUTION

### 3.1 INSTALLATION

A. The station shall be constructed as shown on the drawings.

### 3.2 ELECTRICAL SERVICE

The CONTRACTOR shall contact the electric power company and make arrangements for service on behalf of the OWNER. The OWNER will pay any fees required by the power company for brining power to the station and connecting to the meter base on the backboard. The CONTRACTOR shall provide the meter base and all electrical from the meter base to the pump.

### 3.3 START-UP

A. The manufacturer of the system shall provide field supervision / assistance for installation and start-up of the system. The scheduling of this service shall be coordinated with the Contractor to insure the riser is in place and the control panel is connected to power prior to arrival of the factory field technician. Installation and start-up typically requires one day to complete.

B. A start-up report shall be provided to include all component settings and motor operating characteristics data. The report shall certify the system is properly installed or note any deficiencies found to be corrected.

C. At the time of installation, the contractor shall coordinate with the system supplier and owner to provide operator training and troubleshooting in the field.

D. A complete operations and maintenance manual for the system shall be provided. Information shall include installation and removal procedures, system operation explanation, equipment lists, bill of materials, parts information, service contact information, instructions for each component provided. The manual shall have an index to reference location of each document.

--END OF SECTION--

# 7.0 ENVIRONMENTAL MONITORING PLAN

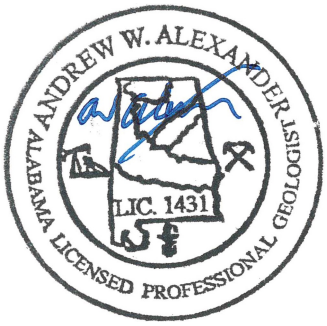
# ENVIRONMENTAL MONITORING PLAN

ARROWHEAD LANDFILL
PERRY COUNTY, ALABAMA
FACILITY PERMIT #53-03

**Prepared For:**
Arrowhead Environmental Partners, LLC
65 Challenger Road (Suite 312)
Ridgefield Park, New Jersey 07660

BLE Project Number J24-4999-66

**January 24, 2025**

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BUNNELL LAMMONS ENGINEERING

January 24, 2025

Arrowhead Environmental Partners, LLC
65 Challenger Road (Suite 312)
Ridgefield Park, New Jersey 07660

Attention: William W. Gay,
Division Vice President

Subject: **Environmental Monitoring Plan**
**Arrowhead Landfill**
Perry County, Alabama
Permit Number 53-03
BLE Project Number J24-4999-66

Mr. Gay:

As authorized, Bunnell-Lammons Engineering, Inc. (BLE) is pleased to present this Environmental Monitoring Plan (EMP) for the Arrowhead Landfill in Perry County, Alabama. This plan is being submitted in general accordance with Alabama Division of Environmental Management (ADEM) Administrative Code 335-13-4-.27(3). The plan contained herein addresses the requirement for an updated EMP that will be part of the Major Modification for the vertical expansion of all three tracts. We understand that the EMP will be submitted to ADEM for review and approval.

We appreciate the opportunity to serve as your geological consultant on this project and look forward to working with you on future projects. If you have any questions, please contact us at (864) 288-1265.

Sincerely,

**BUNNELL LAMMONS ENGINEERING INC.**

Riley L. Blais
Project Hydrogeologist

Andrew W. Alexander, P.G.
Consultant Hydrogeologist
Registered, Alabama No. 1431

cc: Clint Courson, CHMM – HHNT
Kevin Berry, P.E. – HHNT
Brady Stewart – Waste Connections
Susan Reid – Waste Connections

## TABLE OF CONTENTS

**1.0 BACKGROUND INFORMATION ..... 1**
**2.0 GEOLOGIC AND HYDROGEOLOGIC CONDITIONS ..... 2**
**3.0 GROUNDWATER MONITORING PLAN ..... 4**
**3.1 Detection Monitoring Frequency ..... 4**
**3.2 Field Quality Assurance / Quality Control ..... 4**
**3.3 Groundwater Monitoring Well Purging Procedure ..... 4**
***3.3.1 Purging with a Bailer ..... 5***
***3.3.2 Low Flow/Low Volume Method ..... 6***
**3.4 Field Records – Evacuation ..... 7**
**3.5 Groundwater Monitoring Well Sampling Procedure ..... 7**
**3.6 Field Records – Sampling ..... 9**
**3.7 Chain-of-Custody ..... 9**
**3.8 Detection Monitoring Parameters ..... 9**
**3.9 Laboratory Requirements ..... 10**
**3.10 Analytical Reports ..... 11**
**3.11 Reporting ..... 11**
**4.0 STATISTICAL ANALYSIS PLAN ..... 12**
**4.1 Updating Background Data ..... 12**
**4.2 Outlier Analysis ..... 12**
**4.3 Statistical Analysis and Regulatory Pathway ..... 12**
**5.0 GROUNDWATER MONITORING SYSTEM ..... 14**
**5.1 Introduction ..... 14**
**5.2 Relevant Point of Compliance ..... 14**
**5.3 Groundwater Monitoring Well Locations and Phasing Schedule ..... 14**
**5.4 Groundwater Monitoring Well Installation ..... 19**
***5.4.1 Monitoring Well Depths and Screened Intervals ..... 19***
***5.4.2 Location of Groundwater Monitoring Wells ..... 19***
***5.4.3 Groundwater Monitoring Well Installation Procedure and Construction ..... 19***
**5.5 Groundwater Monitoring Well Development ..... 20**
**5.6 Reporting ..... 20**
**6.0 SURFACE WATER MONITORING PLAN ..... 21**
**6.1 Introduction ..... 21**
**6.2 Sampling Procedure ..... 21**
***6.2.1 Dipping Using a Sample Container ..... 21***
***6.2.2 Sampling From a Flowing Outfall ..... 22***
**6.3 Chain of Custody ..... 23**
**6.4 Field And Laboratory Quality Assurance/Quality Control ..... 23**
**6.5 Laboratory Analysis ..... 23**
**6.6 Reporting ..... 23**
**7.0 METHANE GAS MONITORING PLAN ..... 24**
**7.1 Introduction ..... 24**
**7.2 Monitoring Network Design and Phasing ..... 24**

**7.3 Bar Hole Punch Monitoring Procedure ..... 25**
**7.4 Methane Monitoring Well Monitoring Procedure ..... 26**
**7.5 Structure Monitoring Procedure ..... 26**
**7.6 Quality Assurance and Control Procedures ..... 26**
**7.7 Evaluating And Reporting of Monitoring Results ..... 27**
**7.8 Reporting ..... 27**
**7.9 Methane Gas Safety Guidelines ..... 28**
**8.0 METHANE MONITORING WELL INSTALLATION PROCEDURE ..... 28**
**8.1 Methane Monitoring Well Installation ..... 28**
**8.2 Reporting ..... 29**
**9.0 REFERENCES ..... 30**

## TABLES

Table 1 Groundwater Monitoring Well Construction Details
Table 2 Monitoring Matrix
Table 3 Preservation Procedures and Holding Times

## FIGURES

Figure 1 Site Location Map
Figure 2 Groundwater Elevation Contour Map (Eutaw Formation) – March 13, 2024
Figure 3 Type II Groundwater Monitoring Well Construction Detail
Figure 4 Type III Groundwater Monitoring Well Construction Detail
Figure 5 Methane Monitoring Probe Construction Detail

## APPENDICES

Appendix A Environmental Monitoring Network Maps
Appendix B Example Field Log
Appendix C Groundwater Monitoring Well Boring Logs
Appendix D Methane Monitoring Well Boring Logs

## 1.0 BACKGROUND INFORMATION

The following information was sourced from various documents in PDF and AutoCAD format provided by Hodges, Harbin, Newberry & Tribble, Inc. (HHNT) and from our prior work at the facility. The Arrowhead Landfill is located in Perry County, Alabama southeast of the town of Uniontown (**Figure 1**). The permittee is Perry County Associates, LLC. To date, a portion of Tract 1 (Cell 1 through Cell 8) have been developed (began receiving waste in 2007), and the remaining Tract 1 area, Tract 2, and Tract 3 are scheduled to be developed in the future.

This Environmental Monitoring Plan (EMP) has been prepared to include procedures and locations for groundwater (and perched water) and methane gas monitoring as required by ADEM Rule 335-13-4-.27 (groundwater and perched water) and 335-13-4-.16 (methane gas). The groundwater and perched water monitoring well locations and methane monitoring locations are indicated in **Appendix A**.

The water monitoring network currently has six (6) groundwater monitoring wells set in the Eutaw Formation [sands] and seven (7) perched water monitoring wells set in the overlying Selma Group [clay and chalk]. Available groundwater and perched water monitoring well construction details are included on **Table 1**.

The methane monitoring network currently consists of fourteen (14) permanent bar hole punch locations, forty-two (42) methane monitoring wells, and seven (7) structures. Additional temporary bar hole punch locations are sampled as needed during phased cell construction.

The current ADEM approved Water Quality Monitoring Plan (WQMP) and Methane Monitoring Plan (MMP) were prepared by BLE and were submitted in a report titled *Environmental Monitoring Plan – Horizontal Expansion* dated December 15, 2021.

We understand that this EMP will be submitted as part of the permit application required by ADEM and will replace the previous EMP in its entirety.

## 2.0 GEOLOGIC AND HYDROGEOLOGIC CONDITIONS

Geologic conditions for this site summarized herein are described in the *Solid Waste Permit Application, Volume 1 of 2, Site Analysis, Perry County Associates Landfill*, dated September 2005, prepared by Jordan, Jones, and Goulding (JJ&G) which has been previously reviewed and approved by ADEM.

The site is underlain by Cretaceous-age Coastal Plain sediments comprised of the Selma Group (clay and chalk) overlying the Eutaw Formation (sand).

Regionally, the Selma Group is comprised of the Ripley Formation, Demopolis Chalk, Arcola Limestone Member, and Mooreville chalk. Locally, the Selma Group generally consists of about 440 to 563 feet of low permeability, gray, clay and chalk at the landfill site. The upper 10 to 20 feet near the ground surface consists of brown clay, which represents the upper weathered portion of the formation. Underlying the Selma Group is the Eutaw Formation, which consists of gray glauconitic fine to medium sand and is a regional water supply aquifer.

The uppermost physical presence of groundwater and first saturated zone is located 440 to 570 feet below ground surface at the top of the Eutaw Formation below the confining Selma Group clay and chalk. The Selma Group strata are unsaturated, are not an aquifer, and serve as the confining layer for the underlying Eutaw Formation. The potentiometric surface for wells installed into the Eutaw Formation aquifer groundwater ranges from about 80 to 150 feet below ground surface.

The existing shallow monitoring wells (GWM-12 through GWM-18) are set in the upper weathered portion of the Selma Group chalk to intersect potential perched water, but they were dry when they were installed. The Selma Group strata are unsaturated, not an aquifer, and serve as the confining layer for the underlying Eutaw Formation. Water in the shallow monitoring wells is an accumulation of surface water in the well itself and not groundwater and not evidence of a saturated condition in the Selma Group strata. Monitoring wells installed in the Selma Group strata have been referred to as “groundwater” monitoring wells as a matter of naming convenience, however the shallow wells do not contain groundwater since the Selma Group strata is not saturated. The shallow monitoring wells will for convenience continue to be referred to as “groundwater” monitoring wells throughout this document.

The existing deep monitoring wells (GWM-1 through GWM-6) were set to intersect the upper portion of the Eutaw Formation at depths ranging from 460.0 to 580.5 feet. Stabilized potentiometric water levels in the Eutaw Formation range from about 80 to 150 feet below ground surface.

Historical groundwater elevation contour maps included in the semi-annual sampling reports have indicated very little potentiometric head difference in the water levels from the six existing deep monitoring wells set to intersect the Eutaw Formation. Potentiometric head differences among the six wells during the thirty-eight semi-annual sampling events since 2007 have ranged from 0.39 feet (N23; September 12, 2016) to 10.00 feet (N24; March 8, 2017) with an average head difference of 2.47 feet across the site. The most recent groundwater elevation contour map from March 13, 2024 is included as **Figure 2**.

The number, location, and placement of monitoring wells are recommended herein based on the geologic and hydrogeologic site characteristics described in the aforementioned JJ&G 2005 Permit Application and

on recent groundwater elevation contour maps included with the semi-annual water quality monitoring reports.

## 3.0 GROUNDWATER MONITORING PLAN

The purpose of the groundwater monitoring plan (GWMP) is to outline the necessary procedures and documentation for obtaining representative groundwater samples at the subject site in accordance with the Alabama Department of Environmental Management (ADEM) Administrative Code 335-13-4-.27(3).

### 3.1 Detection Monitoring Frequency

Detection monitoring at the facility is typically scheduled to occur semi-annually, typically each March and September. Detection monitoring will occur during the active life of the facility and also during the post-closure care period.

If additional verification sampling/ resampling is warranted, the sampling should be performed approximately 30-90 days from the original sampling event.

Baseline sampling of the wells prior to the landfill opening is required in order to establish a statistical database. Baseline sampling includes collection of a minimum of four independent samples from each groundwater monitoring well during the first semi-annual sampling period. As new cells are constructed, at least one sampling event will be conducted for each well prior to waste placement in the newly constructed cell.

### 3.2 Field Quality Assurance / Quality Control

It is the responsibility of the sampling contractor to ensure the reliability of the analytical data gathered during the monitoring program. Field instruments that the sampler uses will be calibrated prior to field use and recalibrated in the field each day in accordance with manufacturer's' specifications. The calibrations will be recorded in the field log as stated in **Section 3.4** of this plan.

Additionally, trip blanks and field blanks will be part of each sampling event. Trip blanks consist of samples that are filled in the laboratory with deionized water and then carried to the field and put through the entire sampling procedure. A minimum of one trip blank per cooler or one trip blank per cooler that contains volatile organic compounds (VOCs) should be utilized. The trip blank samples will be analyzed to determine if the storage or handling of the field samples has jeopardized their integrity. Field blank samples are prepared in the field by filling the appropriate sample bottles from the field supply of deionized water. The field blanks will be analyzed to account for any contamination that may occur as a result of site ambient air conditions. Field blanks also serve as an additional check for contamination in the containers, the sample cooler, the cleaning operations, or the chemical preservatives.

### 3.3 Groundwater Monitoring Well Purging Procedure

Water in each well's water column should be removed so that water from the formation can enter the well. If possible, purging and sampling should be conducted from the anticipated cleanest (i.e., least contaminated location) to the most contaminated location.

Prior to purging, a new plastic sheet, such as a drop cloth, should be placed around the well as a work area. The protective well casing should then be unlocked. The measuring tape and electronic water level indicator used for well depth and water levels measurements should be brought to the plastic sheet. Note that the measuring tape and electronic water level indicator should be pre-cleaned in the laboratory and maintained in a clean condition or otherwise protected prior to initial field use. New latex or nitrite gloves

should be donned. The well cap should then be unlocked, removed and placed top-down on a corner of the plastic sheet.

Next, well depth and water level measurements should be made. Measure well depth from the reference point at the top of the well casing to the bottom of the well with the weighted measuring tape. Alternatively, well depth may be obtained from data provided on the well construction logs.

Water level measurements should be measured from the reference point at the top of the well casing to the water surface with an electronic water level indicator. Well depth measurements should be made to the nearest 0.10 foot and water level measurements should be made to the nearest 0.01 foot. Groundwater elevations in wells which monitor the same waste management area should be made within a 48-hour period.

1. The volume of water to be evacuated should then be calculated using the following procedure:
   Subtract the depth to water from the total well depth to obtain the height of the volume of water in the well (h).

2. Multiply h times the appropriate conversion factor to obtain the volume of water in the well in gallons:

   - 2-inch inside diameter well, h x 0.1623 = volume (gal)
   - 4-inch inside diameter well, h x 0.6528 = volume (gal)

Note that the weighted measuring tape and/or electronic water level indicator should be field cleaned between wells by rinsing in deionized water, followed by a thorough rinse with a non-phosphate laboratory grade detergent solution, followed by a rinse in deionized water. The equipment should then be allowed to air dry and maintained in a clean condition or otherwise protected for use at the next well.

A positive gas displacement bladder pump or bailer will be used to purge each well. The procedure for well evacuation will depend on the yield of the well. An adequate purge is typically achieved when three to five well volumes have been removed. For low yield wells, attempts should be made to avoid purging them to dryness. However, if a well is unintentionally purged to dryness, this generally constitutes an adequate purge and the well can be sampled following a sufficient recovery. It is preferable that dedicated positive gas displacement Teflon bladder pumps, portable pumps, or peristaltic pumps be used for purging and sampling (see Low Flow Purging / Sampling Procedure). However, if they cannot be used, stainless steel sampling bailers or disposable Teflon bailers may be used.

### *3.3.1 Purging with a Bailer*

1. Bring two dishpans and a measuring container to the work area.

2. Bring the bailer, which has been pre-cleaned in the laboratory and maintained in a clean condition (or an unopened disposable Teflon bailer) to the work area. Unwrap the bailer without touching it.

3. Bring the roll of bailer cord, which has been maintained in a clean condition (or unopened plastic) to the work area.

4. The bailer-handler and helper should don new nitrile or latex gloves.

5. The end of the bailer rope is tied to the top of the bailer. Ensure that the rope does not touch any item while in use.

6. The bailer is lifted and lowered carefully into the well until it is submerged.

7. The bailer is slowly raised from the water in a hand over hand manner and the rope is allowed to fall into the clean dishpan or gathered in hand.

8. Pour groundwater from the bailer into the measuring container. Repeat the bailing procedure until three to five well volumes have been evacuated.

9. If the well goes dry before 3 volumes are obtained, then sampling should occur when the well has recovered sufficiently to provide a sample volume. Sampling should occur in accordance with Section 3.5, *Groundwater Monitoring Well Sampling Procedure*, as soon as adequate volume has recovered.

10. The used gloves, used rope, and the plastic sheet are rolled up and disposed in an appropriate manner.

### *3.3.2 Low Flow/Low Volume Method*

Alternatively, positive gas displacement Teflon bladder pumps, portable pumps or a peristaltic pump may also be used for purging and sampling. Pumps should be made of PVC or stainless steel with internal Teflon bladders. Prior to purging, pumps should be placed mid-way in the wetted screen interval with minimum disturbance to the well. After the pump has been installed, the pump can be operated by pulsing air into the bladder with an air compressor and pump controller unit, which is used to vary discharge to the desired flow rate. Only inert material on the pumps will come into contact with the samples.

During purging, measurements of purge rate, pH, temperature, turbidity and specific conductance should be measured at periodic intervals and recorded in the bound field book as discussed in **Section 3.4, *Field Records – Evacuation***. Groundwater quality is considered stable and ready for sample collection when the indicator parameters have shown no increasing or decreasing trends for three consecutive readings in a row as follows:

- ± 0.1 for pH
- ± 3% for specific conductance
- ± 10% for DO, turbidity and temperature

Final turbidity readings should be stable and, if possible, below 10 NTUs.

### 3.4 Field Records – Evacuation

A bound field book containing numbered pages or a separate field log for each well should be maintained by the sample collector to record all pertinent information regarding the evacuation and sampling of monitoring wells. An example field log is included as **Appendix B**. This recorded information is necessary to maintain well sampling data and should become part of the analytical report. The sample collector should sign and date each page of the field book or the log. The following data should be determined as follows and recorded upon the evacuation of each well:

1. Sample collector's name, date, and time that evacuation was initiated and completed.
2. Name of the facility, city and state.
3. Well identification (i.e., monitor well number, code or name).
4. Well depth and water level depth.
5. Well casing inside diameter.
6. The calculated well volume.
7. Total gallons evacuated (well yield).
8. Water level following evacuation, to the nearest 0.01 foot.
9. Method of evacuation (type of bailer, pump, etc.).
10. Measurements of purge rate, pH, temperature, turbidity and specific conductance during purging along with the time of each measurement.
11. Any comments or information pertaining to the condition of the well such as no cap, broken casing, grout deterioration, etc.
12. Calibration records for field instruments utilized by the samplers.

### 3.5 Groundwater Monitoring Well Sampling Procedure

Once the well has been adequately purged and field parameters have stabilized, samples should be collected according to the following procedure:

1. Prior to sample collection, the sampler and helper should don new nitrile or latex gloves.
2. A helper may unscrew the appropriate sample caps and place them aside without touching the interiors or dislodging any Teflon discs inside the caps.
3. The samples are poured into the bottles and are filled to the top without headspace. A helper can hold the bottle and be responsible for recapping without touching the interior of the cap and screwing down tightly. It is not good practice to leave samples in the sun; rather they should be placed in an ice chest as soon as possible.

4. The organic samples are the most delicate and should be collected first. A sample for volatile analysis should be filled so that the vial has a meniscus. A cap will be used to close the vial so that no bubbles can be seen when the sample vial is inverted. The volatile samples are always collected in pairs. The other organic samples usually require two or three 1-liter bottles without preservative and these should be collected next, also without headspace.

5. Groundwater samples will not be field filtered. However, if excessive turbidity becomes a problem, a sample may be collected for dissolved metals to demonstrate that metals detections are related to turbidity. The dissolved metals sample should be collected immediately following the volatile samples in order to minimize sample turbidity. The dissolved metal samples will be filtered in the laboratory and preserved with HNO3.

6. Finally, preserved samples should be collected, taking great care that the acids and salts in the bottles do not contact the helper's gloves and thus pass into other caps and bottles. A list of preservatives and holding times is presented in **Appendix C**. Do not allow the bailer to touch sample bottles, or allow rope ends or gloved fingers to contact the sample well water while pouring.

7. The remaining sample bottles should now be carried to the ice chest to be labeled, placed in the ice chest, and chilled with ice.

8. The labels can be pre-filled out leaving less work and time delay at the site. The label will have:

    - Name of facility
    - Date and time of sampling
    - Sample description
    - Sampler's name

    Additionally, each sample bottle should be marked with an identification (ID) number using a glass-marking crayon which is resistant to water. Bottle caps are good places to add an ID. This is a precaution in case labels get wet or are dislodged during transport.

9. The well cap is replaced securely and the protective well casing should be locked.

10. The rope is untied from the bailer and used rope is discarded.

11. The disposable materials such as (but not limited to) used gloves, used rope, bailers, dishpan and the plastic sheet are collected and discarded in an appropriate manner after each groundwater monitoring well has been sampled.

12. Proceed to the next well. Repeat.

Note that it is good practice to retain an extra set of sample bottles in the event of breakage or accidental contamination. Also note that all waste derived from sampling activities (gloves, bailers, etc.) will be disposed in accordance with standard practice.

### 3.6 Field Records – Sampling

An accurate and thorough field log, which will contain specific information concerning the evacuation and sampling of the groundwater monitoring wells, will be maintained. The following information will be recorded on the field log at the time of sampling:

1. Collector's name, date, and time of sampling.
2. Sample identification number.
3. Measurement of pH, temperature, turbidity, and specific conductance at the time of sample collection.
4. Method of sample collection – type of bailer, pump, etc.
5. Sample characteristics – Color, turbidity, odor, sediment, surface oil, etc.
6. Weather conditions at the time of sampling.
7. Any additional field observations, comments, or recommendations.

### 3.7 Chain-of-Custody

Custody and protection of samples is an important legal consideration. As few people as possible should handle the samples. The sampler is personally responsible for collected samples and will be able to attest to the integrity of samples until transfer. If samples are placed in an unattended vehicle, the vehicle will be secured. Any cooler will be locked or located in a place which is locked and is accessible only to responsible parties. A custody seal will be affixed to the cooler if the samples are to be shipped. Upon check-in at the laboratory, the condition of the custody seals will be attested.

A chain-of-custody form will be used to document the handling of the samples from the moment of collection until testing. The ID of each sampling point will be recorded on the form. Note that several bottles collected for different parameters will have the same ID number if they originate from one sampling point. The form will be completed while in the field at each well (at least time and sample number) before proceeding to the next well. The form will contain the facility name, date of sampling and name of the collector. Each transfer of custody is recorded with an appropriate signature, date and time. If the samples are to be shipped, they will be sealed. The driver for a courier service (if used) will sign the custody form or the courier will be indicated on the COC, and a bill of lading will be secured.

### 3.8 Detection Monitoring Parameters

Groundwater samples should be tested in the field for pH, specific conductance, temperature, and turbidity. Groundwater samples will be analyzed in the laboratory for the inorganic and organic constituents contained in 335-13-4-.27(3): *Appendix I Constituents for Detection Monitoring* and boron, calcium, chloride, fluoride, sulfate, and total dissolved solids (TDS) [**Table 2**]. Groundwater samples will not be field filtered prior to laboratory analysis. The preservation procedures and holding times specified in **Table 3** should be utilized.

### 3.9 Laboratory Requirements

The recommended minimum requirements for the laboratory are as follows:

- Maintain preservation of the samples via refrigeration.
- Log in samples and record pertinent information such as the condition of samples, the sample container and sample seals.
- Maintain the external Chain-of-Custody form as well as the in-house or intra-lab Chain-of-Custody if the laboratory transfers controlled access.
- Analyses should be performed within prescribed holding times:
    - Record date and time of analyses.
    - Identify methods of analyses and any extraction methods.
    - Use only methods which are approved by the project manager and are acceptable to the involved regulatory agency, if known.

The lab should employ effective analytical practices and techniques such as:

- Clean all glassware and analytical tools, e.g. pipettes, syringes, etc.
- Use analytical reagent grade chemicals and traceable certified standards.
- Use distilled and/or deionized water with a conductivity of 1.0 μmhos/cm or less, “organic free” where necessary.
- Analysts should be adequately trained with special emphasis on laboratory safety. New analysts should become thoroughly familiarized with all laboratory safety procedures and equipment.
- Servicing of the analytical instrumentation should occur frequently, and records of the servicing should be maintained.

A quality assurance/quality control (QA/QC) Program should be maintained. At a minimum, the quality assurance/quality control program should include the following components:

- Calibration of laboratory instruments to within acceptable EPA and/or manufacturer’s limits and frequencies.
- Documented inspection, maintenance, and servicing of all laboratory instruments and applicable equipment.
- Use of reference standards and quality control samples (blanks, spikes, duplicates, etc.).
- Use of thorough, documented QC procedures to monitor accuracy and precision of data.
- Regular participation in external laboratory evaluations (e.g. EPA Performance Audit Program).
- Continuous in-house training program.
- Maintenance of laboratory notebooks for each analytical method and copies of all analytical reports. All raw data produced should be checked for validity before reported and permanently stored.

### 3.10 Analytical Reports

All analytical reports will be complete with analytical data, sample ID, sample source, date sampled, date received, parameters tested, results, date extracted (if applicable) and analyzed, analyst, referenced methodologies, QC data such as percent recovery of matrix spikes and duplicate results, field logs, analysis request forms, and chain-of-custody forms. Signed copies of the monitoring results are required.

### 3.11 Reporting

Within 90 days after the date(s) of sampling (or resampling), the operator will submit a semi-annual report to the Department. Additionally, no more than 30 days after receipt of the analytical data, it should be determined whether there has been a statistically significant increase (SSI) over background at each well. Statistical analysis should be conducted in accordance with Section 4.0., *Statistical Analysis Plan*. Semi-annual reports should contain the information specified in the March 2011 *Alabama Groundwater Monitoring Reporting Guidance for Solid Waste Facilities* including field reports, analytical reports, results of statistical analysis of the groundwater data, groundwater flow rates, a groundwater elevation contour map which includes flow directions and recommendations based on the results of the groundwater monitoring.

## 4.0 STATISTICAL ANALYSIS PLAN

The statical analysis plan outlined herein shall apply to Tract 1 through Tract 3 at the facility. The facility currently utilizes intrawell statistical methodology per the facility permit.

### 4.1 Updating Background Data

Background data for statistical evaluations may be updated approximately every two (2) years in general accordance with the procedures outline in Chapter 5.3.2 of the *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Unified Guidance* [Unified Guidance] (March 2009 or latest version). The background well at the facility will be periodically tested using a Wilcoxon rank-sum test and/or appropriate trend test to evaluate if background groundwater conditions have changed substantially since the previous update. If no statistically significant trend has been calculated from the recently collected background data, the data may be added to the background pool.

### 4.2 Outlier Analysis

Outlier analysis will be performed every two years in conjunction with the background updates using the screening tools and formal tests described in Chapter 12 of the Unified Guidance. The screening tools include probability plots (Chapter 12.1) and box plots (Chapter 12.2). The formal tests include Dixon's test (Chapter 12.3) and Rosner's test Chapter 12.4). Outliers will only be selected for removal if they meet the specified criteria and follow the rationale provided in Chapter 5.2.3, Chapter 6.3.3, and Chapter 12 of the Unified Guidance.

### 4.3 Statistical Analysis and Regulatory Pathway

In order to determine whether the groundwater is receiving contamination from the waste unit, it is necessary to compare the laboratory analytical results from each semi-annual event to the background laboratory analytical results. Statistical analysis of the groundwater data will begin after the baseline sampling events (N=1 through N=4) have taken place and after each subsequent semi-annual event. Baseline sampling events N=1 through N=4 for each new groundwater well should be performed in accordance with the detection monitoring and phasing schedule (**Section 3.1** and **Section 5.3**) and prior to the placement of waste in any new cells. Statistical analysis will be performed in accordance with Rule 335-13-4-.27(2)(k-m). Several inherent variabilities can affect the laboratory results and these inherent variabilities should be considered:

- The sampling technique will vary somewhat from event to event even under ideal conditions.
- The aquifer will contain a certain quantity of elements.
- The laboratory test itself can vary slightly.
- Seasonal variations can result in slightly different chemical constituents in the water samples.
- Turbidity of the sample can affect the results.

A method which identifies significant deviation beyond the inherent deviation will be used. Upon receipt of data from each semi-annual event, the statistical database will be updated. Three methods of statistical analysis may be performed on the data. The method used will depend on the number of detected

concentrations and the distribution of the data for a specific compound. Techniques for performing statistical analysis will follow the Unified Guidance (March 2009 or latest version).
The performance criteria specified in this Guidance Document is consistent with 335-13-4-.27(2)(m). Selection of the statistical test to be used is based on the following:

- If greater than 50% of the data are not detected, non-parametric Prediction Limits may be performed.
- If less than 50% of the data are not detected, Normal Prediction Limits may be performed.
- Other statistical methods may be used if approved by ADEM.

Within 30 days after receiving the analytical report(s), it will be determined whether there has been an SSI over background at each well. If it is determined that there is an SSI over background concentrations, ADEM will be notified within 14 days of the finding and a copy of the notification should be placed in the operating record. A demonstration may be made that a source other than the landfill caused the detects or that the SSI resulted from natural variation in groundwater quality or from an error in sampling, analysis or statistical evaluation. This demonstration will be certified by a qualified groundwater scientist and will be submitted to ADEM. If the demonstration, or other response acceptable to ADEM, has not been made within 90 days, an assessment monitoring program that conforms with 335-13-4-.27(4)(a) through (j) should be initiated.

Statistical testing to determine the requirement for corrective action may include a confidence interval (or other test approved by ADEM) to be utilized for any constituent with a validated SSI to determine if the constituent is detected at statistically significant levels above the groundwater protection standard in accordance with 335-13-4-.27(4)(g).

Within 14 days after determining that a constituent is detected at statistically significant levels above the groundwater protection standard the owner or operator must place a note in the operating record identifying the constituents that have exceeded the groundwater protection standards and notify the department and all appropriate local government officials that the notice has been placed in the operating record.

Additionally, the owner or operator must either perform the assessment actions, notification actions, and corrective measures defined in 335-13-4-.27(4)(g)(3)(i-iv) or may demonstrate that a source other than the landfill caused the contamination or that the SSI resulted from natural variation in groundwater quality or from an error in sampling, analysis or statistical evaluation. This demonstration will be certified by a qualified groundwater scientist and will be submitted to ADEM. Until a successful demonstration has been made, the owner or operator must comply with 335-13-4-.27(4)(g), including initiating an assessment of corrective measures.

Within 90 days of finding that any of the constituents listed in Appendix II or ADEM approved alternative list have been detected at a statistically significant level exceeding the groundwater protection standards the owner or operator should initiate an assessment of corrective measures (corrective action) in general accordance with 335-13-4-.27(5)(a-d). Such an assessment must be completed within a reasonable period of time.

# 5.0 GROUNDWATER MONITORING SYSTEM

## 5.1 Introduction

In accordance with 335-13-4-.27(2)(a), groundwater monitoring wells should be designed to yield groundwater samples from the first saturated zone. The groundwater monitoring network should contain at least one well that represents the quality of background groundwater that has not been affected by leakage from the landfill and the monitoring network should be sufficient to represent the quality of groundwater passing the relevant point of compliance. The existing and proposed monitoring network (2 background wells and 39 compliance wells) is sufficient to meet these requirements. We note that these totals include both shallow monitoring wells which contain perched water and deep monitoring wells which contain groundwater. All wells are referred to a groundwater monitoring wells for convenience. Groundwater monitoring well construction details for existing wells are summarized in **Table 1** and the boring logs/well construction diagrams are included in **Appendix C** for reference.

## 5.2 Relevant Point of Compliance

The relevant point of compliance has been established less than 150 meters (492 feet) from the boundary of the cells. The determination of the relevant point of compliance was based on the following factors:

- The hydrogeologic characteristics of the facility and the surrounding land;
- The anticipated physical/chemical characteristics of the leachate;
- The direction of groundwater flow;
- The proximity and direction of groundwater users;
- The availability of alternative drinking water supplies; and
- Public health, safety, and welfare effects.

## 5.3 Groundwater Monitoring Well Locations and Phasing Schedule

Forty-one (41) monitoring wells (24 shallow Selma Group monitoring wells and 17 deep Eutaw Formation monitoring wells) constitute the groundwater monitoring system and their locations are indicated on the Environmental Monitoring Network Maps (**Appendix A**). There are three tracts identified as facility waste disposal units (Tract 1, Tract 2, and Tract 3), and there are monitoring wells associated with each individual Tract. The monitoring wells will be installed in phases as new landfill tracts are constructed. The monitoring well locations have been selected based on the configuration of the potetiometic surface of the groundwater aquifer in the Eutaw Formation, associated groundwater flow directions, and proposed cell sump locations.

The locations and phasing schedule of the existing and proposed monitoring wells are discussed below:

| MONITORING WELL | PROPOSED/EXISTING WELL LOCATIONS |
|---|---|
| **GWM-1 (Existing Well)** | Existing background monitoring well set to intersect the deep groundwater in the upper portion of the **Eutaw Formation** north of Tract 3. The well was installed in conjunction with the construction of **Tract 1** at the facility. |

| MONITORING WELL | PROPOSED/EXISTING WELL LOCATIONS |
|---|---|
| **GWM-2 (Existing Well)** | Existing compliance monitoring well set to intersect the deep groundwater in the upper portion of the **Eutaw Formation** south of Tract 1. The well was installed in conjunction with the construction of **Tract 1** at the facility. |
| **GWM-3 (Existing Well)** | Existing compliance monitoring well set to intersect the deep groundwater in the upper portion of the **Eutaw Formation** south of Tract 1. The well was installed in conjunction with the construction of **Tract 1** at the facility. |
| **GWM-4 (Existing Well)** | Existing compliance monitoring well set to intersect the deep groundwater in the upper portion of the **Eutaw Formation** west of Tract 1. The well was installed in conjunction with the construction of **Tract 1** at the facility. |
| **GWM-5 (Existing Well)** | Existing background monitoring well set to intersect the deep groundwater in the upper portion of the **Eutaw Formation** north of Tract 2. The well was installed in conjunction with the construction of **Tract 1** at the facility. |
| **GMW-6 (Existing Well)** | Existing compliance monitoring well set to intersect the deep groundwater in the upper portion of the **Eutaw Formation** east of Tract 1. The well was installed in conjunction with **Tract 1** Expansion construction. |
| **GWM-7 (Proposed Well)** | Proposed compliance monitoring well that will be set to intersect the deep groundwater in the upper portion of the **Eutaw Formation** south of Tract 2. The well will be installed in conjunction with **Tract 2 (Cells No. 1-4)** construction. |
| **GWM-8 (Proposed Well)** | Proposed compliance monitoring well that will be set to intersect the deep groundwater in the upper portion of the **Eutaw Formation** southwest of Tract 2. The well will be installed in conjunction with **Tract 2 (Cells No. 1-4)** construction. |
| **GWM-9 (Proposed Well)** | Proposed compliance monitoring well that will be set to intersect the deep groundwater in the upper portion of the **Eutaw Formation** west of Tract 2. The well will be installed in conjunction with **Tract 2 (Cells No. 1-4)** construction. |
| **GWM-10 (Proposed Well)** | Proposed compliance monitoring well that will be set to intersect the deep groundwater in the upper portion of the **Eutaw Formation** west of Tract 2. The well will be installed in conjunction with **Tract 2 (Cells No. 5-9)** construction. |
| **GWM-11 (Proposed Well)** | Proposed compliance monitoring well that will be set to intersect the deep groundwater in the upper portion of the **Eutaw Formation** northwest of Tract 2. The well will be installed in conjunction with **Tract 2 (Cells No. 5-9)** construction. |
| **GWM-12 (Existing Well)** | Existing compliance monitoring well set to intersect the perched water in the upper portion of the **Selma Group clay and chalk** east of Tract 1. The well was installed in conjunction with **Tract 1** Expansion construction. |

| MONITORING WELL | PROPOSED/EXISTING WELL LOCATIONS |
|---|---|
| **GWM-13 (Existing Well)** | Existing compliance monitoring well set to intersect the perched water in the upper portion of the **Selma Group clay and chalk** east of Tract 1. The well was installed in conjunction with **Tract 1** Expansion construction. |
| **GWM-14 (Existing Well)** | Existing compliance monitoring well set to intersect the perched water in the upper portion of the **Selma Group clay and chalk** north of Tract 1. The well was installed in conjunction with **Tract 1** Expansion construction. |
| **GWM-15 (Existing Well)** | Existing compliance monitoring well set to intersect the perched water in the upper portion of the **Selma Group clay and chalk** south of Tract 1. The well was installed in conjunction with the construction of **Tract 1** at the facility. |
| **GWM-16 (Existing Well)** | Existing compliance monitoring well set to intersect the perched water in the upper portion of the **Selma Group clay and chalk** south of Tract 1. The well was installed in conjunction with the construction of **Tract 1** at the facility. |
| **GWM-17 (Existing Well)** | Existing compliance monitoring well set to intersect the perched water in the upper portion of the **Selma Group clay and chalk** west of Tract 1. The well was installed in conjunction with the construction of **Tract 1** at the facility. |
| **GWM-18 (Existing Well)** | Existing compliance monitoring well set to intersect the perched water in the upper portion of the **Selma Group clay and chalk** east of Tract 1. The well was installed in conjunction with **Tract 1** Expansion construction. |
| **GWM-19 (Proposed Well)** | Proposed compliance monitoring well set to intersect the perched water in the upper portion of the **Selma Group clay and chalk** east of Tract 2. The well will be installed in conjunction with **Tract 2 (Cells No. 1-4)** construction. |
| **GWM-20 (Proposed Well)** | Proposed compliance monitoring well set to intersect the perched water in the upper portion of the **Selma Group clay and chalk** south of Tract 2. The well will be installed in conjunction with **Tract 2 (Cells No. 1-4)** construction. |
| **GWM-21 (Proposed Well)** | Proposed compliance monitoring well set to intersect the perched water in the upper portion of the **Selma Group clay and chalk** south of Tract 2. The well will be installed in conjunction with **Tract 2 (Cells No. 1-4)** construction. |
| **GWM-22 (Proposed Well)** | Proposed compliance monitoring well set to intersect the perched water in the upper portion of the **Selma Group clay and chalk** west of Tract 2. The well will be installed in conjunction with **Tract 2 (Cells No. 1-4)** construction. |
| **GWM-23 (Proposed Well)** | Proposed compliance monitoring well set to intersect the perched water in the upper portion of the **Selma Group clay and chalk** west of Tract 2. The well will be installed in conjunction with **Tract 2 (Cells No. 5-9)** construction. |
| **GWM-24 (Proposed Well)** | Proposed compliance monitoring well set to intersect the perched water in the upper portion of the **Selma Group clay and chalk** west of Tract 2. The well will be installed in conjunction with **Tract 2 (Cells No. 5-9)** construction. |

| MONITORING WELL | PROPOSED/EXISTING WELL LOCATIONS |
|---|---|
| **GWM-25 (Proposed Well)** | Proposed compliance monitoring well set to intersect the perched water in the upper portion of the **Selma Group clay and chalk** north of Tract 2. The well will be installed in conjunction with **Tract 2 (Cells No. 5-9)** construction. |
| **GWM-26 (Proposed Well)** | Proposed compliance monitoring well set to intersect the perched water in the upper portion of the **Selma Group clay and chalk** north of Tract 2. The well will be installed in conjunction with **Tract 2 (Cells No. 5-9)** construction. |
| **GWM-27 (Proposed Well)** | Proposed compliance monitoring well set to intersect the perched water in the upper portion of the **Selma Group clay and chalk** south of Tract 3. The well will be installed in conjunction with **Tract 3 (Cells No. 1-10)** construction. |
| **GWM-28 (Proposed Well)** | Proposed compliance monitoring well set to intersect the perched water in the upper portion of the **Selma Group clay and chalk** west of Tract 3. The well will be installed in conjunction with **Tract 3 (Cells No. 1-10)** construction. |
| **GWM-29 (Proposed Well)** | Proposed compliance monitoring well set to intersect the perched water in the upper portion of the **Selma Group clay and chalk** west of Tract 3. The well will be installed in conjunction with **Tract 3 (Cells No. 1-10)** construction. |
| **GWM-30 (Proposed Well)** | Proposed compliance monitoring well that will be set to intersect the deep groundwater in the upper portion of the **Eutaw Formation** north of Tract 3. Installation of this well is scheduled for 2025 in accordance with the work plan approved by ADEM on August 23, 2024. |
| **GWM-31 (Proposed Well)** | Proposed compliance monitoring well set to intersect the perched water in the upper portion of the **Selma Group clay and chalk** north of Tract 3. The well will be installed in conjunction with **Tract 3 (Cells No. 1-10)** construction. |
| **GWM-32 (Proposed Well)** | Proposed compliance monitoring well set to intersect the perched water in the upper portion of the **Selma Group clay and chalk** north of Tract 3. The well will be installed in conjunction with **Tract 3 (Cells No. 1-10)** construction. |
| **GWM-33 (Proposed Well)** | Proposed compliance monitoring well set to intersect the perched water in the upper portion of the **Selma Group clay and chalk** east of Tract 3. The well will be installed in conjunction with **Tract 3 (Cells No. 1-10)** construction. |
| **GWM-34 (Proposed Well)** | Proposed compliance monitoring well set to intersect the perched water in the upper portion of the **Selma Group clay and chalk** east of Tract 3. The well will be installed in conjunction with **Tract 3 (Cells No. 1-10)** construction. |
| **GWM-35 (Proposed Well)** | Proposed compliance monitoring well set to intersect the perched water in the upper portion of the **Selma Group clay and chalk** east of Tract 3. The well will be installed in conjunction with **Tract 3 (Cells No. 1-10)** construction. |
| **GWM-36 (Proposed Well)** | Proposed compliance monitoring well set to intersect the perched water in the upper portion of the **Selma Group clay and chalk** east of Tract 3. The well will be installed in conjunction with **Tract 3 (Cells No. 1-10)** construction. |

| MONITORING WELL | PROPOSED/EXISTING WELL LOCATIONS |
|---|---|
| **GWM-37 (Proposed Well)** | Proposed compliance monitoring well that will be set to intersect the deep groundwater in the upper portion of the **Eutaw Formation** south of Tract 3. The well will be installed in conjunction with **Tract 3 (Cells No. 1-10)** construction. |
| **GWM-38 (Proposed Well)** | Proposed compliance monitoring well that will be set to intersect the deep groundwater in the upper portion of the **Eutaw Formation** west of Tract 3. The well will be installed in conjunction with **Tract 3 (Cells No. 1-10)** construction. |
| **GWM-39 (Proposed Well)** | Proposed compliance monitoring well that will be set to intersect the deep groundwater in the upper portion of the **Eutaw Formation** west of Tract 3. The well will be installed in conjunction with **Tract 3 (Cells No. 1-10)** construction. |
| **GWM-40 (Proposed Well)** | Proposed compliance monitoring well that will be set to intersect the deep groundwater in the upper portion of the **Eutaw Formation** east of Tract 3. The well will be installed in conjunction with **Tract 3 (Cells No. 1-10)** construction. |
| **GWM-41 (Proposed Well)** | Proposed compliance monitoring well set to intersect the deep groundwater in the upper portion of the **Eutaw Formation** south of Tract 1. The well will be installed in conjunction with the construction of **Tract 1** at the facility. Installation of this well is scheduled for 2025 in accordance with the work plan approved by ADEM on August 23, 2024. |

## 5.4 Groundwater Monitoring Well Installation

### 5.4.1 *Monitoring Well Depths and Screened Intervals*

The twenty-four (24) shallow monitoring wells (GWM-12 through GWM-29 and GWM-31 through GWM-36) are designed to monitor the shallow (perched) water in the upper weathered portion of the Selma Group chalk and clay. It is anticipated that water in these shallow wells will be a seasonal feature and dependent on weather conditions. The depth of these wells will likely be in the 10 to 30 feet below ground surface range. The screened interval of these wells will be set to encounter the upper weathered portion of the Selma Group chalk and clay.

The 17 deep groundwater monitoring wells (GWM-1 through GWM-11, GWM-30, and GWM-37 through GWM-41) are designed to monitor the groundwater in the upper portion of the Eutaw Formation sand at the site. The depth of these wells will likely be in the 450 to 600 feet range; however, the depth to the stabilized water level will likely be in the 80 to 150 feet range.

### 5.4.2 *Location of Groundwater Monitoring Wells*

The deep monitoring well locations were selected to intercept groundwater flow upgradient and side gradient/ downgradient from the landfill cells. Areas downgradient of cell sumps, leachate tanks, and convergent groundwater flow areas were targeted for monitoring. The number of monitoring wells (24 shallow and 17 deep) is sufficient to provide representative water quality samples of the groundwater in the uppermost water-bearing Eutaw Formation aquifer flowing past the relevant point of compliance and of the perched water (if present) in the shallow wells installed in the unsaturated Selma Group strata.

### *5.4.3 Groundwater Monitoring Well Installation Procedure and Construction*

Prior to installation of any groundwater monitoring well, in accordance with 335-13-4-.27(2)(c)(2), a plan outlining the well installation, design, construction, etc. will be submitted to ADEM a minimum of 90 days prior to the installation and this plan must be approved by ADEM. Groundwater monitoring wells will be constructed in accordance with "Design and Installation of Groundwater Monitoring Wells in Aquifers," ASTM Subcommittee D18.21 on Groundwater Monitoring. A geologist who is licensed in the state of Alabama will oversee the groundwater monitoring well installation and a drilling contractor will perform the installation.

Monitoring wells screened in the Selma Group clay and chalk will be set as Type II wells and wells screened in Eutaw Formation will be set as Type III wells (double cased). Typical Type II and Type III groundwater monitoring well construction details are shown as **Figure 3** and **Figure 4**, respectively. The groundwater monitoring wells will generally consist of 4-inch or 4.5-inch polyvinyl chloride (PVC) casing (Schedule 80 or SDR-17, with flush-threaded or Certa-Lok joints) inserted into a 6-inch (or larger) diameter borehole. The bottom 10-foot section of each well will be a manufactured well screen with 0.010-inch wide slots. The Type III riser will generally consist of 8-inch PVC casing (Schedule 80 or SDR-21, with flush-threaded or Certa-Lok joints) inserted into a 10-inch (or larger) diameter borehole. Centralizers will be installed every 50 feet on the PVC risers during well construction to stabilize the casing.

The borehole annulus should be filled with washed-sand around the outside of the well screen to two (2) feet above the top of the screen interval. A minimum two- foot thick bentonite seal will immediately overlie the filter pack. A cement/bentonite mixture should be used as the annular sealant above the bentonite seal and below the frost line.

A 4-ft by 4-ft concrete pad should be constructed at the ground surface for each well. A PVC protective cap will be placed on each well and a lockable metal cover will be placed over each well. Permanent well labels should be placed on a 4-inch by 4-inch marker post painted blue and on the outside of the metal cover. A vent hole will be installed in the top of the PVC casing and will serve as an avenue for escape of air. A weep hole will also be installed at the base of the metal casing and will provide an avenue for drainage of moisture from the casing. All wells that are subject to traffic will have four (4) bollards installed around them.

## 5.5 Groundwater Monitoring Well Development

Newly constructed wells will be developed to remove particulates that are present in the well due to construction activities, and to try to re-establish the natural hydraulic flow conditions of the aquifer which may have been disturbed as a result of drilling. Development of new monitoring wells will be performed no sooner than 24 hours after well construction. Wells may be developed with disposable bailers, a mechanical well developer, or other approved method. A surge block may be used during development. In the event a pump is employed, the design of the pump will be such that any groundwater that has come into contact with air is not allowed to drain back into the well. Each well will be developed until sediment-free water with stabilized field parameters (e.g., temperature, pH, turbidity, and specific conductance) is obtained. Shallow wells installed in the Selma Group chalk and clay are typically dry because the strata is not saturated. These wells will be developed only if they contain perched water.

Well development equipment (bailers, pumps, surge blocks) and any additional equipment that contacts subsurface formations will be decontaminated prior to on-site use, between consecutive on-site uses, and/or between consecutive well installations.

Formation water should be used for surging the well. If a well is constructed in a low yielding water-bearing formation, an outside source of water may be introduced into the well to facilitate development. In this case, the water should be chemically analyzed to ensure that it should not contaminate the aquifer.

Samples withdrawn from the facility's monitoring wells should be clay- and silt-free; therefore, existing wells may require redevelopment from time to time based upon observed turbidity levels during sampling activities. If redevelopment of an existing monitoring well is required, it will be performed in a manner similar to that used for a new well.

## 5.6 Reporting

A report documenting the well installation including boring logs, well diagrams and field procedures will be submitted to ADEM within 60 days of well installation, development and survey completion.

# 6.0 SURFACE WATER MONITORING PLAN

## 6.1 Introduction

Four (4) surface water points have been established at the facility to supplement the existing groundwater monitoring network. The locations of the surface water monitoring points are shown in **Appendix A** – ***EMP-1*** and ***EMP-2***. Surface water monitoring will occur at the facility on a semi-annual basis, typically in March and September in conjunction with the groundwater monitoring events. Surface water samples will only be collected if flowing water is observed during the sampling event.

## 6.2 Sampling Procedure

Generally, automated or semi-automated samplers or other manual devices accessible from the banks of a stream or surface-water body should be used to collect surface water samples whenever possible. If naturally occurring conditions inhibit this method of sample collection, the sample may be obtained by wading up-current (and downstream) of the sampling station. The sample should be collected in an area representative of minimal turbulence and aeration. Because sample containers may be dipped by hand into the stream, extreme care will be employed to avoid contamination into the mouth of the container. If pre-preserved sample containers are used, the sampler should be careful not to displace the preservative from a pre-preserved sample container.

The following procedures are recommended for extraction and subsequent collection of surface-water samples when sampling at in-stream locations:

### *6.2.1 Dipping Using a Sample Container*

1. Hold the bottle near the base with one hand, and with the other, remove the cap being careful not to dislodge any Teflon discs inside the cap.

2. Push the sample container into the water (mouth down) and tilt up towards the current to fill. A depth of about six inches is satisfactory. Great care should be taken to avoid breaching the surface while filling the container.

3. During times of little current movement, move the container slowly through the water laterally.

4. During times of extreme drought when the stream depths are too shallow to allow submersion of the sample container, a pool may be scooped out of the channel bottom and allowed to clear prior to sampling. However, sampling will not be conducted when stream flow conditions are below the 7-day, 10-year minimum flow (7Q10) condition.

5. Containers should be filled with sample and should be filled to the top without headspace and without bubbles. The bottle should be recapped without touching the interior of the cap. It is not good practice to leave samples in the sun; rather they should be removed to the ice chest as soon as possible.

6. The organic samples are the most delicate and should be collected first. A sample for volatile analysis should be filled so that the vial has a meniscus. A cap will be used to close the vial so that no bubbles can be seen when the sample vial is inverted. The volatile samples are always collected in pairs. The other organic samples usually require two or three 1-liter bottles without preservative

and these should be collected next, also without headspace. Finally, preserved samples should be collected, taking great care that the acids and salts in the bottles do not contact the helper's gloves and thus pass to other caps and bottles. Do not allow the bailer to touch sample bottles, or allow rope ends or gloved fingers to contact the sample well water while pouring.

7. The remaining sample bottles should now be carried to the ice chest to be labeled, placed in the ice chest, and chilled with ice.

8. The labels can be pre-filled out leaving less work and time delay at the site. The label should have:
    - Name of facility
    - Date of sampling and time
    - Sample description
    - Sampler's name

    Additionally, each sample bottle will be marked with an identification (ID) number using a glass-marking crayon which is resistant to water. Bottle caps are good places to add an ID. This is a precaution in case labels get wet or come off during transport.

### *6.2.2 Sampling From a Flowing Outfall*

1. Hold the bottle near the base with one hand, and with the other, remove the cap being careful not to dislodge any Teflon discs inside the cap.

2. Hold the container underneath the outfall and allow the container to be filled to the top without headspace. The bottle should be recapped without touching the interior of the cap. It is not good practice to leave samples in the sun; rather they should be removed to the ice chest as soon as possible.

3. The organic samples are the most delicate and should be collected first. A sample for volatile analysis should be filled so that the vial has a meniscus. A cap will be used to close the vial so that no bubbles can be seen when the sample vial is inverted. The volatile samples are always collected in pairs. The other organic samples usually require two or three 1-liter bottles without preservative and these should be collected next, also without headspace. Finally, preserved samples should be collected, taking great care that the acids and salts in the bottles do not contact the helper's gloves and thus pass to other caps and bottles.

4. The remaining sample bottles should now be carried to the ice chest to be labeled, placed in the ice chest, and chilled with ice.

5. The labels can be pre-filled out leaving less work and time delay at the site. The label may have:
    - Name of facility
    - Date of sampling and time
    - Sample description, Sampler's name

    Additionally, each sample bottle may be marked with an ID number using a glass-marking crayon which is resistant to water. Bottle caps are good places to add an ID. This is a precaution in case labels get wet or come off during transport.

### 6.3 Chain of Custody

Custody and protection of samples is an important legal consideration. As few people as possible should handle the samples. The sampler is personally responsible for collected samples and will be able to attest to the integrity of samples until transfer. If samples are placed in an unattended vehicle, the vehicle will be secured. Any cooler will be locked or located in a place which is locked and is accessible only to responsible parties. A custody seal will be affixed to the cooler if the samples are to be shipped. Upon check-in at the laboratory, the condition of the custody seals will be attested.

A chain-of-custody form will be used to document the handling of the samples from the moment of collection until testing. The identification number (ID) of each sampling point will be recorded on the form. Note that several bottles collected for different parameters will have the same ID number if they come from one sampling point. The form will be taken out to the field and is filled out at each sampling point (at least time and sample number) before proceeding to the next sampling point. The form will contain the facility name, date of sampling and name of the collector. Each transfer of custody is recorded with an appropriate signature, date and time. If the samples are to be shipped, they will be sealed. The driver for the delivery service will sign the custody form and a bill of lading will be secured.

### 6.4 Field And Laboratory Quality Assurance/Quality Control

It is the responsibility of the sampling contractor to ensure the reliability of the analytical data gathered during the monitoring program. The field and laboratory Quality Assurance/Quality Control will be in accordance with **Section 3.2: Field Quality Assurance/Quality Control** and **Section 3.9: Laboratory Requirements**.

### 6.5 Laboratory Analysis

Surface water samples will be tested in the field for pH, specific conductance, temperature, and turbidity. Surface water samples will be analyzed in the laboratory for biological oxygen demand (BOD), chemical oxygen demand (COD), total dissolved solids (TDS), total suspended solids (TSS), oil and grease, and total metals (cadmium chromium, and copper) [**Table 1**]. Surface water samples will not be field filtered prior to laboratory analysis.

### 6.6 Reporting

Surface water results will be submitted to ADEM as part of the semi-annual water quality monitoring reports.

# 7.0 METHANE GAS MONITORING PLAN

## 7.1 Introduction

Explosive gas monitoring will typically be conducted on a quarterly basis in March, June, September and December during the active life of the site and during the post closure care period. Bar hole punches and methane monitoring wells will be used to measure explosive gas at the facility.

## 7.2 Monitoring Network Design and Phasing

Landfill gas monitoring points have been established on site between the landfill units and the facility boundary (**Appendix A – *EMP-3***). Since groundwater is a vertical barrier for potential methane gas migration, areas selected for monitoring are along the facility boundary where streams, wetlands, and sediment ponds are not present.

Methane monitoring will be conducted at the seventy-three (73) proposed bar hole punch locations (MM-1 through MM-52 and MM-109 through MM-129), fourteen (14) existing bar hole punch locations (MM-53 through MM-58, MM-63, MM-86 through MM-90, MM-107R, and MM-108R), forty-two (42) existing monitoring well locations (MM-59 through MM-62, MM-64 through MM-85 and MM-91 through MM-104, MM-105R, and MM-106R), seven on-site structures (Scale House, Old Scale House, Office, Maintenance Shed Office, and Strom Shelters [3]), and culverts/drop inlets once they are constructed. The bar hole punch locations and methane monitoring points are spaced approximately 300 feet apart in the western, northern, and eastern portions of the facility. In the southern portion of the site the bar hole punch locations and methane monitoring wells (MM-66 through MM-129) are spaced approximately 100 feet apart or 300 feet apart due to residences located as close as 600 feet south and west of the facility. The locations of the methane monitoring points are indicated in **Appendix A** – ***EMP-1*** and ***EMP-3***. All bar hole punch locations have been established by a licensed surveyor and marked with identification posts prior to the completion of the first waste cell constructed at the facility.

Bar hole punch locations shown as existing are currently being sampled. All bar hole punch locations shown as proposed will be sampled after cell construction progresses to that area of the landfill. Additional temporary bar hole punch locations may be sampled as needed during cell phasing and are not listed below.

| MONITORING LOCATION | LOCATIONS AND JUSTIFICATION |
|---|---|
| MM-1 to MM-20 | Proposed bar hole punch locations on a 300-foot spacing at the western property boundary. |
| MM-21 to MM-40 | Proposed bar hole punch locations on a 300-foot spacing at the northern property boundary. |
| MM-41 to MM-52 | Proposed bar hole punch locations on a 300-foot spacing at the eastern property boundary. |
| MM-53 to MM-58 | Existing bar hole punch locations on a 300-foot spacing at the eastern property boundary. |
| MM-59 to MM-62 | Existing methane monitoring well locations on a 300-foot spacing at the eastern property boundary. |

| MONITORING LOCATION | LOCATIONS AND JUSTIFICATION |
|---|---|
| MM-63 | Existing bar-hole punch location on a 300-foot spacing at the eastern property boundary. |
| MM-64 to MM-65 | Existing methane monitoring well locations on a 300-foot spacing at the eastern property boundary. |
| MM-66 to MM-70 | Existing methane monitoring well locations on a 100-foot spacing at the eastern property boundary. |
| MM-71 to MM-85 | Existing methane monitoring well locations on a 100-foot spacing at the southern property boundary. |
| MM-86 to MM-90 | Existing bar hole punch locations on a 100-foot spacing at the southwestern property boundary. |
| MM-91 to MM-102 | Existing methane monitoring well locations on a 100-foot spacing at the southwestern property boundary. |
| MM-103 and MM-104, MM-105R and MM-106R | Existing methane monitoring well locations on a 300-foot spacing at the southwestern property boundary. |
| MM-107R to MM-108R | Existing bar hole punch locations on a 100-foot spacing at the southwestern property boundary. |
| MM-109 to MM-129 | Proposed bar hole punch locations on a 100-foot or 300-foot spacing at the southwestern property boundary. |
| Temporary BHP | Existing and proposed temporary bar hole punches as needed. |
| On-site structures | Scale House, Old Scale House, Office, Maintenance Shed Office, and Storm Shelters (3) |

### 7.3 Bar Hole Punch Monitoring Procedure

Bar hole punches will be used to measure explosive gas at the facility. A new bar hole punch will be performed during each event at the approved location. Screening at each location will consist of initially forming a small hole (1-inch diameter and a minimum of 4 feet into the soil) using a bar hole punch. At most locations, this hole should remain open for sufficient time to allow for collection and measurement of gases within the soil. If the hole tends to collapse, the facility will consider installing soil gas sampling points in these locations. The hole will be sealed at ground surface for 30 to 60 minutes until tested. The hole will not be vented prior to sampling.

An air sample from the hole will be withdrawn and analyzed with a combustible gas indicator between 30 and 60 minutes after punching the hole. The combustible gas indicator should provide direct readings for methane concentrations (0-100% methane and 0-100% of the lower explosive limit (LEL)). Percent methane by volume, percent LEL and percent $O_2$ will be recorded on approved ADEM forms. Other pertinent data such

as ambient air temperatures and weather conditions should also be recorded. If an initial reading yields an exceedance, the hole will be sealed at ground surface again for 30 to 60 minutes and retested. Both the initial test and the retest should be reported.

### 7.4 Methane Monitoring Well Monitoring Procedure

Wells will also be used to measure explosive gas at the facility. Immediately after approaching the well and opening the casing, an air sample from the well casing will be withdrawn and analyzed with a combustible gas indicator. The wells will not be allowed to vent for any period of time prior to methane monitoring. In order to prevent ambient air intrusion into the well and the potential loss of accumulated gas, either the top of the well should be sealed off during methane sampling or a quick connect attached to the well cap should be utilized. The combustible gas indicator must provide direct readings of methane concentrations (0-100% methane by volume) in order to record methane concentrations greater than 100% of the lower explosive limit (LEL). The combustible gas indicator must also be capable of providing accurate methane readings in an oxygen deficient environment and must provide oxygen readings.

Percent methane by volume, percent LEL and percent $O_2$ will be recorded on approved ADEM forms. The peak reading for methane should be recorded. Other pertinent data such as ambient air temperatures and weather conditions should also be recorded.

If an initial reading yields an exceedance, a retest will be performed. Both the initial test and the retest should be reported.

### 7.5 Structure Monitoring Procedure

Each explosive gas monitoring event will also include screening inside of structures which are conducive to gas accumulation. These include all on-site structures and may include culverts, under bridges, and drop inlets. Readings of percent methane by volume, percent LEL, and percent $O_2$ will be obtained at each point and readings will be recorded on the approved ADEM form.

### 7.6 Quality Assurance and Control Procedures

The following quality assurance and control procedures will be implemented:

- The combustible gas indicator will be calibrated in the field immediately prior to each monitoring event and will be and periodically calibrated by the manufacturer. These calibrations will be in accordance with the manufacturer's recommendations and schedule.

- Sampling will not be performed if conditions conductive to decreasing gas concentrations are present (e.g. subsurface gas pressure less than atmospheric pressure). In this case, sampling will be delayed until the condition passes.

- Sampling will be conducted when gas pressures are at a maximum. Subsurface gas pressures have a diurnal cycle and generally are at a maximum during the afternoon. Therefore, ideally sampling should be conducted after 12:00 noon, but not begin after 5:00 p.m.

- Gas production will vary with changes in seasons and climatic conditions. Each sampling event will be conducted under the same conditions, as near as possible, as the preceding event. Therefore, the operator will review the log of the times and conditions which existed during the preceding sampling event and attempt to emulate those conditions during subsequent events.

## 7.7 Evaluating And Reporting of Monitoring Results

Interpretation of quarterly explosive gas monitoring results will be as follows:

- Methane gas concentrations shall not exceed the LEL (5% methane) at the facility boundary.

- Methane gas concentrations shall not exceed 25% of the LEL (1.25% methane) in facility structures.

The results of the quarterly explosive gas monitoring will be submitted to ADEM within 30 days of the monitoring event. Reports will also be placed in the facility's operating record.

If during the quarterly monitoring explosive gas levels exceed one of the above specified limits, the owner or operator will:

- Immediately take all necessary steps to ensure protection of human health and property and notify ADEM of the exceedance.

- Within seven (7) days of the exceedance, place in the facility's operating record the explosive gas levels detected and the immediate steps to be taken to protect human health and property.

- Within 20 days of the exceedance, submit to ADEM for approval, a remediation plan for the explosive gas releases. The plan should describe the nature and extent of the problem and the proposed remedy. The plan should be implemented upon approval of ADEM, but within 60 days of detection. Also within 60 days of detection, a copy of the plan should be placed in the facility's operating record and ADEM should be notified that the plan has been implemented.

## 7.8 Reporting

Methane gas monitoring results will be submitted to ADEM within 30 days of the methane monitoring event.

### 7.9 Methane Gas Safety Guidelines

The following guidelines should be followed when at a landfill in the presence of potentially dangerous gases:

- No person should enter a vault or a trench on a landfill without first checking for the presence of methane gas. The person entering the vault or trench should wear a safety harness with a second person standing by to pull him or her to safety.
- Anyone installing vent wells in a landfill should wear a safety harness to prevent falling into the borehole. Open holes should be covered when they are left unattended.
- Smoking should be prohibited at all times on the landfill especially where drilling, excavating or installation of equipment is taking place or where gas is venting from the landfill.
- Collected gas from a mechanically evacuated system should always be cleared to minimize air pollution and any potential explosion or fire hazard.
- Methane gas in a concentration of 5 to 15 percent is an explosive mixture. Gas accumulations should be monitored in enclosed structures to ensure that explosive conditions are avoided and, if detected, appropriate action is taken to avoid a source of ignition and to vent the structure.
- Permanent methane monitoring meters are recommended for all onsite structures.

Personnel working at the landfill will be provided training regarding the danger posed by landfill gases. Personnel operating safety equipment around the landfill will be thoroughly trained in its use and have a clear understanding of the meaning of observations made with the monitoring equipment.

## 8.0 METHANE MONITORING WELL INSTALLATION PROCEDURE

The purpose of this methane monitoring well installation procedure is to outline the procedures that should be utilized when installing wells at the landfill.

### 8.1 Methane Monitoring Well Installation

Well installation will be performed by an Alabama-licensed drilling contractor and will be supervised by an Alabama-licensed geologist or engineer. Commercially available Schedule 40, 1 or 2-inch nominal diameter PVC with flush threaded connections will be used for the casing and screens. The PVC screen and casing should be chemically and physical stable. The borehole diameter will be 6 inches or larger. The screens will be manufactured with 0.020 inch slots. The top of the screened section (for any new proposed well) will begin at approximately 5 feet below ground surface and will extend to either: 1) above the stabilized groundwater level or 2) within 5 feet of the base grade of the adjacent cell being monitored, whichever is shallower.

The material used to construct the filter pack around the outside of the well screen will consist of commercially available, chemically inert, well-rounded, dimensionally stable, pea gravel. The filter pack will be placed in the borehole around the screen and will extend to the top of the screened interval (approximately 5 feet below ground surface). A minimum of 0.5 feet of coarse silica sand will be placed on top of the filter pack. A minimum 0.5-foot bentonite seal, which will consist of chemically inert bentonite chips or granular bentonite, will overlie the coarse silica sand. Potable water will be used to hydrate the bentonite. The remaining approximately 4-feet of the borehole annulus will be filled up to the ground surface with a bentonite/cement grout mixture.

The pea gravel, sand and bentonite described above will be placed around the screen/casing by dropping the materials directly down the borehole. A tamping device may be used to reduce the potential for bridging of these materials. The cement-bentonite grout will be placed in the borehole via continuous pour or using a tremie pipe.

A mounded 3-foot by 3-foot concrete pad will be constructed at the ground surface for each well. A protective cap with a quick connect valve will be placed on each well and a protective metal casing with a keyed lock will be placed over each well. A weep hole will be installed at the base of the metal casing. Pea gravel will be placed in the annular space between the well and the metal casing. Permanent well identification labels will be placed on a 4-inch by 4-inch marker post painted red, and on the outside of the metal casing of each well. Four (4) bollards will be installed surrounding all wells that are subject to traffic for protection. A typical methane monitoring well construction detail is shown as **Figure 5**.

In the event that groundwater is encountered within 6 feet of the ground surface while drilling, a bar hole punch methane monitoring location should be considered as a substitute for the proposed methane monitoring well.

### 8.2 Reporting

A report documenting the installation including boring logs, well diagrams and field procedures, will be submitted to ADEM within 60 days of well installation and survey completion.

## 9.0 REFERENCES

Bunnell-Lammons Engineering, Inc.; July 13, 2007; *Groundwater Monitoring Well Installation Report (Tract 1), Perry County Associates Landfill, Perry County, Alabama*; BLE Project Number J07-4999-05.

Bunnell-Lammons Engineering, Inc.; September 24, 2007; *Methane Monitoring Probe Installation Report (Tract 1, Cell Nos. 3-5), Perry County Associates Landfill, Perry County, Alabama*; BLE Project Number J07-4999-06.

Bunnell-Lammons Engineering, Inc.; October 5, 2009; *Methane Monitoring Probe Installation Report: Tract 1 West, Perry County Associates Landfill, Perry County, Alabama*; BLE Project Number J09-4999-18.

Bunnell-Lammons Engineering, Inc.; December 31, 2012; *Groundwater Monitoring Well and Methane Monitoring Probe Installation Report (Tract 1 Expansion), Perry County Associates Landfill, Perry County, Alabama*; BLE Project Number J12-4999-30.

Bunnell-Lammons Engineering, Inc.; December 15, 2021; *Environmental Monitoring Plan – Horizontal Expansion, Perry County Associates Landfill, Arrowhead Landfill, Perry County, Alabama*; BLE Project Number J11-4999-29.

Bunnell-Lammons Engineering, Inc.; April 20, 2024 (Revised August 8, 2024); *Work Plan for Groundwater Monitoring Well Installation: GWM-30 & GWM-41, Arrowhead Landfill, Perry County, Alabama*; BLE Project Number J24-4999-63.

Bunnell-Lammons Engineering, Inc.; July 12, 2024; *Semi-Annual Water Quality Monitoring Report – First Event of 2024 (N38), Arrowhead Landfill, Perry County, Alabama*; BLE Project Number J24-4999-60.

Bunnell-Lammons Engineering, Inc.; August 15, 2024; *GWM-13 Vertical Extension – Cell 8 Construction, Arrowhead Landfill, Perry County, Alabama*; BLE Project Number J24-4999-64.

Hodges, Harbin, Newberry, & Tribble, Inc.; April 2011; *Arrowhead Landfill Horizontal Expansion for Perry County Associates, LLC, Perry County, Alabama*; Sheet 3 of 19 titled *Top of Clay Liner Grading Plan – Tracts 1, 2, and 3*.

Jordan, Jones, and Goulding; September 2005; *Solid Waste Permit Application, Volume 1 of 2, Site Analysis, Perry County Associates Landfill*

# TABLES

# Table 1
## Groundwater Monitoring Well Construction Details
## Arrowhead Landfill
## Perry County, Alabama
## BLE Project Number J24-4999-66

| Well Identifier | Ground Elev. | TOC Elev. | Water-Bearing Zone | Well Depth | Screened Interval Depth | Screened Interval Elevation | Installation Date | Well Construction |
|---|---|---|---|---|---|---|---|---|
| GWM-1 | 200.10 | 203.32 | Eutaw formation | 460.5 | 450.0 - 460.0 | -249.9 - -259.9 | 5/16/2007 | 4-inch Black Steel Casing |
| GWM-2 | 271.20 | 274.42 | Eutaw formation | 581.0 | 570.5 - 580.5 | -299.3 - -309.3 | 5/2/2007 | 4-inch Black Steel Casing |
| GWM-3 | 269.50 | 272.54 | Eutaw formation | 570.5 | 560.0 - 570.0 | -290.5 - -300.5 | 3/14/2007 | 4-inch Black Steel Casing |
| GWM-4 | 269.00 | 272.55 | Eutaw formation | 579.5 | 569.0 - 579.0 | -300.0 - -310.0 | 5/9/2007 | 4-inch Black Steel Casing |
| GWM-5 | 212.70 | 215.76 | Eutaw formation | 481.5 | 471.0 - 481.0 | -258.3 - -268.3 | 5/23/2007 | 4-inch Black Steel Casing |
| GWM-6 | 259.14 | 262.26 | Eutaw formation | 555.0 | 544.5 - 554.5 | -285.4 - -295.4 | 9/24/2012 | 4-inch Schedule 80 PVC Casing |
| GWM-12 | 272.91 | 276.06 | Selma Group | 28.5 | 18.0 - 28.0 | 254.9 - 244.9 | 10/3/2012 | 4-inch Schedule 80 PVC Casing |
| GWM-13 | 266.77 | 269.88 | Selma Group | 33.2 | 22.7 - 32.7 | 244.1 - 234.1 | 10/4/2012 | 4-inch Schedule 80 PVC Casing |
| GWM-14 | 235.06 | 237.99 | Selma Group | 25.5 | 15.0 - 25.0 | 220.1 - 210.1 | 10/4/2012 | 4-inch Schedule 80 PVC Casing |
| GWM-15 | 271.20 | 274.62 | Selma Group | 22.7 | 12.25 - 22.25 | 259.0 - 249.0 | 5/9/2007 | 4-inch Black Steel Casing |
| GWM-16 | 269.50 | 272.51 | Selma Group | 23.2 | 12.75 - 22.75 | 256.8 - 246.8 | 5/9/2007 | 4-inch Black Steel Casing |
| GWM-17 | 269.40 | 273.20 | Selma Group | 22.7 | 12.25 - 22.25 | 257.2 - 247.2 | 5/10/2007 | 4-inch Black Steel Casing |
| GWM-18 | 282.59 | 285.60 | Selma Group | 25.5 | 15.0 - 25.0 | 267.6 - 257.6 | 10/3/2012 | 4-inch Schedule 80 PVC Casing |

**NOTES:**

1. Elevations are in feet.
2. TOC = Top Of Casing
3. Depths are in feet below ground surface.
4. Well information from various well installation reports prepared by BLE

**Table 2**
**Monitoring Matrix**
**Arrowhead Landfill**
**Perry County, Alabama**
**BLE Project Number J24-4999-66**

| | | March | September |
|---|---|---|---|
| | **Station ID** | ***Analytical Suite*** | ***Analytical Suite*** |
| **Background Wells** | **GWM-1** | **A-1 + CCR** | **A-1 + CCR** |
| | **GWM-5** | **A-1 + CCR** | **A-1 + CCR** |
| **Compliance Wells** | **GWM-2** | **A-1 + CCR** | **A-1 +CCR** |
| | **GWM-3** | **A-1 + CCR** | **A-1 + CCR** |
| | **GWM-4** | **A-1 + CCR** | **A-1 + CCR** |
| | **GWM-6** | **A-1 + CCR** | **A-1 + CCR** |
| | **GWM-12** | **A-1 + CCR** | **A-1 + CCR** |
| | **GWM-13** | **A-1 + CCR** | **A-1 + CCR** |
| | **GWM-14** | **A-1 + CCR** | **A-1 + CCR** |
| | **GWM-15** | **A-1 + CCR** | **A-1 + CCR** |
| | **GWM-16** | **A-1 + CCR** | **A-1 + CCR** |
| | **GWM-17** | **A-1 + CCR** | **A-1 + CCR** |
| | **GWM-18** | **A-1 + CCR** | **A-1 + CCR** |
| **Surface Water** | **SWM-1** | **B-1** | **B-1** |
| | **SWM-2** | **B-1** | **B-1** |
| | **SWM-3** | **B-1** | **B-1** |
| | **SWM-4** | **B-1** | **B-1** |
| **Quality Control** | **Trip Blank** | **A-1 VOC** | **A-1 VOC** |
| | **Field Blank** | **A-1 + CCR** | **A-1 + CCR** |

**Notes:**
A-1 = ADEM Rule 335-14-4 *Appendix I* VOCs and total metals
A-1 VOC = Appendix 1 VOCs Only
B-1 = biological oxygen demand (BOD), chemical oxygen demand (COD), total dissolved solids, total suspended solids, oil and grease, and total metals (cadmium, chromium, copper)
CCR = Total dissolved solids, chloride, fluoride, sulfate, total boron, and total calcium
All sample locations analyzed for field parameters (pH, specific conductivity, temperature, and turbidity).

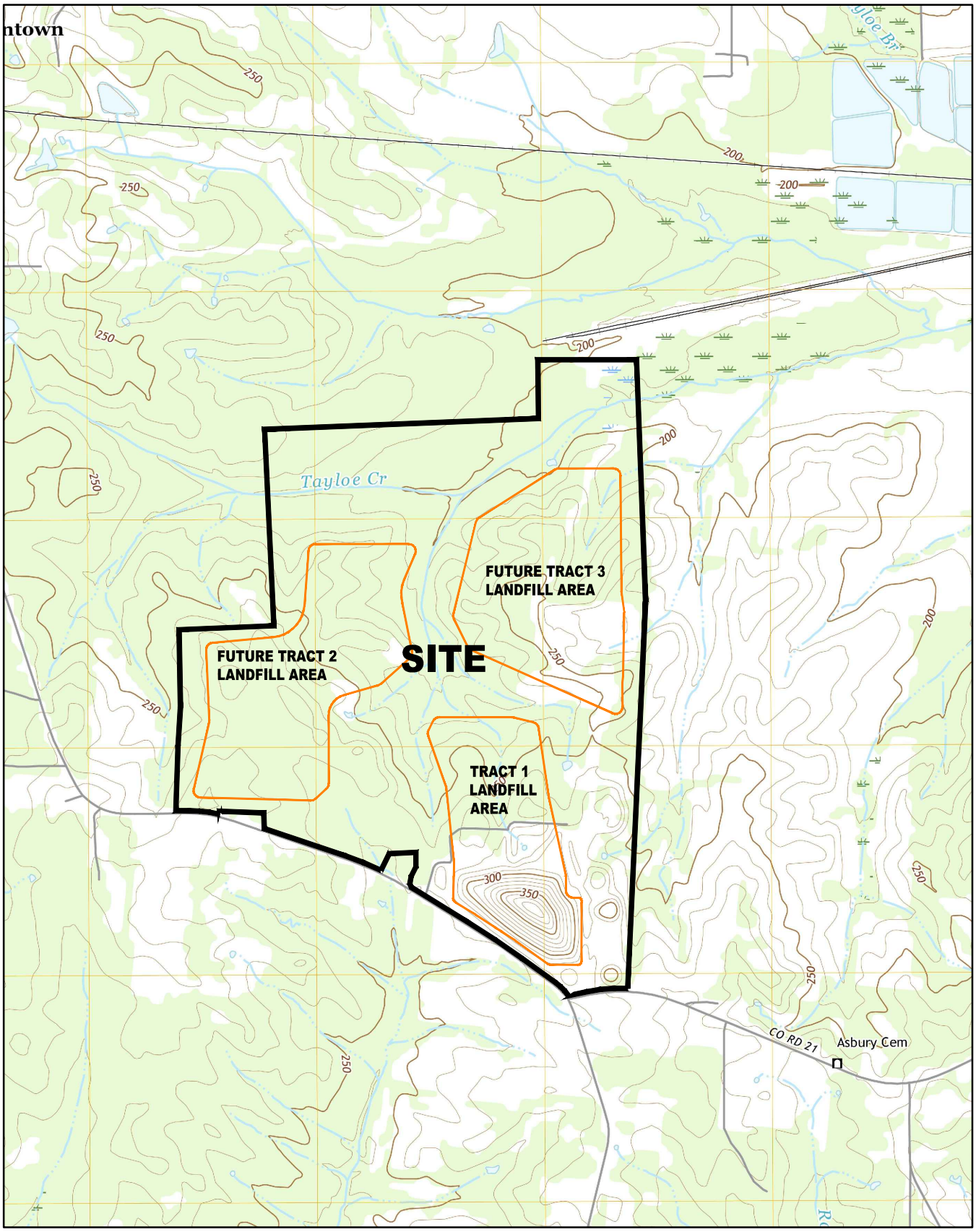
**Table 3**
**Sampling and Preservation Procedures**
**Arrowhead Landfill**
**Perry County, Alabama**
**BLE Project Number J24-4999-66**

| Parameter | Container & Volume | Preservative | Maximum Holding Time |
|---|---|---|---|
| Cyanide | P,G; 250 mL | 4°C NaOH to pH>12 | 14 days |
| Sulfide | P,G; 250 mL | 4°C, add Zinc Acetate and NaOH | 7 days |
| Sulfate | P; 250 mL | 4°C | 28 days |
| Nitrate | P; 250 mL | 4°C | 48 hours |
| ortho-Phosphate | P; 250 mL | 4°C | 48 hours |
| Chloride | P,G; 250 mL | 4°C | 28 days |
| Alkalinity | P,G; 250 mL | 4°C | 14 days |
| Total Dissolved Solids | P,G; 250 mL | 4°C | 7 days |
| Total Suspended Solids | P; 1000 mL | 4°C | 7 days |
| Mercury (total) | P; 250 mL | HNO3 to pH<2 | 28 days |
| Metals (total) except mercury | P; 250 mL | HNO3 to pH<2 | 6 months |
| Base Neutrals & Acids | G, Teflon-lined cap; 2-250 mL | 4°C | 7 days to extraction, 40 days after extraction |
| Chlorinated Pesticides/PCBs | G, Teflon-lined cap; 2-250 mL | 4°C | 7 days to extraction, 40 days after extraction |
| Chlorinated Acids | G, Teflon-lined cap; 2-250 mL | 4°C | 7 days to extraction, 40 days after extraction |
| Purgeables | 2-40 mL VOA w/G, Teflon-lined septum | 4°C; HCl to pH<2 | 14 days |
| BOD | P; 1000 mL | 6°C | 48 hours |
| COD | P; 250 mL | 6°C, H2SO4 to pH<2 | 28 days |
| Oil & Grease | G, 2x1000ml | 4°C; HCl to pH<2 | 28 days |
| Phenols | G; 250 ml | 4C, H2SO4 to pH<2 | 28 days |

**Notes:** P - Plastic, G - Glass, T - Fluorocarbon Resin (PTFE, Teflon®, FEP, etc.)

No headspace should be allowed in the volatile organic compound containers.

# FIGURES




2000 1000 0 2000 4000

APPROXIMATE SCALE IN FEET

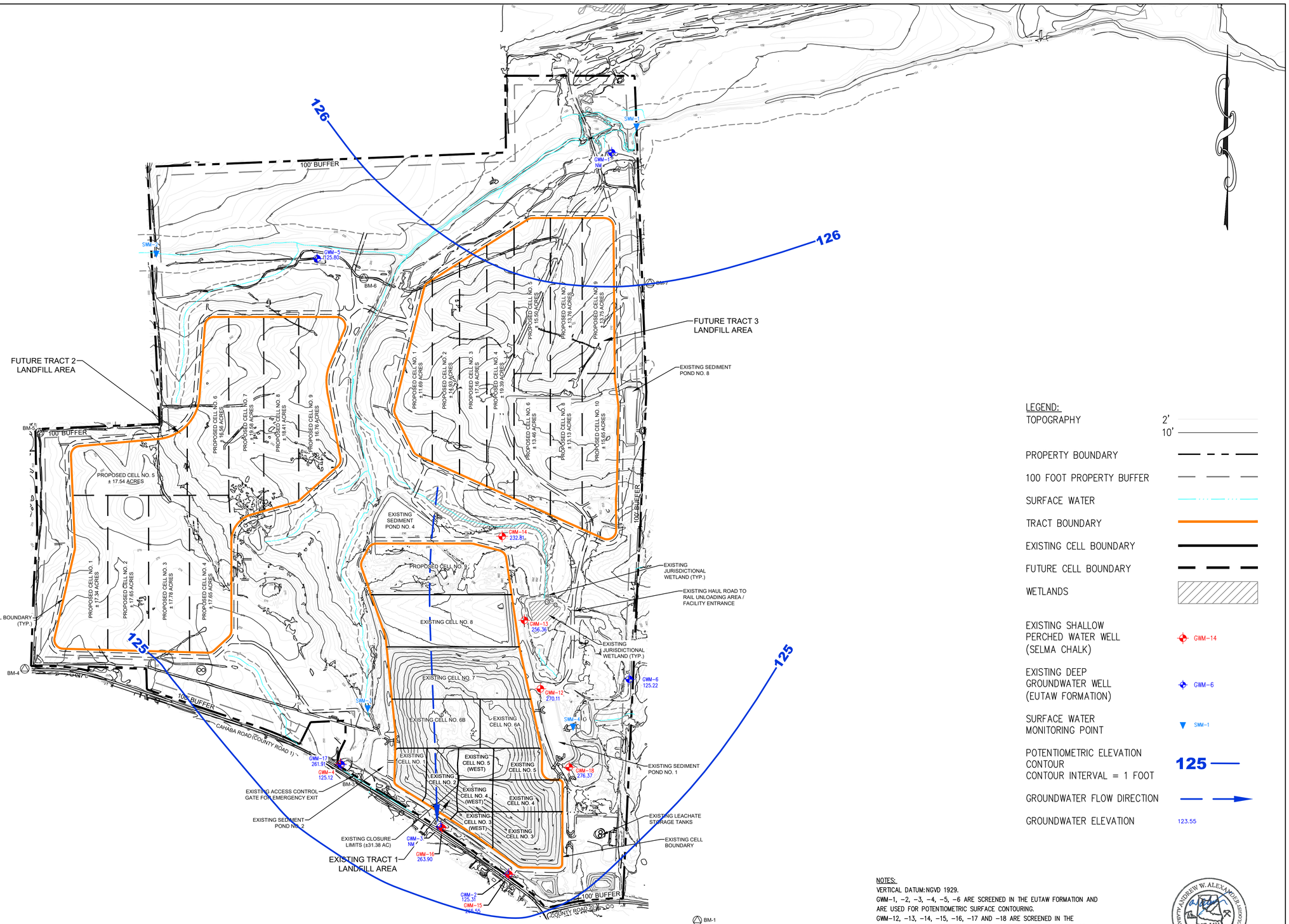
REFERENCE:
USGS TOPOGRAPHIC MAP, 7.5 MINUTE SERIES,
UNIONTOWN EAST, AL. QUADRANGLE, 2020.

| | | | |
|---|---|---|---|
| DRAWN: | KLW | DATE: | 12-2-24 |
| CHECKED: | RLB | CAD: | ARROWHLF-66SLM |
| APPROVED: | AWA | JOB NO: | J24-4999-66 |

BUNNELL LAMMONS ENGINEERING
6004 Ponders Court, Greenville, SC 29615
Phone: (864) 288-1265 Fax: (864) 288-4430

**SITE LOCATION MAP**
ARROWHEAD LANDFILL
PERRY COUNTY, ALABAMA

FIGURE
1




LEGEND:

- TOPOGRAPHY 2' / 10'
- PROPERTY BOUNDARY
- 100 FOOT PROPERTY BUFFER
- SURFACE WATER
- TRACT BOUNDARY
- EXISTING CELL BOUNDARY
- FUTURE CELL BOUNDARY
- WETLANDS
- EXISTING SHALLOW PERCHED WATER WELL (SELMA CHALK) — GWM-14
- EXISTING DEEP GROUNDWATER WELL (EUTAW FORMATION) — GWM-6
- SURFACE WATER MONITORING POINT — SWM-1
- POTENTIOMETRIC ELEVATION CONTOUR, CONTOUR INTERVAL = 1 FOOT — 125
- GROUNDWATER FLOW DIRECTION
- GROUNDWATER ELEVATION — 123.55

NOTES:
VERTICAL DATUM: NGVD 1929.
GWM-1, -2, -3, -4, -5, -6 ARE SCREENED IN THE EUTAW FORMATION AND ARE USED FOR POTENTIOMETRIC SURFACE CONTOURING.
GWM-12, -13, -14, -15, -16, -17 AND -18 ARE SCREENED IN THE WEATHERED PORTION OF THE SELMA CHALK NEAR THE GROUND SURFACE AND ARE NOT USED FOR POTENTIOMETRIC SURFACE CONTOURING.
METHANE MONITORING LOCATIONS ARE NOT SHOWN ON THIS FIGURE.

ANDREW W. ALEXANDER, LIC. 14311, STATE OF ALABAMA, LICENSED PROFESSIONAL GEOLOGIST

| REVISIONS | | |
|---|---|---|
| No. | DESCRIPTION | BY |
| | | |
| | | |
| | | |

DRAWN: KLW
CHECKED: RLB
APPROVED: AWA

DATE: 1-24-25
CAD FILE: ARROWHLF-66 POT-031324
JOB NO: J24-4999-66

BLE BUNNELL LAMMONS ENGINEERING
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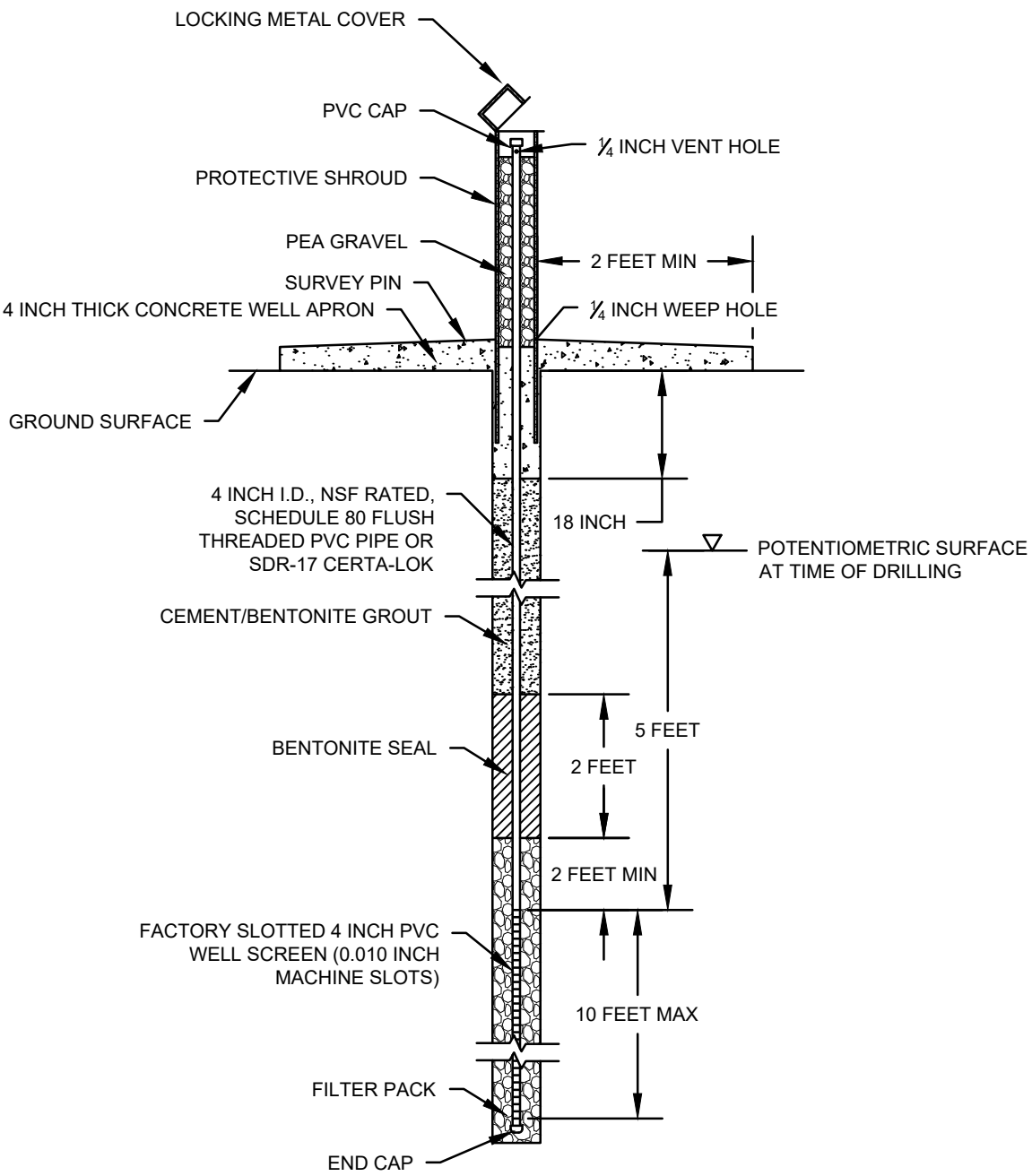
(864) 288-1255

GROUNDWATER ELEVATION CONTOUR MAP (EUTAW FORMATION) – MARCH 13, 2024
ARROWHEAD LANDFILL
PERRY COUNTY, ALABAMA

FIGURE NO. 2

# TYPE II GROUNDWATER MONITORING WELL CONSTRUCTION DETAIL

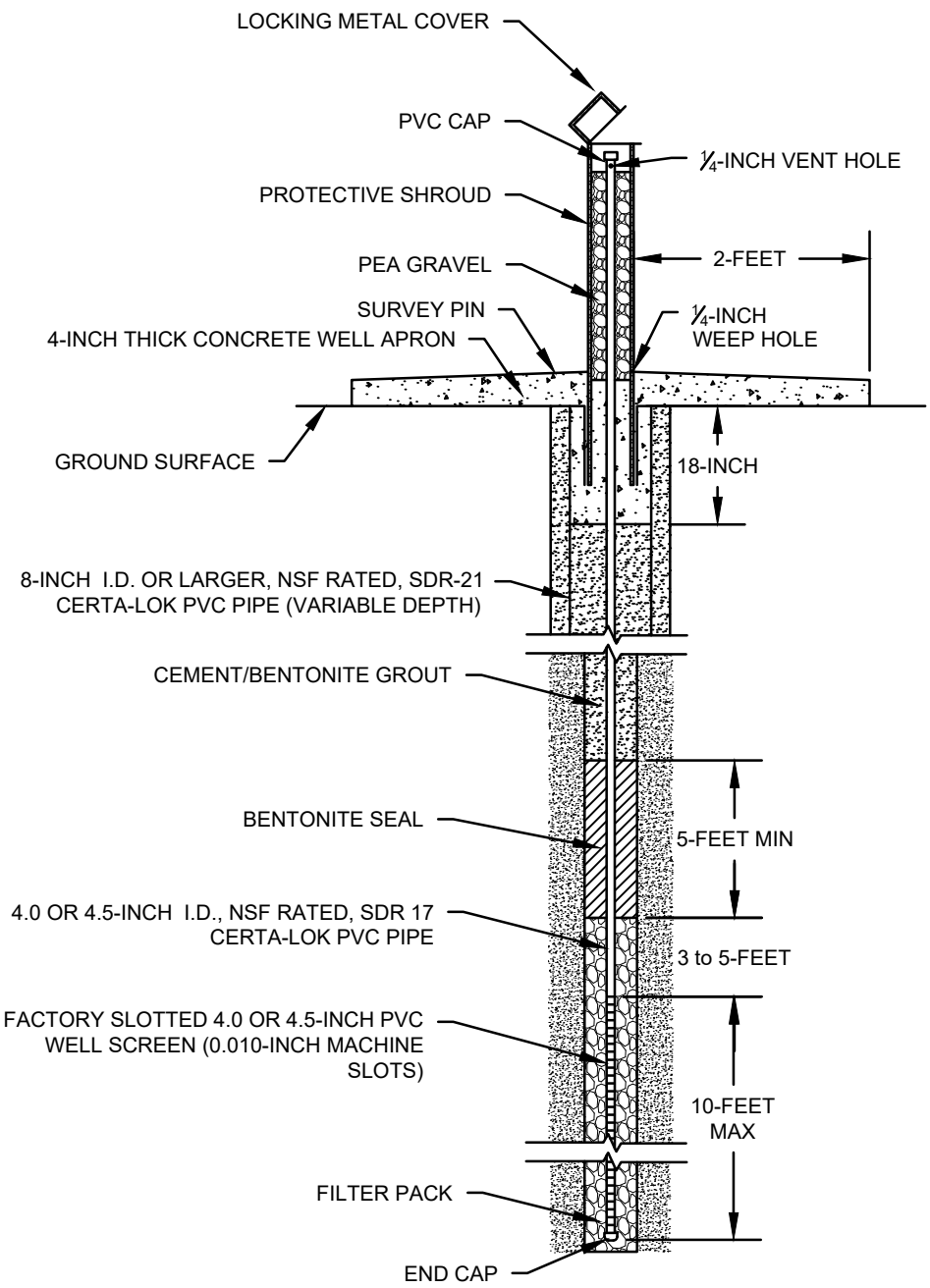
SCALE: NOT TO SCALE




| | | | |
|---|---|---|---|
| DRAWN: KLW | DATE: 12-4-24 | BUNNELL LAMMONS ENGINEERING<br>6004 Ponders Court, Greenville, SC 29615<br>Phone: (864) 288-1265 Fax: (864) 288-4430 | TYPE II GROUNDWATER MONITORING WELL CONSTRUCTION DETAIL<br>ARROWHEAD LANDFILL<br>PERRY COUNTY, ALABAMA |
| CHECKED: RLB | CAD: ARROWHLF-66TYP 2 GW WELL | | |
| APPROVED: AWA | JOB NO: J24-4999-66 | | FIGURE 3 |

# TYPE III GROUNDWATER MONITORING WELL CONSTRUCTION DETAIL

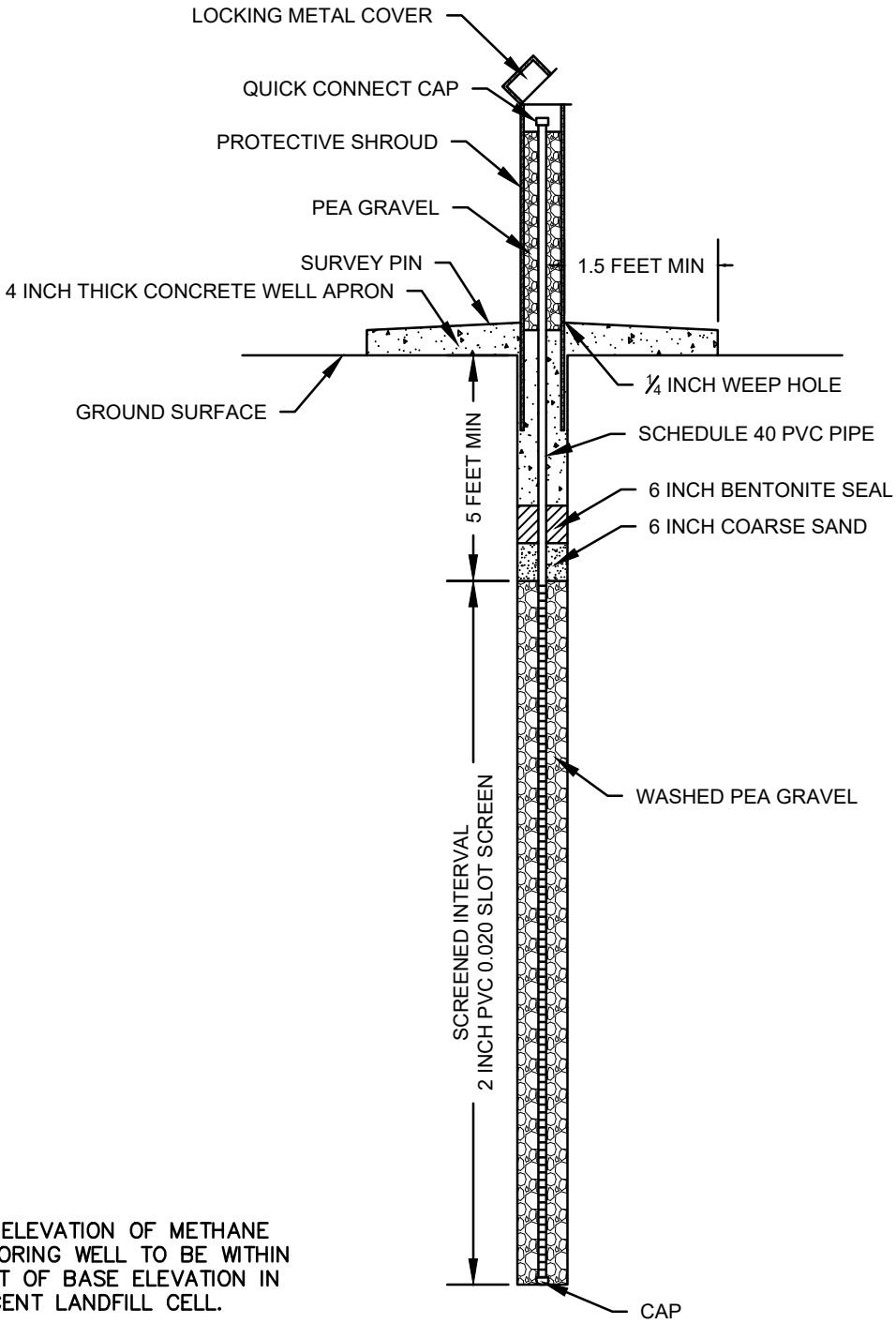
SCALE: NOT TO SCALE




| | | | |
|---|---|---|---|
| DRAWN: KLW | DATE: 12-4-24 | BUNNELL LAMMONS ENGINEERING<br>6004 Ponders Court, Greenville, SC 29615<br>Phone: (864) 288-1265 Fax: (864) 288-4430 | TYPE III GROUNDWATER MONITORING WELL CONSTRUCTION DETAIL<br>ARROWHEAD LANDFILL<br>PERRY COUNTY, ALABAMA |
| CHECKED: RLB | CAD: ARROWHEAD-66TYP 3 GW WELL | | |
| APPROVED: AWA | JOB NO: J24-4999-66 | | FIGURE 4 |

# METHANE MONITORING WELL CONSTRUCTION DETAIL

SCALE: NOT TO SCALE

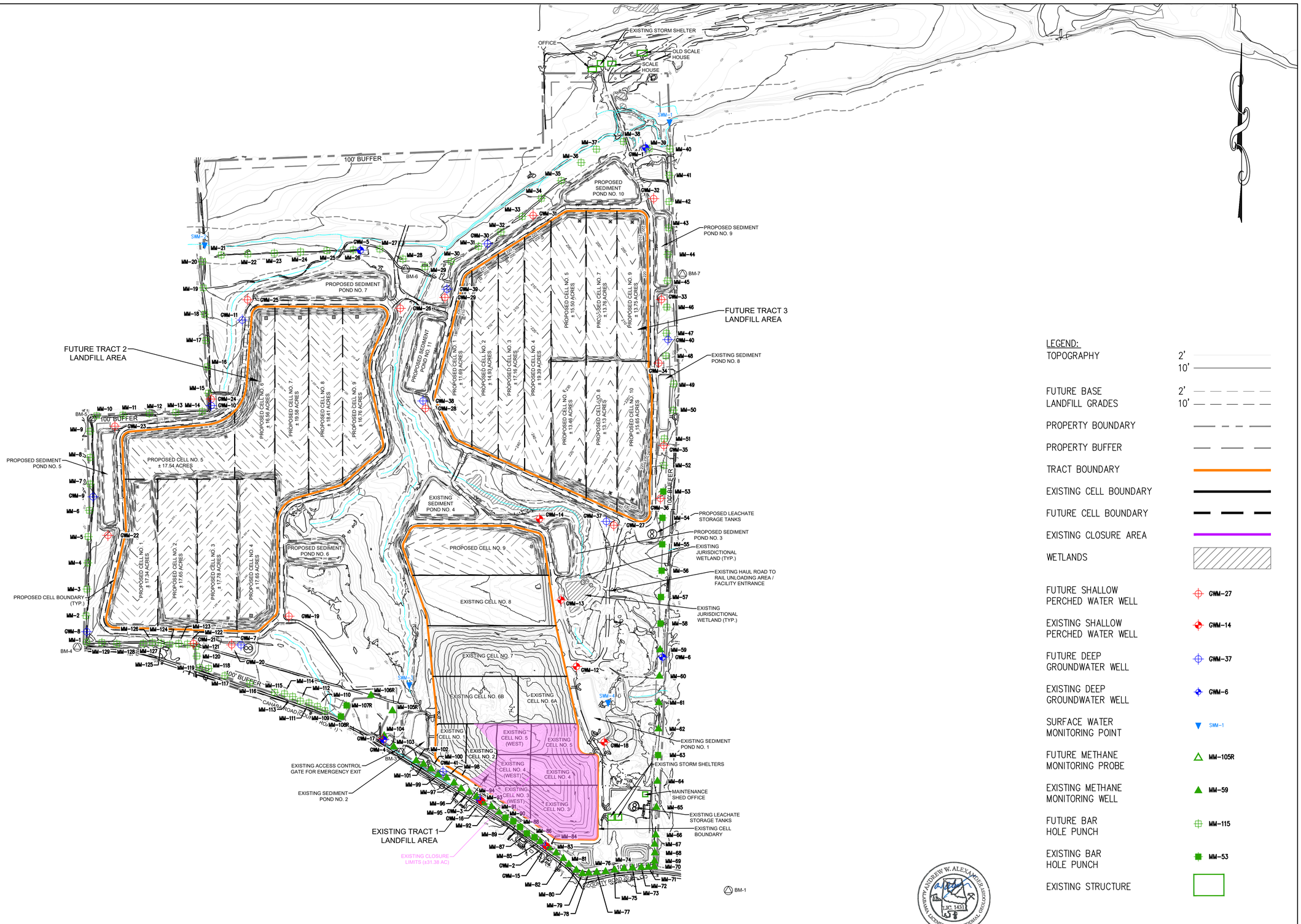



NOTE:
BASE ELEVATION OF METHANE MONITORING WELL TO BE WITHIN 5 FEET OF BASE ELEVATION IN ADJACENT LANDFILL CELL.

| | | | |
|---|---|---|---|
| DRAWN: KLW | DATE: 12-2-24 | BUNNELL LAMMONS ENGINEERING | FIGURE |
| CHECKED: RLB | CAD: ARROWHLF-66MM WELL DETAIL | 6004 Ponders Court, Greenville, SC 29615<br>Phone: (864) 288-1265 Fax: (864) 288-4430 | METHANE MONITORING WELL CONSTRUCTION DETAIL<br>ARROWHEAD LANDFILL<br>PERRY COUNTY, ALABAMA |
| APPROVED: AWA | JOB NO: J24-4999-66 | | 5 |

# APPENDIX A

# ENVIRONMENTAL MONITORING NETWORK MAPS




LEGEND:

| | |
|---|---|
| TOPOGRAPHY | 2' / 10' |
| FUTURE BASE LANDFILL GRADES | 2' / 10' |
| PROPERTY BOUNDARY | |
| PROPERTY BUFFER | |
| TRACT BOUNDARY | |
| EXISTING CELL BOUNDARY | |
| FUTURE CELL BOUNDARY | |
| EXISTING CLOSURE AREA | |
| WETLANDS | |
| FUTURE SHALLOW PERCHED WATER WELL | GWM-27 |
| EXISTING SHALLOW PERCHED WATER WELL | GWM-14 |
| FUTURE DEEP GROUNDWATER WELL | GWM-37 |
| EXISTING DEEP GROUNDWATER WELL | GWM-6 |
| SURFACE WATER MONITORING POINT | SWM-1 |
| FUTURE METHANE MONITORING PROBE | MM-105R |
| EXISTING METHANE MONITORING WELL | MM-59 |
| FUTURE BAR HOLE PUNCH | MM-115 |
| EXISTING BAR HOLE PUNCH | MM-53 |
| EXISTING STRUCTURE | |

ANDREW W. ALEXANDER
LICENSED PROFESSIONAL GEOLOGIST
LIC. 1431

| REVISIONS | | |
|---|---|---|
| No. | DESCRIPTION | BY |
| | | |
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| | | |

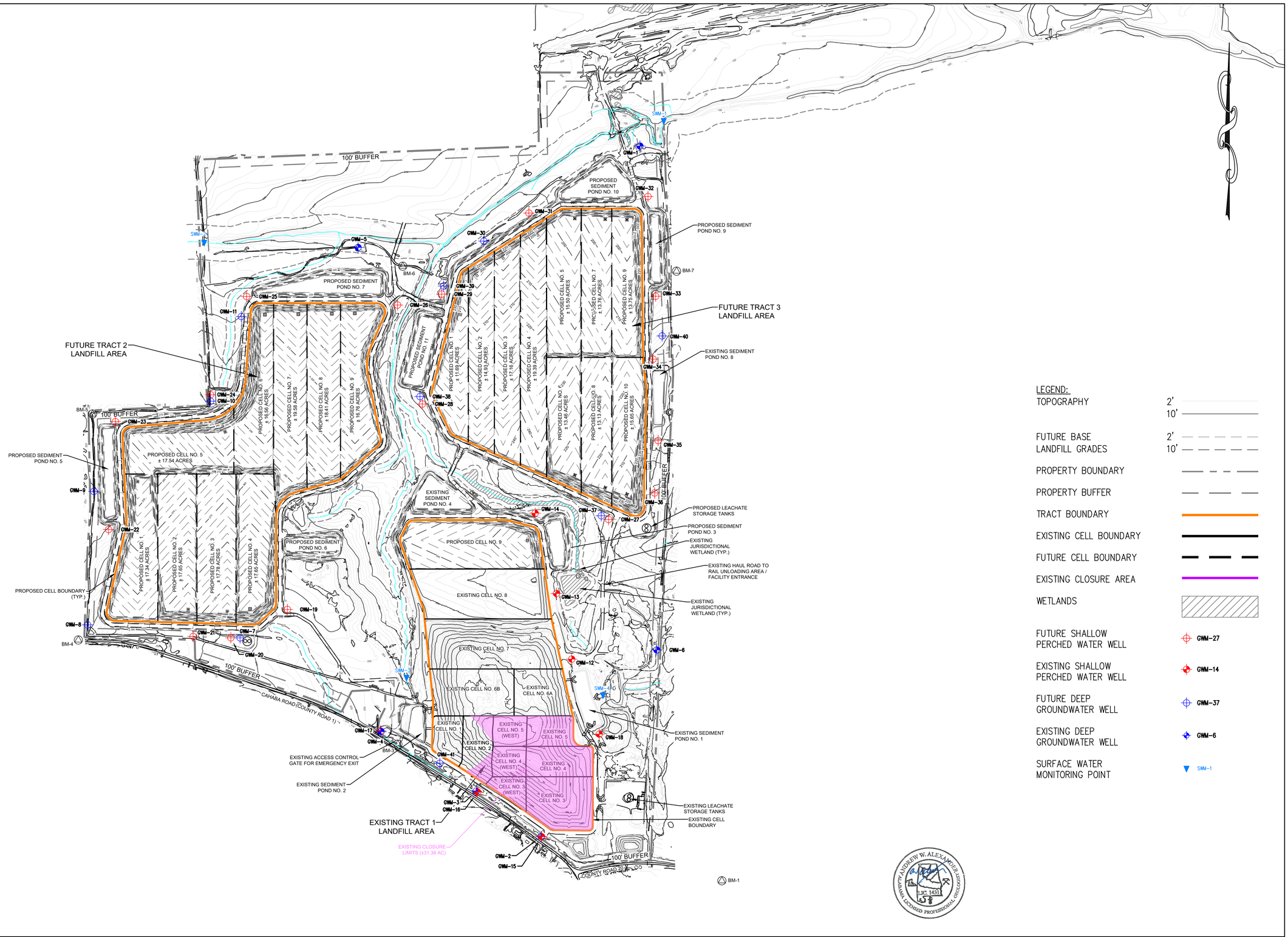
| | |
|---|---|
| DRAWN: | KLW |
| CHECKED: | RLB |
| APPROVED: | AWA |

| | |
|---|---|
| DATE: | 1-24-25 |
| CAD FILE: | ARROWHLF-66HYDROPROD |
| JOB NO: | J24-4999-66 |

BUNNELL LAMMONS ENGINEERING
6004 Ponders Court, Greenville, SC 29615
(864) 288-1255

ENVIRONMENTAL MONITORING NETWORK
ARROWHEAD LANDFILL
PERRY COUNTY, ALABAMA

FIGURE NO.
EMP-1




LEGEND:

| | |
|---|---|
| TOPOGRAPHY | 2' / 10' |
| FUTURE BASE LANDFILL GRADES | 2' / 10' |
| PROPERTY BOUNDARY | |
| PROPERTY BUFFER | |
| TRACT BOUNDARY | |
| EXISTING CELL BOUNDARY | |
| FUTURE CELL BOUNDARY | |
| EXISTING CLOSURE AREA | |
| WETLANDS | |
| FUTURE SHALLOW PERCHED WATER WELL | GWM-27 |
| EXISTING SHALLOW PERCHED WATER WELL | GWM-14 |
| FUTURE DEEP GROUNDWATER WELL | GWM-37 |
| EXISTING DEEP GROUNDWATER WELL | GWM-6 |
| SURFACE WATER MONITORING POINT | SWM-1 |

500 250 0 500 1000
APPROXIMATE SCALE IN FEET

WESLEY ANDREW W. ALEXANDER LICENSED PROFESSIONAL GEOLOGIST LIC. 1431

| REVISIONS | | |
|---|---|---|
| No. | DESCRIPTION | BY |
| | | |
| | | |
| | | |

DRAWN: KLW
CHECKED: RLB
APPROVED: AWA

DATE: 1-24-25
CAD FILE: ARROWHLF-66HYDROPROD
JOB NO: J24-4999-66

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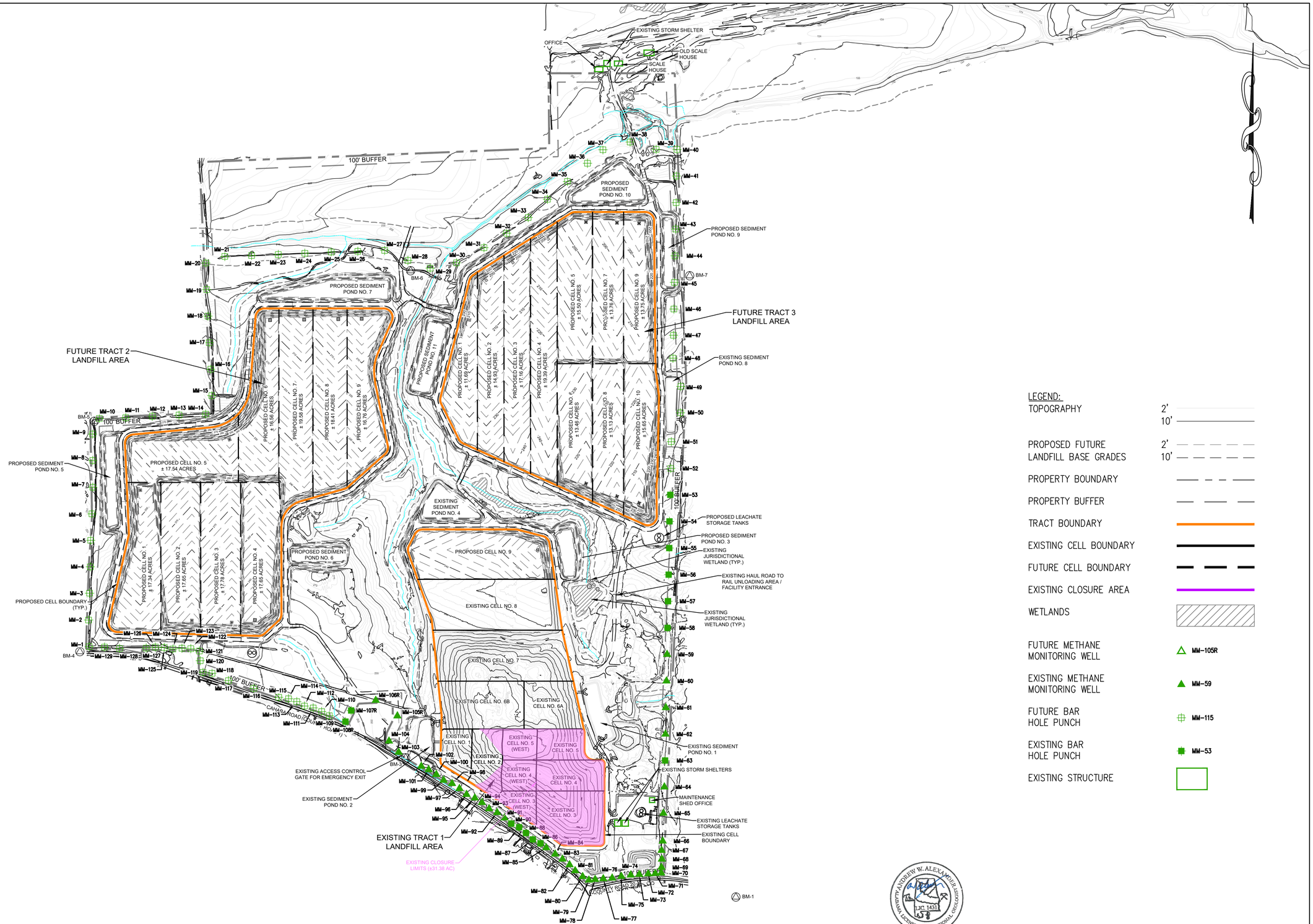
(864) 298-1265

WATER QUALITY MONITORING NETWORK
ARROWHEAD LANDFILL
PERRY COUNTY, ALABAMA

FIGURE NO.
EMP-2




LEGEND:

| | |
|---|---|
| TOPOGRAPHY | 2' / 10' |
| PROPOSED FUTURE LANDFILL BASE GRADES | 2' / 10' |
| PROPERTY BOUNDARY | |
| PROPERTY BUFFER | |
| TRACT BOUNDARY | |
| EXISTING CELL BOUNDARY | |
| FUTURE CELL BOUNDARY | |
| EXISTING CLOSURE AREA | |
| WETLANDS | |
| FUTURE METHANE MONITORING WELL | MM-105R |
| EXISTING METHANE MONITORING WELL | MM-59 |
| FUTURE BAR HOLE PUNCH | MM-115 |
| EXISTING BAR HOLE PUNCH | MM-53 |
| EXISTING STRUCTURE | |

500 250 0 500 1000
APPROXIMATE SCALE IN FEET

ANDREW W. ALEXANDER
LIC. 1431
STATE OF ALABAMA LICENSED PROFESSIONAL GEOLOGIST

| REVISIONS | | |
|---|---|---|
| No. | DESCRIPTION | BY |
| | | |
| | | |
| | | |

DRAWN: KLW
CHECKED: RLB
APPROVED: AWA

DATE: 1-24-25
CAD FILE: ARROWHLF-66HYDROPROD
JOB NO: J24-4999-66

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LANDFILL GAS MONITORING NETWORK
ARROWHEAD LANDFILL
PERRY COUNTY, ALABAMA

FIGURE NO.
EMP-3

# APPENDIX B

# EXAMPLE FIELD LOG

# EXAMPLE FIELD LOG

Site Name _____ Location _____
Collector _____ Method of evac.
Sample Point ID _____ (type of bailer, pump, etc.) _____

EVACUATION: Date/Time: _____ Well Depth (ft.) _____
Water Level Depth, Ft.: _____ Well Volume (gal.) _____
Casing Diameter, In.: _____ Total Gallons evac. _____
Well level after evac., Ft.: _____ Complete – Date/Time _____

SAMPLING Collector: _____ Well Collection Sequence # _____
Initiated Date/Time _____ Well Stick-up (ft.) _____ Water Level Depth (ft.) _____

Completed Date/Time _____ Method of Sample Collection: _____

| Time (Military) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Volume Purged (gallons) | | | | | | | | |
| Purge Rate (gpm) | | | | | | | | |
| pH (S.U.) | | | | | | | | |
| Specific Conductance (umhos/cm) | | | | | | | | |
| Water Temp (°C) | | | | | | | | |
| Turbidity (NTU) | | | | | | | | |

GENERAL INFORMATION:

**Weather Conditions at time of sampling:**_____
**Sample Characteristics:** _____
**Analyte Type Collection Order, Sample Containers, Volumes, Preservatives, and Tests to be Performed:** _____
_____
_____
_____
**Comment and Observations:**_____
_____
**Recommendations:** _____
_____
_____

Certification:

_____ _____
Signed Date

# APPENDIX C

# GROUNDWATER MONITORING WELL BORING LOGS

# KEY TO SOIL CLASSIFICATIONS AND CONSISTENCY DESCRIPTIONS

**BUNNELL-LAMMONS ENGINEERING, INC.**
**GREENVILLE, SOUTH CAROLINA**

| Penetration Resistance* Blows per Foot | Relative Density |
|---|---|
| SANDS | |
| 0 to 4 | Very Loose |
| 5 to 10 | Loose |
| 11 to 20 | Firm |
| 21 to 30 | Very Firm |
| 31 to 50 | Dense |
| over 50 | Very Dense |

| Penetration Resistance* Blows per Foot | Consistency |
|---|---|
| SILTS and CLAYS | |
| 0 to 2 | Very Soft |
| 3 to 4 | Soft |
| 5 to 8 | Firm |
| 9 to 15 | Stiff |
| 16 to 30 | Very Stiff |
| 31 to 50 | Hard |
| over 50 | Very Hard |

*ASTM D 1586

### Particle Size Identification

Boulder: Greater than 300 mm
Cobble: 75 to 300 mm
Gravel:
Coarse - 19 to 75 mm
Fine - 4.75 to 19 mm
Sand:
Coarse - 2 to 4.75 mm
Medium - 0.425 to 2 mm
Fine - 0.075 to 0.425 mm
Silt & Clay: Less than 0.075 mm

## KEY TO DRILLING SYMBOLS

Grab Sample

Split Spoon Sample

Undisturbed Sample

NR = No reaction to HCL

NA = Not applicable

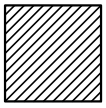
NS = No sample

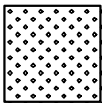
Groundwater Table at Time of Drilling

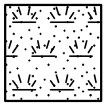
Groundwater Table 24 Hours after Completion of Drilling

## KEY TO SOIL CLASSIFICATIONS

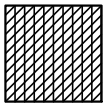
Well-graded Gravel
GW


Low Plasticity Clay
CL

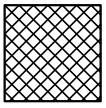

Sand
SW


Topsoil
TOPSOIL

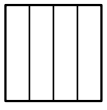
Poorly-graded Gravel
GP

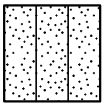

Silty Clay
CL-ML

Clayey Sand
SC

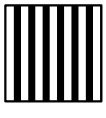

Fill
FILL

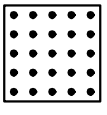
Partially Weathered Rock
BLDRCBBL

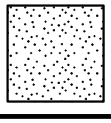

Silt
ML

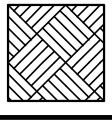

Silty Sand
SM

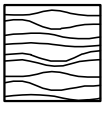
High Plasticity Clay
CH


Clayey Silt
MH


Waste
WOOD


Poorly Graded Sand
SP


Bedrock
BEDROCK


Liquid Sludge
SLUDGE

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**BUNNELL-LAMMONS ENGINEERING, INC.**

GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

# GROUNDWATER MONITORING WELL NO. GWM-1

PROJECT: Perry County Landfill — PROJECT NO.: J07-4999-05

CLIENT: HHNT — START: 5-14-07 END: 5-16-07

LOCATION: Uniontown, Alabama — ELEVATION: 200.1

DRILLER: Allen & Willis Drilling Company, T. Willis — LOGGED BY: M. Preddy

DRILLING METHOD: Failing 1250 Holemaster wash drill

DEPTH TO - WATER> INITIAL: ▽ _____ AFTER 7 HOURS: ▼ 82.5 CAVING> ▨ _____

| ELEVATION/ DEPTH (FT) | DESCRIPTION | SOIL TYPE | SAMPLES | STANDARD PENETRATION RESULTS BLOWS/FOOT (2 5 10 20 30 40 50 70 90) | MONITOR WELL INSTALLATION DETAILS |
|---|---|---|---|---|---|
| 190 | Gray and brown, fine sandy, silty CLAY - (fill) | | | | **SURFACE COMPLETION** 6' X 6' concrete pad with a survey pin and a standup steel cover. A vent hole was put in the top of the well casing. A weep hole was put at the base of the steel cover. Pea gravel was placed between the well casing and steel cover. |
| | Brown, fine sandy, silty CLAY | | | | |
| 180 | Gray LIMEROCK (Selma Group Chalk) | | | | |
| 170 | | | | | |
| 160 | | | | | Ground elev. = 200.1 feet MSL |
| 150 | | | | | |
| 140 | | | | | Top of well casing elev. = 203.32 feet MSL |
| 130 | | | | | |
| 120 | ▼ | | | | |
| 110 | | | | | |
| 100 | | | | | Cement grout, 0 to 435.0 feet |
| 90 | | | | | |
| 80 | | | | | Black steel risers = 21.21 feet each |
| 70 | | | | | |
| 60 | | | | | |
| 50 | | | | | |
| 40 | | | | | Centralizers installed every 50 feet |
| 30 | | | | | |
| 20 | | | | | |
| 10 | | | | | |

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**BUNNELL-LAMMONS ENGINEERING, INC.**

GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

# GROUNDWATER MONITORING WELL NO. GWM-1

PROJECT: Perry County Landfill — PROJECT NO.: J07-4999-05

CLIENT: HHNT — START: 5-14-07 END: 5-16-07

LOCATION: Uniontown, Alabama — ELEVATION: 200.1

DRILLER: Allen & Willis Drilling Company, T. Willis — LOGGED BY: M. Preddy

DRILLING METHOD: Failing 1250 Holemaster wash drill

DEPTH TO - WATER> INITIAL: ▽ _____ AFTER 7 HOURS: ▼ 82.5 CAVING> _____

| ELEVATION/ DEPTH (FT) | DESCRIPTION | SOIL TYPE | SAMPLES | STANDARD PENETRATION RESULTS BLOWS/FOOT (2 5 10 20 30 40 50 70 90) | MONITOR WELL INSTALLATION DETAILS |
|---|---|---|---|---|---|
| -10 | | | | | |
| -20 | | | | | |
| -30 | | | | | |
| -40 | | | | | |
| -50 | | | | | |
| -60 | | | | | |
| -70 | | | | | |
| -80 | | | | | |
| -90 | | | | | |
| -100 | Gray LIMEROCK (Selma Group Chalk) | | | | Cement grout, 0 to 435.0 feet |
| -110 | | | | | |
| -120 | | | | | |
| -130 | | | | | Black steel risers = 21.21 feet each |
| -140 | | | | | |
| -150 | | | | | |
| -160 | | | | | |
| -170 | | | | | Centralizers installed every 50 feet |
| -180 | | | | | |
| -190 | | | | | |

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GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

# GROUNDWATER MONITORING WELL NO. GWM-1

PROJECT: Perry County Landfill — PROJECT NO.: J07-4999-05

CLIENT: HHNT — START: 5-14-07 END: 5-16-07

LOCATION: Uniontown, Alabama — ELEVATION: 200.1

DRILLER: Allen & Willis Drilling Company, T. Willis — LOGGED BY: M. Preddy

DRILLING METHOD: Failing 1250 Holemaster wash drill

DEPTH TO - WATER> INITIAL: ▽ _____ AFTER 7 HOURS: ▼ 82.5 CAVING> _____

| ELEVATION/ DEPTH (FT) | DESCRIPTION | SOIL TYPE | SAMPLES | STANDARD PENETRATION RESULTS BLOWS/FOOT (2 5 10 20 30 40 50 70 90) | MONITOR WELL INSTALLATION DETAILS |
|---|---|---|---|---|---|
| -210 | Gray LIMEROCK (Selma Group Chalk) | | | | Cement grout, 0 to 435.0 feet |
| -220 | | | | | Black steel risers = 21.21 feet each |
| -230 | | | | | Centralizers installed every 50 feet |
| -240 | Gray and black, silty, fine SAND with glauconite (Eutaw Sand Formation) | | | | Bentonite seal, 435.0 to 445.0 feet |
| -250 | | | | | Filter pack, sand 445.0 to 460.5 feet |
| -260 | Boring terminated at 460.5 feet. Groundwater encountered at 82.5 feet on May 21, 2007. 8-inch wash-drilled borehole. | | | | 4-inch diameter, 0.010-inch slotted stainless steel well screen, 450.0 to 460.0 feet |
| -270 | | | | | Total well depth, 460.5 feet |
| -280 | | | | | Sump = 0.5 foot stainless steel |
| -290 | | | | | |
| -300 | | | | | 8-inch diameter borehole |
| -310 | | | | | |
| -320 | | | | | Durham Geo bladder pump installed with intake set at 453 feet |
| -330 | | | | | |
| -340 | | | | | |
| -350 | | | | | |
| -360 | | | | | |
| -370 | | | | | |
| -380 | | | | | |
| -390 | | | | | |

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**BUNNELL-LAMMONS ENGINEERING, INC.**

GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

# GROUNDWATER MONITORING WELL NO. GWM-2

PROJECT: Perry County Landfill — PROJECT NO.: J07-4999-05

CLIENT: HHNT — START: 4-30-07 END: 5-2-07

LOCATION: Uniontown, Alabama — ELEVATION: 271.2

DRILLER: Allen & Willis Drilling Company, T. Willis — LOGGED BY: M. Preddy

DRILLING METHOD: Failing 1250 Holemaster wash drill

DEPTH TO - WATER> INITIAL: ▽ _____ AFTER 9 HOURS: ▼ 148 CAVING> ▨ _____

| ELEVATION/ DEPTH (FT) | DESCRIPTION | SOIL TYPE | SAMPLES | STANDARD PENETRATION RESULTS BLOWS/FOOT (2 5 10 20 30 40 50 70 90) | MONITOR WELL INSTALLATION DETAILS |
|---|---|---|---|---|---|
| 270 | Brown, fine sandy, silty CLAY - (fill) | | | | **SURFACE COMPLETION** 6' X 6' concrete pad with a survey pin and a standup steel cover. A vent hole was put in the top of the well casing. A weep hole was put at the base of the steel cover. Pea gravel was placed between the well casing and steel cover. |
| 260 | Brown, fine sandy, silty CLAY | | | | |
| 250 | Gray LIMEROCK (Selma Group Chalk) | | | | |
| 240 | | | | | |
| 230 | | | | | Ground elev. = 271.2 feet MSL |
| 220 | | | | | |
| 210 | | | | | Top of well casing elev. = 274.42 feet MSL |
| 200 | | | | | |
| 190 | | | | | |
| 180 | | | | | |
| 170 | | | | | Cement grout, 0 to 558.0 feet |
| 160 | | | | | |
| 150 | | | | | |
| 140 | | | | | Black steel risers = 21.0 feet each |
| 130 | | | | | |
| 120 | ▼ | | | | Centralizers installed every 50 feet |
| 110 | | | | | |
| 100 | | | | | |
| 90 | | | | | |
| 80 | | | | | |

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**BUNNELL-LAMMONS ENGINEERING, INC.**

GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

# GROUNDWATER MONITORING WELL NO. GWM-2

PROJECT: Perry County Landfill — PROJECT NO.: J07-4999-05

CLIENT: HHNT — START: 4-30-07 END: 5-2-07

LOCATION: Uniontown, Alabama — ELEVATION: 271.2

DRILLER: Allen & Willis Drilling Company, T. Willis — LOGGED BY: M. Preddy

DRILLING METHOD: Failing 1250 Holemaster wash drill

DEPTH TO - WATER> INITIAL: ▽ _____ AFTER 9 HOURS: ▼ 148 CAVING> _____

| ELEVATION/ DEPTH (FT) | DESCRIPTION | SOIL TYPE | SAMPLES | STANDARD PENETRATION RESULTS BLOWS/FOOT (2 5 10 20 30 40 50 70 90) | MONITOR WELL INSTALLATION DETAILS |
|---|---|---|---|---|---|
| 70 to -120 | Gray LIMEROCK (Selma Group Chalk) | | | | Cement grout, 0 to 558.0 feet<br>Black steel risers = 21.0 feet each<br>Centralizers installed every 50 feet |

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GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

# GROUNDWATER MONITORING WELL NO. GWM-2

PROJECT: Perry County Landfill — PROJECT NO.: J07-4999-05
CLIENT: HHNT — START: 4-30-07 END: 5-2-07
LOCATION: Uniontown, Alabama — ELEVATION: 271.2
DRILLER: Allen & Willis Drilling Company, T. Willis — LOGGED BY: M. Preddy
DRILLING METHOD: Failing 1250 Holemaster wash drill
DEPTH TO - WATER> INITIAL: ▽ ____ AFTER 9 HOURS: ▼ 148 CAVING> ____

| ELEVATION/ DEPTH (FT) | DESCRIPTION | SOIL TYPE | SAMPLES | STANDARD PENETRATION RESULTS BLOWS/FOOT (2 5 10 20 30 40 50 70 90) | MONITOR WELL INSTALLATION DETAILS |
|---|---|---|---|---|---|
| -130 | Gray LIMEROCK (Selma Group Chalk) | | | | |
| -140 | | | | | Cement grout, 0 to 558.0 feet |
| -150 | | | | | |
| -160 | | | | | |
| -170 | | | | | |
| -180 | | | | | |
| -190 | | | | | Durham Geo bladder pump installed with intake set at 574 feet |
| -200 | | | | | |
| -210 | | | | | |
| -220 | | | | | |
| -230 | | | | | |
| -240 | | | | | |
| -250 | | | | | Black steel risers = 21.0 feet each |
| -260 | | | | | |
| -270 | | | | | |
| -280 | | | | | Centralizers installed every 50 feet |
| -290 | | | | | Bentonite seal, 558.0 to 568.0 feet |
| | Gray and black, silty, fine SAND with glauconite (Eutaw Sand Formation) Rock layer from 573 to 574 feet | | | | Filter pack, sand 568.0 to 585.0 feet |
| -300 | | | | | 4-inch diameter, 0.010-inch slotted stainless steel well screen, 570.5 to 580.5 feet |
| -310 | | | | | |
| -320 | Boring terminated at 585 feet. Groundwater encountered at 148 feet on May 9, 2007. 8-inch wash-drilled borehole. | | | | Total well depth, 581.0 feet<br>Sump = 0.5 foot stainless steel<br>8-inch diameter borehole |

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GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

# GROUNDWATER MONITORING WELL NO. GWM-3

PROJECT: Perry County Landfill — PROJECT NO.: J07-4999-05

CLIENT: HHNT — START: 3-12-07 END: 3-14-07

LOCATION: Uniontown, Alabama — ELEVATION: 269.5

DRILLER: Allen & Willis Drilling Company, T. Willis — LOGGED BY: M. Preddy

DRILLING METHOD: Failing 1250 Holemaster wash drill

DEPTH TO - WATER> INITIAL: ▽ _____ AFTER 56 HOURS: ▼ 143.57 CAVING> ▨ _____

| ELEVATION/ DEPTH (FT) | DESCRIPTION | SOIL TYPE | SAMPLES | STANDARD PENETRATION RESULTS BLOWS/FOOT (2 5 10 20 30 40 50 70 90) | MONITOR WELL INSTALLATION DETAILS |
|---|---|---|---|---|---|
| 260 | Brown, fine sandy, silty CLAY - (fill) | | | | SURFACE COMPLETION<br>6' X 6' concrete pad with a survey pin and a standup steel cover. A vent hole was put in the top of the well casing. A weep hole was put at the base of the steel cover. Pea gravel was placed between the well casing and steel cover. |
| | Brown, fine sandy, silty CLAY | | | | |
| 250 | Very light gray and brown LIMEROCK | | | | |
| | Gray LIMEROCK (Selma Group Chalk) | | | | |
| 240 | | | | | |
| 230 | | | | | Ground elev. = 269.5 feet MSL |
| 220 | | | | | |
| 210 | | | | | Top of well casing elev. = 272.54 feet MSL |
| 200 | | | | | |
| 190 | | | | | |
| 180 | | | | | |
| 170 | | | | | Cement grout, 0 to 538.0 feet |
| 160 | | | | | |
| 150 | | | | | |
| 140 | | | | | Black steel risers = 21.0 feet each |
| 130 | ▼ | | | | |
| 120 | | | | | Centralizers installed every 50 feet |
| 110 | | | | | |
| 100 | | | | | |
| 90 | | | | | |
| 80 | | | | | |

GEOT_WELL 4999-05.GPJ 8/20/20

BLE INC.

**BUNNELL-LAMMONS ENGINEERING, INC.**

GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

# GROUNDWATER MONITORING WELL NO. GWM-3

PROJECT: Perry County Landfill — PROJECT NO.: J07-4999-05

CLIENT: HHNT — START: 3-12-07 END: 3-14-07

LOCATION: Uniontown, Alabama — ELEVATION: 269.5

DRILLER: Allen & Willis Drilling Company, T. Willis — LOGGED BY: M. Preddy

DRILLING METHOD: Failing 1250 Holemaster wash drill

DEPTH TO - WATER> INITIAL: ▽ _____ AFTER 56 HOURS: ▼ 143.57 CAVING> _____

| ELEVATION/ DEPTH (FT) | DESCRIPTION | SOIL TYPE | SAMPLES | STANDARD PENETRATION RESULTS BLOWS/FOOT (2 5 10 20 30 40 50 70 90) | MONITOR WELL INSTALLATION DETAILS |
|---|---|---|---|---|---|
| 60 | | | | | |
| 50 | | | | | |
| 40 | | | | | |
| 30 | | | | | |
| 20 | | | | | |
| 10 | | | | | |
| 0 | | | | | |
| -10 | | | | | |
| -20 | | | | | |
| -30 | Gray LIMEROCK (Selma Group Chalk) | | | | Cement grout, 0 to 538.0 feet |
| -40 | | | | | |
| -50 | | | | | Black steel risers = 21.0 feet each |
| -60 | | | | | |
| -70 | | | | | Centralizers installed every 50 feet |
| -80 | | | | | |
| -90 | | | | | |
| -100 | | | | | |
| -110 | | | | | |
| -120 | | | | | |

GEOT_WELL 4999-05.GPJ 8/20/20

BLE INC.

**BUNNELL-LAMMONS ENGINEERING, INC.**

GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

# GROUNDWATER MONITORING WELL NO. GWM-3

PROJECT: Perry County Landfill — PROJECT NO.: J07-4999-05

CLIENT: HHNT — START: 3-12-07 END: 3-14-07

LOCATION: Uniontown, Alabama — ELEVATION: 269.5

DRILLER: Allen & Willis Drilling Company, T. Willis — LOGGED BY: M. Preddy

DRILLING METHOD: Failing 1250 Holemaster wash drill

DEPTH TO - WATER> INITIAL: ▽ _____ AFTER 56 HOURS: ▼ 143.57 CAVING> _____

| ELEVATION/ DEPTH (FT) | DESCRIPTION | SOIL TYPE | SAMPLES | STANDARD PENETRATION RESULTS BLOWS/FOOT (2 5 10 20 30 40 50 70 90) | MONITOR WELL INSTALLATION DETAILS |
|---|---|---|---|---|---|
| -140 | Gray LIMEROCK (Selma Group Chalk) | | | | Cement grout, 0 to 538.0 feet |
| -150 | | | | | |
| -160 | | | | | |
| -170 | | | | | Durham Geo bladder pump installed with intake set at 565 feet |
| -180 | | | | | |
| -190 | | | | | |
| -200 | | | | | |
| -210 | | | | | |
| -220 | | | | | Black steel risers = 21.0 feet each |
| -230 | | | | | |
| -240 | | | | | |
| -250 | | | | | |
| -260 | | | | | Centralizers installed every 50 feet |
| -270 | | | | | |
| -280 | Gray LIMEROCK with glauconite (Selma Group Chalk) | | | | Bentonite seal, 538.0 to 555.0 feet |
| -290 | Gray and black, fine to medium SAND with glauconite (Eutaw Formation) | | | | Filter pack, sand 555.0 to 578.5 feet<br>4-inch diameter, 0.010-inch slotted stainless steel well screen, 560.0 to 570.0 feet |
| -300 | | | | | |
| -310 | Boring terminated at 578.5 feet. Groundwater encountered at 143.57 feet on May 9, 2007. 8-inch wash-drilled borehole. | | | | Total well depth, 570.5 feet |
| -320 | | | | | Sump = 0.5 foot stainless steel<br>8-inch diameter borehole |

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**BUNNELL-LAMMONS ENGINEERING, INC.**

GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

# GROUNDWATER MONITORING WELL NO. GWM-4

PROJECT: Perry County Landfill — PROJECT NO.: J07-4999-05

CLIENT: HHNT — START: 5-7-07 END: 5-9-07

LOCATION: Uniontown, Alabama — ELEVATION: 269.0

DRILLER: Allen & Willis Drilling Company, T. Willis — LOGGED BY: M. Preddy

DRILLING METHOD: Failing 1250 Holemaster wash drill

DEPTH TO - WATER> INITIAL: ▽ _____ AFTER 13 HOURS: ▼ 123.0 CAVING> _____

| ELEVATION/ DEPTH (FT) | DESCRIPTION | SOIL TYPE | SAMPLES | STANDARD PENETRATION RESULTS BLOWS/FOOT (2 5 10 20 30 40 50 70 90) | MONITOR WELL INSTALLATION DETAILS |
|---|---|---|---|---|---|
| 260 | Brown, fine sandy, silty CLAY - (fill) | | | | **SURFACE COMPLETION** 6' X 6' concrete pad with a survey pin and a standup steel cover. A vent hole was put in the top of the well casing. A weep hole was put at the base of the steel cover. Pea gravel was placed between the well casing and steel cover. |
| 250 | Brown, fine sandy, silty CLAY | | | | |
| 240 | Gray LIMEROCK (Selma Group Chalk) | | | | |
| 230 | | | | | Ground elev. = 269.0 feet MSL |
| 220 | | | | | |
| 210 | | | | | Top of well casing elev. = 272.55 feet MSL |
| 200 | | | | | |
| 190 | | | | | |
| 180 | | | | | |
| 170 | | | | | Cement grout, 0 to 552.5 feet |
| 160 | | | | | |
| 150 | | | | | Black steel risers = 21.21 feet each |
| 140 | | | | | |
| 130 | | | | | Centralizers installed every 50 feet. |
| 120 | | | | | |
| 110 | | | | | |
| 100 | | | | | |
| 90 | | | | | |
| 80 | | | | | |
| 70 | | | | | |

GEOT_WELL 4999-05.GPJ 8/20/20

BLE INC.

**BUNNELL-LAMMONS ENGINEERING, INC.**

GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

# GROUNDWATER MONITORING WELL NO. GWM-4

PROJECT: Perry County Landfill — PROJECT NO.: J07-4999-05

CLIENT: HHNT — START: 5-7-07 END: 5-9-07

LOCATION: Uniontown, Alabama — ELEVATION: 269.0

DRILLER: Allen & Willis Drilling Company, T. Willis — LOGGED BY: M. Preddy

DRILLING METHOD: Failing 1250 Holemaster wash drill

DEPTH TO - WATER> INITIAL: ▽ _____ AFTER 13 HOURS: ▼ 123.0 CAVING> _____

| ELEVATION/ DEPTH (FT) | DESCRIPTION | SOIL TYPE | SAMPLES | STANDARD PENETRATION RESULTS BLOWS/FOOT (2 5 10 20 30 40 50 70 90) | MONITOR WELL INSTALLATION DETAILS |
|---|---|---|---|---|---|
| 60 | | | | | |
| 50 | | | | | |
| 40 | | | | | |
| 30 | | | | | |
| 20 | | | | | |
| 10 | | | | | |
| 0 | | | | | |
| -10 | | | | | |
| -20 | | | | | |
| -30 | Gray LIMEROCK (Selma Group Chalk) | | | | Cement grout, 0 to 552.5 feet |
| -40 | | | | | |
| -50 | | | | | Black steel risers = 21.21 feet each |
| -60 | | | | | |
| -70 | | | | | Centralizers installed every 50 feet. |
| -80 | | | | | |
| -90 | | | | | |
| -100 | | | | | |
| -110 | | | | | |
| -120 | | | | | |
| -130 | | | | | |

GEOT_WELL 4999-05.GPJ 8/20/20

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**BUNNELL-LAMMONS ENGINEERING, INC.**

GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

# GROUNDWATER MONITORING WELL NO. GWM-4

PROJECT: Perry County Landfill — PROJECT NO.: J07-4999-05

CLIENT: HHNT — START: 5-7-07 END: 5-9-07

LOCATION: Uniontown, Alabama — ELEVATION: 269.0

DRILLER: Allen & Willis Drilling Company, T. Willis — LOGGED BY: M. Preddy

DRILLING METHOD: Failing 1250 Holemaster wash drill

DEPTH TO - WATER> INITIAL: ▽ _____ AFTER 13 HOURS: ▼ 123.0 CAVING> _____

| ELEVATION/ DEPTH (FT) | DESCRIPTION | SOIL TYPE | SAMPLES | STANDARD PENETRATION RESULTS BLOWS/FOOT (2 5 10 20 30 40 50 70 90) | MONITOR WELL INSTALLATION DETAILS |
|---|---|---|---|---|---|
| -140 to -290 | Gray LIMEROCK (Selma Group Chalk) | | | | Cement grout, 0 to 552.5 feet<br>Durham Geo bladder pump installed with intake set at 571 feet<br>Black steel risers = 21.21 feet each<br>Centralizers installed every 50 feet.<br>Bentonite seal, 552.5 to 564.0 feet |
| -290 to -310 | Gray and black, silty, fine SAND with glauconite (Eutaw Sand Formation). Rock layer from 567 to 568 feet | | | | Filter pack, sand 564.0 to 585.0 feet<br>4-inch diameter, 0.010-inch slotted stainless steel well screen, 569.0 to 579.0 feet |
| -310 to -330 | Boring terminated at 585 feet. Groundwater was encountered at 123.0 feet on May 21, 2007. 8-inch wash-drilled borehole. | | | | Total well depth, 579.5 feet<br>Sump = 0.5 foot stainless steel<br>8-inch diameter borehole |

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**BUNNELL-LAMMONS ENGINEERING, INC.**

GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

# GROUNDWATER MONITORING WELL NO. GWM-5

PROJECT: Perry County Landfill — PROJECT NO.: J07-4999-05

CLIENT: HHNT — START: 5-22-07 END: 5-23-07

LOCATION: Uniontown, Alabama — ELEVATION: 212.7

DRILLER: Allen & Willis Drilling Company, T. Willis — LOGGED BY: M. Preddy

DRILLING METHOD: Failing 1250 Holemaster wash drill

DEPTH TO - WATER> INITIAL: ▽ _____ AFTER 6 HOURS: ▼ 89.5 CAVING> ▨ _____

| ELEVATION/ DEPTH (FT) | DESCRIPTION | SOIL TYPE | SAMPLES | STANDARD PENETRATION RESULTS BLOWS/FOOT (2 5 10 20 30 40 50 70 90) | MONITOR WELL INSTALLATION DETAILS |
|---|---|---|---|---|---|
| 210 | Brown, fine sandy, silty CLAY - (fill) | | | | **SURFACE COMPLETION** 6' X 6' concrete pad with a survey pin and a standup steel cover. A vent hole was put in the top of the well casing. A weep hole was put at the base of the steel cover. Pea gravel was placed between the well casing and steel cover. |
| 200 | Brown, fine sandy, silty CLAY | | | | |
| 190 | Gray LIMEROCK (Selma Group Chalk) | | | | |
| 180 | | | | | |
| 170 | | | | | Ground elev. = 212.7 feet MSL |
| 160 | | | | | |
| 150 | | | | | Top of well casing elev. = 215.76 feet MSL |
| 140 | | | | | |
| 130 | | | | | |
| 120 | ▼ | | | | |
| 110 | | | | | Cement grout, 0 to 456.0 feet |
| 100 | | | | | |
| 90 | | | | | Black steel risers = 21.21 feet each |
| 80 | | | | | |
| 70 | | | | | Centralizers installed every 50 feet |
| 60 | | | | | |
| 50 | | | | | |
| 40 | | | | | |
| 30 | | | | | |
| 20 | | | | | |

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GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

# GROUNDWATER MONITORING WELL NO. GWM-5

PROJECT: Perry County Landfill — PROJECT NO.: J07-4999-05

CLIENT: HHNT — START: 5-22-07 END: 5-23-07

LOCATION: Uniontown, Alabama — ELEVATION: 212.7

DRILLER: Allen & Willis Drilling Company, T. Willis — LOGGED BY: M. Preddy

DRILLING METHOD: Failing 1250 Holemaster wash drill

DEPTH TO - WATER> INITIAL: ▽ _____ AFTER 6 HOURS: ▼ 89.5 CAVING> _____

| ELEVATION/ DEPTH (FT) | DESCRIPTION | SOIL TYPE | SAMPLES | STANDARD PENETRATION RESULTS BLOWS/FOOT (2 5 10 20 30 40 50 70 90) | MONITOR WELL INSTALLATION DETAILS |
|---|---|---|---|---|---|
| 10 to -180 | Gray LIMEROCK (Selma Group Chalk) | | | | Cement grout, 0 to 456.0 feet<br>Black steel risers = 21.21 feet each<br>Centralizers installed every 50 feet |

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**BUNNELL-LAMMONS ENGINEERING, INC.**

GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

# GROUNDWATER MONITORING WELL NO. GWM-5

PROJECT: Perry County Landfill — PROJECT NO.: J07-4999-05

CLIENT: HHNT — START: 5-22-07 END: 5-23-07

LOCATION: Uniontown, Alabama — ELEVATION: 212.7

DRILLER: Allen & Willis Drilling Company, T. Willis — LOGGED BY: M. Preddy

DRILLING METHOD: Failing 1250 Holemaster wash drill

DEPTH TO - WATER> INITIAL: ▽ _____ AFTER 6 HOURS: ▼ 89.5 CAVING> _____

| ELEVATION/ DEPTH (FT) | DESCRIPTION | SOIL TYPE | SAMPLES | STANDARD PENETRATION RESULTS BLOWS/FOOT (2 5 10 20 30 40 50 70 90) | MONITOR WELL INSTALLATION DETAILS |
|---|---|---|---|---|---|
| -190 to -270 | Gray LIMEROCK (Selma Group Chalk) | | | | Cement grout, 0 to 456.0 feet<br>Black steel risers = 21.21 feet each<br>Centralizers installed every 50 feet<br>Bentonite seal, 456.0 to 466.0 feet<br>Filter pack, sand 466.0 to 485.0 feet<br>4-inch diameter, 0.010-inch slotted stainless steel well screen, 471.0 to 481.0 feet |
| -260 to -270 | Gray and black, fine to medium SAND with glauconite (Eutaw Formation) | | | | |
| -280 | Boring terminated at 485 feet. Groundwater encountered at 89.5 feet on May 29, 2007. 8-inch wash-drilled borehole. | | | | Total well depth, 481.5 feet<br>Sump - 0.5 foot stainless steel<br>8-inch diameter borehole<br>Durham Geo bladder pump installed with intake set at 475 feet |
| -290 to -380 | | | | | |

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GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

# GROUNDWATER MONITORING WELL NO. GWM-6

PROJECT: Arrowhead Landfill — PROJECT NO.: J12-4999-30
CLIENT: HHNT — START: 9-16-12 END: 9-24-12
LOCATION: Perry County, Alabama — ELEVATION: 259.1
DRILLER: Allen & Willis Drilling Company, T. Willis — LOGGED BY: P. VanHeest
DRILLING METHOD: MJ Rotary Drill; 8.0-inch wash drilling
DEPTH TO - WATER> INITIAL: ▽ _____ AFTER 24 HOURS: ▼ 140.1 CAVING> _____

| ELEVATION/ DEPTH (FT) | DESCRIPTION | SOIL TYPE | SAMPLES | STANDARD PENETRATION RESULTS BLOWS/FOOT (2 5 10 20 30 40 50 70 90) | MONITOR WELL INSTALLATION DETAILS |
|---|---|---|---|---|---|
| 250 | Brown, fine sandy, silty CLAY - (fill) | | | | **SURFACE COMPLETION** 6' X 6' concrete pad with a survey pin and a standup steel cover. A vent hole was put in the top of the well casing. A weep hole was put at the base of the steel cover. Pea gravel was placed between the well casing and steel cover. |
| 240 | | | | | |
| 230 | | | | | Top of PVC casing elev. = 262.26 feet |
| 220 | | | | | Ground surface elev. = 259.1 feet |
| 210 | | | | | Survey pin elev. = 259.51 feet |
| 200 | | | | | Northing = 878,866.18' |
| 190 | | | | | Easting = 1,979,676.92' |
| 180 | | | | | |
| 170 | | | | | Neat cement, 0 to 522.0 feet |
| 160 | Gray LIMEROCK (Selma Group chalk) | | | | 4-inch diameter Schedule 80 PVC casing |
| 150 | | | | | |
| 140 | | | | | |
| 130 | | | | | 8.0-inch diameter borehole |
| 120 ▼ | | | | | |
| 110 | | | | | |
| 100 | | | | | Centralizers installed every 50 feet |
| 90 | | | | | |
| 80 | | | | | |
| 70 | | | | | |

GEOT_WELL 4999-30.GPJ 8/20/20

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**BUNNELL-LAMMONS ENGINEERING, INC.**
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

# GROUNDWATER MONITORING WELL NO. GWM-6

PROJECT: Arrowhead Landfill — PROJECT NO.: J12-4999-30
CLIENT: HHNT — START: 9-16-12 END: 9-24-12
LOCATION: Perry County, Alabama — ELEVATION: 259.1
DRILLER: Allen & Willis Drilling Company, T. Willis — LOGGED BY: P. VanHeest
DRILLING METHOD: MJ Rotary Drill; 8.0-inch wash drilling
DEPTH TO - WATER> INITIAL: ▽ _____ AFTER 24 HOURS: ▼ 140.1 CAVING> _____

| ELEVATION/ DEPTH (FT) | DESCRIPTION | SOIL TYPE | SAMPLES | STANDARD PENETRATION RESULTS BLOWS/FOOT (2 5 10 20 30 40 50 70 90) | MONITOR WELL INSTALLATION DETAILS |
|---|---|---|---|---|---|
| 50 | | | | | |
| 40 | | | | | |
| 30 | | | | | |
| 20 | | | | | |
| 10 | | | | | Neat cement, 0 to 522.0 feet |
| 0 | | | | | |
| -10 | | | | | |
| -20 | | | | | |
| -30 | | | | | |
| -40 | Gray LIMEROCK (Selma Group chalk) | | | | 8.0-inch diameter borehole |
| -50 | | | | | |
| -60 | | | | | |
| -70 | | | | | |
| -80 | | | | | |
| -90 | | | | | Centralizers installed every 50 feet |
| -100 | | | | | |
| -110 | | | | | |
| -120 | | | | | |
| -130 | | | | | |

GEOT_WELL 4999-30.GPJ 8/20/20

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GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

# GROUNDWATER MONITORING WELL NO. GWM-6

PROJECT: Arrowhead Landfill — PROJECT NO.: J12-4999-30
CLIENT: HHNT — START: 9-16-12 END: 9-24-12
LOCATION: Perry County, Alabama — ELEVATION: 259.1
DRILLER: Allen & Willis Drilling Company, T. Willis — LOGGED BY: P. VanHeest
DRILLING METHOD: MJ Rotary Drill; 8.0-inch wash drilling
DEPTH TO - WATER> INITIAL: ▽ _____ AFTER 24 HOURS: ▼ 140.1 CAVING> _____

| ELEVATION/ DEPTH (FT) | DESCRIPTION | SOIL TYPE | SAMPLES | STANDARD PENETRATION RESULTS BLOWS/FOOT (2 5 10 20 30 40 50 70 90) | MONITOR WELL INSTALLATION DETAILS |
|---|---|---|---|---|---|
| -150 | | | | | |
| -160 | | | | | |
| -170 | | | | | 8.0-inch diameter borehole |
| -180 | | | | | |
| -190 | | | | | |
| -200 | | | | | |
| -210 | | | | | Centralizers installed every 50 feet |
| -220 | Gray LIMEROCK (Selma Group chalk) | | | | |
| -230 | | | | | |
| -240 | | | | | Neat cement, 0 to 522.0 feet |
| -250 | | | | | |
| -260 | | | | | Bentonite seal, 522.0 to 532.0 feet |
| -270 | | | | | Filter pack, sand 532.0 to 555.0 feet |
| -280 | Gray and black, silty, fine SAND with glauconite (Eutaw Sand Formation) | | | | |
| -290 | | | | | 4-inch diameter, 0.010-inch slotted Schedule 80 PVC well screen, 544.5 to 554.5 feet 0.5-foot sump/pipe cap |
| -300 | Boring terminated at 555.0 feet. Groundwater was encountered at 140.1 feet after 24 hours. | | | | |
| -310 | | | | | Total well depth, 555.0 feet |
| -320 | | | | | |
| -330 | | | | | |

GEOT_WELL 4999-30.GPJ 8/20/20

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GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

# GROUNDWATER MONITORING WELL NO. GWM-12

PROJECT: Arrowhead Landfill | PROJECT NO.: J12-4999-30
CLIENT: HHNT | START: 10-3-12 END: 10-3-12
LOCATION: Perry County, Alabama | ELEVATION: 272.9
DRILLER: Landprobe, R. Banks | LOGGED BY: P. VanHeest
DRILLING METHOD: CME 750 ATV; 6-inch air hammer
DEPTH TO - WATER> INITIAL: ▽ dry AFTER 24 HOURS: ▼ dry CAVING> ▨

| ELEVATION/ DEPTH (FT) | DESCRIPTION | SOIL TYPE | SAMPLES | STANDARD PENETRATION RESULTS BLOWS/FOOT (2 5 10 20 30 40 50 70 90) | MONITOR WELL INSTALLATION DETAILS |
|---|---|---|---|---|---|
| 270 / 0 | Brown, fine sandy, silty CLAY - (fill) | | | | SURFACE COMPLETION<br>6' X 6' concrete pad with a survey pin and a standup steel cover. A vent hole was put in the top of the well casing. A weep hole was put at the base of the steel cover. Pea gravel was placed between the well casing and steel cover.<br>Top of PVC casing = 276.06 feet |
| 265 / 5 | Gray, slightly moist, silty CLAY (CL) | | | | Ground surface elev. = 272.9 feet<br>Survey pin elev. = 273.29 feet<br>Northing = 878,746.96'<br>Easting = 1,978,684.14' |
| 260 / 10 | | | | | Grout, 0 to 11.8 feet<br>Bentonite seal, 11.8 to 15.4 feet |
| 255 / 15 | Gray, moist, silty CLAY (CL) | | | | Filter pack, sand 15.4 to 30.0 feet |
| 250 / 20 | | | | | |
| 245 / 25 | | | | | 4-inch diameter, 0.010-inch slotted Schedule 80 PVC well screen, 18.0 to 28.0 feet<br>0.5-foot sump/pipe cap |
| 240 / 30 | Boring terminated at 30.0 feet. No groundwater encountered at time of drilling or after 24 hours. | | | | Total well depth, 28.5 feet<br>6.0-inch diameter borehole |
| 235 / 35 | | | | | |

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GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

# GROUNDWATER MONITORING WELL NO. GWM-13

PROJECT: Arrowhead Landfill | PROJECT NO.: J24-4999-64

CLIENT: HHNT | START: 10-4-12 END: 10-4-12

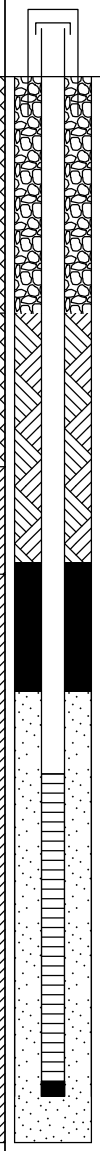
LOCATION: Perry County, Alabama | ELEVATION: 266.77

DRILLER: Landprobe, R. Banks | LOGGED BY: P. VanHeest

DRILLING METHOD: CME 750 ATV; 6-inch air hammer

DEPTH TO - WATER> INITIAL: ▽ dry AFTER 24 HOURS: ▼ dry CAVING> ▨

| ELEVATION/ DEPTH (FT) | DESCRIPTION | SOIL TYPE |
|---|---|---|
| 265 / 0 | Gray, clayey fine to medium SAND - (fill) | |
| 260 / 5 | | |
| 260 / 5 | Brown, fine sandy, silty CLAY - (fill) | |
| 255 / 10 | | |
| 255 / 10 | Grayish-brown, slightly moist, silty CLAY (CL) | |
| 250 / 15 | | |
| 250 / 15 | Gray, slightly moist, silty CLAY (CL) | |
| 245 / 20 | | |
| 240 / 25 | | |
| 235 / 30 | | |
| 230 / 35 | Boring terminated at 34.7 feet below ground surface. No groundwater encountered at time of drilling or after 24 hours. | |
| 225 / 40 | GWM-13 was originally installed as part of the Tract 1 expansion (BLE Project No. J12-4999-30). | |
| 220 / 45 | GWM-13 was vertically extended during Cell 8 construction. 7.67 feet of structural fill was placed. The PVC casing was extended 7.70 feet. | |
| | Values on this log reflect the depths and elevations after the vertical extension of GWM-13 completed in July 2024. | |



MONITOR WELL INSTALLATION DETAILS

- Gravel backfill, 0 to 7.7 feet
- Grout, 7.7 to 15.8 feet
- 6-inch diameter borehole
- Bentonite seal, 15.8 to 20.0 feet
- Filter pack, sand 20.0 to 34.7 feet
- 4-inch diameter, 0.010-inch slotted Schedule 80 PVC well screen, 22.7 to 32.7 feet
- 0.5-foot sump/pipe cap
- Total well depth, 33.2 feet

SURFACE COMPLETION

6' X 6' concrete pad with a survey pin and a standup steel cover. A vent hole was put in the top of the well casing. A weep hole was put at the base of the steel cover. Pea gravel was placed between the well casing and steel cover.

Top of PVC casing elev. = 269.88 feet

Ground surface elev. = 266.77 feet

Concrete pad elev. = 267.14 feet

Northing = 879,504.99'

Easting = 1,978,499.18'

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GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

# GROUNDWATER MONITORING WELL NO. GWM-14

PROJECT: Arrowhead Landfill | PROJECT NO.: J12-4999-30
CLIENT: HHNT | START: 10-4-12 END: 10-4-12
LOCATION: Perry County, Alabama | ELEVATION: 235.1
DRILLER: Landprobe, R. Banks | LOGGED BY: P. VanHeest
DRILLING METHOD: CME 750 ATV; 6-inch air hammer
DEPTH TO - WATER> INITIAL: ▽ dry AFTER 24 HOURS: ▼ dry CAVING> ▨

| ELEVATION/ DEPTH (FT) | DESCRIPTION | SOIL TYPE | SAMPLES | STANDARD PENETRATION RESULTS BLOWS/FOOT (2 5 10 20 30 40 50 70 90) |
|---|---|---|---|---|
| 230 — 5 | Brown, fine sandy, silty CLAY - (fill) | | | |
| | Grayish-brown, slightly moist, silty CLAY (CL) | | | |
| 225 — 10 | | | | |
| | Gray, slightly moist, silty CLAY (CL) | | | |
| 220 — 15 | | | | |
| 215 — 20 | | | | |
| 210 — 25 | | | | |
| | Boring terminated at 27.0 feet. No groundwater encountered at time of drilling or after 24 hours. | | | |
| 205 — 30 | | | | |
| 200 — 35 | | | | |

**MONITOR WELL INSTALLATION DETAILS**

Grout, 0 to 8.3 feet

Bentonite seal, 8.3 to 12.4 feet

Filter pack, sand 12.4 to 27.0 feet

6-inch diameter borehole

4-inch diameter, 0.010-inch slotted Schedule 80 PVC well screen, 15.0 to 25.0 feet

0.5-foot sump/pipe cap

Total well depth, 25.5 feet

SURFACE COMPLETION
6' X 6' concrete pad with a survey pin and a standup steel cover. A vent hole was put in the top of the well casing. A weep hole was put at the base of the steel cover. Pea gravel was placed between the well casing and steel cover.

Top of PVC casing elev. = 237.99 feet

Ground surface elev. = 235.1 feet

Survey pin elev. = 235.37 feet

Northing = 880,438.28'

Easting = 1,978,283.93'

GEOT_WELL 4999-30.GPJ 8/19/20

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# GROUNDWATER MONITORING WELL NO. GWM-15

PROJECT: Perry County Landfill | PROJECT NO.: J07-4999-05
CLIENT: HHNT | START: 5-9-07 END: 5-9-07
LOCATION: Uniontown, Alabama | ELEVATION: 271.2
DRILLER: Bunnell-Lammons Engineering, Inc., J. Gorman | LOGGED BY: M. Preddy
DRILLING METHOD: Mobile B-59 Truck, hollow stem auger
DEPTH TO - WATER> INITIAL: Dry AFTER 24 HOURS: Dry CAVING>

| ELEVATION/ DEPTH (FT) | DESCRIPTION | SOIL TYPE | SAMPLES | STANDARD PENETRATION RESULTS BLOWS/FOOT (2 5 10 20 30 40 50 70 90) |
|---|---|---|---|---|
| 270 / 0 | Stiff, brownish-gray, dry, silty, fine sandy CLAY - (fill) | | 2 7 4 | 13 |
| 265 / 5 | Hard, brown, dry, silty CLAY | | 2 13 32 | 45 |
| 260 / 10 | Hard, gray and brown, moist, silty CLAY | | 9 20 20 | 40 |
| 255 / 15 | Hard, gray, moist, silty CLAY | | 8 19 25 | 44 |
| 250 / 20 | | | 9 18 23 | 41 |
| 245 / 25 | Boring terminated at 26.5 feet. No groundwater encountered at time of drilling. | | | |
| 240 / 30 | | | | |
| 235 / 35 | | | | |

**MONITOR WELL INSTALLATION DETAILS**

- Cement grout, 0 to 7.45 feet
- Riser = 10' + 5.25' black steel
- Bentonite seal, 7.45 to 10 feet
- Filter pack, sand 10 to 26.5 feet
- Centralizer at bottom of 10 foot riser, just above screen
- 4-inch diameter, 0.010-inch slotted stainless steel well screen, 12.25 to 22.25 feet
- Durham Geo bladder pump installed with the intake set at 20 feet
- Sump - 0.5 foot stainless steel
- Total well depth, 22.70 feet
- 8.25-inch diameter borehole

**SURFACE COMPLETION**
6' X 6' concrete pad with a survey pin and a standup steel cover. A vent hole was put in the top of the well casing. A weep hole was put at the base of the steel cover. Pea gravel was placed between the well casing and steel cover.

Ground elev. = 271.2 feet MSL

Top of well casing elev. = 274.62 feet MSL



GEOT_WELL 4999-05.GPJ 8/19/20

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GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

# GROUNDWATER MONITORING WELL NO. GWM-16

PROJECT: Perry County Landfill — PROJECT NO.: J07-4999-05
CLIENT: HHNT — START: 5-9-07 END: 5-9-07
LOCATION: Uniontown, Alabama — ELEVATION: 269.5
DRILLER: Bunnell-Lammons Engineering, Inc., J. Gorman — LOGGED BY: M. Preddy
DRILLING METHOD: Mobile B-59 Truck, hollow stem auger
DEPTH TO - WATER> INITIAL: Dry AFTER 24 HOURS: Dry CAVING>

| ELEVATION/ DEPTH (FT) | DESCRIPTION | SOIL TYPE | SAMPLES | STANDARD PENETRATION RESULTS BLOWS/FOOT (2 5 10 20 30 40 50 70 90) |
|---|---|---|---|---|
| 265 / 5 | Very stiff, brownish-gray, dry, slightly fine sandy, silty CLAY - (fill) | | 5 8 8 | |
| 260 / 10 | Very stiff, brown and gray, slightly moist to moist, silty CLAY | | 5 8 10 | |
| 255 / 15 | | | 3 7 12 | |
| 250 / 20 | Hard to very hard, gray, slightly moist, silty CLAY | | 7 19 22 | |
| 245 / 25 | | | 8 23 28 | |
| 240 / 30 | Boring terminated at 26.5 feet. No groundwater encountered at time of drilling. | | | |
| 235 / 35 | | | | |
| 230 | | | | |

**MONITOR WELL INSTALLATION DETAILS**

Cement grout, 0 to 6.6 feet

Riser = 10' + 5.25' black steel

Bentonite seal, 6.6 to 10 feet

Filter pack, sand 10 to 26.5 feet

Centralizer at bottom of 10 foot riser, just above screen

4-inch diameter, 0.010-inch slotted stainless steel well screen, 12.75 to 22.75 feet

Durham Geo bladder pump installed with the intake set at 20 feet

Sump - 0.5 foot stainless steel

Total well depth, 23.2 feet

8.25-inch diameter borehole

**SURFACE COMPLETION**
6' X 6' concrete pad with a survey pin and a standup steel cover. A vent hole was put in the top of the well casing. A weep hole was put at the base of the steel cover. Pea gravel was placed between the well casing and steel cover.

Ground elev. = 269.5 feet MSL

Top of well casing elev. = 272.51 feet MSL



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**BUNNELL-LAMMONS ENGINEERING, INC.**
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

# GROUNDWATER MONITORING WELL NO. GWM-17

PROJECT: Perry County Landfill | PROJECT NO.: J07-4999-05
CLIENT: HHNT | START: 5-10-07 END: 5-10-07
LOCATION: Uniontown, Alabama | ELEVATION: 269.4
DRILLER: Bunnell-Lammons Engineering, Inc., J. Gorman | LOGGED BY: M. Preddy
DRILLING METHOD: Mobile B-59 Truck, hollow stem auger
DEPTH TO - WATER> INITIAL: Dry AFTER 24 HOURS: Dry CAVING>

| ELEVATION/ DEPTH (FT) | DESCRIPTION | SOIL TYPE | SAMPLES | STANDARD PENETRATION RESULTS BLOWS/FOOT |
|---|---|---|---|---|
| 265 / 5 | Firm, brownish-gray, dry, silty, fine sandy CLAY - (fill) | | 2, 2, 3 | |
| 260 / 10 | Very stiff, red, brown and gray, slightly moist, silty CLAY | | 3, 6, 10 | |
| 255 / 15 | Stiff, brown and gray, slightly moist, silty CLAY | | 3, 6, 9 | |
| 250 / 20 | Hard, gray, slightly moist, silty CLAY | | 8, 16, 21 | |
| 245 / 25 | | | 8, 20, 27 | |
| 240 / 30 | Boring terminated at 26.5 feet. No groundwater encountered at time of drilling. | | | |
| 235 / 35 | | | | |
| 230 | | | | |

STANDARD PENETRATION RESULTS BLOWS/FOOT: 2 5 10 20 30 40 50 70 90

MONITOR WELL INSTALLATION DETAILS

- Cement grout, 0 to 6.8 feet
- Riser = 10' + 5.25' black steel
- Bentonite seal, 6.8 to 10.2 feet
- Filter pack, sand 10.2 to 26.5 feet
- Centralizer at bottom of 10 foot riser, just above screen
- 4-inch diameter, 0.010-inch slotted stainless steel well screen, 12.25 to 22.25 feet
- Durham Geo bladder pump installed with the intake set at 20 feet
- Sump - 0.5 foot stainless steel
- Total well depth, 22.70 feet
- 8.25-inch diameter borehole

**SURFACE COMPLETION**
6' X 6' concrete pad with a survey pin and a standup steel cover. A vent hole was put in the top of the well casing. A weep hole was put at the base of the steel cover. Pea gravel was placed between the well casing and steel cover.

- Ground elev. = 269.4 feet MSL
- Top of well casing elev. = 273.20 feet MSL



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GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

# GROUNDWATER MONITORING WELL NO. GWM-18

PROJECT: Arrowhead Landfill — PROJECT NO.: J12-4999-30

CLIENT: HHNT — START: 10-3-12 END: 10-3-12

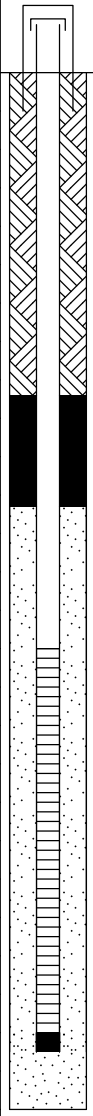
LOCATION: Perry County, Alabama — ELEVATION: 282.6

DRILLER: Landprobe, R. Banks — LOGGED BY: P.VanHeest

DRILLING METHOD: CME 750 ATV; 6-inch air hammer

DEPTH TO - WATER> INITIAL: ▽ dry AFTER 24 HOURS: ▼ dry CAVING> ▨

| ELEVATION/ DEPTH (FT) | DESCRIPTION | SOIL TYPE | SAMPLES | STANDARD PENETRATION RESULTS BLOWS/FOOT (2 5 10 20 30 40 50 70 90) |
|---|---|---|---|---|
| 280 / 0 | Brown, fine sandy, silty CLAY - (fill) | | | |
| 5 | Light brown, slightly moist, silty CLAY (CL) | | | |
| 275 / 10 | | | | |
| 270 | Gray, slightly moist, silty CLAY (CL) | | | |
| 15 | | | | |
| 265 | | | | |
| 20 | | | | |
| 260 | | | | |
| 25 | | | | |
| 255 | Boring terminated at 27.0 feet. No groundwater encountered at time of drilling or after 24 hours. | | | |
| 30 | | | | |
| 250 | | | | |
| 35 | | | | |
| 245 | | | | |



MONITOR WELL INSTALLATION DETAILS

Grout, 0 to 8.4 feet

Bentonite seal, 8.4 to 11.3 feet

Filter pack, sand 11.3 to 27.0 feet

6-inch diameter borehole

4-inch diameter, 0.010-inch slotted Schedule 80 PVC well screen, 15.0 to 25.0 feet

0.5-foot sump/pipe cap

Total well depth, 25.5 feet

SURFACE COMPLETION

6' X 6' concrete pad with a survey pin and a standup steel cover. A vent hole was put in the top of the well casing. A weep hole was put at the base of the steel cover. Pea gravel was placed between the well casing and steel cover.

Top of PVC casing elev. = 285.6 feet

Ground surface elev. = 282.6 feet

Survey pin elev. = 282.92 feet

Northing = 877,891.57'

Easting = 1,979,006.68'

# APPENDIX D

# METHANE MONITORING WELL BORING LOGS

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**BUNNELL-LAMMONS ENGINEERING, INC.**

GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

# METHANE MONITORING WELL NO. MM-59

PROJECT: Arrowhead Landfill — PROJECT NO.: J12-4999-33

CLIENT: HHNT — START: 10-2-12 END: 10-12-12

LOCATION: Perry County, Alabama — ELEVATION: 256.4

DRILLER: Landprobe, R. Banks — LOGGED BY: P. VanHeest

DRILLING METHOD: CME 750 ATV; 6-inch air hammer

DEPTH TO - WATER> INITIAL: ▽ dry AFTER 24 HOURS: ▼ _____ CAVING> _____

| ELEVATION/ DEPTH (FT) | DESCRIPTION | SOIL TYPE | MONITOR WELL INSTALLATION DETAILS |
|---|---|---|---|
| 255 / 0 | Gray, slightly moist, silty CLAY (CL) | | Grout, 0 to 1.5 feet |
| | | | Bentonite seal, 1.5 to 2.2 feet |
| | | | Filter pack, sand 2.2 to 2.9 feet |
| | | | Gravel, 2.9 to 25.0 feet |
| 250 / 5 | | | |
| | | | Borehole diameter, 6.0-inches |
| 245 / 10 | | | |
| | | | 2-inch diameter, 0.020-inch slotted Schedule 40 PVC well screen, 3.0 to 23.0 feet |
| 240 / 15 | | | |
| 235 / 20 | | | |
| | | | Pipe cap |
| 230 / 25 | Boring terminated at 25.0 feet. No groundwater encountered at time of drilling. | | Total well depth, 23.25 feet |
| | | | SURFACE COMPLETION<br>4' x 4' concrete pad with a survey pin and standup steel cover. A weep hole was put at the base of the steel cover. Pea gravel was placed between the well casing and the steel cover. |
| 225 / 30 | | | Top of PVC casing elev. = 259.61 feet |
| | | | Ground surface elev. = 256.4 feet |
| 220 / 35 | | | Survey pin elev. = 257.14 feet |
| | | | Northing = 878,950.57' |
| | | | Easting = 1,979,657.05' |



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# METHANE MONITORING WELL NO. MM-60

PROJECT: Arrowhead Landfill — PROJECT NO.: J12-4999-33

CLIENT: HHNT — START: 9-25-12 END: 9-25-12

LOCATION: Perry County, Alabama — ELEVATION: 253.6

DRILLER: Landprobe, R. Banks — LOGGED BY: P. VanHeest

DRILLING METHOD: CME 750 ATV; 8.25-inch O.D. hollow stem auger

DEPTH TO - WATER> INITIAL: ▽ dry AFTER 24 HOURS: ▼ CAVING>

| ELEVATION/ DEPTH (FT) | DESCRIPTION | SOIL TYPE | SAMPLES | STANDARD PENETRATION RESULTS BLOWS/FOOT (2 5 10 20 30 40 50 70 90) | MONITOR WELL INSTALLATION DETAILS |
|---|---|---|---|---|---|
| 250 / 0 | Very stiff, gray, slightly moist, silty CLAY (CL) | | | | Grout, 0 to 1.5 feet |
| 5 | | | 6 12 15 | ● | Bentonite seal, 1.5 to 2.0 feet<br>Filter pack, sand 2.0 to 2.7 feet<br>Gravel, 2.7 to 10.0 feet |
| 245 | | | | | 2-inch diameter, 0.020-inch slotted Schedule 40 PVC well screen, 3.0 to 10.0 feet |
| 10 | | | 6 12 18 | ● | Slip-on pipe cap |
| 240 | Auger refusal at 10.0 feet. No groundwater encountered at time of drilling. | | | | Total well depth, 10.0 feet<br>SURFACE COMPLETION<br>4' x 4' concrete pad with a survey pin and standup steel cover. A weep hole was put at the base of the steel cover. Pea gravel was placed between the well casing and the steel cover. |
| 15 | | | | | |
| 235 | | | | | Top of PVC casing elev. = 256.54 feet |
| 20 | | | | | Ground surface elev. = 253.6 feet |
| 230 | | | | | Survey pin elev. = 254.05 feet |
| 25 | | | | | Northing = 878,642.46'<br>Easting = 1,979,645.76' |
| 225 | | | | | Borehole diameter, 8.25-inches |
| 30 | | | | | |
| 220 | | | | | |
| 35 | | | | | |
| 215 | | | | | |

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# METHANE MONITORING WELL NO. MM-61

PROJECT: Arrowhead Landfill — PROJECT NO.: J12-4999-33

CLIENT: HHNT — START: 9-25-12 END: 9-25-12

LOCATION: Perry County, Alabama — ELEVATION: 254.4

DRILLER: Landprobe, R. Banks — LOGGED BY: P. VanHeest

DRILLING METHOD: CME 750 ATV; 8.25-inch O.D. hollow stem auger

DEPTH TO - WATER> INITIAL: ▽ dry AFTER 24 HOURS: ▼ CAVING>

| ELEVATION/ DEPTH (FT) | DESCRIPTION | SOIL TYPE | SAMPLES | STANDARD PENETRATION RESULTS BLOWS/FOOT (2 5 10 20 30 40 50 70 90) | MONITOR WELL INSTALLATION DETAILS |
|---|---|---|---|---|---|
| 250 / 0 | Hard, gray, slightly moist, silty CLAY (CL) | | | 9, 16, 21 | Grout, 0 to 1.5 feet |
| 5 | | | | 13, 15, 23 | Bentonite seal, 1.5 to 2.2 feet<br>Filter pack, sand 2.2 to 2.9 feet<br>Gravel, 2.9 to 25.0 feet |
| 245 / 10 | | | | | Borehole diameter, 8.25-inches |
| 240 / 15 | | | | 15, 15, 21 | 2-inch diameter, 0.020-inch slotted Schedule 40 PVC well screen, 3.0 to 23.0 feet |
| 235 / 20 | Very hard, gray, slightly moist, silty CLAY (CL) | | | 19, 26, 28 | |
| 230 / 25 | Boring terminated at 25.0 feet. No groundwater encountered at time of drilling. | | | | Total well depth 23.25 feet |
| 225 / 30 | | | | | SURFACE COMPLETION<br>4' x 4' concrete pad with a survey pin and standup steel cover. A weep hole was put at the base of the steel cover. Pea gravel was placed between the well casing and the steel cover. |
| 220 / 35 | | | | | Top of PVC casing elev. = 256.97 feet<br>Ground surface elev. = 254.4 feet<br>Survey pin elev. = 254.50 feet<br>Northing = 878,349.23'<br>Easting = 1,979,634.69' |
| 215 | | | | | |

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# METHANE MONITORING WELL NO. MM-62

PROJECT: Arrowhead Landfill — PROJECT NO.: J12-4999-33

CLIENT: HHNT — START: 9-26-12 END: 10-1-12

LOCATION: Perry County, Alabama — ELEVATION: 259.8

DRILLER: Landprobe, R. Banks — LOGGED BY: P. Vanheest

DRILLING METHOD: CME 750 ATV; 6-inch air hammer

DEPTH TO - WATER> INITIAL: ▽ dry AFTER 24 HOURS: ▼ _____ CAVING>▨ _____

| ELEVATION/ DEPTH (FT) | DESCRIPTION | SOIL TYPE | SAMPLES | STANDARD PENETRATION RESULTS BLOWS/FOOT (2 5 10 20 30 40 50 70 90) | MONITOR WELL INSTALLATION DETAILS |
|---|---|---|---|---|---|
| 255 – 5 | Hard, gray, slightly moist, silty CLAY (CL) | | 14, 17, 17 | ● | Grout, 0 to 1.4 feet<br>Bentonite seal, 1.4 to 2.3 feet<br>Filter pack, sand 2.3 to 2.9 feet<br>Gravel, 2.9 to 30.0 feet |
| 250 – 10 | Very hard, slightly moist, gray, silty CLAY (CL) | | 18, 32, 37 | ● | Borehole diameter, 6.0-inches |
| 245 – 15 | | | 26, 27, 36 | ● | 2-inch diameter, 0.020-inch slotted Schedule 40 PVC well screen, 3.0 to 28.0 feet |
| 240 – 20 | | | | | |
| 235 – 25 | | | | | |
| 230 – 30 | Boring terminated at 30.0 feet. No groundwater encountered at time of drilling. | | | | Slip-on pipe cap<br>Total well depth, 28.0 feet<br>SURFACE COMPLETION<br>4' x 4' concrete pad with a survey pin and standup steel cover. A weep hole was put at the base of the steel cover. Pea gravel was placed between the well casing and the steel cover. |
| 225 – 35 | | | | | Top of PVC casing elev. = 263.21 feet<br>Ground surface elev. = 259.8 feet<br>Survey pin elev. = 260.58 feet<br>Northing = 878,050.78'<br>Easting = 1,979,629.52' |
| 220 | | | | | |

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GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

# METHANE MONITORING PROBE NO. MM-64

PROJECT: Perry County Landfill | PROJECT NO.: J07-4999-06

CLIENT: HHNT | START: 6-21-07 END: 6-21-07

LOCATION: Uniontown, Alabama | ELEVATION: 266.5

DRILLER: Landprobe, T. Gradwell | LOGGED BY: T. Gradwell

DRILLING METHOD: 4-1/4 inch hollow stem auger

DEPTH TO - WATER> INITIAL: ▽ _____ AFTER 24 HOURS: ▼ _____ CAVING> _____

| ELEVATION/ DEPTH (FT) | DESCRIPTION | SOIL TYPE | MONITOR WELL INSTALLATION DETAILS |
|---|---|---|---|
| 265 / 2 | 6-inches of TOPSOIL<br>Brown silty SAND with very hard CLAY | | Neat cement, 0 to 1.0 feet<br>Bentonite seal, 0 to 2.5 feet<br>Filter pack, sand 2.5 to 3.0 feet<br>Pea gravel, 3.0 to 13.0 feet |
| 260 / 8 | | | 2-inch diameter, 0.020-inch slotted Schedule 40 PVC well screen, 3.0 to 13.0 feet |
| 255 / 12 | | | Pipe cap |
| 14 | Boring terminated at 14.0 feet. No groundwater encountered at time of drilling. | | Total well depth, 13.25 feet<br>Borehole depth, 14.0 feet |
| 250 / 16 | | | SURFACE COMPLETION<br>4" round stand-up locking aluminum protective cover with a 3' x 3' concrete pad at the base with survey pin |
| 245 / 20 | | | 1/4-inch weep hole installed in aluminum cover |
| 22 | | | PVC stick-up = 3.59-feet |
| 24 | | | Top of PVC casing elev. = 270.09 feet |
| 240 / 26 | | | Survey pin elev. = 266.91 feet |
| 28 | | | Ground surface elev. = 266.5 feet |
| 30 | | | Northing = 877,453.19'<br>Easting = 1,979,617.89' |
| 235 / 32 | | | |
| 34 | | | |
| 230 / 36 | | | |
| 38 | | | |

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GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

# METHANE MONITORING PROBE NO. MM-65

PROJECT: Perry County Landfill — PROJECT NO.: J07-4999-06

CLIENT: HHNT — START: 6-26-07 END: 6-26-07

LOCATION: Uniontown, Alabama — ELEVATION: 273.4

DRILLER: Landprobe, T. Gradwell — LOGGED BY: T. Gradwell

DRILLING METHOD: 6-inch air rotary

DEPTH TO - WATER> INITIAL: ▽ _____ AFTER 24 HOURS: ▼ _____ CAVING> _____

| ELEVATION/ DEPTH (FT) | DESCRIPTION | SOIL TYPE | MONITOR WELL INSTALLATION DETAILS |
|---|---|---|---|
| 270 / 0 | 6-inches of TOPSOIL | | Neat cement, 0 to 1.0 feet |
| | Tannish-brown, sandy SILT | | Bentonite seal, 1 to 2.5 feet |
| 2 | | | Filter pack, sand 2.5 to 3.0 feet |
| 4 | | | Pea gravel, 3.0 to 25.0 feet |
| 6 | Very hard, gray, stiff CLAY | | |
| 265 / 8 | | | |
| 10 | | | |
| 12 | | | |
| 260 / 14 | | | 2-inch diameter, 0.020-inch slotted Schedule 40 PVC well screen, 3.0 to 23.0 feet |
| 16 | | | |
| 255 / 18 | | | |
| 20 | | | |
| 22 | | | |
| 250 / 24 | | | Pipe cap |
| | | | Total well depth, 23.25 feet |
| | | | Borehole depth, 25.0 feet |
| 26 | Boring terminated at 25.0 feet. No groundwater encountered at time of drilling. | | SURFACE COMPLETION: 4" round stand-up locking aluminum protective cover with a 3' x 3' concrete pad at the base with survey pin |
| 245 / 28 | | | |
| 30 | | | 1/4-inch weep hole installed in aluminum cover |
| 32 | | | PVC stick-up = 3.59-feet |
| 240 / 34 | | | Top of PVC casing elev. = 276.99 feet |
| 36 | | | Survey pin elev. = 273.78 feet |
| | | | Ground surface elev. = 273.4 feet |
| 235 / 38 | | | Northing = 877,156.58' |
| | | | Easting = 1,979,607.01' |

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GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

# METHANE MONITORING PROBE NO. MM-66

PROJECT: Perry County Landfill — PROJECT NO.: J07-4999-06
CLIENT: HHNT — START: 6-26-07 END: 6-26-07
LOCATION: Uniontown, Alabama — ELEVATION: 280.5
DRILLER: Landprobe, T. Gradwell — LOGGED BY: T. Gradwell
DRILLING METHOD: 6-inch air rotary
DEPTH TO - WATER> INITIAL: ▽ _____ AFTER 24 HOURS: ▼ _____ CAVING> _____

| ELEVATION/ DEPTH (FT) | DESCRIPTION | SOIL TYPE | MONITOR WELL INSTALLATION DETAILS |
|---|---|---|---|
| 280 / 0 | 6-inches of TOPSOIL | | Neat cement, 0 to 1.0 feet |
| | Tannish-brown, silty, sandy CLAY | | Bentonite seal, 1.0 to 2.5 feet |
| 2 | | | Filter pack, sand 2.5 to 3.0 feet |
| 4 | | | Pea gravel, 3.0 to 35.0 feet |
| 275 / 6 | | | |
| | Very hard, gray CLAY | | |
| 8 | | | |
| 270 / 10 | | | |
| 12 | | | |
| 14 | | | |
| 265 / 16 | | | |
| 18 | | | 2-inch diameter, 0.020-inch slotted Schedule 40 PVC well screen, 3.0 to 33.0 feet |
| 260 / 20 | | | |
| 22 | | | |
| 24 | | | |
| 255 / 26 | | | |
| 28 | | | |
| 250 / 30 | | | |
| 32 | | | |
| 34 | | | Pipe cap |
| 245 / 36 | Boring terminated at 35.0 feet. No groundwater encountered at time of drilling. | | Total well depth, 33.25 feet |
| | | | Borehole depth, 35.0 feet |
| 38 | | | SURFACE COMPLETION: 4" round stand-up locking aluminum protective cover with a 3' x 3' concrete pad at the base with survey pin |

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GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

# METHANE MONITORING PROBE NO. MM-66

PROJECT: Perry County Landfill — PROJECT NO.: J07-4999-06

CLIENT: HHNT — START: 6-26-07 END: 6-26-07

LOCATION: Uniontown, Alabama — ELEVATION: 280.5

DRILLER: Landprobe, T. Gradwell — LOGGED BY: T. Gradwell

DRILLING METHOD: 6-inch air rotary

DEPTH TO - WATER> INITIAL: ▽ _____ AFTER 24 HOURS: ▼ _____ CAVING> _____

| ELEVATION/ DEPTH (FT) | DESCRIPTION | SOIL TYPE | MONITOR WELL INSTALLATION DETAILS |
|---|---|---|---|
| 240 | | | 1/4-inch weep hole installed in aluminum cover |
| 42 | | | PVC stick-up = 3.73-feet |
| 44 | | | Top of PVC casing elev. = 284.23 feet |
| 235 | | | Survey pin elev. = 280.88 feet |
| 46 | | | Ground surface elev. = 280.5 feet |
| 48 | | | Northing = 876,841.99' |
| 50 | | | Easting = 1,979,598.88' |
| 230 | | | |
| 52 | | | |
| 54 | | | |
| 225 | | | |
| 56 | | | |
| 58 | | | |
| 60 | | | |
| 220 | | | |
| 62 | | | |
| 64 | | | |
| 215 | | | |
| 66 | | | |
| 68 | | | |
| 70 | | | |
| 210 | | | |
| 72 | | | |
| 74 | | | |
| 205 | | | |
| 76 | | | |
| 78 | | | |

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# METHANE MONITORING PROBE NO. MM-67

PROJECT: Perry County Landfill — PROJECT NO.: J07-4999-06
CLIENT: HHNT — START: 6-26-07 END: 6-27-07
LOCATION: Uniontown, Alabama — ELEVATION: 283.2
DRILLER: Landprobe, T. Gradwell — LOGGED BY: T. Gradwell
DRILLING METHOD: 6-inch air rotary
DEPTH TO - WATER> INITIAL: ▽ _____ AFTER 24 HOURS: ▼ _____ CAVING> _____

| ELEVATION/ DEPTH (FT) | DESCRIPTION | SOIL TYPE | MONITOR WELL INSTALLATION DETAILS |
|---|---|---|---|
| 280 / 0–6 | 6-inches of TOPSOIL<br>Tannish-brown, silty, sandy CLAY | | Neat cement, 0 to 1.0 feet<br>Bentonite seal, 1.0 to 2.5 feet<br>Filter pack, sand 2.5 to 3.0 feet<br>Pea gravel, 3.0 to 40.0 feet |
| 275 / 8 | Very hard, grayish-white CLAY | | |
| 270 / 10–14 | | | |
| 265 / 16–18 | | | 2-inch diameter, 0.020-inch slotted Schedule 40 PVC well screen, 3.0 to 38.0 feet |
| 260 / 20–24 | | | |
| 255 / 26–28 | | | |
| 250 / 30–34 | | | |
| 245 / 36–38 | | | Pipe cap<br>Total well depth, 38.25 feet |



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# METHANE MONITORING PROBE NO. MM-67

PROJECT: Perry County Landfill — PROJECT NO.: J07-4999-06

CLIENT: HHNT — START: 6-26-07 END: 6-27-07

LOCATION: Uniontown, Alabama — ELEVATION: 283.2

DRILLER: Landprobe, T. Gradwell — LOGGED BY: T. Gradwell

DRILLING METHOD: 6-inch air rotary

DEPTH TO - WATER> INITIAL: ▽ _____ AFTER 24 HOURS: ▼ _____ CAVING> _____

| ELEVATION/ DEPTH (FT) | DESCRIPTION | SOIL TYPE | MONITOR WELL INSTALLATION DETAILS |
|---|---|---|---|
| 240 / 42<br>44<br>46<br>235 / 48<br>50<br>52<br>230 / 54<br>56<br>225 / 58<br>60<br>62<br>220 / 64<br>66<br>215 / 68<br>70<br>72<br>210 / 74<br>76<br>205 / 78 | **Boring terminated at 40.0 feet. No groundwater encountered at time of drilling.** | | Borehole depth, 40.0 feet<br>SURFACE COMPLETION<br>4" round stand-up locking aluminum protective cover with a 3' x 3' concrete pad at the base with survey pin<br>1/4-inch weep hole installed in aluminum cover<br>PVC stick-up = 3.51-feet<br>Top of PVC casing elev. = 286.71 feet<br>Survey pin elev. = 283.58 feet<br>Ground surface elev. = 283.2 feet<br>Northing = 876,736.79'<br>Easting = 1,979,586.55' |



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**BUNNELL-LAMMONS ENGINEERING, INC.**
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

# METHANE MONITORING PROBE NO. MM-68

PROJECT: Perry County Landfill — PROJECT NO.: J07-4999-06
CLIENT: HHNT — START: 6-27-07 END: 6-27-07
LOCATION: Uniontown, Alabama — ELEVATION: 285.9
DRILLER: Landprobe, T. Gradwell — LOGGED BY: T. Gradwell
DRILLING METHOD: 6-inch air rotary
DEPTH TO - WATER> INITIAL: ▽ _____ AFTER 24 HOURS: ▼ _____ CAVING> _____

| ELEVATION/ DEPTH (FT) | DESCRIPTION | SOIL TYPE | MONITOR WELL INSTALLATION DETAILS |
|---|---|---|---|
| 285 / 0 | 6-inches of TOPSOIL | | Neat cement, 0 to 1.0 feet |
| | Tannish-brown, silty, sandy CLAY | | Bentonite seal, 1.0 to 2.5 feet |
| 2 | | | Filter pack, sand 2.5 to 3.0 feet |
| 4 | | | Pea gravel, 3.0 to 40.0 feet |
| 280 / 6 | Very hard, gray CLAY | | |
| 8 | | | |
| 10 / 275 | | | |
| 12 | | | |
| 14 | | | |
| 270 / 16 | | | |
| 18 | | | 2-inch diameter, 0.020-inch slotted Schedule 40 PVC well screen, 3.0 to 38.0 feet |
| 20 / 265 | | | |
| 22 | | | |
| 24 | | | |
| 260 / 26 | | | |
| 28 | | | |
| 30 / 255 | | | |
| 32 | | | |
| 34 | | | |
| 250 / 36 | | | |
| 38 | | | Pipe cap |

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GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

# METHANE MONITORING PROBE NO. MM-68

PROJECT: Perry County Landfill — PROJECT NO.: J07-4999-06
CLIENT: HHNT — START: 6-27-07 END: 6-27-07
LOCATION: Uniontown, Alabama — ELEVATION: 285.9
DRILLER: Landprobe, T. Gradwell — LOGGED BY: T. Gradwell
DRILLING METHOD: 6-inch air rotary
DEPTH TO - WATER> INITIAL: ▽ _____ AFTER 24 HOURS: ▼ _____ CAVING> _____

| ELEVATION/ DEPTH (FT) | DESCRIPTION | SOIL TYPE | MONITOR WELL INSTALLATION DETAILS |
|---|---|---|---|
| 245 / 42 | Boring terminated at 40.0 feet. No groundwater encountered at time of drilling. | | Total well depth, 38.25 feet<br>Borehole depth, 40.0 feet<br>SURFACE COMPLETION<br>4" round stand-up locking aluminum protective cover with a 3' x 3' concrete pad at the base with survey pin<br>1/4-inch weep hole installed in aluminum cover<br>PVC stick-up = 3.61-feet<br>Top of PVC casing elev. = 289.51 feet<br>Survey pin elev. = 286.54 feet<br>Ground surface elev. = 285.9 feet<br>Northing = 876,637.69'<br>Easting = 1,979,589.19' |
| 44 | | | |
| 240 / 46 | | | |
| 48 | | | |
| 50 | | | |
| 235 / 52 | | | |
| 54 | | | |
| 230 / 56 | | | |
| 58 | | | |
| 60 | | | |
| 225 / 62 | | | |
| 64 | | | |
| 220 / 66 | | | |
| 68 | | | |
| 70 | | | |
| 215 / 72 | | | |
| 74 | | | |
| 210 / 76 | | | |
| 78 | | | |

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GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

# METHANE MONITORING PROBE NO. MM-69

PROJECT: Perry County Landfill — PROJECT NO.: J07-4999-06

CLIENT: HHNT — START: 6-27-07 END: 6-27-07

LOCATION: Uniontown, Alabama — ELEVATION: 287.9

DRILLER: Landprobe, T. Gradwell — LOGGED BY: T. Gradwell

DRILLING METHOD: 6-inch air rotary

DEPTH TO - WATER> INITIAL: ▽ _____ AFTER 24 HOURS: ▼ _____ CAVING> _____

| ELEVATION/ DEPTH (FT) | DESCRIPTION | SOIL TYPE | MONITOR WELL INSTALLATION DETAILS |
|---|---|---|---|
| 285 / 2 | 6-inches of TOPSOIL | | Neat cement, 0 to 1.0 feet |
| | Tannish-brown, silty, sandy CLAY | | Bentonite seal, 1.0 to 2.5 feet |
| 285 / 4 | | | Filter pack, sand 2.5 to 3.0 feet |
| | | | Pea gravel, 3.0 to 45.0 feet |
| 285 / 6 | | | |
| 280 / 8 | Very hard, gray CLAY | | |
| | | | |
| 280 / 10 | | | |
| 275 / 12 | | | |
| | | | |
| 275 / 14 | | | |
| | | | |
| 270 / 16 | | | |
| | | | |
| 270 / 18 | | | |
| | | | |
| 265 / 20 | | | 2-inch diameter, 0.020-inch slotted Schedule 40 PVC well screen, 3.0 to 43.0 feet |
| | | | |
| 265 / 22 | | | |
| | | | |
| 260 / 24 | | | |
| | | | |
| 260 / 26 | | | |
| | | | |
| 255 / 28 | | | |
| | | | |
| 255 / 30 | | | |
| | | | |
| 250 / 32 | | | |
| | | | |
| 250 / 34 | | | |
| | | | |
| 250 / 36 | | | |
| | | | |
| 250 / 38 | | | |

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**BUNNELL-LAMMONS ENGINEERING, INC.**

GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

# METHANE MONITORING PROBE NO. MM-69

PROJECT: Perry County Landfill — PROJECT NO.: J07-4999-06

CLIENT: HHNT — START: 6-27-07 END: 6-27-07

LOCATION: Uniontown, Alabama — ELEVATION: 287.9

DRILLER: Landprobe, T. Gradwell — LOGGED BY: T. Gradwell

DRILLING METHOD: 6-inch air rotary

DEPTH TO - WATER> INITIAL: ▽ _____ AFTER 24 HOURS: ▼ _____ CAVING> ▨

| ELEVATION/ DEPTH (FT) | DESCRIPTION | SOIL TYPE | MONITOR WELL INSTALLATION DETAILS |
|---|---|---|---|
| 42 / 245 / 44 | Very hard, gray CLAY | | 2-inch diameter, 0.020-inch slotted Schedule 40 PVC well screen, 3.0 to 43.0 feet<br>Pipe cap<br>Total well depth, 43.25 feet |
| 46 / 240 / 48 / 50 / 52 / 235 / 54 / 56 / 230 / 58 / 60 / 62 / 225 / 64 / 66 / 220 / 68 / 70 / 72 / 215 / 74 / 76 / 210 / 78 | Boring terminated at 40.0 feet. No groundwater encountered at time of drilling. | | Borehole depth, 45.0 feet<br><br>SURFACE COMPLETION<br>4" round stand-up locking aluminum protective cover with a 3' x 3' concrete pad at the base with survey pin<br>1/4-inch weep hole installed in aluminum cover<br><br>PVC stick-up = 3.71-feet<br><br>Top of PVC casing elev. = 291.61 feet<br><br>Survey pin elev. = 288.35 feet<br>Ground surface elev. = 287.9 feet<br>Northing = 876,545.34'<br>Easting = 1,979,585.23' |

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GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

# METHANE MONITORING PROBE NO. MM-70

PROJECT: Perry County Landfill — PROJECT NO.: J07-4999-06

CLIENT: HHNT — START: 6-27-07 END: 6-28-07

LOCATION: Uniontown, Alabama — ELEVATION: 287.2

DRILLER: Landprobe, T. Gradwell — LOGGED BY: T. Gradwell

DRILLING METHOD: 6-inch air rotary

DEPTH TO - WATER> INITIAL: ▽ _____ AFTER 24 HOURS: ▼ _____ CAVING> _____

| ELEVATION/ DEPTH (FT) | DESCRIPTION | SOIL TYPE | MONITOR WELL INSTALLATION DETAILS |
|---|---|---|---|
| 285 / 2 | 6-inches of TOPSOIL<br>Tannish-brown, silty, sandy CLAY | | Neat cement, 0 to 1.0 feet<br>Bentonite seal, 1.0 to 2.5 feet<br>Filter pack, sand 2.5 to 3.0 feet<br>Pea gravel, 3.0 to 45.0 feet |
| 280 / 8 | Very hard, dry, gray CLAY | | |
| 275 / 12 | | | |
| 270 / 18 | | | |
| 265 / 22 | | | 2-inch diameter, 0.020-inch slotted Schedule 40 PVC well screen, 3.0 to 43.0 feet |
| 260 / 28 | | | |
| 255 / 32 | | | |
| 250 / 38 | | | |

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**BUNNELL-LAMMONS ENGINEERING, INC.**

GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

# METHANE MONITORING PROBE NO. MM-70

PROJECT: Perry County Landfill — PROJECT NO.: J07-4999-06

CLIENT: HHNT — START: 6-27-07 END: 6-28-07

LOCATION: Uniontown, Alabama — ELEVATION: 287.2

DRILLER: Landprobe, T. Gradwell — LOGGED BY: T. Gradwell

DRILLING METHOD: 6-inch air rotary

DEPTH TO - WATER> INITIAL: ▽ AFTER 24 HOURS: ▼ CAVING>

| ELEVATION/ DEPTH (FT) | DESCRIPTION | SOIL TYPE | MONITOR WELL INSTALLATION DETAILS |
|---|---|---|---|
| 245 — 42 | Very hard, dry, gray CLAY | | 2-inch diameter, 0.020-inch slotted Schedule 40 PVC well screen, 3.0 to 43.0 feet |
| 44 | | | Pipe cap |
| 46 | | | Total well depth, 43.25 feet |
| 240 — 48 | Boring terminated at 45.0 feet. No groundwater encountered at time of drilling. | | Borehole depth, 45.0 feet |
| 50 | | | SURFACE COMPLETION<br>4" round stand-up locking aluminum protective cover with a 3' x 3' concrete pad at the base with survey pin<br>1/4-inch weep hole installed in aluminum cover |
| 235 — 52 | | | PVC stick-up = 3.40-feet |
| 54 | | | Top of PVC casing elev. = 290.60 feet |
| 56 | | | Survey pin elev. = 287.49 feet |
| 230 — 58 | | | Ground surface elev. = 287.2 feet |
| 60 | | | Northing = 876,480.96' |
| 225 — 62 | | | Easting = 1,979,582.39' |
| 64 | | | |
| 66 | | | |
| 220 — 68 | | | |
| 70 | | | |
| 215 — 72 | | | |
| 74 | | | |
| 76 | | | |
| 210 — 78 | | | |

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# METHANE MONITORING PROBE NO. MM-71

PROJECT: Perry County Landfill — PROJECT NO.: J07-4999-06

CLIENT: HHNT — START: 6-28-07 END: 6-28-07

LOCATION: Uniontown, Alabama — ELEVATION: 288.0

DRILLER: Landprobe, T. Gradwell — LOGGED BY: T. Gradwell

DRILLING METHOD: 6-inch air rotary

DEPTH TO - WATER> INITIAL: ▽ _____ AFTER 24 HOURS: ▼ _____ CAVING> _____

| ELEVATION/ DEPTH (FT) | DESCRIPTION | SOIL TYPE | MONITOR WELL INSTALLATION DETAILS |
|---|---|---|---|
| 288 / 0 | 6-inches of TOPSOIL | | Neat cement, 0 to 1.0 feet |
| | Tannish-brown, silty, sandy CLAY | | Bentonite seal, 1.0 to 2.5 feet |
| 285 / 2 | | | Filter pack, sand 2.5 to 3.0 feet |
| 4 | | | Pea gravel, 3.0 to 45.0 feet |
| 6 | | | |
| 280 / 8 | Very hard, dry, gray CLAY | | |
| 10 | | | |
| 275 / 12 | | | |
| 14 | | | |
| 16 | | | |
| 270 / 18 | | | |
| 20 | | | 2-inch diameter, 0.020-inch slotted Schedule 40 PVC well screen, 3.0 to 43.0 feet |
| 22 | | | |
| 265 / 24 | | | |
| 26 | | | |
| 260 / 28 | | | |
| 30 | | | |
| 32 | | | |
| 255 / 34 | | | |
| 36 | | | |
| 250 / 38 | | | |

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GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

# METHANE MONITORING PROBE NO. MM-71

PROJECT: Perry County Landfill — PROJECT NO.: J07-4999-06

CLIENT: HHNT — START: 6-28-07 END: 6-28-07

LOCATION: Uniontown, Alabama — ELEVATION: 288.0

DRILLER: Landprobe, T. Gradwell — LOGGED BY: T. Gradwell

DRILLING METHOD: 6-inch air rotary

DEPTH TO - WATER> INITIAL: ▽ _____ AFTER 24 HOURS: ▼ _____ CAVING> _____

| ELEVATION/ DEPTH (FT) | DESCRIPTION | SOIL TYPE | MONITOR WELL INSTALLATION DETAILS |
|---|---|---|---|
| 245 / 42–44 | Very hard, dry, gray CLAY | | 2-inch diameter, 0.020-inch slotted Schedule 40 PVC well screen, 3.0 to 43.0 feet<br>Pipe cap<br>Total well depth, 43.25 feet |
| 240 / 46–50 | Boring terminated at 45.0 feet. No groundwater encountered at time of drilling. | | Borehole depth, 45.0 feet<br>SURFACE COMPLETION<br>4" round stand-up locking aluminum protective cover with a 3' x 3' concrete pad at the base with survey pin<br>1/4-inch weep hole installed in aluminum cover<br>PVC stick-up = 3.39-feet<br>Top of PVC casing elev. = 291.39 feet<br>Survey pin elev. = 288.45 feet<br>Ground surface elev. = 288.0 feet<br>Northing = 876,475.67'<br>Easting = 1,979,515.29' |
| 235 / 52–54 | | | |
| 230 / 58–60 | | | |
| 225 / 62–64 | | | |
| 220 / 66–68 | | | |
| 215 / 70–74 | | | |
| 210 / 76–78 | | | |

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GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

# METHANE MONITORING PROBE NO. MM-72

PROJECT: Perry County Landfill — PROJECT NO.: J07-4999-06

CLIENT: HHNT — START: 6-28-07 END: 6-28-07

LOCATION: Uniontown, Alabama — ELEVATION: 287.2

DRILLER: Landprobe, T. Gradwell — LOGGED BY: T. Gradwell

DRILLING METHOD: 6-inch air rotary

DEPTH TO - WATER> INITIAL: ▽ _____ AFTER 24 HOURS: ▼ _____ CAVING> _____

| ELEVATION/ DEPTH (FT) | DESCRIPTION | SOIL TYPE | MONITOR WELL INSTALLATION DETAILS |
|---|---|---|---|
| 285 / 2 | 6-inches of TOPSOIL | | Neat cement, 0 to 1.0 feet |
| | Tannish-brown, silty, sandy CLAY | | Bentonite seal, 1.0 to 2.5 feet |
| 285 / 4 | | | Filter pack, sand 2.5 to 3.0 feet |
| | | | Pea gravel, 3.0 to 45.0 feet |
| 285 / 6 | | | |
| 280 / 8 | Very hard, dry, gray CLAY | | |
| 280 / 10 | | | |
| 275 / 12 | | | |
| 275 / 14 | | | |
| 275 / 16 | | | |
| 270 / 18 | | | |
| 270 / 20 | | | 2-inch diameter, 0.020-inch slotted Schedule 40 PVC well screen, 3.0 to 43.0 feet |
| 265 / 22 | | | |
| 265 / 24 | | | |
| 265 / 26 | | | |
| 260 / 28 | | | |
| 260 / 30 | | | |
| 255 / 32 | | | |
| 255 / 34 | | | |
| 255 / 36 | | | |
| 250 / 38 | | | |

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**BUNNELL-LAMMONS ENGINEERING, INC.**

GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

# METHANE MONITORING PROBE NO. MM-72

PROJECT: Perry County Landfill — PROJECT NO.: J07-4999-06

CLIENT: HHNT — START: 6-28-07 END: 6-28-07

LOCATION: Uniontown, Alabama — ELEVATION: 287.2

DRILLER: Landprobe, T. Gradwell — LOGGED BY: T. Gradwell

DRILLING METHOD: 6-inch air rotary

DEPTH TO - WATER> INITIAL: ▽ _____ AFTER 24 HOURS: ▼ _____ CAVING> _____

| ELEVATION/ DEPTH (FT) | DESCRIPTION | SOIL TYPE | MONITOR WELL INSTALLATION DETAILS |
|---|---|---|---|
| 245 — 42 | Very hard, dry, gray CLAY | | 2-inch diameter, 0.020-inch slotted Schedule 40 PVC well screen, 3.0 to 43.0 feet |
| 44 | | | Pipe cap |
| | | | Total well depth, 43.25 feet |
| 46 | Boring terminated at 45.0 feet. No groundwater encountered at time of drilling. | | Borehole depth, 45.0 feet |
| 240 — 48 | | | SURFACE COMPLETION<br>4" round stand-up locking aluminum protective cover with a 3' x 3' concrete pad at the base with survey pin<br>1/4-inch weep hole installed in aluminum cover |
| 50 | | | PVC stick-up = 3.43-feet |
| 235 — 52 | | | Top of PVC casing elev. = 290.63 feet |
| 54 | | | Survey pin elev. = 287.77 feet |
| 56 | | | Ground surface elev. = 287.2 feet |
| 230 — 58 | | | Northing = 876,472.08' |
| 60 | | | Easting = 1,979,435.36' |
| 225 — 62 | | | |
| 64 | | | |
| 66 | | | |
| 220 — 68 | | | |
| 70 | | | |
| 215 — 72 | | | |
| 74 | | | |
| 76 | | | |
| 210 — 78 | | | |

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GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

# METHANE MONITORING PROBE NO. MM-73

PROJECT: Perry County Landfill — PROJECT NO.: J07-4999-06

CLIENT: HHNT — START: 6-28-07 END: 6-28-07

LOCATION: Uniontown, Alabama — ELEVATION: 285.6

DRILLER: Landprobe, T. Gradwell — LOGGED BY: T. Gradwell

DRILLING METHOD: 6-inch air rotary

DEPTH TO - WATER> INITIAL: ▽ _____ AFTER 24 HOURS: ▼ _____ CAVING> _____

| ELEVATION/ DEPTH (FT) | DESCRIPTION | SOIL TYPE | MONITOR WELL INSTALLATION DETAILS |
|---|---|---|---|
| 285 / 0 | 6-inches of TOPSOIL | | Neat cement, 0 to 1.0 feet |
| | Tannish-brown, silty, sandy CLAY | | Bentonite seal, 1.0 to 2.5 feet |
| 2 | | | Filter pack, sand 2.5 to 3.0 feet |
| 4 | | | Pea gravel, 3.0 to 40.0 feet |
| 280 / 6 | | | |
| | Very hard, dry, gray CLAY | | |
| 8 | | | |
| 275 / 10 | | | |
| 12 | | | |
| 14 | | | |
| 270 / 16 | | | |
| 18 | | | |
| 265 / 20 | | | 2-inch diameter, 0.020-inch slotted Schedule 40 PVC well screen, 3.0 to 38.0 feet |
| 22 | | | |
| 24 | | | |
| 260 / 26 | | | |
| 28 | | | |
| 255 / 30 | | | |
| 32 | | | |
| 34 | | | |
| 250 / 36 | | | |
| 38 | | | Pipe cap |



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GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

# METHANE MONITORING PROBE NO. MM-73

PROJECT: Perry County Landfill — PROJECT NO.: J07-4999-06

CLIENT: HHNT — START: 6-28-07 END: 6-28-07

LOCATION: Uniontown, Alabama — ELEVATION: 285.6

DRILLER: Landprobe, T. Gradwell — LOGGED BY: T. Gradwell

DRILLING METHOD: 6-inch air rotary

DEPTH TO - WATER> INITIAL: ▽ _____ AFTER 24 HOURS: ▼ _____ CAVING> _____

| ELEVATION/ DEPTH (FT) | DESCRIPTION | SOIL TYPE | MONITOR WELL INSTALLATION DETAILS |
|---|---|---|---|
| 245 – 42 – 44 – 240 – 46 – 48 – 50 – 235 – 52 – 54 – 230 – 56 – 58 – 60 – 225 – 62 – 64 – 220 – 66 – 68 – 70 – 215 – 72 – 74 – 210 – 76 – 78 | **Boring terminated at 40.0 feet. No groundwater encountered at time of drilling.** | | Total well depth, 38.25 feet<br>Borehole depth, 40.0 feet<br>SURFACE COMPLETION<br>4" round stand-up locking aluminum protective cover with a 3' x 3' concrete pad at the base with survey pin<br>1/4-inch weep hole installed in aluminum cover<br>PVC stick-up = 3.64-feet<br>Top of PVC casing elev. = 289.24 feet<br>Survey pin elev. = 286.07 feet<br>Ground surface elev. = 285.6 feet<br>Northing = 876,465.10'<br>Easting = 1,979,334.39' |

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GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

# METHANE MONITORING PROBE NO. MM-74

PROJECT: Perry County Landfill — PROJECT NO.: J07-4999-06

CLIENT: HHNT — START: 6-29-07 END: 6-29-07

LOCATION: Uniontown, Alabama — ELEVATION: 283.2

DRILLER: Landprobe, T. Gradwell — LOGGED BY: T. Gradwell

DRILLING METHOD: 6-inch air rotary

DEPTH TO - WATER> INITIAL: ▽ _____ AFTER 24 HOURS: ▼ _____ CAVING> _____

| ELEVATION/ DEPTH (FT) | DESCRIPTION | SOIL TYPE | MONITOR WELL INSTALLATION DETAILS |
|---|---|---|---|
| 280 / 0 | 6-inches of TOPSOIL | | Neat cement, 0 to 1.0 feet |
| | Tannish-brown, silty, sandy CLAY | | Bentonite seal, 1.0 to 2.5 feet |
| 2 | | | Filter pack, sand 2.5 to 3.0 feet |
| | | | Pea gravel, 3.0 to 40.0 feet |
| 4 | | | |
| 6 | | | |
| 275 / 8 | Very hard, dry, gray CLAY | | |
| 10 | | | |
| 12 | | | |
| 270 / 14 | | | |
| 16 | | | |
| 265 / 18 | | | |
| 20 | | | 2-inch diameter, 0.020-inch slotted Schedule 40 PVC well screen, 3.0 to 38.0 feet |
| 22 | | | |
| 260 / 24 | | | |
| 26 | | | |
| 255 / 28 | | | |
| 30 | | | |
| 32 | | | |
| 250 / 34 | | | |
| 36 | | | |
| 245 / 38 | | | Pipe cap |

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GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

# METHANE MONITORING PROBE NO. MM-74

PROJECT: Perry County Landfill — PROJECT NO.: J07-4999-06

CLIENT: HHNT — START: 6-29-07 END: 6-29-07

LOCATION: Uniontown, Alabama — ELEVATION: 283.2

DRILLER: Landprobe, T. Gradwell — LOGGED BY: T. Gradwell

DRILLING METHOD: 6-inch air rotary

DEPTH TO - WATER> INITIAL: ▽ _____ AFTER 24 HOURS: ▼ _____ CAVING> _____

| ELEVATION/ DEPTH (FT) | DESCRIPTION | SOIL TYPE | MONITOR WELL INSTALLATION DETAILS |
|---|---|---|---|
| 42<br>240 44<br>46<br>235 48<br>50<br>52<br>230 54<br>56<br>225 58<br>60<br>62<br>220 64<br>66<br>215 68<br>70<br>72<br>210 74<br>76<br>205 78 | **Boring terminated at 40.0 feet. No groundwater encountered at time of drilling.** | | Total well depth, 38.25 feet<br>Borehole depth, 40.0 feet<br>SURFACE COMPLETION<br>4" round stand-up locking aluminum protective cover with a 3' x 3' concrete pad at the base with survey pin<br>1/4-inch weep hole installed in aluminum cover<br>PVC stick-up = 3.56-feet<br>Top of PVC casing elev. = 286.76 feet<br>Survey pin elev. = 283.56 feet<br>Ground surface elev. = 283.2 feet<br>Northing = 876,458.55'<br>Easting = 1,979,237.71' |

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GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

# METHANE MONITORING PROBE NO. MM-75

PROJECT: Perry County Landfill — PROJECT NO.: J07-4999-06

CLIENT: HHNT — START: 6-29-07 END: 6-29-07

LOCATION: Uniontown, Alabama — ELEVATION: 280.4

DRILLER: Landprobe, T. Gradwell — LOGGED BY: T. Gradwell

DRILLING METHOD: 6-inch air rotary

DEPTH TO - WATER> INITIAL: ▽ _____ AFTER 24 HOURS: ▼ _____ CAVING> _____

| ELEVATION/ DEPTH (FT) | DESCRIPTION | SOIL TYPE | MONITOR WELL INSTALLATION DETAILS |
|---|---|---|---|
| 280 / 0 | 6-inches of TOPSOIL | | Neat cement, 0 to 1.0 feet |
| | Tannish-brown, silty, sandy CLAY | | Bentonite seal, 1.0 to 2.5 feet |
| 2 | | | Filter pack, sand 2.5 to 3.0 feet |
| 4 | | | Pea gravel, 3.0 to 35.0 feet |
| 275 / 6 | | | |
| 8 | Very hard, dry, gray CLAY | | |
| 270 / 10 | | | |
| 12 | | | |
| 14 | | | |
| 265 / 16 | | | |
| 18 | | | |
| 260 / 20 | | | 2-inch diameter, 0.020-inch slotted Schedule 40 PVC well screen, 3.0 to 33.0 feet |
| 22 | | | |
| 24 | | | |
| 255 / 26 | | | |
| 28 | | | |
| 250 / 30 | | | |
| 32 | | | |
| 34 | | | Pipe cap |
| | | | Total well depth, 33.25 feet |
| 245 / 36 | Boring terminated at 35.0 feet. No groundwater encountered at time of drilling. | | Borehole depth, 35.0 feet |
| 38 | | | SURFACE COMPLETION: 4" round stand-up locking aluminum protective cover with a 3' x 3' concrete pad at the base with survey pin |

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GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

# METHANE MONITORING PROBE NO. MM-75

PROJECT: Perry County Landfill — PROJECT NO.: J07-4999-06

CLIENT: HHNT — START: 6-29-07 END: 6-29-07

LOCATION: Uniontown, Alabama — ELEVATION: 280.4

DRILLER: Landprobe, T. Gradwell — LOGGED BY: T. Gradwell

DRILLING METHOD: 6-inch air rotary

DEPTH TO - WATER> INITIAL: ▽ _____ AFTER 24 HOURS: ▼ _____ CAVING> _____

| ELEVATION/ DEPTH (FT) | DESCRIPTION | SOIL TYPE | MONITOR WELL INSTALLATION DETAILS |
|---|---|---|---|
| 240 / 42 / 44 / 235 / 46 / 48 / 230 / 50 / 52 / 54 / 225 / 56 / 58 / 220 / 60 / 62 / 64 / 215 / 66 / 68 / 210 / 70 / 72 / 74 / 205 / 76 / 78 | | | 1/4-inch weep hole installed in aluminum cover<br>PVC stick-up = 3.68 feet<br>Top of PVC casing elev. = 284.08 feet<br>Survey pin elev. = 280.93 feet<br>Ground surface elev. = 280.4 feet<br>Northing = 876,443.46'<br>Easting = 1,979,131.91' |

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# METHANE MONITORING PROBE NO. MM-76

PROJECT: Perry County Landfill — PROJECT NO.: J07-4999-06

CLIENT: HHNT — START: 6-29-07 END: 6-29-07

LOCATION: Uniontown, Alabama — ELEVATION: 277.5

DRILLER: Landprobe, T. Gradwell — LOGGED BY: T. Gradwell

DRILLING METHOD: 6-inch air rotary

DEPTH TO - WATER> INITIAL: ▽ _____ AFTER 24 HOURS: ▼ _____ CAVING> _____

| ELEVATION/ DEPTH (FT) | DESCRIPTION | SOIL TYPE | MONITOR WELL INSTALLATION DETAILS |
|---|---|---|---|
| 275 / 2 | 6-inches of TOPSOIL<br>Tannish-brown, silty, sandy CLAY | | Neat cement, 0 to 1.0 feet<br>Bentonite seal, 1.0 to 2.5 feet<br>Filter pack, sand 2.5 to 3.0 feet<br>Pea gravel, 3.0 to 35.0 feet |
| 270 / 8 | Very hard, dry, gray CLAY | | |
| 265 / 12 | | | |
| 260 / 18 | | | |
| 255 / 22 | | | 2-inch diameter, 0.020-inch slotted Schedule 40 PVC well screen, 3.0 to 33.0 feet |
| 250 / 28 | | | |
| 245 / 32 | | | |
| 240 / 36 | Boring terminated at 35.0 feet. No groundwater encountered at time of drilling. | | Pipe cap<br>Total well depth, 33.25 feet<br>Borehole depth, 35.0 feet<br>SURFACE COMPLETION<br>4" round stand-up locking aluminum protective cover with a 3' x 3' concrete pad at the base with survey pin |
| 38 | | | |

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GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

# METHANE MONITORING PROBE NO. MM-76

PROJECT: Perry County Landfill — PROJECT NO.: J07-4999-06

CLIENT: HHNT — START: 6-29-07 END: 6-29-07

LOCATION: Uniontown, Alabama — ELEVATION: 277.5

DRILLER: Landprobe, T. Gradwell — LOGGED BY: T. Gradwell

DRILLING METHOD: 6-inch air rotary

DEPTH TO - WATER> INITIAL: ▽ _____ AFTER 24 HOURS: ▼ _____ CAVING> _____

| ELEVATION/ DEPTH (FT) | DESCRIPTION | SOIL TYPE | MONITOR WELL INSTALLATION DETAILS |
|---|---|---|---|
| 235 / 42 | | | 1/4-inch weep hole installed in aluminum cover |
| 44 | | | PVC stick-up = 3.91 feet |
| | | | Top of PVC casing elev. = 281.41 feet |
| 46 | | | Survey pin elev. = 278.06 feet |
| 230 / 48 | | | Ground surface elev. = 277.5 feet |
| | | | Northing = 876,424.18' |
| 50 | | | Easting = 1,979,028.48' |
| 225 / 52 | | | |
| 54 | | | |
| | | | |
| 56 | | | |
| 220 / 58 | | | |
| 60 | | | |
| | | | |
| 62 | | | |
| 215 / 64 | | | |
| | | | |
| 66 | | | |
| 210 / 68 | | | |
| | | | |
| 70 | | | |
| 205 / 72 | | | |
| | | | |
| 74 | | | |
| | | | |
| 76 | | | |
| 200 / 78 | | | |

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GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

# METHANE MONITORING PROBE NO. MM-77

PROJECT: Perry County Landfill — PROJECT NO.: J07-4999-06

CLIENT: HHNT — START: 6-29-07 END: 6-30-07

LOCATION: Uniontown, Alabama — ELEVATION: 274.9

DRILLER: Landprobe, T. Gradwell — LOGGED BY: T. Gradwell

DRILLING METHOD: 6-inch air rotary

DEPTH TO - WATER> INITIAL: ▽ _____ AFTER 24 HOURS: ▼ _____ CAVING> _____

| ELEVATION/ DEPTH (FT) | DESCRIPTION | SOIL TYPE | MONITOR WELL INSTALLATION DETAILS |
|---|---|---|---|
| 270 / 0 | 6-inches of TOPSOIL | | Neat cement, 0 to 1.0 feet |
| 2 | Tannish-brown, sandy, silty CLAY | | Neat cement, 1.0 to 2.5 feet |
| 4 | | | Filter pack, sand 2.5 to 3.0 feet |
| 6 | | | Pea gravel, 3.0 to 28.0 feet |
| 8 | Very hard, dry, gray CLAY | | |
| 265 / 10 | | | |
| 12 | | | 2-inch diameter, 0.020-inch slotted Schedule 40 PVC well screen, 3.0 to 28.0 feet |
| 260 / 14 | | | |
| 16 | | | |
| 18 | | | |
| 255 / 20 | | | |
| 22 | | | |
| 24 | | | |
| 250 / 26 | | | |
| 28 | | | Pipe cap |
| 245 / 30 | | | Total well depth, 28.25 feet |
| | Boring terminated at 30.0 feet. No groundwater encountered at time of drilling. | | Borehole depth, 30.0 feet |
| 32 | | | SURFACE COMPLETION<br>4" round stand-up locking aluminum protective cover with a 3' x 3' concrete pad at the base with survey pin<br>1/4-inch weep hole installed in aluminum cover |
| 240 / 34 | | | |
| 36 | | | PVC stick-up = 3.58 feet<br>Top of PVC casing elev. = 276.48 feet<br>Survey pin elev. = 275.29 feet<br>Ground surface elev. = 274.9 feet<br>Northing = 876,417.10'<br>Easting = 1,978,927.97' |
| 38 | | | |

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# METHANE MONITORING PROBE NO. MM-78

PROJECT: Perry County Landfill — PROJECT NO.: J07-4999-06

CLIENT: HHNT — START: 6-30-07 END: 6-30-07

LOCATION: Uniontown, Alabama — ELEVATION: 273.0

DRILLER: Landprobe, T. Gradwell — LOGGED BY: T. Gradwell

DRILLING METHOD: 6-inch air rotary

DEPTH TO - WATER> INITIAL: ▽ _____ AFTER 24 HOURS: ▼ _____ CAVING> _____

| ELEVATION/ DEPTH (FT) | DESCRIPTION | SOIL TYPE | MONITOR WELL INSTALLATION DETAILS |
|---|---|---|---|
| 270 / 0 | 6-inches of TOPSOIL | | Neat cement, 0 to 1.0 feet |
| 2 | Dark tannish-brown, silty CLAY | | Bentonite seal, 1.0 to 2.5 feet |
| 4 | | | Filter pack, sand 2.5 to 3.0 feet<br>Pea gravel, 3.0 to 28.0 feet |
| 6 | | | |
| 265 / 8 | Very hard, dry, gray CLAY | | |
| 10 | | | |
| 12 | | | 2-inch diameter, 0.020-inch slotted Schedule 40 PVC well screen, 3.0 to 28.0 feet |
| 260 / 14 | | | |
| 16 | | | |
| 255 / 18 | | | |
| 20 | | | |
| 22 | | | |
| 250 / 24 | | | |
| 26 | | | |
| 245 / 28 | | | Pipe cap |
| 30 | | | Total well depth, 28.25 feet |
| | Boring terminated at 30.0 feet. No groundwater encountered at time of drilling. | | Borehole depth, 30.0 feet |
| 32 | | | SURFACE COMPLETION<br>4" round stand-up locking aluminum protective cover with a 3' x 3' concrete pad at the base with survey pin<br>1/4-inch weep hole installed in aluminum cover<br>PVC stick-up = 3.66 feet<br>Top of PVC casing elev. = 276.66 feet<br>Survey pin elev. = 273.62 feet<br>Ground surface elev. = 273.0 feet<br>Northing = 876,408.68'<br>Easting = 1,978,836.20' |
| 240 / 34 | | | |
| 36 | | | |
| 235 / 38 | | | |

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GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

# METHANE MONITORING PROBE NO. MM-79

PROJECT: Perry County Landfill — PROJECT NO.: J07-4999-06

CLIENT: HHNT — START: 6-30-07 END: 6-30-07

LOCATION: Uniontown, Alabama — ELEVATION: 271.7

DRILLER: Landprobe, T. Gradwell — LOGGED BY: T. Gradwell

DRILLING METHOD: 6-inch air rotary

DEPTH TO - WATER> INITIAL: ▽ _____ AFTER 24 HOURS: ▼ _____ CAVING> _____

| ELEVATION/ DEPTH (FT) | DESCRIPTION | SOIL TYPE | MONITOR WELL INSTALLATION DETAILS |
|---|---|---|---|
| 270 / 2 | 6-inches of TOPSOIL<br>Dark tannish-brown, silty CLAY | | Neat cement, 0 to 1.0 feet<br>Bentonite seal, 1.0 to 2.5 feet<br>Filter pack, sand 2.5 to 3.0 feet<br>Pea gravel, 3.0 to 25.0 feet |
| 265 / 6 | Very hard, dry, gray CLAY | | |
| 260 / 12 | | | 2-inch diameter, 0.020-inch slotted Schedule 40 PVC well screen, 3.0 to 23.0 feet |
| 255 / 18 | | | |
| 250 / 22 | | | Pipe cap |
| 245 / 26 | Boring terminated at 25.0 feet. No groundwater encountered at time of drilling. | | Total well depth, 23.25 feet<br>Borehole depth, 25.0 feet |
| 240 / 32 | | | SURFACE COMPLETION<br>4" round stand-up locking aluminum protective cover with a 3' x 3' concrete pad at the base with survey pin<br>1/4-inch weep hole installed in aluminum cover<br>PVC stick-up = 3.56 feet<br>Top of PVC casing elev. = 275.26 feet<br>Survey pin elev. = 272.14 feet<br>Ground surface elev. = 271.7 feet<br>Northing = 876,401.69'<br>Easting = 1,978,765.86' |
| 235 / 38 | | | |



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# METHANE MONITORING PROBE NO. MM-80

PROJECT: Perry County Landfill — PROJECT NO.: J07-4999-06
CLIENT: HHNT — START: 6-30-07 END: 6-30-07
LOCATION: Uniontown, Alabama — ELEVATION: 271.8
DRILLER: Landprobe, T. Gradwell — LOGGED BY: T. Gradwell
DRILLING METHOD: 6-inch air rotary
DEPTH TO - WATER> INITIAL: ▽ _____ AFTER 24 HOURS: ▼ _____ CAVING> _____

| ELEVATION/ DEPTH (FT) | DESCRIPTION | SOIL TYPE | MONITOR WELL INSTALLATION DETAILS |
|---|---|---|---|
| 270 / 2 | 6-inches of TOPSOIL<br>Dark brownish-tan, silty CLAY | | Neat cement, 0 to 1.0 feet<br>Bentonite seal, 1.0 to 2.5 feet<br>Filter pack, sand 2.5 to 3.0 feet<br>Pea gravel, 3.0 to 25.0 feet |
| 265 / 8 | Very hard, dry, gray CLAY | | |
| 260 / 12 | | | 2-inch diameter, 0.020-inch slotted Schedule 40 PVC well screen, 3.0 to 23.0 feet |
| 255 / 18 | | | |
| 250 / 22 | | | Pipe cap |
| 245 / 26 | Boring terminated at 25.0 feet. No groundwater encountered at time of drilling. | | Total well depth, 23.25 feet<br>Borehole depth, 25.0 feet |
| 240 / 32 | | | SURFACE COMPLETION<br>4" round stand-up locking aluminum protective cover with a 3' x 3' concrete pad at the base with survey pin<br>1/4-inch weep hole installed in aluminum cover<br>PVC stick-up = 3.68 feet<br>Top of PVC casing elev. = 275.48 feet<br>Survey pin elev. = 272.17 feet<br>Ground surface elev. = 271.8 feet<br>Northing = 876,440.88'<br>Easting = 1,978,695.61' |
| 235 / 38 | | | |



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GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

# METHANE MONITORING PROBE NO. MM-81

PROJECT: Perry County Landfill — PROJECT NO.: J07-4999-06
CLIENT: HHNT — START: 7-1-07 END: 7-1-07
LOCATION: Uniontown, Alabama — ELEVATION: 271.2
DRILLER: Landprobe, T. Gradwell — LOGGED BY: T. Gradwell
DRILLING METHOD: 6-inch air rotary
DEPTH TO - WATER> INITIAL: ▽ _____ AFTER 24 HOURS: ▼ _____ CAVING> _____

| ELEVATION/ DEPTH (FT) | DESCRIPTION | SOIL TYPE | MONITOR WELL INSTALLATION DETAILS |
|---|---|---|---|
| 270 / 0 | 6-inches of TOPSOIL | | Neat cement, 0 to 1.0 feet |
| | Tannish-brown, silty CLAY | | Bentonite seal,1.0 to 2.5 feet |
| 2 | | | Filter pack, sand 2.5 to 3.0 feet |
| 4 | | | Pea gravel, 3.0 to 25.0 feet |
| 265 / 6 | Very hard, dry, gray CLAY | | |
| 8 | | | |
| 10 | | | |
| 260 / 12 | | | 2-inch diameter, 0.020-inch slotted Schedule 40 PVC well screen, 3.0 to 23.0 feet |
| 14 | | | |
| 255 / 16 | | | |
| 18 | | | |
| 20 | | | |
| 250 / 22 | | | |
| 24 | | | Pipe cap |
| 245 / 26 | Boring terminated at 25.0 feet. No groundwater encountered at time of drilling. | | Total well depth, 23.25 feet |
| | | | Borehole depth, 25.0 feet |
| 28 | | | SURFACE COMPLETION<br>4" round stand-up locking aluminum protective cover with a 3' x 3' concrete pad at the base with survey pin |
| 30 | | | |
| 240 / 32 | | | 1/4-inch weep hole installed in aluminum cover |
| 34 | | | PVC stick-up = 3.49 feet |
| | | | Top of PVC casing elev. = 274.69 feet |
| | | | Survey pin elev. = 271.53 feet |
| 235 / 36 | | | Ground surface elev. = 271.2 feet |
| 38 | | | Northing = 876,507.02' |
| | | | Easting = 1,978,610.70' |

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# METHANE MONITORING PROBE NO. MM-82

**BUNNELL-LAMMONS ENGINEERING, INC.**
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

PROJECT: Perry County Landfill
PROJECT NO.: J07-4999-06
CLIENT: HHNT
START: 7-1-07 END: 7-1-07
LOCATION: Uniontown, Alabama
ELEVATION: 270.1
DRILLER: Landprobe, T. Gradwell
LOGGED BY: T. Gradwell
DRILLING METHOD: 6-inch air rotary
DEPTH TO - WATER> INITIAL: ▽ AFTER 24 HOURS: ▼ CAVING>

| ELEVATION/ DEPTH (FT) | DESCRIPTION | SOIL TYPE | MONITOR WELL INSTALLATION DETAILS |
|---|---|---|---|
| 265 / 0–6 | 6-inches of TOPSOIL<br>Tannish-brown, silty CLAY | | Neat cement, 0 to 1.0 feet<br>Bentonite seal, 1.0 to 2.5 feet<br>Filter pack, sand 2.5 to 3.0 feet<br>Pea gravel, 3.0 to 20.0 feet |
| 260 / 8–14 | Gray CLAY | | 2-inch diameter, 0.020-inch slotted Schedule 40 PVC well screen, 3.0 to 18.0 feet |
| 255 / 16–18 | | | Pipe cap |
| 250 / 20 | Boring terminated at 20.0 feet. No groundwater encountered at time of drilling. | | Total well depth, 18.25 feet<br>Borehole depth, 20.0 feet |
| 245 / 22–26 | | | SURFACE COMPLETION<br>4" round stand-up locking aluminum protective cover with a 3' x 3' concrete pad at the base with survey pin<br>1/4-inch weep hole installed in aluminum cover |
| 240 / 28–32 | | | PVC stick-up = 3.72 feet<br>Top of PVC casing elev. = 273.82 feet<br>Survey pin elev. = 270.51 feet<br>Ground surface elev. = 270.1 feet<br>Northing = 876,574.41'<br>Easting = 1,978,547.53' |
| 235 / 34–38 | | | |

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GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

# METHANE MONITORING PROBE NO. MM-83

PROJECT: Perry County Landfill — PROJECT NO.: J07-4999-06

CLIENT: HHNT — START: 7-1-07 END: 7-1-07

LOCATION: Uniontown, Alabama — ELEVATION: 268.5

DRILLER: Landprobe, T. Gradwell — LOGGED BY: T. Gradwell

DRILLING METHOD: 6-inch air rotary

DEPTH TO - WATER> INITIAL: ▽ _____ AFTER 24 HOURS: ▼ _____ CAVING> ▨ _____

| ELEVATION/ DEPTH (FT) | DESCRIPTION | SOIL TYPE | MONITOR WELL INSTALLATION DETAILS |
|---|---|---|---|
| 265 / 2 | 6-inches of TOPSOIL | | Neat cement, 0 to 1.0 feet |
| 265 / 4 | Tannish-brown, silty CLAY | | Bentonite seal, 1.0 to 2.5 feet |
| 265 / 6 | | | Filter pack, sand 2.5 to 3.0 feet<br>Pea gravel, 3.0 to 20.0 feet |
| 260 / 8 | Gray CLAY | | |
| 260 / 10 | | | 2-inch diameter, 0.020-inch slotted Schedule 40 PVC well screen, 3.0 to 18.0 feet |
| 255 / 12 | | | |
| 255 / 14 | | | |
| 255 / 16 | | | |
| 250 / 18 | | | Pipe cap |
| 250 / 20 | | | Total well depth, 18.25 feet |
| 245 / 22 | Boring terminated at 20.0 feet. No groundwater encountered at time of drilling. | | Borehole depth, 20.0 feet |
| 245 / 24 | | | SURFACE COMPLETION<br>4" round stand-up locking aluminum protective cover with a 3' x 3' concrete pad at the base with survey pin |
| 245 / 26 | | | 1/4-inch weep hole installed in aluminum cover |
| 240 / 28 | | | PVC stick-up = 3.56 feet |
| 240 / 30 | | | Top of PVC casing elev. = 272.06 feet |
| 240 / 32 | | | Survey pin elev. = 268.83 feet |
| 235 / 34 | | | Ground surface elev. = 268.5 feet |
| 235 / 36 | | | Northing = 876,638.20' |
| 235 / 38 | | | Easting = 1,978,467.56' |
| 230 | | | |

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GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

# METHANE MONITORING PROBE NO. MM-84

PROJECT: Perry County Landfill | PROJECT NO.: J07-4999-06

CLIENT: HHNT | START: 7-2-07 END: 7-2-07

LOCATION: Uniontown, Alabama | ELEVATION: 272.2

DRILLER: Landprobe, T. Gradwell | LOGGED BY: T. Gradwell

DRILLING METHOD: 6-inch air rotary

DEPTH TO - WATER> INITIAL: ▽ _____ AFTER 24 HOURS: ▼ _____ CAVING> _____

| ELEVATION/ DEPTH (FT) | DESCRIPTION | SOIL TYPE | MONITOR WELL INSTALLATION DETAILS |
|---|---|---|---|
| 270 / 2 | Tan and gray CLAY - (fill) | | Neat cement, 0 to 1.0 feet<br>Bentonite seal, 1.0 to 2.5 feet<br>Filter pack, sand 2.5 to 3.0 feet<br>Pea gravel, 3.0 to 20.0 feet |
| 4 | Tannish-brown, silty CLAY | | |
| 265 / 6 | | | |
| 8 | Very hard, dry, gray CLAY | | 2-inch diameter, 0.020-inch slotted Schedule 40 PVC well screen, 3.0 to 18.0 feet |
| 260 / 10 | | | |
| 12 | | | |
| 14 | | | |
| 255 / 16 | | | |
| 18 | | | Pipe cap |
| 20 | | | Total well depth, 18.25 feet |
| 250 / 22 | Boring terminated at 20.0 feet. No groundwater encountered at time of drilling. | | Borehole depth, 20.0 feet |
| 24 | | | SURFACE COMPLETION<br>4" round stand-up locking aluminum protective cover with a 3' x 3' concrete pad at the base with survey pin |
| 245 / 26 | | | 1/4-inch weep hole installed in aluminum cover |
| 28 | | | PVC stick-up = 3.58 feet |
| 30 | | | Top of PVC casing elev. = 275.78 feet |
| 240 / 32 | | | Survey pin elev. = 272.47 feet |
| 34 | | | Ground surface elev. = 272.2 feet |
| 36 | | | Northing = 876,694.73' |
| 235 / 38 | | | Easting = 1,978,385.16' |

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GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

# METHANE MONITORING PROBE NO. MM-85

PROJECT: Perry County Landfill — PROJECT NO.: J07-4999-06

CLIENT: HHNT — START: 7-1-07 END: 7-1-07

LOCATION: Uniontown, Alabama — ELEVATION: 262.5

DRILLER: Landprobe, T. Gradwell — LOGGED BY: T. Gradwell

DRILLING METHOD: 6-inch air rotary

DEPTH TO - WATER> INITIAL: ▽ _____ AFTER 24 HOURS: ▼ _____ CAVING> _____

| ELEVATION/ DEPTH (FT) | DESCRIPTION | SOIL TYPE | MONITOR WELL INSTALLATION DETAILS |
|---|---|---|---|
| 260 / 2 | 6-inches of TOPSOIL<br>Tannish-brown, silty CLAY | | Neat cement, 0 to 1.0 feet<br>Bentonite seal, 1.0 to 2.5 feet<br>Filter pack, sand 2.5 to 3.0 feet<br>Pea gravel, 3.0 to 10.0 feet |
| 4 | Gray CLAY | | 2-inch diameter, 0.020-inch slotted Schedule 40 PVC well screen, 3.0 to 8.0 feet |
| 255 / 8 | | | Pipe cap |
| 10 | Boring terminated at 10.0 feet. No groundwater encountered at time of drilling. | | Total well depth, 8.25 feet<br>Borehole depth, 10.0 feet |
| 250 / 12 | | | SURFACE COMPLETION<br>4" round stand-up locking aluminum protective cover with a 3' x 3' concrete pad at the base with survey pin |
| 14 | | | |
| 16 | | | 1/4-inch weep hole installed in aluminum cover |
| 245 / 18 | | | PVC stick-up = 3.55 feet |
| 20 | | | Top of PVC casing elev. = 266.05 feet |
| 240 / 22 | | | Survey pin elev. = 262.89 feet |
| 24 | | | Ground surface elev. = 262.5 feet |
| 26 | | | Northing = 876,767.03' |
| 235 / 28 | | | Easting = 1,978,284.29' |
| 30 | | | |
| 32 | | | |
| 230 / 34 | | | |
| 36 | | | |
| 225 / 38 | | | |

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GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

# METHANE MONITORING PROBE NO. MM-91

PROJECT: Perry Uniontown Landfill — PROJECT NO.: J09-4999-18

CLIENT: Hodges, Harbin, Newberry & Tribble, Inc. — START: 9-9-09 END: 9-9-09

LOCATION: Uniontown, Alabama — ELEVATION: 261.5

DRILLER: Landprobe, R. Banks — LOGGED BY: M. Preddy/C. Brown

DRILLING METHOD: CME 750 ATV; 8-1/4 inch OD hollow stem auger

DEPTH TO - WATER> INITIAL: ▽ _____ AFTER 24 HOURS: ▼ _____ CAVING> _____

| ELEVATION/ DEPTH (FT) | DESCRIPTION | SOIL TYPE | MONITOR WELL INSTALLATION DETAILS |
|---|---|---|---|
| 260 / 0 | 6-inches of TOPSOIL | | Neat cement, 0 to 1.84 feet |
| 260 / 2 | Stiff, brown, slightly moist, silty CLAY | | Bentonite seal, 1.84 to 2.84 feet |
| 260 / 4 | | | Filter pack, sand 2.84 to 3.44 feet<br>Pea gravel, 3.44 to 8.47 feet |
| 255 / 6 | | | 2-inch diameter, 0.010-inch slotted Schedule 40 PVC well screen, 3.22 to 8.22 feet |
| 255 / 8 | Hard, brown and gray, slightly moist, silty CLAY | | Pipe cap |
| 250 / 10 | Boring terminated at 8.47 feet. | | Total well depth, 8.47 feet |
| 250 / 12 | | | SURFACE COMPLETION<br>4" round stand-up locking aluminum protective cover with a 3' x 3' concrete pad at the base with survey pin |
| 245 / 14 | | | |
| 245 / 16 | | | 1/4-inch weep hole installed in aluminum cover |
| 245 / 18 | | | PVC stick-up = 2.96-feet |
| 240 / 20 | | | Top of PVC casing elev. = 264.48 feet |
| 240 / 22 | | | Survey pin elev. = 261.94 feet |
| 240 / 24 | | | Ground surface elev. = 261.5 feet |
| 235 / 26 | | | Northing = 877,100.63' |
| 235 / 28 | | | Easting = 1,977,800.62' |
| 230 / 30 | | | |
| 230 / 32 | | | |
| 230 / 34 | | | |
| 225 / 36 | | | |
| 225 / 38 | | | |

GEOT_WELLNB 499... .GPJ 9/29/09

BLE INC.

**BUNNELL-LAMMONS ENGINEERING, INC.**

GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

# METHANE MONITORING PROBE NO. MM-92

PROJECT: Perry Uniontown Landfill — PROJECT NO.: J09-4999-18

CLIENT: Hodges, Harbin, Newberry & Tribble, Inc. — START: 9-9-09 END: 9-9-09

LOCATION: Uniontown, Alabama — ELEVATION: 263.0

DRILLER: Landprobe, R. Banks — LOGGED BY: M. Preddy/C. Brown

DRILLING METHOD: CME 750 ATV; 8-1/4 inch OD hollow stem auger

DEPTH TO - WATER> INITIAL: ▽ AFTER 24 HOURS: ▼ CAVING>

| ELEVATION/ DEPTH (FT) | DESCRIPTION | SOIL TYPE | MONITOR WELL INSTALLATION DETAILS |
|---|---|---|---|
| 260 / 2 | 6-inches of TOPSOIL | | Neat cement, 0 to 1.19 feet |
| | Light brown, slightly moist, silty CLAY | | Bentonite seal, 1.19 to 2.19 feet |
| 260 / 4 | | | Filter pack, sand 2.19 to 2.79 feet<br>Pea gravel, 2.79 to 8.19 feet |
| 260 / 6 | Very stiff, gray, slightly moist, silty CLAY | | 2-inch diameter, 0.010-inch slotted Schedule 40 PVC well screen, 2.94 to 7.94 feet |
| 255 / 8 | | | Pipe cap |
| | Boring terminated at 8.19 feet. | | Total well depth, 8.19 feet |
| 250 / 10 | | | SURFACE COMPLETION<br>4" round stand-up locking aluminum protective cover with a 3' x 3' concrete pad at the base with survey pin |
| 250 / 12 | | | |
| 250 / 14 | | | |
| | | | 1/4-inch weep hole installed in aluminum cover |
| 245 / 16 | | | |
| 245 / 18 | | | PVC stick-up = 3.04-feet |
| 245 / 20 | | | Top of PVC casing elev. = 266.00 feet |
| 245 / 22 | | | Survey pin elev. = 263.37 feet |
| 240 / 24 | | | Ground surface elev. = 263.0 feet |
| 240 / 26 | | | Northing = 877,158.82' |
| | | | Easting = 1,977,726.85' |
| 235 / 28 | | | |
| 235 / 30 | | | |
| 230 / 32 | | | |
| 230 / 34 | | | |
| 230 / 36 | | | |
| 225 / 38 | | | |

GEOT_WELLNB 4999-1.GPJ 9/29/09

BLE INC.

**BUNNELL-LAMMONS ENGINEERING, INC.**

GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

# METHANE MONITORING PROBE NO. MM-93

PROJECT: Perry Uniontown Landfill — PROJECT NO.: J09-4999-18

CLIENT: Hodges, Harbin, Newberry & Tribble, Inc. — START: 9-9-09 END: 9-9-09

LOCATION: Uniontown, Alabama — ELEVATION: 264.2

DRILLER: Landprobe, R. Banks — LOGGED BY: M. Preddy/C. Brown

DRILLING METHOD: CME 750 ATV; 8-1/4 inch OD hollow stem auger

DEPTH TO - WATER> INITIAL: ▽ AFTER 24 HOURS: ▼ CAVING>

| ELEVATION/ DEPTH (FT) | DESCRIPTION | SOIL TYPE | MONITOR WELL INSTALLATION DETAILS |
|---|---|---|---|
| 260 / 0–4 | 6-inches of TOPSOIL<br>Stiff, brown, slightly moist, silty CLAY | | Neat cement, 0 to 1.41 feet<br>Bentonite seal, 1.41 to 2.41 feet<br>Filter pack, sand 2.41 to 3.1 feet<br>Pea gravel, 3.1 to 13.12 feet |
| 255 / 4–12 | Very stiff, light brown, slightly moist, clayey SILT | | 2-inch diameter, 0.010-inch slotted Schedule 40 PVC well screen, 2.87 to 12.87 feet<br>Pipe cap |
| 250 / 14 | Boring terminated at 13.12 feet. | | Total well depth, 13.12 feet<br>SURFACE COMPLETION<br>4" round stand-up locking aluminum protective cover with a 3' x 3' concrete pad at the base with survey pin<br>1/4-inch weep hole installed in aluminum cover<br>PVC stick-up = 2.57-feet<br>Top of PVC casing elev. = 266.79 feet<br>Survey pin elev. = 264.41 feet<br>Ground surface elev. = 264.2 feet<br>Northing = 877,198.39'<br>Easting = 1,977,656.35' |

245 / 20 · 240 / 24 · 235 / 30 · 230 / 34 · 225 / 38

GEOT_WELLNB 4999-1.GPJ 9/29/09

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**BUNNELL-LAMMONS ENGINEERING, INC.**

GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

# METHANE MONITORING PROBE NO. MM-94

PROJECT: Perry Uniontown Landfill — PROJECT NO.: J09-4999-18

CLIENT: Hodges, Harbin, Newberry & Tribble, Inc. — START: 9-9-09 END: 9-9-09

LOCATION: Uniontown, Alabama — ELEVATION: 264.5

DRILLER: Landprobe, R. Banks — LOGGED BY: M. Preddy/C. Brown

DRILLING METHOD: CME 750 ATV; 8-1/4 inch OD hollow stem auger

DEPTH TO - WATER> INITIAL: ▽ AFTER 24 HOURS: ▼ CAVING>

| ELEVATION/ DEPTH (FT) | DESCRIPTION | SOIL TYPE | MONITOR WELL INSTALLATION DETAILS |
|---|---|---|---|
| 260 / 0–6 | 6-inches of TOPSOIL<br>Stiff, brown, slightly moist, fine to medium sandy, silty CLAY | | Neat cement, 0 to 1.09 feet<br>Bentonite seal, 1.09 to 2.09 feet<br>Filter pack, sand 2.09 to 2.69 feet<br>Pea gravel, 2.69 to 13.19 feet |
| 255 / 8–12 | Very stiff, grayish-brown, clayey SILT | | 2-inch diameter, 0.010-inch slotted Schedule 40 PVC well screen, 2.94 to 12.94 feet |
| 250 / 14 | Boring terminated at 13.19 feet. | | Pipe cap<br>Total well depth, 13.19 feet<br>SURFACE COMPLETION<br>4" round stand-up locking aluminum protective cover with a 3' x 3' concrete pad at the base with survey pin<br>1/4-inch weep hole installed in aluminum cover<br>PVC stick-up = 2.97-feet<br>Top of PVC casing elev. = 267.42 feet<br>Survey pin elev. = 264.85 feet<br>Ground surface elev. = 264.5 feet<br>Northing = 877,288.82'<br>Easting = 1,977,547.87' |

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**BUNNELL-LAMMONS ENGINEERING, INC.**

GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

# METHANE MONITORING PROBE NO. MM-95

PROJECT: Perry Uniontown Landfill — PROJECT NO.: J09-4999-18

CLIENT: Hodges, Harbin, Newberry & Tribble, Inc. — START: 9-8-09 END: 9-8-09

LOCATION: Uniontown, Alabama — ELEVATION: 264.6

DRILLER: Landprobe, R. Banks — LOGGED BY: M. Preddy/C. Brown

DRILLING METHOD: CME 750 ATV; 8-1/4 inch OD hollow stem auger

DEPTH TO - WATER> INITIAL: ▽ _____ AFTER 24 HOURS: ▼ _____ CAVING> _____

| ELEVATION/ DEPTH (FT) | DESCRIPTION | SOIL TYPE | MONITOR WELL INSTALLATION DETAILS |
|---|---|---|---|
| 260 / 0–8 | Stiff, brown, moist, silty CLAY | | Neat cement, 0 to 1.62 feet<br>Bentonite seal, 1.62 to 2.62 feet<br>Filter pack, sand 2.62 to 3.22 feet<br>Pea gravel, 3.22 to 23.52 feet |
| 255 / 8–10 | Hard, grayish-brown to gray, moist, fine sandy, silty CLAY | | |
| 250 / 10–20 | | | 2-inch diameter, 0.010-inch slotted Schedule 40 PVC well screen, 3.27 to 23.27 feet |
| 245 / 20–24 | | | Pipe cap<br>Total well depth, 23.52 feet<br>SURFACE COMPLETION |
| 240 / 24 | Boring terminated at 23.52 feet. | | |
| 235 / 30 | | | 4" round stand-up locking aluminum protective cover with a 3' x 3' concrete pad at the base with survey pin<br>1/4-inch weep hole installed in aluminum cover<br>PVC stick-up = 3.10-feet |
| 230 / 34 | | | Top of PVC casing elev. = 267.67 feet |
| 230 / 36 | | | Survey pin elev. = 264.87 feet |
| 225 / 38 | | | Ground surface elev. = 264.6 feet<br>Northing = 877,340.18'<br>Easting = 1,977,475.02' |

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**BUNNELL-LAMMONS ENGINEERING, INC.**

GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

# METHANE MONITORING PROBE NO. MM-96

PROJECT: Perry Uniontown Landfill — PROJECT NO.: J09-4999-18

CLIENT: Hodges, Harbin, Newberry & Tribble, Inc. — START: 9-3-09 END: 9-3-09

LOCATION: Uniontown, Alabama — ELEVATION: 264.2

DRILLER: Landprobe, R. Banks — LOGGED BY: M. Preddy/C. Brown

DRILLING METHOD: CME 750 ATV; 8-1/4 inch OD hollow stem auger

DEPTH TO - WATER> INITIAL: ▽ _____ AFTER 24 HOURS: ▼ _____ CAVING> _____

| ELEVATION/ DEPTH (FT) | DESCRIPTION | SOIL TYPE | MONITOR WELL INSTALLATION DETAILS |
|---|---|---|---|
| 260 / 4 | Stiff, brown, slightly moist, silty CLAY | | Neat cement, 0 to 1.15 feet<br>Bentonite seal, 1.15 to 2.15 feet<br>Filter pack, sand 2.15 to 2.75 feet<br>Pea gravel, 2.75 to 13.25 feet |
| 255 / 10 | | | 2-inch diameter, 0.010-inch slotted Schedule 40 PVC well screen, 3.00 to 13.00 feet |
| 12 | Hard, grayish-brown, moist, silty CLAY | | |
| 250 / 14 | Boring terminated at 13.25 feet. | | Pipe cap<br>Total well depth, 13.25 feet<br>SURFACE COMPLETION<br>4" round stand-up locking aluminum protective cover with a 3' x 3' concrete pad at the base with survey pin<br>1/4-inch weep hole installed in aluminum cover<br>PVC stick-up = 2.90-feet<br>Top of PVC casing elev. = 267.07 feet<br>Survey pin elev. = 264.49 feet<br>Ground surface elev. = 264.2 feet<br>Northing = 877,375.13'<br>Easting = 1,977,374.74' |
| 245 / 20 | | | |
| 240 / 24 | | | |
| 235 / 30 | | | |
| 230 / 34 | | | |
| 225 / 38 | | | |

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**BUNNELL-LAMMONS ENGINEERING, INC.**

GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

# METHANE MONITORING PROBE NO. MM-97

PROJECT: Perry Uniontown Landfill | PROJECT NO.: J09-4999-18

CLIENT: Hodges, Harbin, Newberry & Tribble, Inc. | START: 9-3-09 END: 9-3-09

LOCATION: Uniontown, Alabama | ELEVATION: 264.5

DRILLER: Landprobe, R. Banks | LOGGED BY: M. Preddy/C. Brown

DRILLING METHOD: CME 750 ATV; 8-1/4 inch OD hollow stem auger

DEPTH TO - WATER> INITIAL: ▽ _____ AFTER 24 HOURS: ▼ _____ CAVING>

| ELEVATION/ DEPTH (FT) | DESCRIPTION | SOIL TYPE | MONITOR WELL INSTALLATION DETAILS |
|---|---|---|---|
| 260 / 2 | Brown, slightly moist, silty CLAY | | Neat cement, 0 to 1.25 feet |
| | | | Bentonite seal, 1.25 to 2.25 feet |
| | | | Filter pack, sand 2.25 to 2.85 feet<br>Pea gravel, 2.85 to 23.35 feet |
| 255 / 12 | Hard, grayish-brown, moist, clayey SILT | | 2-inch diameter, 0.010-inch slotted Schedule 40 PVC well screen, 3.10 to 23.10 feet |
| 250 / 14 | | | |
| 245 / 20 | | | |
| 240 / 24 | Boring terminated at 23.35 feet. | | Pipe cap |
| | | | Total well depth, 23.35 feet |
| | | | SURFACE COMPLETION<br>4" round stand-up locking aluminum protective cover with a 3' x 3' concrete pad at the base with survey pin |
| 235 / 30 | | | 1/4-inch weep hole installed in aluminum cover |
| | | | PVC stick-up = 2.86-feet |
| | | | Top of PVC casing elev. = 267.37 feet |
| 230 / 34 | | | Survey pin elev. = 264.84 feet |
| | | | Ground surface elev. = 264.5 feet |
| 225 / 38 | | | Northing = 877,438.48'<br>Easting = 1,977,316.97' |

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**BUNNELL-LAMMONS ENGINEERING, INC.**

GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

# METHANE MONITORING PROBE NO. MM-98

PROJECT: Perry Uniontown Landfill — PROJECT NO.: J09-4999-18

CLIENT: Hodges, Harbin, Newberry & Tribble, Inc. — START: 9-4-09 END: 9-4-09

LOCATION: Uniontown, Alabama — ELEVATION: 261.9

DRILLER: Landprobe, R. Banks — LOGGED BY: M. Preddy/C. Brown

DRILLING METHOD: CME 750 ATV; 8-1/4 inch OD hollow stem auger

DEPTH TO - WATER> INITIAL: ▽ AFTER 24 HOURS: ▼ CAVING>

| ELEVATION/ DEPTH (FT) | DESCRIPTION | SOIL TYPE | MONITOR WELL INSTALLATION DETAILS |
|---|---|---|---|
| 260 / 2 | Stiff, gray and light brown, silty CLAY | | Neat cement, 0 to 1.18 feet<br>Bentonite seal, 1.18 to 2.18feet<br>Filter pack, sand 2.18 to 2.78 feet<br>Pea gravel, 2.78 to 23.08 feet |
| 4 | | | |
| 6 / 255 | Hard, gray, silty CLAY | | |
| 8 | | | |
| 10 | | | |
| 250 / 12 | | | 2-inch diameter, 0.010-inch slotted Schedule 40 PVC well screen, 2.83 to 22.83 feet |
| 14 | | | |
| 16 / 245 | | | |
| 18 | | | |
| 20 | | | |
| 240 / 22 | | | Pipe cap |
| 24 | Boring terminated at 23.08 feet. | | Total well depth, 23.08 feet |
| 26 | | | SURFACE COMPLETION<br>4" round stand-up locking aluminum protective cover with a 3' x 3' concrete pad at the base with survey pin |
| 235 / 28 | | | |
| 30 | | | 1/4-inch weep hole installed in aluminum cover |
| 230 / 32 | | | PVC stick-up = 3.17-feet |
| 34 | | | Top of PVC casing elev. = 265.04 feet |
| 36 | | | Survey pin elev. = 262.38 feet |
| 225 / 38 | | | Ground surface elev. = 261.9 feet<br>Northing = 877,504.82'<br>Easting = 1,977,206.62' |

GEOT_WELLNB 4999-.GPJ 9/29/09

BLE INC.

**BUNNELL-LAMMONS ENGINEERING, INC.**

GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

# METHANE MONITORING PROBE NO. MM-99

PROJECT: Perry Uniontown Landfill — PROJECT NO.: J09-4999-18

CLIENT: Hodges, Harbin, Newberry & Tribble, Inc. — START: 9-9-09 END: 9-9-09

LOCATION: Uniontown, Alabama — ELEVATION: 261.3

DRILLER: Landprobe, R. Banks — LOGGED BY: M. Preddy/C. Brown

DRILLING METHOD: CME 750 ATV; 8-1/4 inch OD hollow stem auger

DEPTH TO - WATER> INITIAL: ▽ _____ AFTER 24 HOURS: ▼ _____ CAVING> _____

| ELEVATION/ DEPTH (FT) | DESCRIPTION | SOIL TYPE | MONITOR WELL INSTALLATION DETAILS |
|---|---|---|---|
| 260 / 2 | 6-inches of TOPSOIL<br>Stiff, brown, silty CLAY | | Neat cement, 0 to 1.29 feet<br>Bentonite seal, 1.29 to 2.29 feet<br>Filter pack, sand 2.29 to 2.99 feet<br>Pea gravel, 2.99 to 18.29 feet |
| 255 / 6 | Hard, gray and light brown, silty CLAY | | |
| 250 / 12 | Hard, gray, slightly fine sandy, silty CLAY | | 2-inch diameter, 0.010-inch slotted Schedule 40 PVC well screen, 3.04 to 18.04 feet |
| 245 / 18 | Boring terminated at 18.29 feet. | | Pipe cap<br>Total well depth, 18.29 feet<br>SURFACE COMPLETION<br>4" round stand-up locking aluminum protective cover with a 3' x 3' concrete pad at the base with survey pin<br>1/4-inch weep hole installed in aluminum cover<br>PVC stick-up = 3.30-feet<br>Top of PVC casing elev. = 264.57 feet<br>Survey pin elev. = 261.86 feet<br>Ground surface elev. = 261.3 feet<br>Northing = 877,541.38'<br>Easting = 1,977,131.23' |
| 240 / 22 | | | |
| 235 / 26 | | | |
| 230 / 32 | | | |
| 225 / 36 | | | |
| / 38 | | | |

GEOT_WELLNB 4999-...GPJ 9/29/09

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**BUNNELL-LAMMONS ENGINEERING, INC.**

GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

# METHANE MONITORING PROBE NO. MM-100

PROJECT: Perry Uniontown Landfill — PROJECT NO.: J09-4999-18

CLIENT: Hodges, Harbin, Newberry & Tribble, Inc. — START: 9-10-09 END: 9-10-09

LOCATION: Uniontown, Alabama — ELEVATION: 259.5

DRILLER: Landprobe, R. Banks — LOGGED BY: M. Preddy/C. Brown

DRILLING METHOD: CME 750 ATV; 8-1/4 inch OD hollow stem auger

DEPTH TO - WATER> INITIAL: ▽ _____ AFTER 24 HOURS: ▼ _____ CAVING> _____

| ELEVATION/ DEPTH (FT) | DESCRIPTION | SOIL TYPE | MONITOR WELL INSTALLATION DETAILS |
|---|---|---|---|
| 255 / 0–6 | 6-inches of TOPSOIL<br>Very stiff, brown, moist, silty CLAY | | Neat cement, 0 to 1.73 feet<br>Bentonite seal, 1.73 to 2.73 feet<br>Filter pack, sand 2.73 to 3.33 feet<br>Pea gravel, 3.33 to 18.33 feet |
| 250 / 6–10 | Hard, light gray to gray, moist, clayey SILT | | |
| 245 / 10–18 | | | 2-inch diameter, 0.010-inch slotted Schedule 40 PVC well screen, 3.08 to 18.33 feet |
| 240 / 18–20 | Boring terminated at 18.33 feet. | | Pipe cap<br>Total well depth, 18.33 feet |
| 235 / 20–28 | | | SURFACE COMPLETION<br>4" round stand-up locking aluminum protective cover with a 3' x 3' concrete pad at the base with survey pin<br>1/4-inch weep hole installed in aluminum cover<br>PVC stick-up = 3.13-feet |
| 230 / 28–30 | | | Top of PVC casing elev. = 262.66 feet<br>Survey pin elev. = 260.07 feet |
| 225 / 30–38 | | | Ground surface elev. = 259.5 feet<br>Northing = 877,591.46'<br>Easting = 1,977,039.45' |
| 220 / 38 | | | |

GEOT_WELLNB 495_ .GPJ 9/29/09

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**BUNNELL-LAMMONS ENGINEERING, INC.**

GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

# METHANE MONITORING PROBE NO. MM-101

PROJECT: Perry Uniontown Landfill — PROJECT NO.: J09-4999-18

CLIENT: Hodges, Harbin, Newberry & Tribble, Inc. — START: 9-10-09 END: 9-10-09

LOCATION: Uniontown, Alabama — ELEVATION: 258.8

DRILLER: Landprobe, R. Banks — LOGGED BY: M. Preddy/C. Brown

DRILLING METHOD: CME 750 ATV; 8-1/4 inch OD hollow stem auger

DEPTH TO - WATER> INITIAL: ▽ _____ AFTER 24 HOURS: ▼ _____ CAVING> _____

| ELEVATION/ DEPTH (FT) | DESCRIPTION | SOIL TYPE | MONITOR WELL INSTALLATION DETAILS |
|---|---|---|---|
| 255 / 0 | 6-inches of TOPSOIL | | Neat cement, 0 to 1.14 feet |
| 255 / 2 | Brown, slightly moist, fine sandy, silty CLAY | | Bentonite seal, 1.14 to 2.14 feet |
| 255 / 2 | | | Filter pack, sand 2.14 to 2.77 feet |
| 255 / 2 | | | Pea gravel, 2.77 to 18.07 feet |
| 255 / 4 | | | |
| 255 / 6 | | | |
| 250 / 8 | Hard, light brown, moist, clayey SILT | | |
| 250 / 10 | | | 2-inch diameter, 0.010-inch slotted Schedule 40 PVC well screen, 2.82 to 17.82 feet |
| 245 / 12 | Hard, gray, moist, clayey SILT | | |
| 245 / 14 | | | |
| 245 / 16 | | | |
| 240 / 18 | | | Pipe cap |
| 240 / 18 | Boring terminated at 18.07 feet. | | Total well depth, 18.07 feet |
| 240 / 20 | | | SURFACE COMPLETION<br>4" round stand-up locking aluminum protective cover with a 3' x 3' concrete pad at the base with survey pin |
| 240 / 22 | | | |
| 235 / 24 | | | 1/4-inch weep hole installed in aluminum cover |
| 235 / 26 | | | PVC stick-up = 3.20-feet |
| 235 / 28 | | | Top of PVC casing elev. = 261.97 feet |
| 230 / 30 | | | Survey pin elev. = 259.28 feet |
| 230 / 32 | | | Ground surface elev. = 258.8 feet |
| 230 / 32 | | | Northing = 877,658.29' |
| 230 / 32 | | | Easting = 1,976,948.04' |
| 225 / 34 | | | |
| 225 / 36 | | | |
| 220 / 38 | | | |

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GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

# METHANE MONITORING PROBE NO. MM-102

PROJECT: Perry Uniontown Landfill — PROJECT NO.: J09-4999-18

CLIENT: Hodges, Harbin, Newberry & Tribble, Inc. — START: 9-10-09 END: 9-10-09

LOCATION: Uniontown, Alabama — ELEVATION: 258.3

DRILLER: Landprobe, R. Banks — LOGGED BY: M. Preddy/C. Brown

DRILLING METHOD: CME 750 ATV; 8-1/4 inch OD hollow stem auger

DEPTH TO - WATER> INITIAL: ▽ _____ AFTER 24 HOURS: ▼ _____ CAVING> _____

| ELEVATION/ DEPTH (FT) | DESCRIPTION | SOIL TYPE | MONITOR WELL INSTALLATION DETAILS |
|---|---|---|---|
| 255 / 0 | 6-inches of TOPSOIL | | Neat cement, 0 to 1.12 feet |
| | Stiff, brown, slightly moist, silty CLAY | | Bentonite seal, 1.12 to 2.12 feet |
| 2 | | | Filter pack, sand 2.12 to 2.78 feet |
| 4 | | | Pea gravel, 2.78 to 18.01 feet |
| 6 | | | |
| 250 / 8 | Hard, gray, moist, silty CLAY | | 2-inch diameter, 0.010-inch slotted Schedule 40 PVC well screen, 2.76 to 17.76 feet |
| 10 | | | |
| 12 | | | |
| 245 / 14 | | | |
| 16 | | | |
| 240 / 18 | Boring terminated at 18.01 feet. | | Pipe cap |
| | | | Total well depth, 18.01 feet |
| 20 | | | SURFACE COMPLETION: 4" round stand-up locking aluminum protective cover with a 3' x 3' concrete pad at the base with survey pin |
| 22 | | | |
| 235 / 24 | | | 1/4-inch weep hole installed in aluminum cover |
| 26 | | | PVC stick-up = 3.15-feet |
| 230 / 28 | | | Top of PVC casing elev. = 261.42 feet |
| 30 | | | Survey pin elev. = 258.74 feet |
| 32 | | | Ground surface elev. = 258.3 feet |
| 225 / 34 | | | Northing = 877,689.98' |
| | | | Easting = 1,976,892.29' |
| 36 | | | |
| 220 / 38 | | | |

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**BUNNELL-LAMMONS ENGINEERING, INC.**

GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

# METHANE MONITORING PROBE NO. MM-103

PROJECT: Perry Uniontown Landfill — PROJECT NO.: J09-4999-18

CLIENT: Hodges, Harbin, Newberry & Tribble, Inc. — START: 9-3-09 END: 9-3-09

LOCATION: Uniontown, Alabama — ELEVATION: 260.6

DRILLER: Landprobe, R. Banks — LOGGED BY: M. Preddy/C. Brown

DRILLING METHOD: CME 750 ATV; 8-1/4 inch OD hollow stem auger

DEPTH TO - WATER> INITIAL: ▽ _____ AFTER 24 HOURS: ▼ _____ CAVING> _____

| ELEVATION/ DEPTH (FT) | DESCRIPTION | SOIL TYPE | MONITOR WELL INSTALLATION DETAILS |
|---|---|---|---|
| 260 / 0 | Soft, light brown, moist, fine to medium sandy, clayey SILT | | Neat cement, 0 to 1.19 feet |
| 2 | | | Bentonite seal, 1.19 to 2.19 feet |
| 4 | | | Filter pack, sand 2.19 to 2.82 feet<br>Pea gravel, 2.82 to 18.27 feet |
| 255 / 6 | | | |
| 8 | Hard, gray, moist, clayey SILT | | 2-inch diameter, 0.010-inch slotted Schedule 40 PVC well screen, 3.02 to 18.02 feet |
| 250 / 10 | | | |
| 12 | Very hard, gray, slightly moist, clayey SILT | | |
| 245 / 14 | | | |
| 16 | | | |
| 18 | | | Pipe cap |
| | Boring terminated at 18.27 feet. | | Total well depth, 18.27 feet |
| 240 / 20 | | | SURFACE COMPLETION<br>4" round stand-up locking aluminum protective cover with a 3' x 3' concrete pad at the base with survey pin |
| 22 | | | |
| 24 | | | 1/4-inch weep hole installed in aluminum cover |
| 235 / 26 | | | PVC stick-up = 3.04-feet |
| 28 | | | Top of PVC casing elev. = 263.68 feet |
| 30 | | | Survey pin elev. = 261.07 feet |
| 230 / 32 | | | Ground surface elev. = 260.6 feet |
| 34 | | | Northing = 877,885.56' |
| 225 / 36 | | | Easting = 1,976,636.30' |
| 38 | | | |

GEOT_WELLNB 499... .GPJ 9/29/09

BLE INC.

**BUNNELL-LAMMONS ENGINEERING, INC.**

GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

# METHANE MONITORING PROBE NO. MM-104

PROJECT: Perry Uniontown Landfill | PROJECT NO.: J09-4999-18

CLIENT: Hodges, Harbin, Newberry & Tribble, Inc. | START: 9-9-09 END: 9-9-09

LOCATION: Uniontown, Alabama | ELEVATION: 269.8

DRILLER: Landprobe, R. Banks | LOGGED BY: M. Preddy/C. Brown

DRILLING METHOD: CME 750 ATV; 8-1/4 inch OD hollow stem auger

DEPTH TO - WATER> INITIAL: ▽ AFTER 24 HOURS: ▼ CAVING>

| ELEVATION/ DEPTH (FT) | DESCRIPTION | SOIL TYPE | MONITOR WELL INSTALLATION DETAILS |
|---|---|---|---|
| 265 / 0 | Stiff, brown, moist, fine sandy, silty CLAY - (fill) | | Neat cement, 0 to 1.11 feet<br>Bentonite seal, 1.11 to 2.11 feet<br>Filter pack, sand 2.11 to 2.73 feet<br>Pea gravel, 2.73 to 33.03 feet<br><br>SURFACE COMPLETION<br>4" round stand-up locking aluminum protective cover with a 3' x 3' concrete pad at the base with survey pin<br><br>1/4-inch weep hole installed in aluminum cover<br><br>PVC stick-up = 2.92-feet<br><br>Top of PVC casing elev. = 272.68 feet<br><br>Survey pin elev. = 269.96 feet<br><br>Ground surface elev. = 269.8 feet<br><br>Northing = 877,971.35'<br>Easting = 1,976,509.46' |
| 260 / 10 | | | |
| 255 / 15 | Hard, grayish-brown, moist, fine to medium sandy, clayey SILT | | |
| 250 / 20 | | | |
| 245 / 25 | Very stiff, gray, moist, silty CLAY | | 2-inch diameter, 0.010-inch slotted Schedule 40 PVC well screen, 2.78 to 32.78 feet<br><br>Pipe cap<br><br>Total well depth, 33.03 feet |
| 240 / 30 | | | |
| 235 / 35 | Boring terminated at 33.03 feet. | | |
| 230 / 40 | | | |

GEOT_WELLNB 4999-18.GPJ 9/29/09

BLB INC.

**BUNNELL-LAMMONS ENGINEERING, INC.**

GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

# METHANE MONITORING PROBE NO. MM-105R

PROJECT: Arrowhead Landfill — PROJECT NO.: J16-4999-41

CLIENT: Perry County Associate, LLC — START: 4-26-16 END: 4-26-16

LOCATION: Perrry County, Alabama — ELEVATION: 264.88

DRILLER: CTL, Inc., L. Perkins — LOGGED BY: D. Weinstein

DRILLING METHOD: CME 550 ATV; 8-1/4 inch OD hollow stem auger

DEPTH TO - WATER> INITIAL: ▽ _____ AFTER 24 HOURS: ▼ _____ CAVING> _____

| ELEVATION/ DEPTH (FT) | DESCRIPTION | SOIL TYPE | SAMPLES | STANDARD PENETRATION RESULTS BLOWS/FOOT (2 5 10 20 30 40 50 70 90) | MONITOR WELL INSTALLATION DETAILS |
|---|---|---|---|---|---|
| | TOPSOIL | | | | Neat cement, 0 to 2.3 feet |
| 260 — 5 | Very stiff, white to yellowish-brown, slightly moist, fine to medium sandy, silty CLAY | | 6 8 8 | ● | Bentonite seal, 2.3 to 2.8 feet<br>Filter pack, sand 2.8 to 3.4 feet<br>Pea gravel, 3.4 to 19.0 feet |
| 255 — 10 | Hard, gray, slightly moist, fine to medium sandy, clayey SILT | | 8 22 20 | ● | 2-inch diameter, 0.020-inch slotted Schedule 40 PVC well screen, 3.3 to 18.3 feet |
| 250 — 15 | | | 11 21 20 | ● | Pipe cap |
| 245 — 20 | Boring terminated at 19.0 feet. No groundwater encountered at time of drilling. | | | | Total well depth, 18.50 feet |
| | | | | | SURFACE COMPLETION<br>4" round stand-up locking aluminum protective cover with a 4' x 4' concrete pad at the base with survey pin |
| 240 — 25 | | | | | 1/4-inch weep hole installed in aluminum cover |
| | | | | | PVC stick-up = 3.3-feet |
| | | | | | Top of PVC casing elev. = 268.18 feet |
| 235 — 30 | | | | | Survey pin elev. = 265.42 feet |
| | | | | | Ground surface elev. = 264.88 feet |
| | | | | | Northing = 878,328.61' |
| | | | | | Easting = 1,976,617.09' |
| 230 — 35 | | | | | |

GEOT□WELL 4999-41.GPJ 6/4/16

BLB INC.

**BUNNELL-LAMMONS ENGINEERING, INC.**

GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

# METHANE MONITORING PROBE NO. MM-106R

PROJECT: Arrowhead Landfill — PROJECT NO.: J16-4999-41

CLIENT: Perry County Associate, LLC — START: 4-25-16 END: 4-26-16

LOCATION: Perrry County, Alabama — ELEVATION: 265.43

DRILLER: CTL, Inc., L. Perkins — LOGGED BY: D. Weinstein

DRILLING METHOD: CME 550 ATV; 8-1/4 inch OD hollow stem auger

DEPTH TO - WATER> INITIAL: _____ AFTER 24 HOURS: _____ CAVING> _____

| ELEVATION/ DEPTH (FT) | DESCRIPTION | SOIL TYPE | SAMPLES | STANDARD PENETRATION RESULTS BLOWS/FOOT (2 5 10 20 30 40 50 70 90) | MONITOR WELL INSTALLATION DETAILS |
|---|---|---|---|---|---|
| 265 / 0 | TOPSOIL | | | | Neat cement, 0 to 2.0 feet |
| | Stiff, white to yellowish-brown, slightly moist, fine to medium sandy, silty CLAY | | 5 6 6 | ● at 12 | Bentonite seal, 2.0 to 3.0 feet<br>Filter pack, sand 3.0 to 3.5 feet<br>Pea gravel, 3.5 to 19.0 feet |
| 260 / 5 | | | | | |
| | Very hard, gray, slightly moist, fine to medium sandy, clayey SILT | | 16 20 32 | ● at 50 | |
| 255 / 10 | | | | | 2-inch diameter, 0.020-inch slotted Schedule 40 PVC well screen, 3.3 to 18.3 feet |
| | Hard, gray, slightly moist, fine to medium sandy, clayey SILT | | 12 19 20 | ● at 40 | |
| 250 / 15 | | | | | |
| 245 / 20 | Boring terminated at 19.0 feet. No groundwater encountered at time of drilling. | | | | Pipe cap<br>Total well depth, 18.50 feet<br>SURFACE COMPLETION<br>4" round stand-up locking aluminum protective cover with a 4' x 4' concrete pad at the base with survey pin |
| 240 / 25 | | | | | 1/4-inch weep hole installed in aluminum cover<br>PVC stick-up = 2.8-feet<br>Top of PVC casing elev. = 268.23 feet |
| 235 / 30 | | | | | Survey pin elev. = 265.73 feet<br>Ground surface elev. = 265.43 feet<br>Northing = 878,454.98'<br>Easting = 1,976,472.57' |
| 230 / 35 | | | | | |

GEOT□WELL 4999-41.GPJ 6/4/16

# 8.0 LEACHATE COLLECTION SYSTEM CALCULATIONS

A. Leachate Collection System Equivalency, prepared by Golder Associates, Inc., dated July 21, 2010

The enclosed evaluation was originally submitted to and approved by ADEM through a minor modification to revise the protective cover thickness from 24 inches to 12 inches. This evaluation provides the demonstration of performance supporting this request.

| Golder Associates | Subject : Leachate Collection System Equivalency | | | | | |
|---|---|---|---|---|---|---|
| | Job#: | 0939-0298.06 | Made by: | SJA | Date: | 7/21/2010 |
| | Ref: | Perry County - Arrowhead Landfill - AL | Checked by: | CMM | Sheet: | 1 of 1 |
| | | | Reviewed by: | GLH | | |

**Objective :**

Compare the hydraulic performance of the proposed leachate collection system versus the permitted leachate collection system. The proposed leachate collection system will only include 12 inches of protective cover instead of 24 inches.

**Method :**

Use the results from the USEPA Hydrologic Evaluation of Landfill Performance (HELP) model version 3.07 (see HELP Evaluation Calculations) to estimate the maximum head on the liner for active conditions for both leachate collection systems.

| Liner System | Layer 1 | Layer 2 | Layer 3 | Layer 4 | Layer 5 |
|---|---|---|---|---|---|
| Permitted | 12" daily cover | 240" waste | 24" Protective cover | .06" FML | 24" clay liner ($10^{-7}$ c/s) |
| Alternative LCS | 6" daily cover | 240" waste | 12" Protective cover | .06" FML | 24" clay liner ($10^{-7}$ c/s) |

**Assumptions :**

- The SCS Run-off curve number was calculated by HELP using slope and soil texture info.
- Climatological data for Montgomery, Alabama, was used.
- The scenarios were run with a 1 year simulation period for an active phase with waste height of 15ft.
- The initial soil water content was estimated by the model.
- The geomembrane has 3 manufacturing defects and 3 installation defects.
- The scenarios were modeled using a minimum slope of LCS of 2.0% for the original permit and 2.6% for the proposed conditions.
- The maximum drainage pipe spacing was calculated to be 200ft in order to meet the head requirements.
- The scenarios assumed that 25% of the area allowed runoff per the stormwater diversion berms in the landfill cell design.

**Model Results : (See attached Runs)**

The following percolation/leakage rates through the bottom layer of the liner system were calculated by the HELP model:

**Percolation/Leakage Rates (See attached HELP Model runs)**

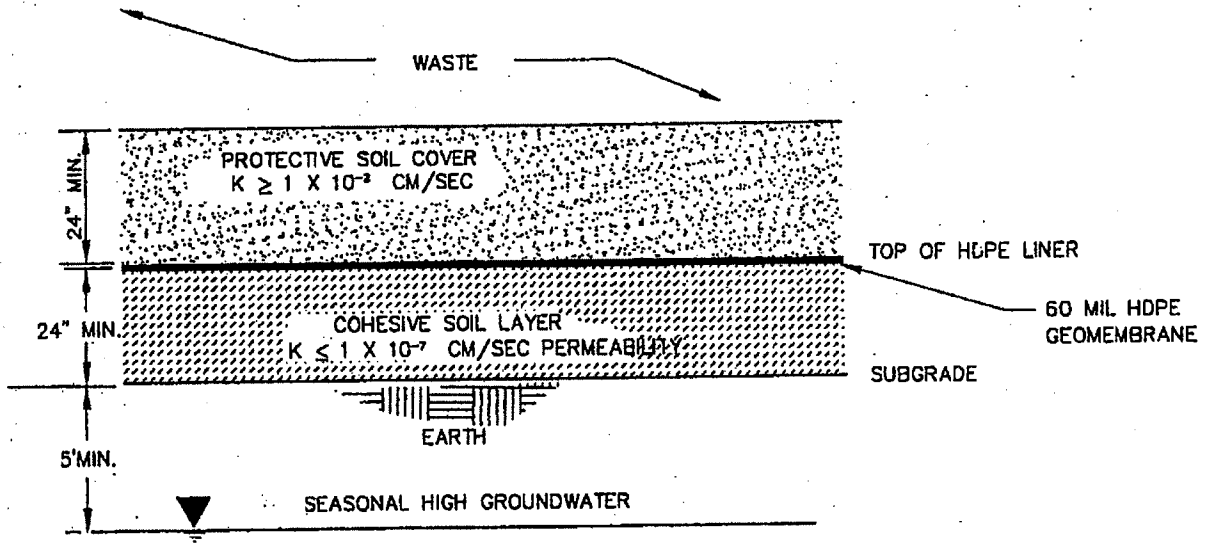
| Liner Type | Peak Leachate collected (cf/day/ac) | Avg. Daily Leachate collected (cf/day/ac) | Max. Head on Liner (Inches) |
|---|---|---|---|
| Subtitle D | 172.3 | 73.81 | 11.6 |
| Proposed Liner | 212.0 | 65.54 | 11.6 |

**Conclusion:**

From the calculations above it can be seen that the proposed leachate collection system nominally equivalent in hydraulic performance to the permitted leachate collection system, and both systems are calculated to have maximum head conditions under the required limit of 12 inches.

Arrowhead Landfill Proposed Bottom Liner Modification

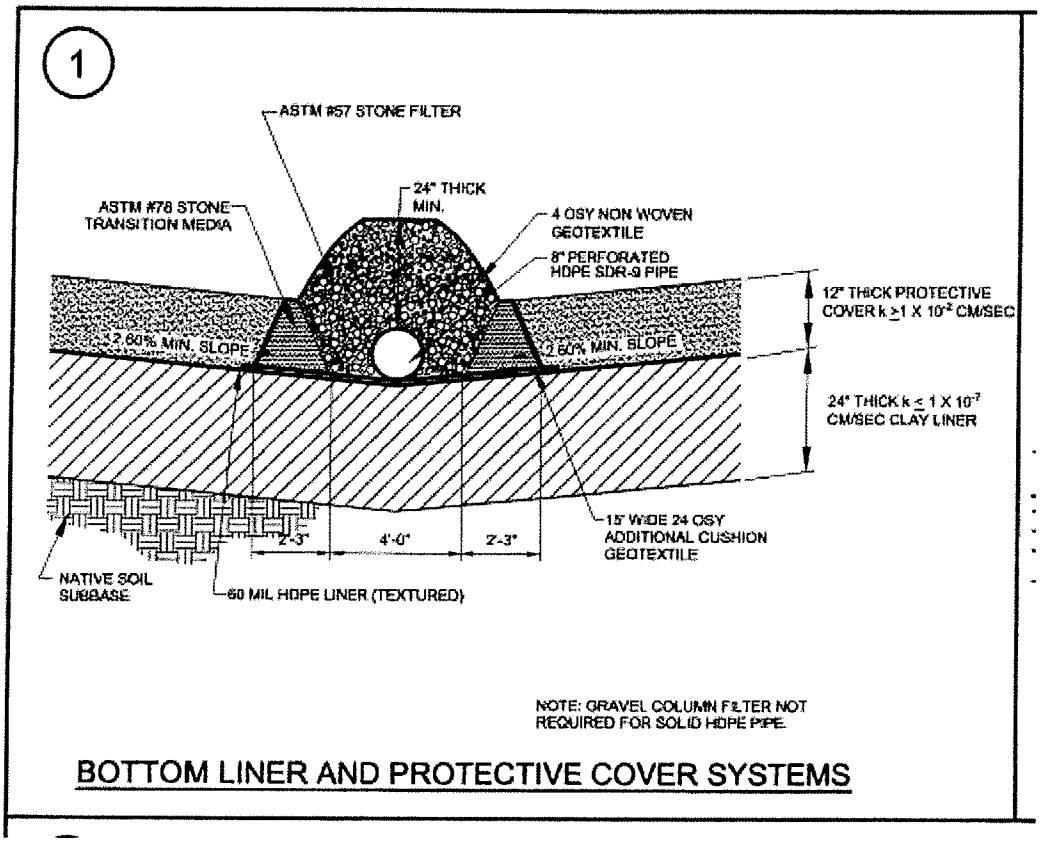
Original Permitted Bottom Liner Leachate Collection System (LCS) – JJ&G 2001




COMPOSITE LINER (1/13)
N.T.S.

NOTE:
MINIMUM BASE LINER SLOPE IS 3%.
MAXIMUM BASE LINER SLOPE IS 3:1.

Proposed Alternative Bottom Liner Leachate Collection System (LCS) – HHNT 2010



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**                                                                  **
**                                                                  **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE        **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)        **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY           **
**                    USAE WATERWAYS EXPERIMENT STATION             **
**              FOR USEPA RISK REDUCTION ENGINEERING LABORATORY      **
**                                                                  **
**                                                                  **
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SOLAR RADIATION DATA FILE:   C:\DOCUME~1\SADDISON\DESKTOP\HELP3\AH-A.D13
EVAPOTRANSPIRATION DATA:     C:\DOCUME~1\SADDISON\DESKTOP\HELP3\AH-A.D11
SOIL AND DESIGN DATA FILE:   C:\DOCUME~1\SADDISON\DESKTOP\HELP3\ah-opbl.D10
OUTPUT DATA FILE:            C:\DOCUME~1\SADDISON\DESKTOP\HELP3\ah-opbl.OUT

TIME:  14:58     DATE:   7/27/2010

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     TITLE:  Arrowhead active conditions - original permitted base liner *

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     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
            COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                                LAYER  1
                                --------

                TYPE 1 - VERTICAL PERCOLATION LAYER
                    MATERIAL TEXTURE NUMBER  15
     THICKNESS                    =     12.00   INCHES      DAILY COVER
     POROSITY                     =      0.4750 VOL/VOL
     FIELD CAPACITY               =      0.3780 VOL/VOL
     WILTING POINT                =      0.2650 VOL/VOL
     INITIAL SOIL WATER CONTENT   =      0.4264 VOL/VOL
     EFFECTIVE SAT. HYD. COND.    =  0.170000003000E-04 CM/SEC


                                LAYER  2
                                --------

                TYPE 1 - VERTICAL PERCOLATION LAYER
                    MATERIAL TEXTURE NUMBER  18
     THICKNESS                    =    180.00   INCHES      WASTE
     POROSITY                     =      0.6710 VOL/VOL
     FIELD CAPACITY               =      0.2920 VOL/VOL
     WILTING POINT                =      0.0770 VOL/VOL
     INITIAL SOIL WATER CONTENT   =      0.3097 VOL/VOL
     EFFECTIVE SAT. HYD. COND.    =  0.100000005000E-02 CM/SEC
```

LAYER 3

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 1

PROTECTIVE COVER

| | | | |
|---|---|---|---|
| THICKNESS | = | 24.00 | INCHES |
| POROSITY | = | 0.4170 | VOL/VOL |
| FIELD CAPACITY | = | 0.0450 | VOL/VOL |
| WILTING POINT | = | 0.0180 | VOL/VOL |
| INITIAL SOIL WATER CONTENT | = | 0.0949 | VOL/VOL |
| EFFECTIVE SAT. HYD. COND. | = | 0.999999978000E-02 | CM/SEC |
| SLOPE | = | 2.00 | PERCENT |
| DRAINAGE LENGTH | = | 200.0 | FEET |

LAYER 4

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 35

FML

| | | | |
|---|---|---|---|
| THICKNESS | = | 0.06 | INCHES |
| POROSITY | = | 0.0000 | VOL/VOL |
| FIELD CAPACITY | = | 0.0000 | VOL/VOL |
| WILTING POINT | = | 0.0000 | VOL/VOL |
| INITIAL SOIL WATER CONTENT | = | 0.0000 | VOL/VOL |
| EFFECTIVE SAT. HYD. COND. | = | 0.199999996000E-12 | CM/SEC |
| FML PINHOLE DENSITY | = | 8.10 | HOLES/ACRE |
| FML INSTALLATION DEFECTS | = | 3.00 | HOLES/ACRE |
| FML PLACEMENT QUALITY | = | 4 - POOR | |

LAYER 5

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 16

CCL

| | | | |
|---|---|---|---|
| THICKNESS | = | 24.00 | INCHES |
| POROSITY | = | 0.4270 | VOL/VOL |
| FIELD CAPACITY | = | 0.4180 | VOL/VOL |
| WILTING POINT | = | 0.3670 | VOL/VOL |
| INITIAL SOIL WATER CONTENT | = | 0.4270 | VOL/VOL |
| EFFECTIVE SAT. HYD. COND. | = | 0.100000001000E-06 | CM/SEC |

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE #15 WITH BARE GROUND CONDITIONS, A SURFACE SLOPE OF 5.% AND A SLOPE LENGTH OF 400. FEET.

| | | | |
|---|---|---|---|
| SCS RUNOFF CURVE NUMBER | = | 96.60 | |
| FRACTION OF AREA ALLOWING RUNOFF | = | 25.0 | PERCENT |
| AREA PROJECTED ON HORIZONTAL PLANE | = | 1.000 | ACRES |
| EVAPORATIVE ZONE DEPTH | = | 10.0 | INCHES |
| INITIAL WATER IN EVAPORATIVE ZONE | = | 4.282 | INCHES |
| UPPER LIMIT OF EVAPORATIVE STORAGE | = | 4.750 | INCHES |
| LOWER LIMIT OF EVAPORATIVE STORAGE | = | 2.650 | INCHES |
| INITIAL SNOW WATER | = | 0.000 | INCHES |
| INITIAL WATER IN LAYER MATERIALS | = | 73.386 | INCHES |
| TOTAL INITIAL WATER | = | 73.386 | INCHES |
| TOTAL SUBSURFACE INFLOW | = | 0.00 | INCHES/YEAR |

## EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
MONTGOMERY ALABAMA

| | | |
|---|---|---|
| STATION LATITUDE | = 32.18 | DEGREES |
| MAXIMUM LEAF AREA INDEX | = 0.00 | |
| START OF GROWING SEASON (JULIAN DATE) | = 59 | |
| END OF GROWING SEASON (JULIAN DATE) | = 329 | |
| EVAPORATIVE ZONE DEPTH | = 10.0 | INCHES |
| AVERAGE ANNUAL WIND SPEED | = 6.70 | MPH |
| AVERAGE 1ST QUARTER RELATIVE HUMIDITY | = 68.00 | % |
| AVERAGE 2ND QUARTER RELATIVE HUMIDITY | = 70.00 | % |
| AVERAGE 3RD QUARTER RELATIVE HUMIDITY | = 75.00 | % |
| AVERAGE 4TH QUARTER RELATIVE HUMIDITY | = 72.00 | % |

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR MONTGOMERY ALABAMA

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

| JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|
| 4.20 | 4.51 | 5.92 | 4.38 | 4.00 | 3.45 |
| 4.78 | 3.17 | 4.72 | 2.27 | 2.98 | 4.78 |

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR MONTGOMERY ALABAMA

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

| JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|
| 46.70 | 49.90 | 56.80 | 65.20 | 72.40 | 79.10 |
| 81.70 | 81.20 | 76.70 | 65.30 | 55.00 | 48.90 |

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR MONTGOMERY ALABAMA
AND STATION LATITUDE = 32.18 DEGREES

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 1

| | JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|---|
| **PRECIPITATION** | | | | | | |
| TOTALS | 2.22 | 4.04 | 4.41 | 1.16 | 2.14 | 5.87 |
| | 3.21 | 4.04 | 4.78 | 2.77 | 0.88 | 7.59 |
| STD. DEVIATIONS | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **RUNOFF** | | | | | | |
| TOTALS | 0.156 | 0.533 | 0.625 | 0.043 | 0.155 | 0.526 |
| | 0.153 | 0.505 | 1.609 | 0.369 | 0.111 | 1.337 |
| STD. DEVIATIONS | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| **EVAPOTRANSPIRATION** | | | | | | |
| TOTALS | 2.200 | 2.128 | 3.079 | 1.920 | 2.219 | 4.588 |
| | 3.428 | 2.972 | 1.558 | 3.467 | 0.814 | 1.076 |
| STD. DEVIATIONS | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| **LATERAL DRAINAGE COLLECTED FROM LAYER 3** | | | | | | |
| TOTALS | 0.6594 | 1.2346 | 1.0827 | 1.2181 | 0.8607 | 0.5458 |
| | 0.3691 | 0.2408 | 0.1669 | 0.2235 | 0.4635 | 0.3567 |
| STD. DEVIATIONS | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| **PERCOLATION/LEAKAGE THROUGH LAYER 5** | | | | | | |
| TOTALS | 0.0026 | 0.0046 | 0.0041 | 0.0045 | 0.0033 | 0.0022 |
| | 0.0015 | 0.0010 | 0.0007 | 0.0010 | 0.0019 | 0.0015 |
| STD. DEVIATIONS | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

| | | | | | | |
|---|---|---|---|---|---|---|
| **DAILY AVERAGE HEAD ON TOP OF LAYER 4** | | | | | | |
| AVERAGES | 3.7534 | 7.7810 | 6.1629 | 7.1647 | 4.8995 | 3.2105 |
| | 2.1012 | 1.3706 | 0.9816 | 1.2725 | 2.7265 | 2.0302 |
| STD. DEVIATIONS | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 1

| | INCHES | CU. FEET | PERCENT |
|---|---|---|---|
| PRECIPITATION | 43.11 ( 0.000) | 156489.3 | 100.00 |
| RUNOFF | 6.122 ( 0.0000) | 22221.33 | 14.200 |
| EVAPOTRANSPIRATION | 29.449 ( 0.0000) | 106900.54 | 68.312 |
| LATERAL DRAINAGE COLLECTED FROM LAYER 3 | 7.42177 ( 0.00000) | 26941.037 | 17.21590 |
| PERCOLATION/LEAKAGE THROUGH LAYER 5 | 0.02889 ( 0.00000) | 104.860 | 0.06701 |
| AVERAGE HEAD ON TOP OF LAYER 4 | 3.621 ( 0.000) | | |
| CHANGE IN WATER STORAGE | 0.089 ( 0.0000) | 321.51 | 0.205 |

AVG YEARLY COLLECTION

PEAK DAILY VALUES FOR YEARS 1 THROUGH 1

| | (INCHES) | (CU. FT.) |
|---|---|---|
| PRECIPITATION | 3.71 | 13467.300 |
| RUNOFF | 1.320 | 4791.3281 |
| DRAINAGE COLLECTED FROM LAYER 3 | 0.04746 | 172.29695 |
| PERCOLATION/LEAKAGE THROUGH LAYER 5 | 0.000175 | 0.63400 |
| AVERAGE HEAD ON TOP OF LAYER 4 | 8.376 | |
| MAXIMUM HEAD ON TOP OF LAYER 4 | 11.616 | |
| LOCATION OF MAXIMUM HEAD IN LAYER 3 (DISTANCE FROM DRAIN) | 61.3 FEET | |
| SNOW WATER | 2.02 | 7328.4658 |

PEAK DAILY

MAX CALCULATED HEAD

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.4534

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.2650

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner
by Bruce M. McEnroe, University of Kansas
ASCE Journal of Environmental Engineering
Vol. 119, No. 2, March 1993, pp. 262-270.

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FINAL WATER STORAGE AT END OF YEAR 1

| LAYER | (INCHES) | (VOL/VOL) |
|---|---|---|
| 1 | 5.1189 | 0.4266 |
| 2 | 55.7441 | 0.3097 |
| 3 | 2.3636 | 0.0985 |
| 4 | 0.0000 | 0.0000 |
| 5 | 10.2480 | 0.4270 |
| SNOW WATER | 0.000 | |

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**                                                                              **
**                                                                              **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE                   **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                    **
**                   DEVELOPED BY ENVIRONMENTAL LABORATORY                      **
**                     USAE WATERWAYS EXPERIMENT STATION                        **
**              FOR USEPA RISK REDUCTION ENGINEERING LABORATORY                 **
**                                                                              **
**                                                                              **
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TEMPERATURE DATA FILE:       C:\DOCUME~1\SADDISON\DESKTOP\HELP3\AH-A.D7
SOLAR RADIATION DATA FILE:   C:\DOCUME~1\SADDISON\DESKTOP\HELP3\AH-A.D13
EVAPOTRANSPIRATION DATA:     C:\DOCUME~1\SADDISON\DESKTOP\HELP3\AH-A.D11
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OUTPUT DATA FILE:            C:\DOCUME~1\SADDISON\DESKTOP\HELP3\ah-newb4.OUT

TIME:  15:40     DATE:   7/27/2010

**********************************************************************************

     TITLE:  Arrowhead active conditions - proposed base liner system -
     2.6%, 25% runoff, 200 ft pipe spacing, good placement                    *

**********************************************************************************

     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
            COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.

                                LAYER  1
                                --------

            TYPE 1 - VERTICAL PERCOLATION LAYER
                MATERIAL TEXTURE NUMBER  15                          DAILY COVER
     THICKNESS                    =      6.00   INCHES
     POROSITY                     =      0.4750 VOL/VOL
     FIELD CAPACITY               =      0.3780 VOL/VOL
     WILTING POINT                =      0.2650 VOL/VOL
     INITIAL SOIL WATER CONTENT   =      0.4286 VOL/VOL
     EFFECTIVE SAT. HYD. COND.    =  0.170000003000E-04 CM/SEC

                                LAYER  2
                                --------

            TYPE 1 - VERTICAL PERCOLATION LAYER                      WASTE
                MATERIAL TEXTURE NUMBER  18
     THICKNESS                    =    180.00   INCHES
     POROSITY                     =      0.6710 VOL/VOL
     FIELD CAPACITY               =      0.2920 VOL/VOL
     WILTING POINT                =      0.0770 VOL/VOL
     INITIAL SOIL WATER CONTENT   =      0.3095 VOL/VOL
     EFFECTIVE SAT. HYD. COND.    =  0.100000005000E-02 CM/SEC
```

LAYER 3

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 1

PROTECTIVE COVER

| | | | |
|---|---|---|---|
| THICKNESS | = | 12.00 | INCHES |
| POROSITY | = | 0.4170 | VOL/VOL |
| FIELD CAPACITY | = | 0.0450 | VOL/VOL |
| WILTING POINT | = | 0.0180 | VOL/VOL |
| INITIAL SOIL WATER CONTENT | = | 0.0870 | VOL/VOL |
| EFFECTIVE SAT. HYD. COND. | = | 0.999999978000E-02 | CM/SEC |
| SLOPE | = | 2.60 | PERCENT |
| DRAINAGE LENGTH | = | 200.0 | FEET |

LAYER 4

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 35

FML

| | | | |
|---|---|---|---|
| THICKNESS | = | 0.06 | INCHES |
| POROSITY | = | 0.0000 | VOL/VOL |
| FIELD CAPACITY | = | 0.0000 | VOL/VOL |
| WILTING POINT | = | 0.0000 | VOL/VOL |
| INITIAL SOIL WATER CONTENT | = | 0.0000 | VOL/VOL |
| EFFECTIVE SAT. HYD. COND. | = | 0.199999996000E-12 | CM/SEC |
| FML PINHOLE DENSITY | = | 3.00 | HOLES/ACRE |
| FML INSTALLATION DEFECTS | = | 3.00 | HOLES/ACRE |
| FML PLACEMENT QUALITY | = | 3 - GOOD | |

LAYER 5

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 16

CCL

| | | | |
|---|---|---|---|
| THICKNESS | = | 24.00 | INCHES |
| POROSITY | = | 0.4270 | VOL/VOL |
| FIELD CAPACITY | = | 0.4180 | VOL/VOL |
| WILTING POINT | = | 0.3670 | VOL/VOL |
| INITIAL SOIL WATER CONTENT | = | 0.4270 | VOL/VOL |
| EFFECTIVE SAT. HYD. COND. | = | 0.100000001000E-06 | CM/SEC |

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE #15 WITH BARE GROUND CONDITIONS, A SURFACE SLOPE OF 5.% AND A SLOPE LENGTH OF 400. FEET.

| | | | |
|---|---|---|---|
| SCS RUNOFF CURVE NUMBER | = | 96.60 | |
| FRACTION OF AREA ALLOWING RUNOFF | = | 25.0 | PERCENT |
| AREA PROJECTED ON HORIZONTAL PLANE | = | 1.000 | ACRES |
| EVAPORATIVE ZONE DEPTH | = | 10.0 | INCHES |
| INITIAL WATER IN EVAPORATIVE ZONE | = | 3.700 | INCHES |
| UPPER LIMIT OF EVAPORATIVE STORAGE | = | 5.534 | INCHES |
| LOWER LIMIT OF EVAPORATIVE STORAGE | = | 1.898 | INCHES |
| INITIAL SNOW WATER | = | 0.000 | INCHES |
| INITIAL WATER IN LAYER MATERIALS | = | 69.572 | INCHES |
| TOTAL INITIAL WATER | = | 69.572 | INCHES |

TOTAL SUBSURFACE INFLOW = 0.00 INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
MONTGOMERY ALABAMA

| | | | |
|---|---|---|---|
| STATION LATITUDE | = | 32.18 | DEGREES |
| MAXIMUM LEAF AREA INDEX | = | 0.00 | |
| START OF GROWING SEASON (JULIAN DATE) | = | 59 | |
| END OF GROWING SEASON (JULIAN DATE) | = | 329 | |
| EVAPORATIVE ZONE DEPTH | = | 10.0 | INCHES |
| AVERAGE ANNUAL WIND SPEED | = | 6.70 | MPH |
| AVERAGE 1ST QUARTER RELATIVE HUMIDITY | = | 68.00 | % |
| AVERAGE 2ND QUARTER RELATIVE HUMIDITY | = | 70.00 | % |
| AVERAGE 3RD QUARTER RELATIVE HUMIDITY | = | 75.00 | % |
| AVERAGE 4TH QUARTER RELATIVE HUMIDITY | = | 72.00 | % |

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR MONTGOMERY ALABAMA

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

| JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|
| 4.20 | 4.51 | 5.92 | 4.38 | 4.00 | 3.45 |
| 4.78 | 3.17 | 4.72 | 2.27 | 2.98 | 4.78 |

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR MONTGOMERY ALABAMA

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

| JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|
| 46.70 | 49.90 | 56.80 | 65.20 | 72.40 | 79.10 |
| 81.70 | 81.20 | 76.70 | 65.30 | 55.00 | 48.90 |

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR MONTGOMERY ALABAMA
AND STATION LATITUDE = 32.18 DEGREES

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 1

| | JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|---|
| PRECIPITATION | | | | | | |
| TOTALS | 2.22 | 4.04 | 4.41 | 1.16 | 2.14 | 5.87 |
| | 3.21 | 4.04 | 4.78 | 2.77 | 0.88 | 7.59 |
| STD. DEVIATIONS | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| RUNOFF | | | | | | |
| TOTALS | 0.153 | 0.519 | 0.612 | 0.043 | 0.157 | 0.518 |
| | 0.150 | 0.497 | 1.566 | 0.354 | 0.111 | 1.253 |
| STD. DEVIATIONS | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| EVAPOTRANSPIRATION | | | | | | |
| TOTALS | 2.224 | 2.330 | 3.293 | 1.740 | 2.437 | 4.582 |
| | 3.464 | 2.888 | 2.062 | 3.476 | 1.069 | 1.078 |
| STD. DEVIATIONS | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| LATERAL DRAINAGE COLLECTED FROM LAYER 3 | | | | | | |
| TOTALS | 1.0268 | 1.3254 | 1.1477 | 1.0736 | 0.6062 | 0.3198 |
| | 0.1816 | 0.0993 | 0.0525 | 0.2534 | 0.3047 | 0.1994 |
| STD. DEVIATIONS | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| PERCOLATION/LEAKAGE THROUGH LAYER 5 | | | | | | |
| TOTALS | 0.0004 | 0.0004 | 0.0004 | 0.0004 | 0.0002 | 0.0001 |
| | 0.0001 | 0.0000 | 0.0000 | 0.0001 | 0.0001 | 0.0001 |
| STD. DEVIATIONS | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

| | | | | | | |
|---|---|---|---|---|---|---|
| DAILY AVERAGE HEAD ON TOP OF LAYER 4 | | | | | | |
| AVERAGES | 4.4973 | 6.4273 | 5.0267 | 4.8589 | 2.6549 | 1.4476 |
| | 0.7955 | 0.4350 | 0.2377 | 1.1098 | 1.3789 | 0.8735 |
| STD. DEVIATIONS | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

**********

AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 1

| | INCHES | CU. FEET | PERCENT |
|---|---|---|---|
| PRECIPITATION | 43.11 ( 0.000) | 156489.3 | 100.00 |
| RUNOFF | 5.932 ( 0.0000) | 21534.58 | 13.761 |
| EVAPOTRANSPIRATION | 30.644 ( 0.0000) | 111237.54 | 71.083 |
| LATERAL DRAINAGE COLLECTED FROM LAYER 3 | 6.59043 ( 0.00000) | 23923.271 | 15.28748 |
| PERCOLATION/LEAKAGE THROUGH LAYER 5 | 0.00232 ( 0.00000) | 8.423 | 0.00538 |
| AVERAGE HEAD ON TOP OF LAYER 4 | 2.479 ( 0.000) | | |
| CHANGE IN WATER STORAGE | -0.059 ( 0.0000) | -214.50 | -0.137 |

AVG ANNUAL COLLECTION

**********

**********

PEAK DAILY VALUES FOR YEARS 1 THROUGH 1

| | (INCHES) | (CU. FT.) |
|---|---|---|
| PRECIPITATION | 3.71 | 13467.300 |
| RUNOFF | 1.287 | 4673.2153 |
| DRAINAGE COLLECTED FROM LAYER 3 | 0.05841 | 212.01025 |
| PERCOLATION/LEAKAGE THROUGH LAYER 5 | 0.000019 | 0.06980 |
| AVERAGE HEAD ON TOP OF LAYER 4 | 7.930 | |
| MAXIMUM HEAD ON TOP OF LAYER 4 | 11.638 | |
| LOCATION OF MAXIMUM HEAD IN LAYER 3 (DISTANCE FROM DRAIN) | 53.1 FEET | |
| SNOW WATER | 2.02 | 7328.4658 |

PEAK DAILY COLLECTION

MAX CAL HEAD

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.4112

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.1898

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner
by Bruce M. McEnroe, University of Kansas
ASCE Journal of Environmental Engineering
Vol. 119, No. 2, March 1993, pp. 262-270.

**********

AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 1

| | INCHES | CU. FEET | PERCENT |
|---|---|---|---|
| PRECIPITATION | 43.11 ( 0.000) | 156489.3 | 100.00 |
| RUNOFF | 5.932 ( 0.0000) | 21534.58 | 13.761 |
| EVAPOTRANSPIRATION | 30.644 ( 0.0000) | 111237.54 | 71.083 |
| LATERAL DRAINAGE COLLECTED FROM LAYER 3 | 6.59043 ( 0.00000) | 23923.271 | 15.28748 |
| PERCOLATION/LEAKAGE THROUGH LAYER 5 | 0.00232 ( 0.00000) | 8.423 | 0.00538 |
| AVERAGE HEAD ON TOP OF LAYER 4 | 2.479 ( 0.000) | | |
| CHANGE IN WATER STORAGE | -0.059 ( 0.0000) | -214.50 | -0.137 |

AVG ANNUAL COLLECTION

PEAK DAILY VALUES FOR YEARS 1 THROUGH 1

| | (INCHES) | (CU. FT.) |
|---|---|---|
| PRECIPITATION | 3.71 | 13467.300 |
| RUNOFF | 1.287 | 4673.2153 |
| DRAINAGE COLLECTED FROM LAYER 3 | 0.05841 | 212.01025 |
| PERCOLATION/LEAKAGE THROUGH LAYER 5 | 0.000019 | 0.06980 |
| AVERAGE HEAD ON TOP OF LAYER 4 | 7.930 | |
| MAXIMUM HEAD ON TOP OF LAYER 4 | 11.638 | |
| LOCATION OF MAXIMUM HEAD IN LAYER 3 (DISTANCE FROM DRAIN) | 53.1 FEET | |
| SNOW WATER | 2.02 | 7328.4658 |

PEAK DAILY COLLECTION

MAX CAL HEAD

| | |
|---|---|
| MAXIMUM VEG. SOIL WATER (VOL/VOL) | 0.4112 |
| MINIMUM VEG. SOIL WATER (VOL/VOL) | 0.1898 |

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner
by Bruce M. McEnroe, University of Kansas
ASCE Journal of Environmental Engineering
Vol. 119, No. 2, March 1993, pp. 262-270.

**********

FINAL WATER STORAGE AT END OF YEAR 1

| LAYER | (INCHES) | (VOL/VOL) |
|---|---|---|
| 1 | 2.5727 | 0.4288 |
| 2 | 55.7151 | 0.3095 |
| 3 | 0.9766 | 0.0814 |
| 4 | 0.0000 | 0.0000 |
| 5 | 10.2480 | 0.4270 |
| SNOW WATER | 0.000 | |

**********
**********

# 9.0 STORMWATER, EROSION AND SEDIMENT CONTROL DESIGN CALCULATIONS

Intentionally not included – pending internal review

# STORMWATER, EROSION AND SEDIMENT CONTROL DESIGN CALCULATIONS

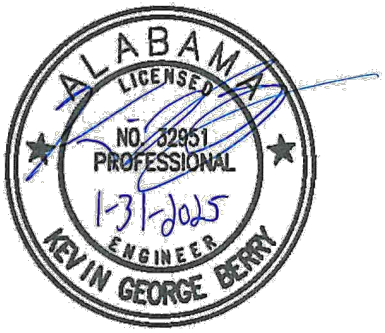
## 2025 VERTICAL EXPANSION APPLICATION
## ARROWHEAD LANDFILL

## PERRY COUNTY ASSOCIATES, LLC
## PERRY COUNTY, ALABAMA

## JANUARY 2025

*(Stormwater, Erosion and Sediment Control Design Calculations are to be reviewed by Design Engineer at the time of final closure to determine if any improvements or changes are warranted. All changes will be appropriately approved by ADEM prior to implementation)*

HHNT
HODGES, HARBIN, NEWBERRY & TRIBBLE, INC.
*Consulting Engineers*




3920 Arkwright Road, Suite 101 | Macon, Georgia | Phone: (478) 743-7175 | Fax: (478) 743-1703

# TABLE OF CONTENTS

INTRODUCTION ..... 1

**1. STORM DRAINAGE CALCULATIONS ..... 3**
a. Design Assumptions ..... 3
b. Landfill Side Slope Drainage Berm ..... 4
c. Side Slope Downdrains ..... 5
d. Drainage Ditches ..... 6
e. Storm Drainage Pipe Structures ..... 7
f. Outlet Protection ..... 10

**2. EXISTING SEDIMENT POND NO. 1 ..... 11**
a. Sediment Storage and Settling Efficiency Calculations ..... 11
b. Total Pond Dewatering at Top of Riser (Elev. 275.00) ..... 12
c. Reservoir Routing ..... 13
d. Emergency Spillway ..... 14
e. Overflow Structure and Carrier Pipe Design ..... 15
f. Anti-Seep Collar Design ..... 16
g. Overflow Structure Base Foundation Design ..... 17

**3. EXPANDED SEDIMENT POND NO. 2 ..... 21**
a. Sediment Storage and Settling Efficiency Calculations ..... 21
b. Total Pond Dewatering at Top of Riser (Elev. 264.50) ..... 22
c. Reservoir Routing ..... 23
d. Emergency Spillway ..... 24
e. Overflow Structure and Carrier Pipe Design ..... 25
f. Anti-Seep Collar Design ..... 26
g. Overflow Structure Base Foundation Design ..... 27

**4. EXISTING SEDIMENT POND NO. 3 ..... 31**
a. Sediment Storage and Settling Efficiency Calculations ..... 31
b. Total Pond Dewatering at Top of Riser (Elev. 251.50) ..... 32
c. Reservoir Routing ..... 33
d. Emergency Spillway ..... 34
e. Overflow Structure and Carrier Pipe Design ..... 35
f. Anti-Seep Collar Design ..... 36
g. Overflow Structure Base Foundation Design ..... 37

**5. PROPOSED SEDIMENT POND NO. 4 ..... 41**
a. Sediment Storage and Settling Efficiency Calculations ..... 41
b. Total Pond Dewatering at Top of Riser (Elev. 231.00) ..... 42
c. Reservoir Routing ..... 43
d. Emergency Spillway ..... 44
e. Overflow Structure and Carrier Pipe Design ..... 45
f. Anti-Seep Collar Design ..... 46
g. Overflow Structure Base Foundation Design ..... 47
**6. PROPOSED SEDIMENT POND NO. 5 ..... 51**
a. Sediment Storage and Settling Efficiency Calculations ..... 51
b. Total Pond Dewatering at Top of Riser (Elev. 271.00) ..... 52
c. Reservoir Routing ..... 54
d. Emergency Spillway ..... 55
e. Overflow Structure and Carrier Pipe Design ..... 56
f. Anti-Seep Collar Design ..... 57
g. Overflow Structure Base Foundation Design ..... 58
**7. PROPOSED SEDIMENT POND NO. 6 ..... 62**
a. Sediment Storage and Settling Efficiency Calculations ..... 62
b. Total Pond Dewatering at Top of Riser (Elev. 263.00) ..... 63
c. Reservoir Routing ..... 65
d. Emergency Spillway ..... 66
e. Overflow Structure and Carrier Pipe Design ..... 67
f. Anti-Seep Collar Design ..... 68
g. Overflow Structure Base Foundation Design ..... 69
**8. PROPOSED SEDIMENT POND NO. 7 ..... 73**
a. Sediment Storage and Settling Efficiency Calculations ..... 73
b. Total Pond Dewatering at Top of Riser (Elev. 220.00) ..... 74
c. Reservoir Routing ..... 75
d. Emergency Spillway ..... 76
e. Overflow Structure and Carrier Pipe Design ..... 77
f. Anti-Seep Collar Design ..... 78
g. Overflow Structure Base Foundation Design ..... 79
**9. EXISTING SEDIMENT POND NO. 8 ..... 83**
a. Sediment Storage and Settling Efficiency Calculations ..... 83
b. Total Pond Dewatering at Top of Riser (Elev. 226.25) ..... 84

c. Reservoir Routing ..... 86
d. Emergency Spillway ..... 87
e. Overflow Structure and Carrier Pipe Design ..... 88
f. Anti-Seep Collar Design ..... 89
g. Overflow Structure Base Foundation Design ..... 90

**10. PROPOSED SEDIMENT POND NO. 9 ..... 94**
a. Sediment Storage and Settling Efficiency Calculations ..... 94
b. Total Pond Dewatering at Top of Riser (Elev. 221.00) ..... 95
c. Reservoir Routing ..... 96
d. Emergency Spillway ..... 97
e. Overflow Structure and Carrier Pipe Design ..... 98
f. Anti-Seep Collar Design ..... 99
g. Overflow Structure Base Foundation Design ..... 100

**11. PROPOSED SEDIMENT POND NO. 10 ..... 104**
a. Sediment Storage and Settling Efficiency Calculations ..... 104
b. Total Pond Dewatering at Top of Riser (Elev. 209.00) ..... 105
c. Reservoir Routing ..... 106
d. Emergency Spillway ..... 107
e. Overflow Structure and Carrier Pipe Design ..... 108
f. Anti-Seep Collar Design ..... 109
g. Overflow Structure Base Foundation Design ..... 110

**12. PROPOSED SEDIMENT POND NO. 11 ..... 114**
a. Sediment Storage and Settling Efficiency Calculations ..... 114
b. Total Pond Dewatering at Top of Riser (Elev. 220.75) ..... 115
c. Reservoir Routing ..... 117
d. Emergency Spillway ..... 118
e. Overflow Structure and Carrier Pipe Design ..... 119
f. Anti-Seep Collar Design ..... 120
g. Overflow Structure Base Foundation Design ..... 121

List of Tables

Table 1 Downdrain Calculations
Table 2 Stormwater Drainage Ditch Calculations
Table 3 Drainage Structures

# INTRODUCTION

The Arrowhead Landfill is an existing municipal solid waste landfill located in Perry County, Alabama. This 2024 Vertical Expansion Application is being submitted in accordance with ADEM Rule 335-13-5-.02 and as required by the current facility permit, this Application provides detailed design calculations for Tract 1 (Existing), Tract 2, and Tract 3. It also provides confirmation that the previously constructed sediment ponds and structures will continue to function adequately through the remaining life of the landfill. The three existing ponds include No. 1, No. 2, and No. 8. All three of these ponds were constructed in accordance with the permitted Design & Operation Plan. The remaining ponds that have not been constructed shall also be constructed in accordance with their approved design. All calculations contained here have been prepared to meet or exceed the guidelines found in the "Alabama Handbook for Erosion Control, Sediment Control, and Stormwater Management on Construction Sites and Urban Areas."

Efforts have been made in the design of this facility to minimize the total disturbed area. Disturbed areas will be stabilized using erosion control measures. Stormwater which comes from off-site and undisturbed areas on-site will be diverted around the landfill. Stormwater which falls onto the landfill will be drained to and be transported by stormwater ditches to one of ten sediment ponds. These ponds are designed to protect water quality by reducing the stormwater runoff rate and removing total suspended solids (TSS) from stormwater runoff. These ponds, as well as a timely application of various erosion and sedimentation practices, will minimize the time that soils are exposed, control stormwater runoff, protect soils from erosive forces, protect surrounding property and preserve water quality. Below is a detailed description of the stormwater, erosion and sedimentation control techniques to be used at the landfill to protect the site and surrounding property.

The best way to control sediment is to minimize erosion at its source. One way to minimize erosion is to control stormwater through the use of stormwater management structures in areas of concentrated water flows. In the design of a landfill closure, stormwater must be controlled, collected and transported from the top of the landfill to the point where it exits the property. Stormwater which falls onto the top of a landfill or along its side slopes, will be collected by a series of side slope drainage berms and side slope downdrain pipes. Side slope drainage berms are vegetated earthen structures constructed across the landfill side slope. These are spaced every 40 vertical feet (approx.) on the landfill side slope. The side slope drainage berms are constructed a minimum of 2' high and at a minimum 2% slope along the stormwater pathway. The purpose of the side slope drainage berm is to reduce the slope length that stormwater runoff will travel as sheet flow, and move the stormwater to a side slope downdrain pipe. A variance was granted by ADEM to increase the vertical spacing of these stormwater drainage berms from 20' vertical to 40' vertical for this facility. Detailed calculations were prepared and submitted with the original variance supporting this request.

All landfill side slopes and berms will be grassed. Berms will be lined with a temporary liner, such as Excelsior Matting or other materials for temporary protection prior to permanent vegetation being established. The side slope downdrain pipes will be used to transport runoff from points on the landfill to the base of landfill sideslopes. These pipes will be 24" diameter corrugated HDPE pipe and will be sized to carry the runoff collected behind each berm while not exceeding 65% of the capacity of the 24" diameter pipe. The downdrain pipes will discharge into a stabilized open stormwater ditch system. A rip-rap apron or other energy dissipating device will be placed at the outlet of each downdrain system to

reduce the velocity of the concentrated pipe flow and prevent the stormwater ditch system around the landfill waste footprint collects all of the stormwater runoff from the outside edge of the access road around the landfill to the top of the landfill. These ditches are 4' wide at the bottom, 4' deep and have 3:1 side slopes. All ditches will be grassed. However if velocities exceed 2 feet per second (i.e. scour velocity), temporary and/or permanent protective measures will be used to prevent scouring. These include temporary liners which are used to protect the ditches until the grass has time to grow and mature, and permanent ditch liners, such as stone rip-rap, concrete or special geotextile materials. These liners are discussed further in this document.

The ditch system transports the stormwater by gravity to one of the sediment ponds. The stormwater is collected in drop inlets and transported under the access road and into the sediment ponds through drainage pipes. The inlets and pipes are sized to handle the 25 year - 24 hour storm event. Temporary drop inlet protection in the form of sediment traps and silt fences are used around the drop inlet to collect sediment from upstream ditches until the ditches are permanently stabilized. These protections help keep sediment out of the drainage pipe system. The outlet of each drainage pipe entering the sediment ponds is also protected from soil scouring with a stone rip-rap apron.

Sediment ponds are to be used for final trapping and settlement of sediment. Specific design specifications for each basin are included in this document.

Based on the topography of the site and the design of the landfill, there are areas that will be disturbed and the stormwater runoff from these areas can not be diverted to one of the sediment ponds. These areas include the outside cut and fill slopes on access roads and the sediment ponds. In order to control erosion and sedimentation, all of these areas will be protected by the installation of silt fencing as well as mulched and vegetated. Mulch helps to reduce runoff and erosion, conserve soil moisture, and prevent soil compaction and crusting. Each of these areas will be stabilized by using temporary and permanent grassing along with slope protective materials, such as Excelsior Matting, permanent erosion control pre-seeded blankets, channel liners, other types of erosion control blankets and mats, or a sprayed-on synthetic polyacrylamide polyamine, if required. The polyamine chemically binds to the fine clay particles and prevents the particles from going into solution. In addition to the use of mulch, grassing and slope protective materials, all areas downhill of a disturbed area will be protected with silt fencing. Silt fencing will capture sediment and prevent it from leaving the site and entering drainageways.

Erosion and sedimentation control measures will be inspected routinely and after significant rainfall events. Any damage observed will be repaired. Cleanout of sediment control structures will occur regularly to maintain the effectiveness of the structures. Sediment removed from these structures will be used as cover soils for the landfill waste. Silt fencing and drop inlet protection will remain in place until sediment contributing areas are stabilized.

The site manager of the landfill will be responsible for the facility stormwater, erosion and sedimentation control program. The address and telephone number of the manager is listed below:

Site Manager
Arrowhead Landfill
622 Tayloe Road
Uniontown, AL 36786
Phone: (334) 628-4844

# 1. STORM DRAINAGE CALCULATIONS

## a. Design Assumptions

The following assumptions are used to size all sideslope downdrains, side slope berms, drainage ditches, and storm drain piping.

1.) All downdrains are designed to flow less than 65% full.

2.) All downdrains are 24" diameter corrugated plastic pipe.

3.) All pipes, berms and ditches are designed using the 24 hour – 25 year storm event unless, otherwise noted.

4.) Side slope drainage berms are min. 24" high and designed at a minimum of 2% slope.

5.) Perimeter drainage ditches shall be designed with a 4' minimum bottom width, 3:1 side slopes and 4' minimum depth.

6.) Drainage ditches with greater than 2.0 fps velocity are designed with temporary ditch stabilization.

7.) Shear stress for temporary ground cover in ditches where the velocity exceeds 2.0 fps, are calculated to determine the type of ditch stabilization to be used.

T = (y)(d)(s)
y = 62.4 #/s.f.
d = depth of flow
s = slope of ditch, ft./ft.

8.) Manning's "n" for 24" dia. corrugated plastic downdrain pipe is:

n = 0.020

9.) See Design and Operation Plans for drainage structure locations.

10.) Storm Drainage flows are calculated using the computer program Hydraflow Hydrographs Extension for AutoCAD Civil 3D 2022, and the SCS Method - Hydrologic Data –

| | | |
|---|---|---|
| a. | Curve Number (CN) | 79 Post-Development |
| b. | Storm Distribution | Type III |
| c. | Time interval | 1 minute |
| d. | Precipitation (10 year) | 5.88 inches |
| e. | Precipitation (25 year) | 7.14 inches |
| f. | Precipitation (100 year) | 9.34 inches |

# Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022

| Hyd. No. | Hydrograph type (origin) | Peak flow (cfs) | Time interval (min) | Time to Peak (min) | Hyd. volume (cuft) | Inflow hyd(s) | Maximum elevation (ft) | Total strge used (cuft) | Hydrograph Description |
|---|---|---|---|---|---|---|---|---|---|
| 1 | SCS Runoff | 5.447 | 1 | 727 | 18,818 | ------ | ------ | ------ | DD No. 1 |
| 2 | SCS Runoff | 10.15 | 1 | 730 | 40,373 | ------ | ------ | ------ | Area to DD No. 2 |
| 3 | Combine | 15.23 | 1 | 729 | 59,190 | 1, 2 | ------ | ------ | DD No. 2 |
| 4 | SCS Runoff | 10.47 | 1 | 734 | 48,187 | ------ | ------ | ------ | Area to DD No. 3 |
| 5 | Combine | 24.63 | 1 | 730 | 107,378 | 3, 4 | ------ | ------ | DD No. 3 |
| 6 | SCS Runoff | 5.649 | 1 | 725 | 18,347 | ------ | ------ | ------ | Area to DD No. 4 |
| 7 | Combine | 29.21 | 1 | 729 | 125,725 | 5, 6 | ------ | ------ | DD No. 4 |
| 8 | SCS Runoff | 3.110 | 1 | 723 | 9,067 | ------ | ------ | ------ | Area to DD No. 6 |
| 9 | Combine | 31.14 | 1 | 728 | 134,792 | 7, 8 | ------ | ------ | DD No. 6 |
| 10 | SCS Runoff | 7.091 | 1 | 728 | 25,945 | ------ | ------ | ------ | Area to DD No. 5 |
| 11 | Combine | 38.23 | 1 | 728 | 160,736 | 9, 10 | ------ | ------ | DD No. 5 |
| 12 | SCS Runoff | 11.33 | 1 | 731 | 47,113 | ------ | ------ | ------ | Area to Ditch 20 |
| 13 | Combine | 48.98 | 1 | 729 | 207,849 | 11, 12 | ------ | ------ | Ditch 20 |
| 14 | SCS Runoff | 7.857 | 1 | 725 | 25,519 | ------ | ------ | ------ | DD No. 49 |
| 15 | SCS Runoff | 8.436 | 1 | 725 | 26,286 | ------ | ------ | ------ | Area to DD No. 50 |
| 16 | Combine | 16.29 | 1 | 725 | 51,805 | 14, 15 | ------ | ------ | DD No. 50 |
| 17 | SCS Runoff | 11.91 | 1 | 729 | 45,130 | ------ | ------ | ------ | Area to Ditch 21 |
| 18 | Combine | 27.11 | 1 | 726 | 96,936 | 16, 17 | ------ | ------ | Ditch 21 / Pipe No. 103 |
| 19 | Combine | 75.07 | 1 | 727 | 304,785 | 13, 18 | ------ | ------ | Pipe No. 101 |
| 20 | SCS Runoff | 14.83 | 1 | 731 | 61,662 | ------ | ------ | ------ | DD No. 7 |
| 21 | SCS Runoff | 7.926 | 1 | 725 | 24,698 | ------ | ------ | ------ | Area to DD No. 8 |
| 22 | Combine | 20.47 | 1 | 727 | 86,360 | 20, 21 | ------ | ------ | DD No. 8 |
| 23 | SCS Runoff | 8.209 | 1 | 725 | 25,580 | ------ | ------ | ------ | Area to DD No. 9 |
| 24 | Combine | 28.16 | 1 | 726 | 111,941 | 22, 23 | ------ | ------ | DD No. 9 |
| 25 | SCS Runoff | 8.605 | 1 | 725 | 26,815 | ------ | ------ | ------ | Area to DD No. 10 |
| 26 | Combine | 36.53 | 1 | 725 | 138,756 | 24, 25 | ------ | ------ | DD No. 10 |
| 27 | SCS Runoff | 8.719 | 1 | 725 | 27,168 | ------ | ------ | ------ | Area to DD No. 11 |
| 28 | Combine | 45.25 | 1 | 725 | 165,924 | 26, 27 | ------ | ------ | DD No. 11 |
| 29 | SCS Runoff | 2.164 | 1 | 722 | 5,934 | ------ | ------ | ------ | Ditch 19 |
| 30 | Combine | 46.90 | 1 | 725 | 171,858 | 28, 29 | ------ | ------ | Pipe 102 |
| 31 | SCS Runoff | 25.44 | 1 | 722 | 69,764 | ------ | ------ | ------ | Area to Pond No. 1 |
| 32 | Combine | 138.23 | 1 | 725 | 546,408 | 19, 30, 31 | ------ | ------ | Total Pond 1 Inflow |
| 33 | SCS Runoff | 15.23 | 1 | 728 | 55,720 | ------ | ------ | ------ | DD No. 37 |
| 34 | SCS Runoff | 11.50 | 1 | 725 | 37,362 | ------ | ------ | ------ | Area to DD No. 38 |

# Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022

| Hyd. No. | Hydrograph type (origin) | Peak flow (cfs) | Time interval (min) | Time to Peak (min) | Hyd. volume (cuft) | Inflow hyd(s) | Maximum elevation (ft) | Total strge used (cuft) | Hydrograph Description |
|---|---|---|---|---|---|---|---|---|---|
| 35 | Combine | 26.28 | 1 | 727 | 93,082 | 33, 34 | ------ | ------ | DD No. 38 |
| 36 | SCS Runoff | 13.20 | 1 | 725 | 42,866 | ------ | ------ | ------ | Area to DD No. 39 |
| 37 | Combine | 39.43 | 1 | 726 | 135,947 | 35, 36 | ------ | ------ | DD No. 39 |
| 38 | SCS Runoff | 13.57 | 1 | 727 | 46,873 | ------ | ------ | ------ | Area to DD No.40 |
| 39 | Combine | 52.95 | 1 | 726 | 182,821 | 37, 38 | ------ | ------ | DD No. 40 |
| 40 | SCS Runoff | 13.86 | 1 | 727 | 47,900 | ------ | ------ | ------ | Area to DD No. 41 |
| 41 | Combine | 66.77 | 1 | 726 | 230,720 | 39, 40 | ------ | ------ | DD No. 41 |
| 42 | SCS Runoff | 7.972 | 1 | 727 | 27,542 | ------ | ------ | ------ | Ditch No. 8 |
| 43 | SCS Runoff | 2.515 | 1 | 722 | 6,896 | ------ | ------ | ------ | Area to Ditch No. 7 |
| 44 | Combine | 9.623 | 1 | 725 | 34,438 | 42, 43 | ------ | ------ | Ditch No. 7 |
| 45 | SCS Runoff | 1.988 | 1 | 722 | 5,453 | ------ | ------ | ------ | Ditch No. 6 |
| 46 | Combine | 77.66 | 1 | 726 | 270,611 | 41, 44, 45 | ------ | ------ | Pipe 202 |
| 47 | SCS Runoff | 6.572 | 1 | 723 | 19,160 | ------ | ------ | ------ | DD No. 42 |
| 48 | SCS Runoff | 8.625 | 1 | 723 | 25,147 | ------ | ------ | ------ | Area to DD No. 43 |
| 49 | Combine | 15.20 | 1 | 723 | 44,307 | 47, 48 | ------ | ------ | DD No. 43 |
| 50 | SCS Runoff | 9.292 | 1 | 730 | 36,951 | ------ | ------ | ------ | DD No. 44 |
| 51 | SCS Runoff | 7.087 | 1 | 725 | 23,017 | ------ | ------ | ------ | Area to DD No. 45 |
| 52 | Combine | 15.58 | 1 | 727 | 59,969 | 50, 51 | ------ | ------ | DD No. 45 |
| 53 | SCS Runoff | 12.06 | 1 | 725 | 37,577 | ------ | ------ | ------ | Area to DD No. 46 |
| 54 | Combine | 26.99 | 1 | 726 | 97,545 | 52, 53 | ------ | ------ | DD No. 46 |
| 55 | SCS Runoff | 9.667 | 1 | 732 | 41,267 | ------ | ------ | ------ | Area to DD Ditch 3 |
| 56 | SCS Runoff | 6.419 | 1 | 725 | 20,849 | ------ | ------ | ------ | DD No. 47 |
| 57 | SCS Runoff | 9.912 | 1 | 725 | 32,191 | ------ | ------ | ------ | Area to DD No. 48 |
| 58 | Combine | 16.33 | 1 | 725 | 53,040 | 56, 57 | ------ | ------ | DD No.48 |
| 59 | SCS Runoff | 5.605 | 1 | 725 | 17,465 | ------ | ------ | ------ | Ditch No. 1 |
| 60 | SCS Runoff | 4.417 | 1 | 725 | 14,344 | ------ | ------ | ------ | Area to Ditch No. 2 |
| 61 | Combine | 10.02 | 1 | 725 | 31,809 | 59, 60 | ------ | ------ | Ditch No. 2 |
| 62 | Combine | 61.00 | 1 | 726 | 223,662 | 54, 55, 58, 61 | ------ | ------ | Ditch No.3 |
| 63 | SCS Runoff | 11.79 | 1 | 736 | 55,440 | ------ | ------ | ------ | Area to Ditch No. 4 |
| 64 | SCS Runoff | 1.696 | 1 | 722 | 4,651 | ------ | ------ | ------ | Ditch No. 5 |
| 65 | Combine | 82.67 | 1 | 725 | 323,409 | 49, 62, 63, | ------ | ------ | Ditch No. 4 |
| 66 | Combine | 83.96 | 1 | 725 | 328,060 | 64, 65 | ------ | ------ | Pipe 201 |
| 67 | SCS Runoff | 15.38 | 1 | 722 | 42,179 | ------ | ------ | ------ | Area to Pond No. 2 |
| 68 | Combine | 172.09 | 1 | 725 | 640,851 | 46, 66, 67 | ------ | ------ | Total Pond No. 2 Inflow |

# Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022

| Hyd. No. | Hydrograph type (origin) | Peak flow (cfs) | Time interval (min) | Time to Peak (min) | Hyd. volume (cuft) | Inflow hyd(s) | Maximum elevation (ft) | Total strge used (cuft) | Hydrograph Description |
|---|---|---|---|---|---|---|---|---|---|
| 69 | SCS Runoff | 11.20 | 1 | 729 | 42,436 | ------ | ------ | ------ | DD No. 12 |
| 70 | SCS Runoff | 12.17 | 1 | 725 | 39,530 | ------ | ------ | ------ | Area to DD No.13 |
| 71 | Combine | 22.69 | 1 | 727 | 81,966 | 69, 70 | ------ | ------ | DD No. 13 |
| 72 | SCS Runoff | 10.81 | 1 | 725 | 33,695 | ------ | ------ | ------ | Area to DD No. 14 |
| 73 | Combine | 33.05 | 1 | 726 | 115,661 | 71, 72 | ------ | ------ | DD No. 14 |
| 74 | SCS Runoff | 10.76 | 1 | 725 | 33,519 | ------ | ------ | ------ | Area to DD No. 15 |
| 75 | Combine | 43.60 | 1 | 725 | 149,180 | 73, 74 | ------ | ------ | DD No. 15 |
| 76 | SCS Runoff | 10.76 | 1 | 725 | 33,519 | ------ | ------ | ------ | Area to DD No. 16 |
| 77 | Combine | 54.36 | 1 | 725 | 182,700 | 75, 76 | ------ | ------ | DD No. 16 |
| 78 | SCS Runoff | 8.328 | 1 | 728 | 30,472 | ------ | ------ | ------ | Ditch No.18 |
| 79 | SCS Runoff | 11.14 | 1 | 727 | 38,491 | ------ | ------ | ------ | Area to Ditch No. 17 |
| 80 | Combine | 72.94 | 1 | 726 | 251,662 | 77, 78, 79 | ------ | ------ | Ditch No. 17 |
| 81 | SCS Runoff | 2.749 | 1 | 722 | 7,538 | ------ | ------ | ------ | Area to Ditch No. 16 |
| 82 | Combine | 74.90 | 1 | 725 | 259,200 | 80, 81 | ------ | ------ | Ditch No. 16 |
| 83 | SCS Runoff | 8.832 | 1 | 725 | 27,521 | ------ | ------ | ------ | DD No. 17 |
| 84 | SCS Runoff | 9.285 | 1 | 725 | 28,932 | ------ | ------ | ------ | Area to DD No. 18 |
| 85 | Combine | 18.12 | 1 | 725 | 56,453 | 83, 84 | ------ | ------ | DD No. 18 |
| 86 | SCS Runoff | 10.42 | 1 | 725 | 32,460 | ------ | ------ | ------ | Area to DD No. 19 |
| 87 | Combine | 28.53 | 1 | 725 | 88,914 | 85, 86 | ------ | ------ | DD No. 19 |
| 88 | SCS Runoff | 6.635 | 1 | 727 | 22,923 | ------ | ------ | ------ | Area to DD No. 20 |
| 89 | Combine | 34.95 | 1 | 725 | 111,837 | 87, 88 | ------ | ------ | DD No. 20 |
| 90 | Combine | 109.84 | 1 | 725 | 371,036 | 82, 89 | ------ | ------ | Pipe No. 301 |
| 91 | SCS Runoff | 16.24 | 1 | 727 | 56,111 | ------ | ------ | ------ | Area to Pond No. 3 |
| 92 | Combine | 125.54 | 1 | 725 | 427,148 | 90, 91 | ------ | ------ | Total Pond No. 3 Inflow |
| 94 | Reservoir | 4.089 | 1 | 1044 | 426,678 | 32 | 274.68 | 402,260 | Pond No. 1 - Perm Pool |
| 95 | Reservoir | 47.08 | 1 | 750 | 546,400 | 32 | 276.41 | 174,201 | Pond No. 1 - Riser |
| 96 | Reservoir | 6.346 | 1 | 968 | 577,268 | 68 | 262.98 | 443,094 | Pond No. 2 - perm pool |
| 97 | Reservoir | 90.13 | 1 | 739 | 640,845 | 68 | 265.75 | 160,287 | Pond No. 2 - riser |
| 98 | Reservoir | 3.837 | 1 | 994 | 368,221 | 92 | 250.26 | 302,667 | Pond No. 3 - perm pool |
| 99 | Reservoir | 60.39 | 1 | 738 | 427,140 | 92 | 252.49 | 107,855 | Pond No. 3 - riser |

# Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022

| Hyd. No. | Hydrograph type (origin) | Peak flow (cfs) | Time interval (min) | Time to Peak (min) | Hyd. volume (cuft) | Inflow hyd(s) | Maximum elevation (ft) | Total strge used (cuft) | Hydrograph Description |
|---|---|---|---|---|---|---|---|---|---|
| 1 | SCS Runoff | 7.713 | 1 | 727 | 27,018 | ------ | ------ | ------ | DD No. 1 |
| 2 | SCS Runoff | 14.40 | 1 | 730 | 57,966 | ------ | ------ | ------ | Area to DD No. 2 |
| 3 | Combine | 21.62 | 1 | 728 | 84,984 | 1, 2 | ------ | ------ | DD No. 2 |
| 4 | SCS Runoff | 14.87 | 1 | 734 | 69,187 | ------ | ------ | ------ | Area to DD No. 3 |
| 5 | Combine | 34.99 | 1 | 730 | 154,171 | 3, 4 | ------ | ------ | DD No. 3 |
| 6 | SCS Runoff | 8.012 | 1 | 725 | 26,343 | ------ | ------ | ------ | Area to DD No. 4 |
| 7 | Combine | 41.49 | 1 | 729 | 180,513 | 5, 6 | ------ | ------ | DD No. 4 |
| 8 | SCS Runoff | 4.408 | 1 | 723 | 13,018 | ------ | ------ | ------ | Area to DD No. 6 |
| 9 | Combine | 44.25 | 1 | 728 | 193,531 | 7, 8 | ------ | ------ | DD No. 6 |
| 10 | SCS Runoff | 10.05 | 1 | 728 | 37,251 | ------ | ------ | ------ | Area to DD No. 5 |
| 11 | Combine | 54.30 | 1 | 728 | 230,782 | 9, 10 | ------ | ------ | DD No. 5 |
| 12 | SCS Runoff | 16.08 | 1 | 731 | 67,644 | ------ | ------ | ------ | Area to Ditch 20 |
| 13 | Combine | 69.54 | 1 | 728 | 298,425 | 11, 12 | ------ | ------ | Ditch 20 |
| 14 | SCS Runoff | 11.14 | 1 | 725 | 36,640 | ------ | ------ | ------ | DD No. 49 |
| 15 | SCS Runoff | 11.96 | 1 | 724 | 37,741 | ------ | ------ | ------ | Area to DD No. 50 |
| 16 | Combine | 23.08 | 1 | 725 | 74,381 | 14, 15 | ------ | ------ | DD No. 50 |
| 17 | SCS Runoff | 16.89 | 1 | 729 | 64,797 | ------ | ------ | ------ | Area to Ditch 21 |
| 18 | Combine | 38.45 | 1 | 726 | 139,179 | 16, 17 | ------ | ------ | Ditch 21 / Pipe No. 103 |
| 19 | Combine | 106.69 | 1 | 727 | 437,604 | 13, 18 | ------ | ------ | Pipe No. 101 |
| 20 | SCS Runoff | 21.05 | 1 | 731 | 88,533 | ------ | ------ | ------ | DD No. 7 |
| 21 | SCS Runoff | 11.23 | 1 | 724 | 35,461 | ------ | ------ | ------ | Area to DD No. 8 |
| 22 | Combine | 29.12 | 1 | 727 | 123,995 | 20, 21 | ------ | ------ | DD No. 8 |
| 23 | SCS Runoff | 11.64 | 1 | 724 | 36,728 | ------ | ------ | ------ | Area to DD No. 9 |
| 24 | Combine | 40.02 | 1 | 726 | 160,722 | 22, 23 | ------ | ------ | DD No. 9 |
| 25 | SCS Runoff | 12.20 | 1 | 724 | 38,501 | ------ | ------ | ------ | Area to DD No. 10 |
| 26 | Combine | 51.94 | 1 | 725 | 199,223 | 24, 25 | ------ | ------ | DD No. 10 |
| 27 | SCS Runoff | 12.36 | 1 | 724 | 39,007 | ------ | ------ | ------ | Area to DD No. 11 |
| 28 | Combine | 64.28 | 1 | 725 | 238,231 | 26, 27 | ------ | ------ | DD No. 11 |
| 29 | SCS Runoff | 3.063 | 1 | 722 | 8,520 | ------ | ------ | ------ | Ditch 19 |
| 30 | Combine | 66.59 | 1 | 725 | 246,751 | 28, 29 | ------ | ------ | Pipe 102 |
| 31 | SCS Runoff | 36.01 | 1 | 722 | 100,167 | ------ | ------ | ------ | Area to Pond No. 1 |
| 32 | Combine | 196.46 | 1 | 725 | 784,521 | 19, 30, 31 | ------ | ------ | Total Pond 1 Inflow |
| 33 | SCS Runoff | 21.58 | 1 | 728 | 80,002 | ------ | ------ | ------ | DD No. 37 |
| 34 | SCS Runoff | 16.32 | 1 | 725 | 53,643 | ------ | ------ | ------ | Area to DD No. 38 |

# Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022

| Hyd. No. | Hydrograph type (origin) | Peak flow (cfs) | Time interval (min) | Time to Peak (min) | Hyd. volume (cuft) | Inflow hyd(s) | Maximum elevation (ft) | Total strge used (cuft) | Hydrograph Description |
|---|---|---|---|---|---|---|---|---|---|
| 35 | Combine | 37.25 | 1 | 726 | 133,645 | 33, 34 | ------ | ------ | DD No. 38 |
| 36 | SCS Runoff | 18.72 | 1 | 725 | 61,546 | ------ | ------ | ------ | Area to DD No. 39 |
| 37 | Combine | 55.91 | 1 | 726 | 195,191 | 35, 36 | ------ | ------ | DD No. 39 |
| 38 | SCS Runoff | 19.21 | 1 | 727 | 67,300 | ------ | ------ | ------ | Area to DD No.40 |
| 39 | Combine | 75.10 | 1 | 726 | 262,490 | 37, 38 | ------ | ------ | DD No. 40 |
| 40 | SCS Runoff | 19.63 | 1 | 727 | 68,773 | ------ | ------ | ------ | Area to DD No. 41 |
| 41 | Combine | 94.71 | 1 | 726 | 331,264 | 39, 40 | ------ | ------ | DD No. 41 |
| 42 | SCS Runoff | 11.29 | 1 | 727 | 39,545 | ------ | ------ | ------ | Ditch No. 8 |
| 43 | SCS Runoff | 3.560 | 1 | 722 | 9,902 | ------ | ------ | ------ | Area to Ditch No. 7 |
| 44 | Combine | 13.65 | 1 | 725 | 49,446 | 42, 43 | ------ | ------ | Ditch No. 7 |
| 45 | SCS Runoff | 2.815 | 1 | 722 | 7,829 | ------ | ------ | ------ | Ditch No. 6 |
| 46 | Combine | 110.11 | 1 | 726 | 388,539 | 41, 44, 45 | ------ | ------ | Pipe 202 |
| 47 | SCS Runoff | 9.314 | 1 | 723 | 27,509 | ------ | ------ | ------ | DD No. 42 |
| 48 | SCS Runoff | 12.22 | 1 | 723 | 36,106 | ------ | ------ | ------ | Area to DD No. 43 |
| 49 | Combine | 21.54 | 1 | 723 | 63,615 | 47, 48 | ------ | ------ | DD No. 43 |
| 50 | SCS Runoff | 13.18 | 1 | 730 | 53,054 | ------ | ------ | ------ | DD No. 44 |
| 51 | SCS Runoff | 10.05 | 1 | 725 | 33,048 | ------ | ------ | ------ | Area to DD No. 45 |
| 52 | Combine | 22.12 | 1 | 727 | 86,102 | 50, 51 | ------ | ------ | DD No. 45 |
| 53 | SCS Runoff | 17.09 | 1 | 724 | 53,952 | ------ | ------ | ------ | Area to DD No. 46 |
| 54 | Combine | 38.27 | 1 | 726 | 140,053 | 52, 53 | ------ | ------ | DD No. 46 |
| 55 | SCS Runoff | 13.72 | 1 | 732 | 59,250 | ------ | ------ | ------ | Area to DD Ditch 3 |
| 56 | SCS Runoff | 9.105 | 1 | 725 | 29,935 | ------ | ------ | ------ | DD No. 47 |
| 57 | SCS Runoff | 14.06 | 1 | 725 | 46,219 | ------ | ------ | ------ | Area to DD No. 48 |
| 58 | Combine | 23.16 | 1 | 725 | 76,154 | 56, 57 | ------ | ------ | DD No.48 |
| 59 | SCS Runoff | 7.944 | 1 | 724 | 25,076 | ------ | ------ | ------ | Ditch No. 1 |
| 60 | SCS Runoff | 6.264 | 1 | 725 | 20,595 | ------ | ------ | ------ | Area to Ditch No. 2 |
| 61 | Combine | 14.19 | 1 | 725 | 45,671 | 59, 60 | ------ | ------ | Ditch No. 2 |
| 62 | Combine | 86.54 | 1 | 726 | 321,129 | 54, 55, 58, 61 | ------ | ------ | Ditch No.3 |
| 63 | SCS Runoff | 16.75 | 1 | 735 | 79,600 | ------ | ------ | ------ | Area to Ditch No. 4 |
| 64 | SCS Runoff | 2.401 | 1 | 722 | 6,678 | ------ | ------ | ------ | Ditch No. 5 |
| 65 | Combine | 117.56 | 1 | 725 | 464,344 | 49, 62, 63, | ------ | ------ | Ditch No. 4 |
| 66 | Combine | 119.38 | 1 | 725 | 471,023 | 64, 65 | ------ | ------ | Pipe 201 |
| 67 | SCS Runoff | 21.77 | 1 | 722 | 60,560 | ------ | ------ | ------ | Area to Pond No. 2 |
| 68 | Combine | 244.40 | 1 | 725 | 920,123 | 46, 66, 67 | ------ | ------ | Total Pond No. 2 Inflow |

# Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022

| Hyd. No. | Hydrograph type (origin) | Peak flow (cfs) | Time interval (min) | Time to Peak (min) | Hyd. volume (cuft) | Inflow hyd(s) | Maximum elevation (ft) | Total strge used (cuft) | Hydrograph Description |
|---|---|---|---|---|---|---|---|---|---|
| 69 | SCS Runoff | 15.88 | 1 | 729 | 60,929 | ------ | ------ | ------ | DD No. 12 |
| 70 | SCS Runoff | 17.26 | 1 | 725 | 56,756 | ------ | ------ | ------ | Area to DD No.13 |
| 71 | Combine | 32.15 | 1 | 727 | 117,685 | 69, 70 | ------ | ------ | DD No. 13 |
| 72 | SCS Runoff | 15.33 | 1 | 724 | 48,379 | ------ | ------ | ------ | Area to DD No. 14 |
| 73 | Combine | 46.84 | 1 | 726 | 166,065 | 71, 72 | ------ | ------ | DD No. 14 |
| 74 | SCS Runoff | 15.25 | 1 | 724 | 48,126 | ------ | ------ | ------ | Area to DD No. 15 |
| 75 | Combine | 61.87 | 1 | 725 | 214,191 | 73, 74 | ------ | ------ | DD No. 15 |
| 76 | SCS Runoff | 15.25 | 1 | 724 | 48,126 | ------ | ------ | ------ | Area to DD No. 16 |
| 77 | Combine | 77.09 | 1 | 725 | 262,316 | 75, 76 | ------ | ------ | DD No. 16 |
| 78 | SCS Runoff | 11.80 | 1 | 728 | 43,751 | ------ | ------ | ------ | Ditch No.18 |
| 79 | SCS Runoff | 15.78 | 1 | 727 | 55,264 | ------ | ------ | ------ | Area to Ditch No. 17 |
| 80 | Combine | 103.35 | 1 | 725 | 361,332 | 77, 78, 79 | ------ | ------ | Ditch No. 17 |
| 81 | SCS Runoff | 3.891 | 1 | 722 | 10,823 | ------ | ------ | ------ | Area to Ditch No. 16 |
| 82 | Combine | 106.29 | 1 | 725 | 372,155 | 80, 81 | ------ | ------ | Ditch No. 16 |
| 83 | SCS Runoff | 12.52 | 1 | 724 | 39,514 | ------ | ------ | ------ | DD No. 17 |
| 84 | SCS Runoff | 13.16 | 1 | 724 | 41,540 | ------ | ------ | ------ | Area to DD No. 18 |
| 85 | Combine | 25.68 | 1 | 724 | 81,054 | 83, 84 | ------ | ------ | DD No. 18 |
| 86 | SCS Runoff | 14.76 | 1 | 724 | 46,606 | ------ | ------ | ------ | Area to DD No. 19 |
| 87 | Combine | 40.44 | 1 | 724 | 127,661 | 85, 86 | ------ | ------ | DD No. 19 |
| 88 | SCS Runoff | 9.396 | 1 | 727 | 32,913 | ------ | ------ | ------ | Area to DD No. 20 |
| 89 | Combine | 49.49 | 1 | 725 | 160,573 | 87, 88 | ------ | ------ | DD No. 20 |
| 90 | Combine | 155.78 | 1 | 725 | 532,728 | 82, 89 | ------ | ------ | Pipe No. 301 |
| 91 | SCS Runoff | 23.00 | 1 | 727 | 80,563 | ------ | ------ | ------ | Area to Pond No. 3 |
| 92 | Combine | 178.11 | 1 | 725 | 613,291 | 90, 91 | ------ | ------ | Total Pond No. 3 Inflow |
| 94 | Reservoir | 17.62 | 1 | 811 | 636,597 | 32 | 275.40 | 488,875 | Pond No. 1 - Perm Pool |
| 95 | Reservoir | 51.87 | 1 | 753 | 784,514 | 32 | 277.14 | 269,027 | Pond No. 1 - Riser |
| 96 | Reservoir | 10.59 | 1 | 935 | 796,183 | 68 | 264.62 | 643,075 | Pond No. 2 - perm pool |
| 97 | Reservoir | 105.39 | 1 | 743 | 920,117 | 68 | 266.33 | 236,670 | Pond No. 2 - riser |
| 98 | Reservoir | 6.626 | 1 | 944 | 501,109 | 92 | 251.60 | 439,224 | Pond No. 3 - perm pool |
| 99 | Reservoir | 69.77 | 1 | 742 | 613,284 | 92 | 252.97 | 160,388 | Pond No. 3 - riser |

# Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022

| Hyd. No. | Hydrograph type (origin) | Peak flow (cfs) | Time interval (min) | Time to Peak (min) | Hyd. volume (cuft) | Inflow hyd(s) | Maximum elevation (ft) | Total strge used (cuft) | Hydrograph Description |
|---|---|---|---|---|---|---|---|---|---|
| 1 | SCS Runoff | 5.803 | 1 | 725 | 18,848 | ------ | ------ | ------ | DD No. 21 |
| 2 | SCS Runoff | 11.69 | 1 | 727 | 40,372 | ------ | ------ | ------ | Area to DD No. 22 |
| 3 | Combine | 17.45 | 1 | 726 | 59,220 | 1, 2 | ------ | ------ | DD No. 22 |
| 4 | SCS Runoff | 7.869 | 1 | 725 | 24,522 | ------ | ------ | ------ | Area to DD No.23 |
| 5 | Combine | 25.03 | 1 | 726 | 83,742 | 3, 4 | ------ | ------ | DD No. 23 |
| 6 | SCS Runoff | 9.908 | 1 | 725 | 30,873 | ------ | ------ | ------ | Area to DD No. 24 |
| 7 | Combine | 34.87 | 1 | 725 | 114,615 | 5, 6 | ------ | ------ | DD No. 24 |
| 8 | SCS Runoff | 12.84 | 1 | 725 | 41,698 | ------ | ------ | ------ | Area to DD No. 25 |
| 9 | Combine | 47.71 | 1 | 725 | 156,313 | 7, 8 | ------ | ------ | DD No. 25 |
| 10 | SCS Runoff | 11.29 | 1 | 727 | 39,004 | ------ | ------ | ------ | Area to DD No. 26 |
| 11 | Combine | 58.66 | 1 | 726 | 195,317 | 9, 10 | ------ | ------ | DD No. 26 |
| 12 | SCS Runoff | 2.699 | 1 | 723 | 7,869 | ------ | ------ | ------ | Ditch No. 15 |
| 13 | SCS Runoff | 7.941 | 1 | 733 | 35,240 | ------ | ------ | ------ | Area to Ditch No. 14 |
| 14 | Combine | 9.084 | 1 | 733 | 43,110 | 12, 13 | ------ | ------ | Ditch No. 14 |
| 15 | SCS Runoff | 5.913 | 1 | 729 | 22,397 | ------ | ------ | ------ | Ditch No. 13 |
| 16 | Combine | 72.63 | 1 | 726 | 260,823 | 11, 14, 15 | ------ | ------ | Pipe 401 |
| 17 | SCS Runoff | 3.850 | 1 | 725 | 11,996 | ------ | ------ | ------ | Ditch No. 9 |
| 18 | SCS Runoff | 8.185 | 1 | 728 | 29,949 | ------ | ------ | ------ | Area to Ditch No. 10 |
| 19 | SCS Runoff | 16.85 | 1 | 728 | 61,640 | ------ | ------ | ------ | DD No. 32 |
| 20 | SCS Runoff | 13.87 | 1 | 725 | 45,034 | ------ | ------ | ------ | Area to DD No. 33 |
| 21 | Combine | 30.17 | 1 | 727 | 106,674 | 19, 20 | ------ | ------ | DD No. 33 |
| 22 | SCS Runoff | 13.87 | 1 | 725 | 45,034 | ------ | ------ | ------ | Area to DD No. 34 |
| 23 | Combine | 44.03 | 1 | 726 | 151,708 | 21, 22 | ------ | ------ | DD No. 34 |
| 24 | SCS Runoff | 13.87 | 1 | 725 | 45,034 | ------ | ------ | ------ | Area to DD No. 35 |
| 25 | Combine | 57.88 | 1 | 726 | 196,743 | 23, 24 | ------ | ------ | DD No. 35 |
| 26 | SCS Runoff | 14.17 | 1 | 725 | 46,035 | ------ | ------ | ------ | Area to DD No. 36 |
| 27 | Combine | 72.05 | 1 | 726 | 242,778 | 25, 26 | ------ | ------ | DD No. 36 |
| 28 | Combine | 83.68 | 1 | 726 | 284,723 | 17, 18, 27 | ------ | ------ | Ditch No. 10 |
| 29 | SCS Runoff | 9.398 | 1 | 725 | 30,523 | ------ | ------ | ------ | DD No. 28 |
| 30 | SCS Runoff | 11.45 | 1 | 725 | 37,195 | ------ | ------ | ------ | Area to DD No. 29 |
| 31 | Combine | 20.85 | 1 | 725 | 67,718 | 29, 30 | ------ | ------ | DD No. 29 |
| 32 | SCS Runoff | 11.93 | 1 | 727 | 41,228 | ------ | ------ | ------ | Area to Ditch No. 30 |
| 33 | Combine | 32.73 | 1 | 726 | 108,946 | 31, 32 | ------ | ------ | DD No. 30 |
| 34 | SCS Runoff | 10.27 | 1 | 725 | 33,359 | ------ | ------ | ------ | Area to DD No. 31 |

# Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022

| Hyd. No. | Hydrograph type (origin) | Peak flow (cfs) | Time interval (min) | Time to Peak (min) | Hyd. volume (cuft) | Inflow hyd(s) | Maximum elevation (ft) | Total strge used (cuft) | Hydrograph Description |
|---|---|---|---|---|---|---|---|---|---|
| 35 | Combine | 43.00 | 1 | 726 | 142,305 | 33, 34 | ------ | ------ | DD No. 31 |
| 36 | SCS Runoff | 3.169 | 1 | 727 | 10,948 | ------ | ------ | ------ | Area to Ditch No. 11 |
| 37 | Combine | 129.84 | 1 | 726 | 437,976 | 28, 35, 36 | ------ | ------ | Ditch No. 11 |
| 38 | SCS Runoff | 4.711 | 1 | 728 | 17,238 | ------ | ------ | ------ | Area to Ditch No. 12 |
| 39 | Combine | 134.40 | 1 | 726 | 455,215 | 37, 38 | ------ | ------ | Ditch No. 12 |
| 40 | SCS Runoff | 8.322 | 1 | 725 | 25,933 | ------ | ------ | ------ | DD No. 27 |
| 41 | Combine | 142.42 | 1 | 726 | 481,148 | 39, 40 | ------ | ------ | Pipe 402 |
| 43 | SCS Runoff | 34.97 | 1 | 723 | 101,958 | ------ | ------ | ------ | Area to Pond No. 4 |
| 44 | Combine | 245.69 | 1 | 725 | 843,929 | 16, 41, 43 | ------ | ------ | Total Pond No. 4 Inflow |
| 46 | Reservoir | 8.882 | 1 | 957 | 781,304 | 44 | 230.75 | 574,397 | Pond No. 4 - perm pool |
| 47 | Reservoir | 112.06 | 1 | 739 | 843,921 | 44 | 232.34 | 225,133 | Pond No. 4 - riser |

# Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022

| Hyd. No. | Hydrograph type (origin) | Peak flow (cfs) | Time interval (min) | Time to Peak (min) | Hyd. volume (cuft) | Inflow hyd(s) | Maximum elevation (ft) | Total strge used (cuft) | Hydrograph Description |
|---|---|---|---|---|---|---|---|---|---|
| 1 | SCS Runoff | 8.231 | 1 | 725 | 27,061 | ------ | ------ | ------ | DD No. 21 |
| 2 | SCS Runoff | 16.55 | 1 | 727 | 57,966 | ------ | ------ | ------ | Area to DD No. 22 |
| 3 | Combine | 24.73 | 1 | 726 | 85,027 | 1, 2 | ------ | ------ | DD No. 22 |
| 4 | SCS Runoff | 11.15 | 1 | 724 | 35,208 | ------ | ------ | ------ | Area to DD No.23 |
| 5 | Combine | 35.44 | 1 | 726 | 120,235 | 3, 4 | ------ | ------ | DD No. 23 |
| 6 | SCS Runoff | 14.04 | 1 | 724 | 44,327 | ------ | ------ | ------ | Area to DD No. 24 |
| 7 | Combine | 49.45 | 1 | 725 | 164,562 | 5, 6 | ------ | ------ | DD No. 24 |
| 8 | SCS Runoff | 18.21 | 1 | 725 | 59,870 | ------ | ------ | ------ | Area to DD No. 25 |
| 9 | Combine | 67.65 | 1 | 725 | 224,431 | 7, 8 | ------ | ------ | DD No. 25 |
| 10 | SCS Runoff | 15.99 | 1 | 727 | 56,001 | ------ | ------ | ------ | Area to DD No. 26 |
| 11 | Combine | 83.17 | 1 | 725 | 280,433 | 9, 10 | ------ | ------ | DD No. 26 |
| 12 | SCS Runoff | 3.825 | 1 | 723 | 11,298 | ------ | ------ | ------ | Ditch No. 15 |
| 13 | SCS Runoff | 11.28 | 1 | 733 | 50,598 | ------ | ------ | ------ | Area to Ditch No. 14 |
| 14 | Combine | 12.87 | 1 | 732 | 61,896 | 12, 13 | ------ | ------ | Ditch No. 14 |
| 15 | SCS Runoff | 8.380 | 1 | 729 | 32,157 | ------ | ------ | ------ | Ditch No. 13 |
| 16 | Combine | 103.00 | 1 | 726 | 374,486 | 11, 14, 15 | ------ | ------ | Pipe 401 |
| 17 | SCS Runoff | 5.457 | 1 | 724 | 17,224 | ------ | ------ | ------ | Ditch No. 9 |
| 18 | SCS Runoff | 11.60 | 1 | 728 | 43,001 | ------ | ------ | ------ | Area to Ditch No. 10 |
| 19 | SCS Runoff | 23.87 | 1 | 728 | 88,502 | ------ | ------ | ------ | DD No. 32 |
| 20 | SCS Runoff | 19.67 | 1 | 725 | 64,659 | ------ | ------ | ------ | Area to DD No. 33 |
| 21 | Combine | 42.82 | 1 | 726 | 153,161 | 19, 20 | ------ | ------ | DD No. 33 |
| 22 | SCS Runoff | 19.67 | 1 | 725 | 64,659 | ------ | ------ | ------ | Area to DD No. 34 |
| 23 | Combine | 62.43 | 1 | 726 | 217,820 | 21, 22 | ------ | ------ | DD No. 34 |
| 24 | SCS Runoff | 19.67 | 1 | 725 | 64,659 | ------ | ------ | ------ | Area to DD No. 35 |
| 25 | Combine | 82.04 | 1 | 726 | 282,480 | 23, 24 | ------ | ------ | DD No. 35 |
| 26 | SCS Runoff | 20.10 | 1 | 725 | 66,096 | ------ | ------ | ------ | Area to DD No. 36 |
| 27 | Combine | 102.08 | 1 | 726 | 348,575 | 25, 26 | ------ | ------ | DD No. 36 |
| 28 | Combine | 118.59 | 1 | 726 | 408,801 | 17, 18, 27 | ------ | ------ | Ditch No. 10 |
| 29 | SCS Runoff | 13.33 | 1 | 725 | 43,825 | ------ | ------ | ------ | DD No. 28 |
| 30 | SCS Runoff | 16.24 | 1 | 725 | 53,404 | ------ | ------ | ------ | Area to DD No. 29 |
| 31 | Combine | 29.57 | 1 | 725 | 97,228 | 29, 30 | ------ | ------ | DD No. 29 |
| 32 | SCS Runoff | 16.90 | 1 | 727 | 59,194 | ------ | ------ | ------ | Area to Ditch No. 30 |
| 33 | Combine | 46.36 | 1 | 726 | 156,423 | 31, 32 | ------ | ------ | DD No. 30 |
| 34 | SCS Runoff | 14.57 | 1 | 725 | 47,896 | ------ | ------ | ------ | Area to DD No. 31 |

# Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022

| Hyd. No. | Hydrograph type (origin) | Peak flow (cfs) | Time interval (min) | Time to Peak (min) | Hyd. volume (cuft) | Inflow hyd(s) | Maximum elevation (ft) | Total strge used (cuft) | Hydrograph Description |
|---|---|---|---|---|---|---|---|---|---|
| 35 | Combine | 60.89 | 1 | 726 | 204,318 | 33, 34 | ------ | ------ | DD No. 31 |
| 36 | SCS Runoff | 4.488 | 1 | 727 | 15,720 | ------ | ------ | ------ | Area to Ditch No. 11 |
| 37 | Combine | 183.97 | 1 | 726 | 628,838 | 28, 35, 36 | ------ | ------ | Ditch No. 11 |
| 38 | SCS Runoff | 6.677 | 1 | 728 | 24,751 | ------ | ------ | ------ | Area to Ditch No. 12 |
| 39 | Combine | 190.46 | 1 | 726 | 653,589 | 37, 38 | ------ | ------ | Ditch No. 12 |
| 40 | SCS Runoff | 11.80 | 1 | 724 | 37,234 | ------ | ------ | ------ | DD No. 27 |
| 41 | Combine | 201.77 | 1 | 726 | 690,823 | 39, 40 | ------ | ------ | Pipe 402 |
| 43 | SCS Runoff | 49.56 | 1 | 723 | 146,389 | ------ | ------ | ------ | Area to Pond No. 4 |
| 44 | Combine | 348.61 | 1 | 725 | 1,211,698 | 16, 41, 43 | ------ | ------ | Total Pond No. 4 Inflow |
| 46 | Reservoir | 38.38 | 1 | 775 | 1,134,598 | 44 | 231.52 | 698,508 | Pond No. 4 - perm pool |
| 47 | Reservoir | 129.99 | 1 | 743 | 1,211,694 | 44 | 232.97 | 335,116 | Pond No. 4 - riser |

# Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022

| Hyd. No. | Hydrograph type (origin) | Peak flow (cfs) | Time interval (min) | Time to Peak (min) | Hyd. volume (cuft) | Inflow hyd(s) | Maximum elevation (ft) | Total strge used (cuft) | Hydrograph Description |
|---|---|---|---|---|---|---|---|---|---|
| 1 | SCS Runoff | 9.660 | 1 | 728 | 35,347 | ------ | ------ | ------ | DD9 |
| 2 | SCS Runoff | 9.244 | 1 | 725 | 30,023 | ------ | ------ | ------ | Area to DD10 |
| 3 | Combine | 18.59 | 1 | 726 | 65,370 | 1, 2 | ------ | ------ | DD10 |
| 4 | SCS Runoff | 11.09 | 1 | 725 | 36,027 | ------ | ------ | ------ | Area to DD11 |
| 5 | Combine | 29.68 | 1 | 726 | 101,397 | 3, 4 | ------ | ------ | DD11 |
| 6 | SCS Runoff | 13.57 | 1 | 727 | 46,873 | ------ | ------ | ------ | Area to DD12 |
| 7 | Combine | 43.20 | 1 | 726 | 148,271 | 5, 6 | ------ | ------ | DD12 |
| 8 | SCS Runoff | 12.92 | 1 | 727 | 44,649 | ------ | ------ | ------ | DD13 |
| 9 | SCS Runoff | 13.66 | 1 | 725 | 44,367 | ------ | ------ | ------ | Area to DD14 |
| 10 | Combine | 26.53 | 1 | 726 | 89,016 | 8, 9 | ------ | ------ | DD14 |
| 11 | Combine | 69.73 | 1 | 726 | 237,287 | 7, 10 | ------ | ------ | DD12 & DD14 |
| 12 | SCS Runoff | 6.669 | 1 | 733 | 29,595 | ------ | ------ | ------ | Ditch No. 4 |
| 13 | Combine | 74.92 | 1 | 726 | 266,882 | 11, 12 | ------ | ------ | Ditch No. 4, DD14, & DD12 |
| 14 | SCS Runoff | 6.190 | 1 | 740 | 32,503 | ------ | ------ | ------ | Area to Ditch No. 5 |
| 15 | Combine | 78.73 | 1 | 726 | 299,385 | 13, 14 | ------ | ------ | Ditch No. 5 |
| 16 | SCS Runoff | 6.676 | 1 | 725 | 21,683 | ------ | ------ | ------ | DD15 |
| 17 | SCS Runoff | 8.576 | 1 | 725 | 27,854 | ------ | ------ | ------ | Area to DD16 |
| 18 | Combine | 15.25 | 1 | 725 | 49,538 | 16, 17 | ------ | ------ | DD16 |
| 19 | SCS Runoff | 9.860 | 1 | 725 | 32,024 | ------ | ------ | ------ | Area to DD17 |
| 20 | Combine | 25.11 | 1 | 725 | 81,562 | 18, 19 | ------ | ------ | DD17 |
| 21 | SCS Runoff | 11.50 | 1 | 725 | 37,362 | ------ | ------ | ------ | Area to DD18 |
| 22 | Combine | 36.62 | 1 | 725 | 118,924 | 20, 21 | ------ | ------ | DD18 |
| 23 | SCS Runoff | 12.97 | 1 | 727 | 44,820 | ------ | ------ | ------ | Area to DD19 |
| 24 | Combine | 49.52 | 1 | 726 | 163,744 | 22, 23 | ------ | ------ | DD19 |
| 25 | Combine | 128.26 | 1 | 726 | 463,129 | 15, 24 | ------ | ------ | DI. 501 |
| 26 | SCS Runoff | 5.808 | 1 | 730 | 23,094 | ------ | ------ | ------ | Ditch No. 6 |
| 27 | SCS Runoff | 5.348 | 1 | 727 | 18,476 | ------ | ------ | ------ | Ditch No. 8 |
| 28 | SCS Runoff | 14.31 | 1 | 729 | 54,224 | ------ | ------ | ------ | DD20 |
| 29 | SCS Runoff | 8.891 | 1 | 729 | 33,679 | ------ | ------ | ------ | Area to DD21 |
| 30 | Combine | 23.21 | 1 | 729 | 87,903 | 28, 29 | ------ | ------ | DD21 |
| 31 | SCS Runoff | 11.30 | 1 | 725 | 36,695 | ------ | ------ | ------ | Area to DD22 |
| 32 | Combine | 33.53 | 1 | 727 | 124,598 | 30, 31 | ------ | ------ | DD22 |
| 33 | SCS Runoff | 12.07 | 1 | 725 | 39,196 | ------ | ------ | ------ | Area to DD23 |
| 34 | Combine | 45.21 | 1 | 727 | 163,794 | 32, 33 | ------ | ------ | DD23 |

# Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022

| Hyd. No. | Hydrograph type (origin) | Peak flow (cfs) | Time interval (min) | Time to Peak (min) | Hyd. volume (cuft) | Inflow hyd(s) | Maximum elevation (ft) | Total strge used (cuft) | Hydrograph Description |
|---|---|---|---|---|---|---|---|---|---|
| 35 | SCS Runoff | 12.58 | 1 | 727 | 43,452 | ------ | ------ | ------ | DD24 |
| 36 | SCS Runoff | 12.92 | 1 | 727 | 44,649 | ------ | ------ | ------ | Area to DD25 |
| 37 | Combine | 25.50 | 1 | 727 | 88,101 | 35, 36 | ------ | ------ | DD25 |
| 38 | Combine | 70.71 | 1 | 727 | 251,895 | 34, 37 | ------ | ------ | DD23 & DD25 |
| 39 | Combine | 76.05 | 1 | 727 | 270,371 | 27, 38 | ------ | ------ | Ditch No. 8, DD23, & DD25 |
| 40 | SCS Runoff | 7.286 | 1 | 733 | 32,332 | ------ | ------ | ------ | Area to Ditch No. 7 |
| 41 | Combine | 82.08 | 1 | 727 | 302,703 | 39, 40 | ------ | ------ | Ditch No. 7 |
| 42 | Combine | 87.53 | 1 | 727 | 325,797 | 26, 41 | ------ | ------ | DI. 502 |
| 43 | SCS Runoff | 31.40 | 1 | 722 | 86,123 | ------ | ------ | ------ | Area to Pond No. 5 |
| 44 | Combine | 235.44 | 1 | 726 | 875,050 | 25, 42, 43 | ------ | ------ | Pond No. 5 Total Inflow |
| 46 | Reservoir | 16.83 | 1 | 841 | 863,476 | 44 | 270.75 | 506,617 | Pond No. 5 - perm pool |
| 47 | Reservoir | 115.56 | 1 | 741 | 875,043 | 44 | 272.41 | 219,791 | Pond No. 5 - riser |
| 50 | SCS Runoff | 3.170 | 1 | 725 | 9,879 | ------ | ------ | ------ | Ditch No. 3 |
| 51 | SCS Runoff | 8.096 | 1 | 725 | 25,227 | ------ | ------ | ------ | DD7 |
| 52 | SCS Runoff | 10.07 | 1 | 725 | 32,691 | ------ | ------ | ------ | Area to DD8 |
| 53 | Combine | 18.16 | 1 | 725 | 57,919 | 51, 52 | ------ | ------ | DD8 |
| 54 | Combine | 21.33 | 1 | 725 | 67,798 | 50, 53 | ------ | ------ | Ditch No. 3 & DD8 |
| 55 | SCS Runoff | 5.216 | 1 | 734 | 24,007 | ------ | ------ | ------ | Area to Ditch No. 2 |
| 56 | Combine | 24.97 | 1 | 725 | 91,806 | 54, 55 | ------ | ------ | Ditch No. 2 |
| 57 | SCS Runoff | 6.794 | 1 | 725 | 21,170 | ------ | ------ | ------ | DD1 |
| 58 | SCS Runoff | 9.058 | 1 | 725 | 28,227 | ------ | ------ | ------ | Area to DD2 |
| 59 | Combine | 15.85 | 1 | 725 | 49,396 | 57, 58 | ------ | ------ | DD2 |
| 60 | SCS Runoff | 12.48 | 1 | 725 | 40,531 | ------ | ------ | ------ | Area to DD3 |
| 61 | Combine | 28.33 | 1 | 725 | 89,927 | 59, 60 | ------ | ------ | DD3 |
| 62 | SCS Runoff | 13.59 | 1 | 725 | 42,340 | ------ | ------ | ------ | DD4 |
| 63 | SCS Runoff | 11.15 | 1 | 725 | 34,754 | ------ | ------ | ------ | Area to DD5 |
| 64 | Combine | 24.74 | 1 | 725 | 77,094 | 62, 63 | ------ | ------ | DD5 |
| 65 | SCS Runoff | 11.38 | 1 | 725 | 35,460 | ------ | ------ | ------ | Area to DD6 |
| 66 | Combine | 36.12 | 1 | 725 | 112,553 | 64, 65 | ------ | ------ | DD6 |
| 67 | Combine | 64.45 | 1 | 725 | 202,480 | 61, 66 | ------ | ------ | DD3 & DD6 |
| 68 | Combine | 89.42 | 1 | 725 | 294,286 | 56, 67 | ------ | ------ | Ditch No. 2, DD3, & DD6 |
| 69 | SCS Runoff | 8.273 | 1 | 723 | 24,121 | ------ | ------ | ------ | DD67 |
| 70 | SCS Runoff | 9.398 | 1 | 725 | 29,285 | ------ | ------ | ------ | Area to DD68 |

# Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022

| Hyd. No. | Hydrograph type (origin) | Peak flow (cfs) | Time interval (min) | Time to Peak (min) | Hyd. volume (cuft) | Inflow hyd(s) | Maximum elevation (ft) | Total strge used (cuft) | Hydrograph Description |
|---|---|---|---|---|---|---|---|---|---|
| 71 | Combine | 17.55 | 1 | 724 | 53,406 | 69, 70 | ------ | ------ | DD68 |
| 72 | SCS Runoff | 11.55 | 1 | 725 | 35,989 | ------ | ------ | ------ | Area to DD69 |
| 73 | Combine | 29.09 | 1 | 724 | 89,395 | 71, 72 | ------ | ------ | DD69 |
| 74 | SCS Runoff | 8.556 | 1 | 734 | 39,379 | ------ | ------ | ------ | Area to Ditch No. 1 |
| 75 | Combine | 95.40 | 1 | 725 | 333,665 | 68, 74 | ------ | ------ | Ditch No. 1 |
| 76 | Combine | 124.03 | 1 | 725 | 423,059 | 73, 75 | ------ | ------ | Ditch No. 1 & DD69 |
| 77 | SCS Runoff | 9.984 | 1 | 733 | 44,307 | ------ | ------ | ------ | Area to Ditch No. 17 |
| 78 | Combine | 131.30 | 1 | 725 | 467,367 | 76, 77 | ------ | ------ | Ditch No. 17 |
| 79 | SCS Runoff | 14.18 | 1 | 729 | 53,719 | ------ | ------ | ------ | DD61 |
| 80 | SCS Runoff | 11.81 | 1 | 725 | 38,362 | ------ | ------ | ------ | Area to DD62 |
| 81 | Combine | 25.24 | 1 | 727 | 92,081 | 79, 80 | ------ | ------ | DD62 |
| 82 | SCS Runoff | 12.48 | 1 | 727 | 43,110 | ------ | ------ | ------ | Area to DD63 |
| 83 | Combine | 37.72 | 1 | 727 | 135,191 | 81, 82 | ------ | ------ | DD63 |
| 84 | SCS Runoff | 11.04 | 1 | 725 | 34,401 | ------ | ------ | ------ | DD64 |
| 85 | SCS Runoff | 11.55 | 1 | 725 | 35,989 | ------ | ------ | ------ | Area to DD65 |
| 86 | Combine | 22.59 | 1 | 725 | 70,390 | 84, 85 | ------ | ------ | DD65 |
| 87 | SCS Runoff | 12.00 | 1 | 725 | 37,400 | ------ | ------ | ------ | Area to DD66 |
| 88 | Combine | 34.59 | 1 | 725 | 107,790 | 86, 87 | ------ | ------ | DD66 |
| 89 | Combine | 202.24 | 1 | 725 | 710,348 | 78, 83, 88 | ------ | ------ | DI. 601 |
| 90 | SCS Runoff | 20.23 | 1 | 722 | 55,491 | ------ | ------ | ------ | Area to Pond No. 6 |
| 91 | Combine | 217.69 | 1 | 725 | 765,838 | 89, 90 | ------ | ------ | Pond No. 6 Total Inflow |
| 93 | Reservoir | 22.54 | 1 | 782 | 764,979 | 91 | 262.66 | 385,806 | Pond No. 6 - perm pool |
| 94 | Reservoir | 124.75 | 1 | 735 | 765,834 | 91 | 264.35 | 161,227 | Pond No. 6 - riser |

# Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022

| Hyd. No. | Hydrograph type (origin) | Peak flow (cfs) | Time interval (min) | Time to Peak (min) | Hyd. volume (cuft) | Inflow hyd(s) | Maximum elevation (ft) | Total strge used (cuft) | Hydrograph Description |
|---|---|---|---|---|---|---|---|---|---|
| 1 | SCS Runoff | 13.69 | 1 | 728 | 50,751 | ------ | ------ | ------ | DD9 |
| 2 | SCS Runoff | 13.11 | 1 | 725 | 43,106 | ------ | ------ | ------ | Area to DD10 |
| 3 | Combine | 26.38 | 1 | 726 | 93,857 | 1, 2 | ------ | ------ | DD10 |
| 4 | SCS Runoff | 15.73 | 1 | 725 | 51,727 | ------ | ------ | ------ | Area to DD11 |
| 5 | Combine | 42.07 | 1 | 726 | 145,585 | 3, 4 | ------ | ------ | DD11 |
| 6 | SCS Runoff | 19.21 | 1 | 727 | 67,300 | ------ | ------ | ------ | Area to DD12 |
| 7 | Combine | 61.26 | 1 | 726 | 212,884 | 5, 6 | ------ | ------ | DD12 |
| 8 | SCS Runoff | 18.30 | 1 | 727 | 64,107 | ------ | ------ | ------ | DD13 |
| 9 | SCS Runoff | 19.38 | 1 | 725 | 63,701 | ------ | ------ | ------ | Area to DD14 |
| 10 | Combine | 37.60 | 1 | 726 | 127,808 | 8, 9 | ------ | ------ | DD14 |
| 11 | Combine | 98.85 | 1 | 726 | 340,692 | 7, 10 | ------ | ------ | DD12 & DD14 |
| 12 | SCS Runoff | 9.469 | 1 | 733 | 42,492 | ------ | ------ | ------ | Ditch No. 4 |
| 13 | Combine | 106.32 | 1 | 726 | 383,184 | 11, 12 | ------ | ------ | Ditch No. 4, DD14, & DD12 |
| 14 | SCS Runoff | 8.794 | 1 | 740 | 46,668 | ------ | ------ | ------ | Area to Ditch No. 5 |
| 15 | Combine | 111.87 | 1 | 726 | 429,852 | 13, 14 | ------ | ------ | Ditch No. 5 |
| 16 | SCS Runoff | 9.469 | 1 | 725 | 31,132 | ------ | ------ | ------ | DD15 |
| 17 | SCS Runoff | 12.16 | 1 | 725 | 39,993 | ------ | ------ | ------ | Area to DD16 |
| 18 | Combine | 21.63 | 1 | 725 | 71,125 | 16, 17 | ------ | ------ | DD16 |
| 19 | SCS Runoff | 13.99 | 1 | 725 | 45,980 | ------ | ------ | ------ | Area to DD17 |
| 20 | Combine | 35.62 | 1 | 725 | 117,105 | 18, 19 | ------ | ------ | DD17 |
| 21 | SCS Runoff | 16.32 | 1 | 725 | 53,643 | ------ | ------ | ------ | Area to DD18 |
| 22 | Combine | 51.93 | 1 | 725 | 170,748 | 20, 21 | ------ | ------ | DD18 |
| 23 | SCS Runoff | 18.37 | 1 | 727 | 64,352 | ------ | ------ | ------ | Area to DD19 |
| 24 | Combine | 70.13 | 1 | 726 | 235,101 | 22, 23 | ------ | ------ | DD19 |
| 25 | Combine | 182.00 | 1 | 726 | 664,953 | 15, 24 | ------ | ------ | DI. 501 |
| 26 | SCS Runoff | 8.236 | 1 | 730 | 33,159 | ------ | ------ | ------ | Ditch No. 6 |
| 27 | SCS Runoff | 7.573 | 1 | 727 | 26,527 | ------ | ------ | ------ | Ditch No. 8 |
| 28 | SCS Runoff | 20.29 | 1 | 729 | 77,854 | ------ | ------ | ------ | DD20 |
| 29 | SCS Runoff | 12.60 | 1 | 729 | 48,356 | ------ | ------ | ------ | Area to DD21 |
| 30 | Combine | 32.89 | 1 | 729 | 126,210 | 28, 29 | ------ | ------ | DD21 |
| 31 | SCS Runoff | 16.02 | 1 | 725 | 52,685 | ------ | ------ | ------ | Area to DD22 |
| 32 | Combine | 47.58 | 1 | 727 | 178,895 | 30, 31 | ------ | ------ | DD22 |
| 33 | SCS Runoff | 17.12 | 1 | 725 | 56,277 | ------ | ------ | ------ | Area to DD23 |
| 34 | Combine | 64.07 | 1 | 727 | 235,173 | 32, 33 | ------ | ------ | DD23 |

# Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022

| Hyd. No. | Hydrograph type (origin) | Peak flow (cfs) | Time interval (min) | Time to Peak (min) | Hyd. volume (cuft) | Inflow hyd(s) | Maximum elevation (ft) | Total strge used (cuft) | Hydrograph Description |
|---|---|---|---|---|---|---|---|---|---|
| 35 | SCS Runoff | 17.81 | 1 | 727 | 62,387 | ------ | ------ | ------ | DD24 |
| 36 | SCS Runoff | 18.30 | 1 | 727 | 64,107 | ------ | ------ | ------ | Area to DD25 |
| 37 | Combine | 36.11 | 1 | 727 | 126,494 | 35, 36 | ------ | ------ | DD25 |
| 38 | Combine | 100.19 | 1 | 727 | 361,666 | 34, 37 | ------ | ------ | DD23 & DD25 |
| 39 | Combine | 107.76 | 1 | 727 | 388,193 | 27, 38 | ------ | ------ | Ditch No. 8, DD23, & DD25 |
| 40 | SCS Runoff | 10.34 | 1 | 733 | 46,422 | ------ | ------ | ------ | Area to Ditch No. 7 |
| 41 | Combine | 116.42 | 1 | 727 | 434,616 | 39, 40 | ------ | ------ | Ditch No. 7 |
| 42 | Combine | 124.19 | 1 | 727 | 467,774 | 26, 41 | ------ | ------ | DI. 502 |
| 43 | SCS Runoff | 44.46 | 1 | 722 | 123,654 | ------ | ------ | ------ | Area to Pond No. 5 |
| 44 | Combine | 333.93 | 1 | 726 | 1,256,381 | 25, 42, 43 | ------ | ------ | Pond No. 5 Total Inflow |
| 46 | Reservoir | 64.50 | 1 | 757 | 1,243,246 | 44 | 271.70 | 648,445 | Pond No. 5 - perm pool |
| 47 | Reservoir | 132.53 | 1 | 745 | 1,256,375 | 44 | 273.10 | 333,182 | Pond No. 5 - riser |
| 50 | SCS Runoff | 4.494 | 1 | 724 | 14,185 | ------ | ------ | ------ | Ditch No. 3 |
| 51 | SCS Runoff | 11.47 | 1 | 724 | 36,221 | ------ | ------ | ------ | DD7 |
| 52 | SCS Runoff | 14.28 | 1 | 725 | 46,938 | ------ | ------ | ------ | Area to DD8 |
| 53 | Combine | 25.73 | 1 | 725 | 83,159 | 51, 52 | ------ | ------ | DD8 |
| 54 | Combine | 30.22 | 1 | 725 | 97,343 | 50, 53 | ------ | ------ | Ditch No. 3 & DD8 |
| 55 | SCS Runoff | 7.410 | 1 | 734 | 34,469 | ------ | ------ | ------ | Area to Ditch No. 2 |
| 56 | Combine | 35.48 | 1 | 725 | 131,813 | 54, 55 | ------ | ------ | Ditch No. 2 |
| 57 | SCS Runoff | 9.629 | 1 | 724 | 30,395 | ------ | ------ | ------ | DD1 |
| 58 | SCS Runoff | 12.84 | 1 | 724 | 40,527 | ------ | ------ | ------ | Area to DD2 |
| 59 | Combine | 22.47 | 1 | 724 | 70,923 | 57, 58 | ------ | ------ | DD2 |
| 60 | SCS Runoff | 17.70 | 1 | 725 | 58,193 | ------ | ------ | ------ | Area to DD3 |
| 61 | Combine | 40.13 | 1 | 725 | 129,116 | 59, 60 | ------ | ------ | DD3 |
| 62 | SCS Runoff | 19.26 | 1 | 724 | 60,791 | ------ | ------ | ------ | DD4 |
| 63 | SCS Runoff | 15.81 | 1 | 724 | 49,899 | ------ | ------ | ------ | Area to DD5 |
| 64 | Combine | 35.07 | 1 | 724 | 110,690 | 62, 63 | ------ | ------ | DD5 |
| 65 | SCS Runoff | 16.13 | 1 | 724 | 50,912 | ------ | ------ | ------ | Area to DD6 |
| 66 | Combine | 51.20 | 1 | 724 | 161,602 | 64, 65 | ------ | ------ | DD6 |
| 67 | Combine | 91.23 | 1 | 725 | 290,718 | 61, 66 | ------ | ------ | DD3 & DD6 |
| 68 | Combine | 126.71 | 1 | 725 | 422,531 | 56, 67 | ------ | ------ | Ditch No. 2, DD3, & DD6 |
| 69 | SCS Runoff | 11.73 | 1 | 723 | 34,632 | ------ | ------ | ------ | DD67 |
| 70 | SCS Runoff | 13.32 | 1 | 724 | 42,047 | ------ | ------ | ------ | Area to DD68 |

# Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022

| Hyd. No. | Hydrograph type (origin) | Peak flow (cfs) | Time interval (min) | Time to Peak (min) | Hyd. volume (cuft) | Inflow hyd(s) | Maximum elevation (ft) | Total strge used (cuft) | Hydrograph Description |
|---|---|---|---|---|---|---|---|---|---|
| 71 | Combine | 24.85 | 1 | 724 | 76,679 | 69, 70 | ------ | ------ | DD68 |
| 72 | SCS Runoff | 16.37 | 1 | 724 | 51,672 | ------ | ------ | ------ | Area to DD69 |
| 73 | Combine | 41.22 | 1 | 724 | 128,352 | 71, 72 | ------ | ------ | DD69 |
| 74 | SCS Runoff | 12.16 | 1 | 734 | 56,540 | ------ | ------ | ------ | Area to Ditch No. 1 |
| 75 | Combine | 135.34 | 1 | 725 | 479,071 | 68, 74 | ------ | ------ | Ditch No. 1 |
| 76 | Combine | 175.81 | 1 | 725 | 607,421 | 73, 75 | ------ | ------ | Ditch No. 1 & DD69 |
| 77 | SCS Runoff | 14.18 | 1 | 733 | 63,615 | ------ | ------ | ------ | Area to Ditch No. 17 |
| 78 | Combine | 186.30 | 1 | 725 | 671,038 | 76, 77 | ------ | ------ | Ditch No. 17 |
| 79 | SCS Runoff | 20.10 | 1 | 729 | 77,128 | ------ | ------ | ------ | DD61 |
| 80 | SCS Runoff | 16.75 | 1 | 725 | 55,080 | ------ | ------ | ------ | Area to DD62 |
| 81 | Combine | 35.78 | 1 | 727 | 132,208 | 79, 80 | ------ | ------ | DD62 |
| 82 | SCS Runoff | 17.67 | 1 | 727 | 61,896 | ------ | ------ | ------ | Area to DD63 |
| 83 | Combine | 53.45 | 1 | 727 | 194,104 | 81, 82 | ------ | ------ | DD63 |
| 84 | SCS Runoff | 15.65 | 1 | 724 | 49,392 | ------ | ------ | ------ | DD64 |
| 85 | SCS Runoff | 16.37 | 1 | 724 | 51,672 | ------ | ------ | ------ | Area to DD65 |
| 86 | Combine | 32.02 | 1 | 724 | 101,065 | 84, 85 | ------ | ------ | DD65 |
| 87 | SCS Runoff | 17.01 | 1 | 724 | 53,699 | ------ | ------ | ------ | Area to DD66 |
| 88 | Combine | 49.03 | 1 | 724 | 154,763 | 86, 87 | ------ | ------ | DD66 |
| 89 | Combine | 286.98 | 1 | 725 | 1,019,905 | 78, 83, 88 | ------ | ------ | DI. 601 |
| 90 | SCS Runoff | 28.65 | 1 | 722 | 79,673 | ------ | ------ | ------ | Area to Pond No. 6 |
| 91 | Combine | 308.65 | 1 | 725 | 1,099,577 | 89, 90 | ------ | ------ | Pond No. 6 Total Inflow |
| 93 | Reservoir | 74.39 | 1 | 751 | 1,098,530 | 91 | 263.75 | 510,146 | Pond No. 6 - perm pool |
| 94 | Reservoir | 154.21 | 1 | 738 | 1,099,573 | 91 | 264.92 | 231,603 | Pond No. 6 - riser |

# Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022

| Hyd. No. | Hydrograph type (origin) | Peak flow (cfs) | Time interval (min) | Time to Peak (min) | Hyd. volume (cuft) | Inflow hyd(s) | Maximum elevation (ft) | Total strge used (cuft) | Hydrograph Description |
|---|---|---|---|---|---|---|---|---|---|
| 1 | SCS Runoff | 11.91 | 1 | 729 | 45,130 | ------ | ------ | ------ | DD26 |
| 2 | SCS Runoff | 9.613 | 1 | 728 | 35,173 | ------ | ------ | ------ | Area to DD27 |
| 3 | Combine | 21.47 | 1 | 728 | 80,304 | 1, 2 | ------ | ------ | DD27 |
| 4 | SCS Runoff | 13.46 | 1 | 725 | 43,700 | ------ | ------ | ------ | Area to DD28 |
| 5 | Combine | 34.18 | 1 | 727 | 124,003 | 3, 4 | ------ | ------ | DD28 |
| 6 | SCS Runoff | 13.30 | 1 | 725 | 43,199 | ------ | ------ | ------ | DD29 |
| 7 | SCS Runoff | 12.89 | 1 | 725 | 41,865 | ------ | ------ | ------ | Area to DD30 |
| 8 | SCS Runoff | 3.755 | 1 | 723 | 10,948 | ------ | ------ | ------ | Ditch No. 9 |
| 9 | Combine | 26.19 | 1 | 725 | 85,065 | 6, 7, | ------ | ------ | DD30 |
| 10 | Combine | 60.06 | 1 | 726 | 209,068 | 5, 9 | ------ | ------ | DD28 & DD30 |
| 11 | Combine | 63.21 | 1 | 726 | 220,016 | 8, 10 | ------ | ------ | Ditch No. 9, DD28, & DD30 |
| 12 | SCS Runoff | 13.79 | 1 | 731 | 57,332 | ------ | ------ | ------ | Area to Ditch No. 10 |
| 13 | Combine | 74.94 | 1 | 726 | 277,348 | 11, 12 | ------ | ------ | Ditch No. 10 |
| 14 | SCS Runoff | 6.522 | 1 | 725 | 21,183 | ------ | ------ | ------ | DD31 |
| 15 | SCS Runoff | 5.238 | 1 | 725 | 17,013 | ------ | ------ | ------ | Area to DD32 |
| 16 | Combine | 11.76 | 1 | 725 | 38,196 | 14, 15 | ------ | ------ | DD32 |
| 17 | SCS Runoff | 8.371 | 1 | 725 | 27,187 | ------ | ------ | ------ | Area to DD33 |
| 18 | Combine | 20.13 | 1 | 725 | 65,383 | 16, 17 | ------ | ------ | DD33 |
| 19 | SCS Runoff | 10.68 | 1 | 725 | 34,693 | ------ | ------ | ------ | Area to DD34 |
| 20 | Combine | 30.81 | 1 | 725 | 100,076 | 18, 19 | ------ | ------ | DD34 |
| 21 | SCS Runoff | 8.987 | 1 | 725 | 29,189 | ------ | ------ | ------ | Area to DD35 |
| 22 | Combine | 39.80 | 1 | 725 | 129,265 | 20, 21 | ------ | ------ | DD35 |
| 23 | SCS Runoff | 10.40 | 1 | 727 | 35,925 | ------ | ------ | ------ | Area to DD36 |
| 24 | Combine | 50.14 | 1 | 726 | 165,189 | 22, 23 | ------ | ------ | DD36 |
| 25 | Combine | 125.08 | 1 | 726 | 442,538 | 13, 24 | ------ | ------ | DI. 702 |
| 26 | SCS Runoff | 8.690 | 1 | 730 | 34,556 | ------ | ------ | ------ | Ditch No. 11 |
| 27 | SCS Runoff | 9.172 | 1 | 725 | 28,579 | ------ | ------ | ------ | DD37 |
| 28 | SCS Runoff | 10.47 | 1 | 725 | 32,637 | ------ | ------ | ------ | Area to DD38 |
| 29 | Combine | 19.65 | 1 | 725 | 61,216 | 27, 28 | ------ | ------ | DD38 |
| 30 | Combine | 26.91 | 1 | 725 | 95,772 | 26, 29 | ------ | ------ | Ditch No. 11 & DD38 |
| 31 | SCS Runoff | 11.25 | 1 | 731 | 46,766 | ------ | ------ | ------ | Area to Ditch No. 12 |
| 32 | SCS Runoff | 5.281 | 1 | 723 | 15,396 | ------ | ------ | ------ | DD39 |
| 33 | SCS Runoff | 7.756 | 1 | 725 | 24,169 | ------ | ------ | ------ | Area to DD40 |
| 34 | Combine | 12.96 | 1 | 724 | 39,565 | 32, 33 | ------ | ------ | DD40 |

# Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022

| Hyd. No. | Hydrograph type (origin) | Peak flow (cfs) | Time interval (min) | Time to Peak (min) | Hyd. volume (cuft) | Inflow hyd(s) | Maximum elevation (ft) | Total strge used (cuft) | Hydrograph Description |
|---|---|---|---|---|---|---|---|---|---|
| 35 | SCS Runoff | 10.13 | 1 | 725 | 31,578 | ------ | ------ | ------ | Area to DD41 |
| 36 | Combine | 23.08 | 1 | 724 | 71,144 | 34, 35 | ------ | ------ | DD41 |
| 37 | SCS Runoff | 8.114 | 1 | 725 | 26,353 | ------ | ------ | ------ | Area to DD42 |
| 38 | Combine | 30.92 | 1 | 724 | 97,497 | 36, 37 | ------ | ------ | DD42 |
| 39 | SCS Runoff | 9.912 | 1 | 725 | 32,191 | ------ | ------ | ------ | Area to DD43 |
| 40 | Combine | 40.83 | 1 | 725 | 129,688 | 38, 39 | ------ | ------ | DD43 |
| 41 | SCS Runoff | 9.457 | 1 | 727 | 32,674 | ------ | ------ | ------ | Ditch No. 16 |
| 42 | SCS Runoff | 9.295 | 1 | 725 | 30,190 | ------ | ------ | ------ | DD56 |
| 43 | SCS Runoff | 13.25 | 1 | 725 | 43,033 | ------ | ------ | ------ | Area to DD57 |
| 44 | Combine | 22.55 | 1 | 725 | 73,222 | 42, 43 | ------ | ------ | DD57 |
| 45 | SCS Runoff | 13.87 | 1 | 725 | 43,222 | ------ | ------ | ------ | Area to DD58 |
| 46 | Combine | 36.42 | 1 | 725 | 116,444 | 44, 45 | ------ | ------ | DD58 |
| 47 | SCS Runoff | 13.30 | 1 | 725 | 41,458 | ------ | ------ | ------ | Area to DD59 |
| 48 | Combine | 49.72 | 1 | 725 | 157,902 | 46, 47 | ------ | ------ | DD59 |
| 49 | SCS Runoff | 11.72 | 1 | 725 | 36,518 | ------ | ------ | ------ | DD60 |
| 50 | Combine | 61.44 | 1 | 725 | 194,420 | 48, 49 | ------ | ------ | DD59 & DD60 |
| 51 | Combine | 70.58 | 1 | 725 | 227,094 | 41, 50 | ------ | ------ | Ditch No.16, DD59, & DD60 |
| 52 | SCS Runoff | 8.819 | 1 | 730 | 35,069 | ------ | ------ | ------ | Area to Ditch No. 15 |
| 53 | SCS Runoff | 6.615 | 1 | 728 | 24,203 | ------ | ------ | ------ | DD50 |
| 54 | SCS Runoff | 8.266 | 1 | 725 | 25,757 | ------ | ------ | ------ | Area to DD51 |
| 55 | Combine | 14.37 | 1 | 726 | 49,960 | 53, 54 | ------ | ------ | DD51 |
| 56 | SCS Runoff | 9.058 | 1 | 725 | 28,227 | ------ | ------ | ------ | Area to DD52 |
| 57 | Combine | 23.42 | 1 | 725 | 78,187 | 55, 56 | ------ | ------ | DD52 |
| 58 | SCS Runoff | 10.64 | 1 | 725 | 33,166 | ------ | ------ | ------ | Area to DD53 |
| 59 | Combine | 34.06 | 1 | 725 | 111,353 | 57, 58 | ------ | ------ | DD53 |
| 60 | SCS Runoff | 11.66 | 1 | 725 | 36,342 | ------ | ------ | ------ | Area to DD54 |
| 61 | Combine | 45.73 | 1 | 725 | 147,694 | 59, 60 | ------ | ------ | DD54 |
| 62 | SCS Runoff | 13.15 | 1 | 725 | 42,699 | ------ | ------ | ------ | DD55 |
| 63 | Combine | 58.87 | 1 | 725 | 190,394 | 61, 62 | ------ | ------ | DD54 & DD55 |
| 64 | Combine | 77.95 | 1 | 725 | 262,164 | 51, 52, | ------ | ------ | Ditch No. 15 |
| 65 | Combine | 136.82 | 1 | 725 | 452,557 | 63, 64 | ------ | ------ | Ditch No. 15, DD54, & DD55 |
| 66 | SCS Runoff | 8.506 | 1 | 738 | 42,584 | ------ | ------ | ------ | Area to Ditch No. 14 |
| 67 | SCS Runoff | 6.676 | 1 | 725 | 21,683 | ------ | ------ | ------ | DD44 |
| 68 | SCS Runoff | 7.700 | 1 | 725 | 23,993 | ------ | ------ | ------ | Area to DD45 |

# Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022

| Hyd. No. | Hydrograph type (origin) | Peak flow (cfs) | Time interval (min) | Time to Peak (min) | Hyd. volume (cuft) | Inflow hyd(s) | Maximum elevation (ft) | Total strge used (cuft) | Hydrograph Description |
|---|---|---|---|---|---|---|---|---|---|
| 69 | Combine | 14.38 | 1 | 725 | 45,676 | 67, 68 | ------ | ------ | DD45 |
| 70 | SCS Runoff | 9.398 | 1 | 725 | 29,285 | ------ | ------ | ------ | Area to DD46 |
| 71 | Combine | 23.77 | 1 | 725 | 74,961 | 69, 70 | ------ | ------ | DD46 |
| 72 | SCS Runoff | 11.55 | 1 | 725 | 35,989 | ------ | ------ | ------ | Area to DD47 |
| 73 | Combine | 35.32 | 1 | 725 | 110,949 | 71, 72 | ------ | ------ | DD47 |
| 74 | SCS Runoff | 12.07 | 1 | 725 | 39,196 | ------ | ------ | ------ | Area to DD48 |
| 75 | Combine | 47.39 | 1 | 725 | 150,146 | 73, 74 | ------ | ------ | DD48 |
| 76 | SCS Runoff | 13.71 | 1 | 725 | 44,534 | ------ | ------ | ------ | DD49 |
| 77 | Combine | 61.10 | 1 | 725 | 194,680 | 75, 76 | ------ | ------ | DD48 & DD49 |
| 78 | Combine | 142.10 | 1 | 725 | 495,141 | 65, 66, | ------ | ------ | Ditch No. 14 |
| 79 | Combine | 203.20 | 1 | 725 | 689,821 | 77, 78 | ------ | ------ | Ditch No. 14, DD48, & DD49 |
| 80 | SCS Runoff | 12.69 | 1 | 736 | 59,679 | ------ | ------ | ------ | Area to Ditch No. 13 |
| 81 | Combine | 211.73 | 1 | 725 | 749,500 | 79, 80 | ------ | ------ | Ditch No. 13 |
| 82 | Combine | 36.25 | 1 | 726 | 142,539 | 30, 31, | ------ | ------ | Ditch No. 12 |
| 83 | Combine | 288.40 | 1 | 725 | 1,021,726 | 40, 81, 82 | ------ | ------ | DI. 701 |
| 84 | SCS Runoff | 53.80 | 1 | 722 | 147,548 | ------ | ------ | ------ | Area to Pond No. 7 |
| 85 | Combine | 452.76 | 1 | 725 | 1,611,812 | 25, 83, 84 | ------ | ------ | Pond No. 7 Total Inflow |
| 87 | Reservoir | 11.97 | 1 | 1045 | 1,242,327 | 85 | 219.67 | 1,189,562 | Pond No. 7 perm pool |
| 88 | Reservoir | 129.60 | 1 | 750 | 1,611,809 | 85 | 221.95 | 563,289 | Pond No. 7 Riser |

# Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022

| Hyd. No. | Hydrograph type (origin) | Peak flow (cfs) | Time interval (min) | Time to Peak (min) | Hyd. volume (cuft) | Inflow hyd(s) | Maximum elevation (ft) | Total strge used (cuft) | Hydrograph Description |
|---|---|---|---|---|---|---|---|---|---|
| 1 | SCS Runoff | 16.89 | 1 | 729 | 64,797 | ------ | ------ | ------ | DD26 |
| 2 | SCS Runoff | 13.62 | 1 | 728 | 50,501 | ------ | ------ | ------ | Area to DD27 |
| 3 | Combine | 30.47 | 1 | 728 | 115,299 | 1, 2 | ------ | ------ | DD27 |
| 4 | SCS Runoff | 19.08 | 1 | 725 | 62,743 | ------ | ------ | ------ | Area to DD28 |
| 5 | Combine | 48.46 | 1 | 727 | 178,042 | 3, 4 | ------ | ------ | DD28 |
| 6 | SCS Runoff | 18.87 | 1 | 725 | 62,025 | ------ | ------ | ------ | DD29 |
| 7 | SCS Runoff | 18.28 | 1 | 725 | 60,109 | ------ | ------ | ------ | Area to DD30 |
| 8 | SCS Runoff | 5.322 | 1 | 723 | 15,720 | ------ | ------ | ------ | Ditch No. 9 |
| 9 | Combine | 37.15 | 1 | 725 | 122,134 | 6, 7, | ------ | ------ | DD30 |
| 10 | Combine | 85.18 | 1 | 726 | 300,176 | 5, 9 | ------ | ------ | DD28 & DD30 |
| 11 | Combine | 89.62 | 1 | 726 | 315,896 | 8, 10 | ------ | ------ | Ditch No. 9, DD28, & DD30 |
| 12 | SCS Runoff | 19.57 | 1 | 731 | 82,316 | ------ | ------ | ------ | Area to Ditch No. 10 |
| 13 | Combine | 106.42 | 1 | 726 | 398,212 | 11, 12 | ------ | ------ | Ditch No. 10 |
| 14 | SCS Runoff | 9.251 | 1 | 725 | 30,414 | ------ | ------ | ------ | DD31 |
| 15 | SCS Runoff | 7.430 | 1 | 725 | 24,427 | ------ | ------ | ------ | Area to DD32 |
| 16 | Combine | 16.68 | 1 | 725 | 54,841 | 14, 15 | ------ | ------ | DD32 |
| 17 | SCS Runoff | 11.87 | 1 | 725 | 39,035 | ------ | ------ | ------ | Area to DD33 |
| 18 | Combine | 28.55 | 1 | 725 | 93,876 | 16, 17 | ------ | ------ | DD33 |
| 19 | SCS Runoff | 15.15 | 1 | 725 | 49,812 | ------ | ------ | ------ | Area to DD34 |
| 20 | Combine | 43.70 | 1 | 725 | 143,687 | 18, 19 | ------ | ------ | DD34 |
| 21 | SCS Runoff | 12.75 | 1 | 725 | 41,909 | ------ | ------ | ------ | Area to DD35 |
| 22 | Combine | 56.45 | 1 | 725 | 185,596 | 20, 21 | ------ | ------ | DD35 |
| 23 | SCS Runoff | 14.73 | 1 | 727 | 51,580 | ------ | ------ | ------ | Area to DD36 |
| 24 | Combine | 70.99 | 1 | 726 | 237,176 | 22, 23 | ------ | ------ | DD36 |
| 25 | Combine | 177.42 | 1 | 726 | 635,387 | 13, 24 | ------ | ------ | DI. 702 |
| 26 | SCS Runoff | 12.32 | 1 | 730 | 49,615 | ------ | ------ | ------ | Ditch No. 11 |
| 27 | SCS Runoff | 13.00 | 1 | 724 | 41,034 | ------ | ------ | ------ | DD37 |
| 28 | SCS Runoff | 14.85 | 1 | 724 | 46,860 | ------ | ------ | ------ | Area to DD38 |
| 29 | Combine | 27.84 | 1 | 724 | 87,893 | 27, 28 | ------ | ------ | DD38 |
| 30 | Combine | 38.20 | 1 | 725 | 137,508 | 26, 29 | ------ | ------ | Ditch No. 11 & DD38 |
| 31 | SCS Runoff | 15.96 | 1 | 731 | 67,146 | ------ | ------ | ------ | Area to Ditch No. 12 |
| 32 | SCS Runoff | 7.484 | 1 | 723 | 22,106 | ------ | ------ | ------ | DD39 |
| 33 | SCS Runoff | 10.99 | 1 | 724 | 34,701 | ------ | ------ | ------ | Area to DD40 |
| 34 | Combine | 18.35 | 1 | 724 | 56,807 | 32, 33 | ------ | ------ | DD40 |

# Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022

| Hyd. No. | Hydrograph type (origin) | Peak flow (cfs) | Time interval (min) | Time to Peak (min) | Hyd. volume (cuft) | Inflow hyd(s) | Maximum elevation (ft) | Total strge used (cuft) | Hydrograph Description |
|---|---|---|---|---|---|---|---|---|---|
| 35 | SCS Runoff | 14.36 | 1 | 724 | 45,340 | ------ | ------ | ------ | Area to DD41 |
| 36 | Combine | 32.72 | 1 | 724 | 102,147 | 34, 35 | ------ | ------ | DD41 |
| 37 | SCS Runoff | 11.51 | 1 | 725 | 37,838 | ------ | ------ | ------ | Area to DD42 |
| 38 | Combine | 43.86 | 1 | 724 | 139,985 | 36, 37 | ------ | ------ | DD42 |
| 39 | SCS Runoff | 14.06 | 1 | 725 | 46,219 | ------ | ------ | ------ | Area to DD43 |
| 40 | Combine | 57.80 | 1 | 725 | 186,204 | 38, 39 | ------ | ------ | DD43 |
| 41 | SCS Runoff | 13.39 | 1 | 727 | 46,913 | ------ | ------ | ------ | Ditch No. 16 |
| 42 | SCS Runoff | 13.18 | 1 | 725 | 43,346 | ------ | ------ | ------ | DD56 |
| 43 | SCS Runoff | 18.79 | 1 | 725 | 61,786 | ------ | ------ | ------ | Area to DD57 |
| 44 | Combine | 31.98 | 1 | 725 | 105,131 | 42, 43 | ------ | ------ | DD57 |
| 45 | SCS Runoff | 19.66 | 1 | 724 | 62,057 | ------ | ------ | ------ | Area to DD58 |
| 46 | Combine | 51.60 | 1 | 725 | 167,188 | 44, 45 | ------ | ------ | DD58 |
| 47 | SCS Runoff | 18.86 | 1 | 724 | 59,524 | ------ | ------ | ------ | Area to DD59 |
| 48 | Combine | 70.42 | 1 | 725 | 226,713 | 46, 47 | ------ | ------ | DD59 |
| 49 | SCS Runoff | 16.61 | 1 | 724 | 52,432 | ------ | ------ | ------ | DD60 |
| 50 | Combine | 87.00 | 1 | 725 | 279,144 | 48, 49 | ------ | ------ | DD59 & DD60 |
| 51 | Combine | 100.00 | 1 | 725 | 326,058 | 41, 50 | ------ | ------ | Ditch No.16, DD59, & DD60 |
| 52 | SCS Runoff | 12.51 | 1 | 730 | 50,352 | ------ | ------ | ------ | Area to Ditch No. 15 |
| 53 | SCS Runoff | 9.374 | 1 | 728 | 34,751 | ------ | ------ | ------ | DD50 |
| 54 | SCS Runoff | 11.72 | 1 | 724 | 36,981 | ------ | ------ | ------ | Area to DD51 |
| 55 | Combine | 20.39 | 1 | 725 | 71,732 | 53, 54 | ------ | ------ | DD51 |
| 56 | SCS Runoff | 12.84 | 1 | 724 | 40,527 | ------ | ------ | ------ | Area to DD52 |
| 57 | Combine | 33.20 | 1 | 725 | 112,259 | 55, 56 | ------ | ------ | DD52 |
| 58 | SCS Runoff | 15.09 | 1 | 724 | 47,619 | ------ | ------ | ------ | Area to DD53 |
| 59 | Combine | 48.26 | 1 | 725 | 159,879 | 57, 58 | ------ | ------ | DD53 |
| 60 | SCS Runoff | 16.53 | 1 | 724 | 52,179 | ------ | ------ | ------ | Area to DD54 |
| 61 | Combine | 64.76 | 1 | 725 | 212,057 | 59, 60 | ------ | ------ | DD54 |
| 62 | SCS Runoff | 18.65 | 1 | 725 | 61,307 | ------ | ------ | ------ | DD55 |
| 63 | Combine | 83.41 | 1 | 725 | 273,363 | 61, 62 | ------ | ------ | DD54 & DD55 |
| 64 | Combine | 110.56 | 1 | 725 | 376,410 | 51, 52, | ------ | ------ | Ditch No. 15 |
| 65 | Combine | 193.97 | 1 | 725 | 649,773 | 63, 64 | ------ | ------ | Ditch No. 15, DD54, & DD55 |
| 66 | SCS Runoff | 12.08 | 1 | 738 | 61,142 | ------ | ------ | ------ | Area to Ditch No. 14 |
| 67 | SCS Runoff | 9.469 | 1 | 725 | 31,132 | ------ | ------ | ------ | DD44 |
| 68 | SCS Runoff | 10.91 | 1 | 724 | 34,448 | ------ | ------ | ------ | Area to DD45 |

# Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022

| Hyd. No. | Hydrograph type (origin) | Peak flow (cfs) | Time interval (min) | Time to Peak (min) | Hyd. volume (cuft) | Inflow hyd(s) | Maximum elevation (ft) | Total strge used (cuft) | Hydrograph Description |
|---|---|---|---|---|---|---|---|---|---|
| 69 | Combine | 20.36 | 1 | 725 | 65,580 | 67, 68 | ------ | ------ | DD45 |
| 70 | SCS Runoff | 13.32 | 1 | 724 | 42,047 | ------ | ------ | ------ | Area to DD46 |
| 71 | Combine | 33.66 | 1 | 725 | 107,627 | 69, 70 | ------ | ------ | DD46 |
| 72 | SCS Runoff | 16.37 | 1 | 724 | 51,672 | ------ | ------ | ------ | Area to DD47 |
| 73 | Combine | 50.00 | 1 | 725 | 159,299 | 71, 72 | ------ | ------ | DD47 |
| 74 | SCS Runoff | 17.12 | 1 | 725 | 56,277 | ------ | ------ | ------ | Area to DD48 |
| 75 | Combine | 67.12 | 1 | 725 | 215,577 | 73, 74 | ------ | ------ | DD48 |
| 76 | SCS Runoff | 19.45 | 1 | 725 | 63,941 | ------ | ------ | ------ | DD49 |
| 77 | Combine | 86.56 | 1 | 725 | 279,518 | 75, 76 | ------ | ------ | DD48 & DD49 |
| 78 | Combine | 201.64 | 1 | 725 | 710,915 | 65, 66, | ------ | ------ | Ditch No. 14 |
| 79 | Combine | 288.20 | 1 | 725 | 990,433 | 77, 78 | ------ | ------ | Ditch No. 14, DD48, & DD49 |
| 80 | SCS Runoff | 18.03 | 1 | 735 | 85,686 | ------ | ------ | ------ | Area to Ditch No. 13 |
| 81 | Combine | 300.55 | 1 | 725 | 1,076,118 | 79, 80 | ------ | ------ | Ditch No. 13 |
| 82 | Combine | 51.50 | 1 | 726 | 204,654 | 30, 31, | ------ | ------ | Ditch No. 12 |
| 83 | Combine | 409.39 | 1 | 725 | 1,466,977 | 40, 81, 82 | ------ | ------ | DI. 701 |
| 84 | SCS Runoff | 76.17 | 1 | 722 | 211,847 | ------ | ------ | ------ | Area to Pond No. 7 |
| 85 | Combine | 642.29 | 1 | 725 | 2,314,212 | 25, 83, 84 | ------ | ------ | Pond No. 7 Total Inflow |
| 87 | Reservoir | 49.13 | 1 | 819 | 1,870,172 | 85 | 220.61 | 1,454,125 | Pond No. 7 perm pool |
| 88 | Reservoir | 145.05 | 1 | 753 | 2,314,197 | 85 | 222.90 | 854,550 | Pond No. 7 Riser |

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| Hyd. No. | Hydrograph type (origin) | Peak flow (cfs) | Time interval (min) | Time to Peak (min) | Hyd. volume (cuft) | Inflow hyd(s) | Maximum elevation (ft) | Total strge used (cuft) | Hydrograph Description |
|---|---|---|---|---|---|---|---|---|---|
| 1 | SCS Runoff | 12.08 | 1 | 732 | 51,583 | ------ | ------ | ------ | Ditch No. 14 |
| 2 | SCS Runoff | 9.090 | 1 | 725 | 29,522 | ------ | ------ | ------ | DD64 |
| 3 | SCS Runoff | 7.926 | 1 | 725 | 24,698 | ------ | ------ | ------ | Area to DD65 |
| 4 | Combine | 17.02 | 1 | 725 | 54,221 | 2, 3 | ------ | ------ | DD65 |
| 5 | SCS Runoff | 10.87 | 1 | 725 | 33,872 | ------ | ------ | ------ | Area to DD66 |
| 6 | Combine | 27.89 | 1 | 725 | 88,092 | 4, 5 | ------ | ------ | DD66 |
| 7 | SCS Runoff | 11.43 | 1 | 729 | 43,278 | ------ | ------ | ------ | Area to DD67 |
| 8 | Combine | 37.94 | 1 | 725 | 131,371 | 6, 7 | ------ | ------ | DD67 |
| 9 | Combine | 47.71 | 1 | 726 | 182,954 | 1, 8 | ------ | ------ | Ditch No. 14 & DD67 |
| 10 | SCS Runoff | 8.536 | 1 | 729 | 32,332 | ------ | ------ | ------ | Area to Ditch No. 13 |
| 11 | Combine | 55.68 | 1 | 726 | 215,286 | 9, 10 | ------ | ------ | Ditch No. 13 |
| 12 | SCS Runoff | 15.05 | 1 | 725 | 48,870 | ------ | ------ | ------ | DD56 |
| 13 | SCS Runoff | 10.47 | 1 | 725 | 32,637 | ------ | ------ | ------ | Area to DD57 |
| 14 | Combine | 25.52 | 1 | 725 | 81,507 | 12, 13 | ------ | ------ | DD57 |
| 15 | SCS Runoff | 9.055 | 1 | 737 | 43,965 | ------ | ------ | ------ | Area to DD58 |
| 16 | Combine | 31.37 | 1 | 726 | 125,472 | 14, 15 | ------ | ------ | DD58 |
| 17 | SCS Runoff | 11.78 | 1 | 725 | 36,695 | ------ | ------ | ------ | Area to DD59 |
| 18 | Combine | 43.14 | 1 | 725 | 162,167 | 16, 17 | ------ | ------ | DD59 |
| 19 | SCS Runoff | 9.507 | 1 | 730 | 37,806 | ------ | ------ | ------ | Area to DD60 |
| 20 | Combine | 51.19 | 1 | 726 | 199,973 | 18, 19 | ------ | ------ | DD60 |
| 21 | SCS Runoff | 12.57 | 1 | 725 | 39,164 | ------ | ------ | ------ | DD61 |
| 22 | SCS Runoff | 12.74 | 1 | 725 | 39,694 | ------ | ------ | ------ | Area to DD62 |
| 23 | Combine | 25.31 | 1 | 725 | 78,858 | 21, 22 | ------ | ------ | DD62 |
| 24 | SCS Runoff | 14.38 | 1 | 725 | 44,810 | ------ | ------ | ------ | Area to DD63 |
| 25 | Combine | 39.69 | 1 | 725 | 123,667 | 23, 24 | ------ | ------ | DD63 |
| 26 | SCS Runoff | 3.345 | 1 | 723 | 9,751 | ------ | ------ | ------ | Ditch No. 12 |
| 27 | Combine | 148.53 | 1 | 725 | 548,678 | 11, 20, 25, 26 | ------ | ------ | DI. No. 801 |
| 28 | SCS Runoff | 15.20 | 1 | 722 | 41,698 | ------ | ------ | ------ | Area to Pond No. 8 |
| 29 | Combine | 160.13 | 1 | 725 | 590,377 | 27, 28 | ------ | ------ | Pond No. 8 Total Inflow |
| 30 | Reservoir | 22.74 | 1 | 768 | 569,435 | 29 | 226.28 | 304,313 | Pond No. 8 perm pool |
| 31 | Reservoir | 95.94 | 1 | 736 | 590,373 | 29 | 227.71 | 105,076 | Pond No. 8 - riser |
| 33 | SCS Runoff | 5.139 | 1 | 728 | 18,805 | ------ | ------ | ------ | Ditch No. 11 |
| 34 | SCS Runoff | 13.25 | 1 | 730 | 52,690 | ------ | ------ | ------ | DD48 |

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Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022

| Hyd. No. | Hydrograph type (origin) | Peak flow (cfs) | Time interval (min) | Time to Peak (min) | Hyd. volume (cuft) | Inflow hyd(s) | Maximum elevation (ft) | Total strge used (cuft) | Hydrograph Description |
|---|---|---|---|---|---|---|---|---|---|
| 35 | SCS Runoff | 10.19 | 1 | 725 | 31,755 | ------ | ------ | ------ | Area to DD49 |
| 36 | Combine | 21.63 | 1 | 726 | 84,444 | 34, 35 | ------ | ------ | DD49 |
| 37 | SCS Runoff | 11.83 | 1 | 725 | 36,871 | ------ | ------ | ------ | Area to DD50 |
| 38 | Combine | 33.09 | 1 | 725 | 121,315 | 36, 37 | ------ | ------ | DD50 |
| 39 | SCS Runoff | 10.81 | 1 | 725 | 33,695 | ------ | ------ | ------ | Area to DD51 |
| 40 | Combine | 43.91 | 1 | 725 | 155,011 | 38, 39 | ------ | ------ | DD51 |
| 41 | SCS Runoff | 10.76 | 1 | 725 | 33,519 | ------ | ------ | ------ | DD52 |
| 42 | SCS Runoff | 10.47 | 1 | 725 | 32,637 | ------ | ------ | ------ | Area to DD53 |
| 43 | Combine | 21.23 | 1 | 725 | 66,156 | 41, 42 | ------ | ------ | DD53 |
| 44 | SCS Runoff | 10.36 | 1 | 725 | 32,284 | ------ | ------ | ------ | Area to DD54 |
| 45 | Combine | 31.59 | 1 | 725 | 98,440 | 43, 44 | ------ | ------ | DD54 |
| 46 | SCS Runoff | 10.30 | 1 | 725 | 32,108 | ------ | ------ | ------ | Area to DD55 |
| 47 | Combine | 41.90 | 1 | 725 | 130,548 | 45, 46 | ------ | ------ | DD55 |
| 48 | Combine | 85.80 | 1 | 725 | 285,558 | 40, 47 | ------ | ------ | DD51 & DD55 |
| 49 | Combine | 90.54 | 1 | 725 | 304,364 | 33, 48 | ------ | ------ | Ditch No. 11, DD51, & DD55 |
| 50 | SCS Runoff | 5.068 | 1 | 729 | 19,197 | ------ | ------ | ------ | Area to Ditch No. 10 |
| 51 | Combine | 95.00 | 1 | 725 | 323,561 | 49, 50 | ------ | ------ | Ditch No. 10 |
| 52 | SCS Runoff | 7.159 | 1 | 723 | 20,871 | ------ | ------ | ------ | DD43 |
| 53 | SCS Runoff | 6.983 | 1 | 723 | 20,357 | ------ | ------ | ------ | Area to DD44 |
| 54 | Combine | 14.14 | 1 | 723 | 41,228 | 52, 53 | ------ | ------ | DD44 |
| 55 | SCS Runoff | 9.347 | 1 | 725 | 30,356 | ------ | ------ | ------ | Area to DD45 |
| 56 | Combine | 22.97 | 1 | 724 | 71,584 | 54, 55 | ------ | ------ | DD45 |
| 57 | SCS Runoff | 9.228 | 1 | 725 | 28,756 | ------ | ------ | ------ | Area to DD46 |
| 58 | Combine | 32.19 | 1 | 724 | 100,340 | 56, 57 | ------ | ------ | DD46 |
| 59 | SCS Runoff | 10.22 | 1 | 725 | 33,192 | ------ | ------ | ------ | Area to DD47 |
| 60 | Combine | 42.07 | 1 | 724 | 133,532 | 58, 59 | ------ | ------ | DD47 |
| 61 | SCS Runoff | 4.673 | 1 | 725 | 15,178 | ------ | ------ | ------ | Ditch No. 9 |
| 62 | SCS Runoff | 20.82 | 1 | 722 | 57,095 | ------ | ------ | ------ | Area to Pond No. 9 |
| 63 | Combine | 141.61 | 1 | 725 | 472,271 | 51, 60, 61, | ------ | ------ | Pipe No. 901 |
| 64 | Combine | 158.15 | 1 | 724 | 529,365 | 62, 63 | ------ | ------ | Pond No. 9 Total Inflow |
| 65 | Reservoir | 6.778 | 1 | 924 | 505,432 | 64 | 220.78 | 342,662 | Pond No. 9 perm pool |
| 66 | Reservoir | 77.09 | 1 | 736 | 529,361 | 64 | 222.20 | 126,418 | Pond No. 9 riser |

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Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022

| Hyd. No. | Hydrograph type (origin) | Peak flow (cfs) | Time interval (min) | Time to Peak (min) | Hyd. volume (cuft) | Inflow hyd(s) | Maximum elevation (ft) | Total strge used (cuft) | Hydrograph Description |
|---|---|---|---|---|---|---|---|---|---|
| 1 | SCS Runoff | 17.15 | 1 | 732 | 74,063 | ------ | ------ | ------ | Ditch No. 14 |
| 2 | SCS Runoff | 12.89 | 1 | 725 | 42,388 | ------ | ------ | ------ | DD64 |
| 3 | SCS Runoff | 11.23 | 1 | 724 | 35,461 | ------ | ------ | ------ | Area to DD65 |
| 4 | Combine | 24.11 | 1 | 725 | 77,849 | 2, 3 | ------ | ------ | DD65 |
| 5 | SCS Runoff | 15.41 | 1 | 724 | 48,633 | ------ | ------ | ------ | Area to DD66 |
| 6 | Combine | 39.49 | 1 | 725 | 126,482 | 4, 5 | ------ | ------ | DD66 |
| 7 | SCS Runoff | 16.19 | 1 | 729 | 62,138 | ------ | ------ | ------ | Area to DD67 |
| 8 | Combine | 53.86 | 1 | 725 | 188,619 | 6, 7 | ------ | ------ | DD67 |
| 9 | Combine | 67.77 | 1 | 726 | 262,682 | 1, 8 | ------ | ------ | Ditch No. 14 & DD67 |
| 10 | SCS Runoff | 12.10 | 1 | 729 | 46,422 | ------ | ------ | ------ | Area to Ditch No. 13 |
| 11 | Combine | 79.13 | 1 | 726 | 309,104 | 9, 10 | ------ | ------ | Ditch No. 13 |
| 12 | SCS Runoff | 21.34 | 1 | 725 | 70,167 | ------ | ------ | ------ | DD56 |
| 13 | SCS Runoff | 14.85 | 1 | 724 | 46,860 | ------ | ------ | ------ | Area to DD57 |
| 14 | Combine | 36.16 | 1 | 725 | 117,027 | 12, 13 | ------ | ------ | DD57 |
| 15 | SCS Runoff | 12.85 | 1 | 736 | 63,124 | ------ | ------ | ------ | Area to DD58 |
| 16 | Combine | 44.63 | 1 | 725 | 180,151 | 14, 15 | ------ | ------ | DD58 |
| 17 | SCS Runoff | 16.69 | 1 | 724 | 52,685 | ------ | ------ | ------ | Area to DD59 |
| 18 | Combine | 61.29 | 1 | 725 | 232,836 | 16, 17 | ------ | ------ | DD59 |
| 19 | SCS Runoff | 13.48 | 1 | 730 | 54,282 | ------ | ------ | ------ | Area to DD60 |
| 20 | Combine | 72.68 | 1 | 726 | 287,118 | 18, 19 | ------ | ------ | DD60 |
| 21 | SCS Runoff | 17.81 | 1 | 724 | 56,231 | ------ | ------ | ------ | DD61 |
| 22 | SCS Runoff | 18.05 | 1 | 724 | 56,991 | ------ | ------ | ------ | Area to DD62 |
| 23 | Combine | 35.87 | 1 | 724 | 113,223 | 21, 22 | ------ | ------ | DD62 |
| 24 | SCS Runoff | 20.38 | 1 | 724 | 64,337 | ------ | ------ | ------ | Area to DD63 |
| 25 | Combine | 56.25 | 1 | 724 | 177,560 | 23, 24 | ------ | ------ | DD63 |
| 26 | SCS Runoff | 4.740 | 1 | 723 | 14,000 | ------ | ------ | ------ | Ditch No. 12 |
| 27 | Combine | 211.03 | 1 | 725 | 787,782 | 11, 20, 25, 26 | ------ | ------ | DI. No. 801 |
| 28 | SCS Runoff | 21.53 | 1 | 722 | 59,870 | ------ | ------ | ------ | Area to Pond No. 8 |
| 29 | Combine | 227.32 | 1 | 725 | 847,651 | 27, 28 | ------ | ------ | Pond No. 8 Total Inflow |
| 30 | Reservoir | 84.04 | 1 | 746 | 825,955 | 29 | 227.31 | 377,481 | Pond No. 8 perm pool |
| 31 | Reservoir | 108.87 | 1 | 741 | 847,648 | 29 | 228.51 | 166,849 | Pond No. 8 - riser |
| 33 | SCS Runoff | 7.284 | 1 | 728 | 27,001 | ------ | ------ | ------ | Ditch No. 11 |
| 34 | SCS Runoff | 18.79 | 1 | 730 | 75,651 | ------ | ------ | ------ | DD48 |

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| Hyd. No. | Hydrograph type (origin) | Peak flow (cfs) | Time interval (min) | Time to Peak (min) | Hyd. volume (cuft) | Inflow hyd(s) | Maximum elevation (ft) | Total strge used (cuft) | Hydrograph Description |
|---|---|---|---|---|---|---|---|---|---|
| 35 | SCS Runoff | 14.44 | 1 | 724 | 45,593 | ------ | ------ | ------ | Area to DD49 |
| 36 | Combine | 30.75 | 1 | 726 | 121,244 | 34, 35 | ------ | ------ | DD49 |
| 37 | SCS Runoff | 16.77 | 1 | 724 | 52,939 | ------ | ------ | ------ | Area to DD50 |
| 38 | Combine | 47.02 | 1 | 725 | 174,182 | 36, 37 | ------ | ------ | DD50 |
| 39 | SCS Runoff | 15.33 | 1 | 724 | 48,379 | ------ | ------ | ------ | Area to DD51 |
| 40 | Combine | 62.32 | 1 | 725 | 222,562 | 38, 39 | ------ | ------ | DD51 |
| 41 | SCS Runoff | 15.25 | 1 | 724 | 48,126 | ------ | ------ | ------ | DD52 |
| 42 | SCS Runoff | 14.85 | 1 | 724 | 46,860 | ------ | ------ | ------ | Area to DD53 |
| 43 | Combine | 30.09 | 1 | 724 | 94,986 | 41, 42 | ------ | ------ | DD53 |
| 44 | SCS Runoff | 14.68 | 1 | 724 | 46,353 | ------ | ------ | ------ | Area to DD54 |
| 45 | Combine | 44.78 | 1 | 724 | 141,339 | 43, 44 | ------ | ------ | DD54 |
| 46 | SCS Runoff | 14.60 | 1 | 724 | 46,100 | ------ | ------ | ------ | Area to DD55 |
| 47 | Combine | 59.38 | 1 | 724 | 187,438 | 45, 46 | ------ | ------ | DD55 |
| 48 | Combine | 121.59 | 1 | 725 | 410,000 | 40, 47 | ------ | ------ | DD51 & DD55 |
| 49 | Combine | 128.35 | 1 | 725 | 437,001 | 33, 48 | ------ | ------ | Ditch No. 11, DD51, & DD55 |
| 50 | SCS Runoff | 7.183 | 1 | 729 | 27,563 | ------ | ------ | ------ | Area to Ditch No. 10 |
| 51 | Combine | 134.72 | 1 | 725 | 464,563 | 49, 50 | ------ | ------ | Ditch No. 10 |
| 52 | SCS Runoff | 10.15 | 1 | 723 | 29,966 | ------ | ------ | ------ | DD43 |
| 53 | SCS Runoff | 9.896 | 1 | 723 | 29,229 | ------ | ------ | ------ | Area to DD44 |
| 54 | Combine | 20.04 | 1 | 723 | 59,194 | 52, 53 | ------ | ------ | DD44 |
| 55 | SCS Runoff | 13.26 | 1 | 725 | 43,585 | ------ | ------ | ------ | Area to DD45 |
| 56 | Combine | 32.54 | 1 | 724 | 102,779 | 54, 55 | ------ | ------ | DD45 |
| 57 | SCS Runoff | 13.08 | 1 | 724 | 41,287 | ------ | ------ | ------ | Area to DD46 |
| 58 | Combine | 45.62 | 1 | 724 | 144,066 | 56, 57 | ------ | ------ | DD46 |
| 59 | SCS Runoff | 14.49 | 1 | 725 | 47,656 | ------ | ------ | ------ | Area to DD47 |
| 60 | Combine | 59.66 | 1 | 724 | 191,723 | 58, 59 | ------ | ------ | DD47 |
| 61 | SCS Runoff | 6.628 | 1 | 725 | 21,793 | ------ | ------ | ------ | Ditch No. 9 |
| 62 | SCS Runoff | 29.47 | 1 | 722 | 81,975 | ------ | ------ | ------ | Area to Pond No. 9 |
| 63 | Combine | 200.69 | 1 | 725 | 678,078 | 51, 60, 61, | ------ | ------ | Pipe No. 901 |
| 64 | Combine | 224.42 | 1 | 724 | 760,054 | 62, 63 | ------ | ------ | Pond No. 9 Total Inflow |
| 65 | Reservoir | 31.91 | 1 | 758 | 732,590 | 64 | 221.53 | 417,874 | Pond No. 9 perm pool |
| 66 | Reservoir | 89.40 | 1 | 740 | 760,050 | 64 | 222.77 | 189,633 | Pond No. 9 riser |

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| Hyd. No. | Hydrograph type (origin) | Peak flow (cfs) | Time interval (min) | Time to Peak (min) | Hyd. volume (cuft) | Inflow hyd(s) | Maximum elevation (ft) | Total strge used (cuft) | Hydrograph Description |
|---|---|---|---|---|---|---|---|---|---|
| 1 | SCS Runoff | 7.789 | 1 | 739 | 39,736 | ------ | ------ | ------ | Ditch No. 5 |
| 2 | SCS Runoff | 9.398 | 1 | 725 | 29,285 | ------ | ------ | ------ | DD 26 |
| 3 | SCS Runoff | 9.244 | 1 | 725 | 30,023 | ------ | ------ | ------ | Area to DD27 |
| 4 | Combine | 18.64 | 1 | 725 | 59,308 | 2, 3 | ------ | ------ | DD27 |
| 5 | SCS Runoff | 10.22 | 1 | 725 | 33,192 | ------ | ------ | ------ | Area to DD28 |
| 6 | Combine | 28.86 | 1 | 725 | 92,500 | 4, 5 | ------ | ------ | DD28 |
| 7 | SCS Runoff | 11.61 | 1 | 725 | 37,695 | ------ | ------ | ------ | Area to DD29 |
| 8 | Combine | 40.47 | 1 | 725 | 130,195 | 6, 7 | ------ | ------ | DD29 |
| 9 | SCS Runoff | 12.22 | 1 | 725 | 39,697 | ------ | ------ | ------ | DD30 |
| 10 | SCS Runoff | 13.25 | 1 | 725 | 43,033 | ------ | ------ | ------ | Area to DD31 |
| 11 | Combine | 25.47 | 1 | 725 | 82,729 | 9, 10 | ------ | ------ | DD31 |
| 12 | SCS Runoff | 13.97 | 1 | 725 | 45,368 | ------ | ------ | ------ | Area to DD32 |
| 13 | Combine | 39.44 | 1 | 725 | 128,097 | 11, 12 | ------ | ------ | DD32 |
| 14 | SCS Runoff | 9.745 | 1 | 738 | 48,791 | ------ | ------ | ------ | Area to Ditch No. 6 |
| 15 | Combine | 90.95 | 1 | 726 | 346,819 | 1, 8, 13, 14 | ------ | ------ | Ditch No.6 |
| 16 | SCS Runoff | 12.40 | 1 | 732 | 52,936 | ------ | ------ | ------ | DD33 |
| 17 | SCS Runoff | 6.228 | 1 | 725 | 19,406 | ------ | ------ | ------ | Area to DD34 |
| 18 | Combine | 16.37 | 1 | 728 | 72,342 | 16, 17 | ------ | ------ | DD34 |
| 19 | SCS Runoff | 8.474 | 1 | 725 | 27,521 | ------ | ------ | ------ | Area to DD35 |
| 20 | Combine | 24.57 | 1 | 726 | 99,863 | 18, 19 | ------ | ------ | DD35 |
| 21 | SCS Runoff | 8.371 | 1 | 725 | 27,187 | ------ | ------ | ------ | Area to DD36 |
| 22 | Combine | 32.94 | 1 | 726 | 127,050 | 20, 21 | ------ | ------ | DD36 |
| 23 | SCS Runoff | 11.76 | 1 | 725 | 38,196 | ------ | ------ | ------ | Area to DD37 |
| 24 | Combine | 44.69 | 1 | 726 | 165,246 | 22, 23 | ------ | ------ | DD37 |
| 25 | SCS Runoff | 12.68 | 1 | 725 | 41,198 | ------ | ------ | ------ | DD38 |
| 26 | SCS Runoff | 10.58 | 1 | 725 | 34,359 | ------ | ------ | ------ | Area to DD39 |
| 27 | Combine | 23.26 | 1 | 725 | 75,557 | 25, 26 | ------ | ------ | DD39 |
| 28 | SCS Runoff | 10.94 | 1 | 725 | 35,527 | ------ | ------ | ------ | Area to DD40 |
| 29 | Combine | 34.20 | 1 | 725 | 111,084 | 27, 28 | ------ | ------ | DD40 |
| 30 | SCS Runoff | 6.980 | 1 | 729 | 26,438 | ------ | ------ | ------ | Ditch No. 7 |
| 31 | Combine | 176.35 | 1 | 726 | 649,587 | 15, 24, 29, 30 | ------ | ------ | Pipe No. 1001 |
| 32 | SCS Runoff | 8.802 | 1 | 723 | 25,660 | ------ | ------ | ------ | DD41 |
| 33 | SCS Runoff | 9.449 | 1 | 725 | 30,690 | ------ | ------ | ------ | Area to DD42 |
| 34 | Combine | 17.81 | 1 | 724 | 56,350 | 32, 33 | ------ | ------ | DD42 |

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| Hyd. No. | Hydrograph type (origin) | Peak flow (cfs) | Time interval (min) | Time to Peak (min) | Hyd. volume (cuft) | Inflow hyd(s) | Maximum elevation (ft) | Total strge used (cuft) | Hydrograph Description |
|---|---|---|---|---|---|---|---|---|---|
| 35 | SCS Runoff | 6.846 | 1 | 729 | 25,933 | ------ | ------ | ------ | Ditch No. 8 |
| 36 | Combine | 23.66 | 1 | 725 | 82,284 | 34, 35 | ------ | ------ | Pipe No. 1002 |
| 37 | SCS Runoff | 42.92 | 1 | 722 | 117,717 | ------ | ------ | ------ | Area to Pond No. 10 |
| 38 | Combine | 231.66 | 1 | 725 | 849,589 | 31, 36, 37 | ------ | ------ | Pond No. 10 Total Inflow |
| 39 | Reservoir | 5.757 | 1 | 1066 | 606,624 | 38 | 207.96 | 641,418 | Pond No. 10 perm pool |
| 40 | Reservoir | 63.67 | 1 | 751 | 849,574 | 38 | 210.30 | 309,968 | Pond No. 10 riser |

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Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022

| Hyd. No. | Hydrograph type (origin) | Peak flow (cfs) | Time interval (min) | Time to Peak (min) | Hyd. volume (cuft) | Inflow hyd(s) | Maximum elevation (ft) | Total strge used (cuft) | Hydrograph Description |
|---|---|---|---|---|---|---|---|---|---|
| 1 | SCS Runoff | 11.06 | 1 | 739 | 57,052 | ------ | ------ | ------ | Ditch No. 5 |
| 2 | SCS Runoff | 13.32 | 1 | 724 | 42,047 | ------ | ------ | ------ | DD 26 |
| 3 | SCS Runoff | 13.11 | 1 | 725 | 43,106 | ------ | ------ | ------ | Area to DD27 |
| 4 | Combine | 26.41 | 1 | 725 | 85,153 | 2, 3 | ------ | ------ | DD27 |
| 5 | SCS Runoff | 14.49 | 1 | 725 | 47,656 | ------ | ------ | ------ | Area to DD28 |
| 6 | Combine | 40.90 | 1 | 725 | 132,809 | 4, 5 | ------ | ------ | DD28 |
| 7 | SCS Runoff | 16.46 | 1 | 725 | 54,122 | ------ | ------ | ------ | Area to DD29 |
| 8 | Combine | 57.36 | 1 | 725 | 186,932 | 6, 7 | ------ | ------ | DD29 |
| 9 | SCS Runoff | 17.34 | 1 | 725 | 56,996 | ------ | ------ | ------ | DD30 |
| 10 | SCS Runoff | 18.79 | 1 | 725 | 61,786 | ------ | ------ | ------ | Area to DD31 |
| 11 | Combine | 36.13 | 1 | 725 | 118,781 | 9, 10 | ------ | ------ | DD31 |
| 12 | SCS Runoff | 19.81 | 1 | 725 | 65,138 | ------ | ------ | ------ | Area to DD32 |
| 13 | Combine | 55.94 | 1 | 725 | 183,920 | 11, 12 | ------ | ------ | DD32 |
| 14 | SCS Runoff | 13.84 | 1 | 738 | 70,053 | ------ | ------ | ------ | Area to Ditch No. 6 |
| 15 | Combine | 129.07 | 1 | 726 | 497,957 | 1, 8, 13, 14 | ------ | ------ | Ditch No.6 |
| 16 | SCS Runoff | 17.60 | 1 | 732 | 76,005 | ------ | ------ | ------ | DD33 |
| 17 | SCS Runoff | 8.827 | 1 | 724 | 27,862 | ------ | ------ | ------ | Area to DD34 |
| 18 | Combine | 23.28 | 1 | 728 | 103,868 | 16, 17 | ------ | ------ | DD34 |
| 19 | SCS Runoff | 12.02 | 1 | 725 | 39,514 | ------ | ------ | ------ | Area to DD35 |
| 20 | Combine | 34.96 | 1 | 726 | 143,382 | 18, 19 | ------ | ------ | DD35 |
| 21 | SCS Runoff | 11.87 | 1 | 725 | 39,035 | ------ | ------ | ------ | Area to DD36 |
| 22 | Combine | 46.80 | 1 | 726 | 182,417 | 20, 21 | ------ | ------ | DD36 |
| 23 | SCS Runoff | 16.68 | 1 | 725 | 54,841 | ------ | ------ | ------ | Area to DD37 |
| 24 | Combine | 63.43 | 1 | 726 | 237,257 | 22, 23 | ------ | ------ | DD37 |
| 25 | SCS Runoff | 17.99 | 1 | 725 | 59,151 | ------ | ------ | ------ | DD38 |
| 26 | SCS Runoff | 15.00 | 1 | 725 | 49,333 | ------ | ------ | ------ | Area to DD39 |
| 27 | Combine | 33.00 | 1 | 725 | 108,484 | 25, 26 | ------ | ------ | DD39 |
| 28 | SCS Runoff | 15.51 | 1 | 725 | 51,009 | ------ | ------ | ------ | Area to DD40 |
| 29 | Combine | 48.51 | 1 | 725 | 159,493 | 27, 28 | ------ | ------ | DD40 |
| 30 | SCS Runoff | 9.892 | 1 | 729 | 37,960 | ------ | ------ | ------ | Ditch No. 7 |
| 31 | Combine | 250.17 | 1 | 726 | 932,666 | 15, 24, 29, 30 | ------ | ------ | Pipe No. 1001 |
| 32 | SCS Runoff | 12.47 | 1 | 723 | 36,843 | ------ | ------ | ------ | DD41 |
| 33 | SCS Runoff | 13.40 | 1 | 725 | 44,064 | ------ | ------ | ------ | Area to DD42 |
| 34 | Combine | 25.24 | 1 | 724 | 80,907 | 32, 33 | ------ | ------ | DD42 |

# Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022

| Hyd. No. | Hydrograph type (origin) | Peak flow (cfs) | Time interval (min) | Time to Peak (min) | Hyd. volume (cuft) | Inflow hyd(s) | Maximum elevation (ft) | Total strge used (cuft) | Hydrograph Description |
|---|---|---|---|---|---|---|---|---|---|
| 35 | SCS Runoff | 9.703 | 1 | 729 | 37,234 | ------ | ------ | ------ | Ditch No. 8 |
| 36 | Combine | 33.54 | 1 | 725 | 118,141 | 34, 35 | ------ | ------ | Pipe No. 1002 |
| 37 | SCS Runoff | 60.77 | 1 | 722 | 169,017 | ------ | ------ | ------ | Area to Pond No. 10 |
| 38 | Combine | 328.66 | 1 | 725 | 1,219,823 | 31, 36, 37 | ------ | ------ | Pond No. 10 Total Inflow |
| 39 | Reservoir | 10.91 | 1 | 980 | 833,963 | 38 | 209.14 | 915,087 | Pond No. 10 perm pool |
| 40 | Reservoir | 70.87 | 1 | 755 | 1,219,810 | 38 | 210.95 | 469,451 | Pond No. 10 riser |

# Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022

| Hyd. No. | Hydrograph type (origin) | Peak flow (cfs) | Time interval (min) | Time to Peak (min) | Hyd. volume (cuft) | Inflow hyd(s) | Maximum elevation (ft) | Total strge used (cuft) | Hydrograph Description |
|---|---|---|---|---|---|---|---|---|---|
| 1 | SCS Runoff | 5.855 | 1 | 725 | 19,014 | ------ | ------ | ------ | Ditch No. 1 |
| 2 | SCS Runoff | 9.568 | 1 | 725 | 29,814 | ------ | ------ | ------ | DD1 |
| 3 | SCS Runoff | 10.58 | 1 | 725 | 34,359 | ------ | ------ | ------ | Area to DD2 |
| 4 | Combine | 20.15 | 1 | 725 | 64,174 | 2, 3 | ------ | ------ | DD2 |
| 5 | SCS Runoff | 12.23 | 1 | 728 | 44,750 | ------ | ------ | ------ | Area to DD3 |
| 6 | Combine | 31.63 | 1 | 726 | 108,924 | 4, 5 | ------ | ------ | DD3 |
| 7 | SCS Runoff | 12.50 | 1 | 731 | 51,962 | ------ | ------ | ------ | Area to Ditch No. 2 |
| 8 | Combine | 48.11 | 1 | 726 | 179,901 | 1, 6, 7 | ------ | ------ | Ditch No. 2 |
| 9 | SCS Runoff | 6.757 | 1 | 729 | 25,596 | ------ | ------ | ------ | DD4 |
| 10 | SCS Runoff | 10.30 | 1 | 725 | 32,108 | ------ | ------ | ------ | Area to DD5 |
| 11 | Combine | 16.25 | 1 | 725 | 57,704 | 9, 10 | ------ | ------ | DD5 |
| 12 | SCS Runoff | 12.18 | 1 | 728 | 44,576 | ------ | ------ | ------ | Area to DD6 |
| 13 | Combine | 28.03 | 1 | 726 | 102,280 | 11, 12 | ------ | ------ | DD6 |
| 14 | SCS Runoff | 12.33 | 1 | 725 | 40,030 | ------ | ------ | ------ | Area to DD7 |
| 15 | Combine | 40.35 | 1 | 726 | 142,310 | 13, 14 | ------ | ------ | DD7 |
| 16 | SCS Runoff | 13.56 | 1 | 725 | 44,033 | ------ | ------ | ------ | DD8 |
| 17 | SCS Runoff | 13.40 | 1 | 725 | 43,533 | ------ | ------ | ------ | Area to DD9 |
| 18 | Combine | 26.96 | 1 | 725 | 87,566 | 16, 17 | ------ | ------ | DD9 |
| 19 | SCS Runoff | 13.51 | 1 | 725 | 43,867 | ------ | ------ | ------ | Area to DD10 |
| 20 | Combine | 40.47 | 1 | 725 | 131,433 | 18, 19 | ------ | ------ | DD10 |
| 21 | Combine | 80.80 | 1 | 726 | 273,743 | 15, 20 | ------ | ------ | DD7 & DD10 |
| 22 | SCS Runoff | 12.64 | 1 | 733 | 56,111 | ------ | ------ | ------ | Area to Ditch No. 3 |
| 23 | Combine | 147.43 | 1 | 726 | 538,993 | 8, 21, 22 | ------ | ------ | Ditch No. 3 |
| 24 | SCS Runoff | 5.340 | 1 | 723 | 15,567 | ------ | ------ | ------ | DD11 |
| 25 | SCS Runoff | 4.401 | 1 | 723 | 12,830 | ------ | ------ | ------ | Area to DD12 |
| 26 | Combine | 9.740 | 1 | 723 | 28,398 | 24, 25 | ------ | ------ | DD12 |
| 27 | SCS Runoff | 7.041 | 1 | 723 | 20,528 | ------ | ------ | ------ | Area to DD13 |
| 28 | Combine | 16.78 | 1 | 723 | 48,926 | 26, 27 | ------ | ------ | DD13 |
| 29 | SCS Runoff | 6.807 | 1 | 723 | 19,844 | ------ | ------ | ------ | Area to DD14 |
| 30 | Combine | 23.59 | 1 | 723 | 68,770 | 28, 29 | ------ | ------ | DD14 |
| 31 | SCS Runoff | 9.172 | 1 | 725 | 28,579 | ------ | ------ | ------ | Area to DD15 |
| 32 | Combine | 32.43 | 1 | 724 | 97,350 | 30, 31 | ------ | ------ | DD15 |
| 33 | SCS Runoff | 10.42 | 1 | 725 | 32,460 | ------ | ------ | ------ | Area to DD16 |
| 34 | Combine | 42.84 | 1 | 724 | 129,810 | 32, 33 | ------ | ------ | DD16 |

# Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022

| Hyd. No. | Hydrograph type (origin) | Peak flow (cfs) | Time interval (min) | Time to Peak (min) | Hyd. volume (cuft) | Inflow hyd(s) | Maximum elevation (ft) | Total strge used (cuft) | Hydrograph Description |
|---|---|---|---|---|---|---|---|---|---|
| 35 | SCS Runoff | 11.09 | 1 | 725 | 36,027 | ------ | ------ | ------ | Area to DD17 |
| 36 | Combine | 53.55 | 1 | 724 | 165,837 | 34, 35 | ------ | ------ | DD17 |
| 37 | SCS Runoff | 6.659 | 1 | 737 | 32,332 | ------ | ------ | ------ | Area to Ditch No. 4 |
| 38 | Combine | 202.19 | 1 | 725 | 737,162 | 23, 36, 37 | ------ | ------ | Ditch No. 4 |
| 39 | SCS Runoff | 5.358 | 1 | 733 | 23,779 | ------ | ------ | ------ | DD18 |
| 40 | SCS Runoff | 6.865 | 1 | 723 | 20,015 | ------ | ------ | ------ | Area to DD19 |
| 41 | Combine | 10.40 | 1 | 724 | 43,794 | 39, 40 | ------ | ------ | DD19 |
| 42 | SCS Runoff | 8.919 | 1 | 723 | 26,003 | ------ | ------ | ------ | Area to DD20 |
| 43 | Combine | 19.19 | 1 | 724 | 69,797 | 41, 42 | ------ | ------ | DD20 |
| 44 | SCS Runoff | 9.568 | 1 | 725 | 29,814 | ------ | ------ | ------ | Area to DD21 |
| 45 | Combine | 28.75 | 1 | 724 | 99,611 | 43, 44 | ------ | ------ | DD21 |
| 46 | SCS Runoff | 12.40 | 1 | 725 | 38,635 | ------ | ------ | ------ | DD22 |
| 47 | SCS Runoff | 11.95 | 1 | 725 | 37,224 | ------ | ------ | ------ | Area to DD23 |
| 48 | Combine | 24.34 | 1 | 725 | 75,859 | 46, 47 | ------ | ------ | DD23 |
| 49 | SCS Runoff | 12.94 | 1 | 725 | 42,032 | ------ | ------ | ------ | Area to DD24 |
| 50 | Combine | 37.29 | 1 | 725 | 117,891 | 48, 49 | ------ | ------ | DD24 |
| 51 | SCS Runoff | 14.89 | 1 | 725 | 48,370 | ------ | ------ | ------ | Area to DD25 |
| 52 | Combine | 52.18 | 1 | 725 | 166,261 | 50, 51 | ------ | ------ | DD25 |
| 53 | Combine | 282.51 | 1 | 725 | 1,003,034 | 38, 45, 52 | ------ | ------ | DI. 1101 |
| 54 | SCS Runoff | 38.13 | 1 | 722 | 104,566 | ------ | ------ | ------ | Area to Pond No. 11 |
| 55 | Combine | 320.43 | 1 | 725 | 1,139,858 | 53, 54 | ------ | ------ | Pond No. 11 Total Inflow |
| 56 | Reservoir | 26.85 | 1 | 810 | 1,109,307 | 55 | 220.36 | 637,084 | Pond No. 11 perm pool |
| 57 | Reservoir | 151.67 | 1 | 740 | 1,139,856 | 55 | 222.20 | 300,066 | Pond No. 11 riser |

# Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022

| Hyd. No. | Hydrograph type (origin) | Peak flow (cfs) | Time interval (min) | Time to Peak (min) | Hyd. volume (cuft) | Inflow hyd(s) | Maximum elevation (ft) | Total strge used (cuft) | Hydrograph Description |
|---|---|---|---|---|---|---|---|---|---|
| 1 | SCS Runoff | 8.304 | 1 | 725 | 27,301 | ------ | ------ | ------ | Ditch No. 1 |
| 2 | SCS Runoff | 13.56 | 1 | 724 | 42,807 | ------ | ------ | ------ | DD1 |
| 3 | SCS Runoff | 15.00 | 1 | 725 | 49,333 | ------ | ------ | ------ | Area to DD2 |
| 4 | Combine | 28.54 | 1 | 725 | 92,140 | 2, 3 | ------ | ------ | DD2 |
| 5 | SCS Runoff | 17.33 | 1 | 728 | 64,251 | ------ | ------ | ------ | Area to DD3 |
| 6 | Combine | 44.82 | 1 | 726 | 156,391 | 4, 5 | ------ | ------ | DD3 |
| 7 | SCS Runoff | 17.74 | 1 | 731 | 74,607 | ------ | ------ | ------ | Area to Ditch No. 2 |
| 8 | Combine | 68.34 | 1 | 726 | 258,298 | 1, 6, 7 | ------ | ------ | Ditch No. 2 |
| 9 | SCS Runoff | 9.577 | 1 | 729 | 36,751 | ------ | ------ | ------ | DD4 |
| 10 | SCS Runoff | 14.60 | 1 | 724 | 46,100 | ------ | ------ | ------ | Area to DD5 |
| 11 | Combine | 23.08 | 1 | 725 | 82,850 | 9, 10 | ------ | ------ | DD5 |
| 12 | SCS Runoff | 17.26 | 1 | 728 | 64,001 | ------ | ------ | ------ | Area to DD6 |
| 13 | Combine | 39.80 | 1 | 726 | 146,851 | 11, 12 | ------ | ------ | DD6 |
| 14 | SCS Runoff | 17.48 | 1 | 725 | 57,475 | ------ | ------ | ------ | Area to DD7 |
| 15 | Combine | 57.23 | 1 | 726 | 204,327 | 13, 14 | ------ | ------ | DD7 |
| 16 | SCS Runoff | 19.23 | 1 | 725 | 63,222 | ------ | ------ | ------ | DD8 |
| 17 | SCS Runoff | 19.01 | 1 | 725 | 62,504 | ------ | ------ | ------ | Area to DD9 |
| 18 | Combine | 38.24 | 1 | 725 | 125,726 | 16, 17 | ------ | ------ | DD9 |
| 19 | SCS Runoff | 19.16 | 1 | 725 | 62,983 | ------ | ------ | ------ | Area to DD10 |
| 20 | Combine | 57.40 | 1 | 725 | 188,709 | 18, 19 | ------ | ------ | DD10 |
| 21 | Combine | 114.46 | 1 | 726 | 393,036 | 15, 20 | ------ | ------ | DD7 & DD10 |
| 22 | SCS Runoff | 17.95 | 1 | 733 | 80,563 | ------ | ------ | ------ | Area to Ditch No. 3 |
| 23 | Combine | 209.25 | 1 | 726 | 773,877 | 8, 21, 22 | ------ | ------ | Ditch No. 3 |
| 24 | SCS Runoff | 7.568 | 1 | 723 | 22,351 | ------ | ------ | ------ | DD11 |
| 25 | SCS Runoff | 6.237 | 1 | 723 | 18,421 | ------ | ------ | ------ | Area to DD12 |
| 26 | Combine | 13.80 | 1 | 723 | 40,773 | 24, 25 | ------ | ------ | DD12 |
| 27 | SCS Runoff | 9.979 | 1 | 723 | 29,474 | ------ | ------ | ------ | Area to DD13 |
| 28 | Combine | 23.78 | 1 | 723 | 70,247 | 26, 27 | ------ | ------ | DD13 |
| 29 | SCS Runoff | 9.647 | 1 | 723 | 28,492 | ------ | ------ | ------ | Area to DD14 |
| 30 | Combine | 33.43 | 1 | 723 | 98,739 | 28, 29 | ------ | ------ | DD14 |
| 31 | SCS Runoff | 13.00 | 1 | 724 | 41,034 | ------ | ------ | ------ | Area to DD15 |
| 32 | Combine | 45.93 | 1 | 723 | 139,773 | 30, 31 | ------ | ------ | DD15 |
| 33 | SCS Runoff | 14.76 | 1 | 724 | 46,606 | ------ | ------ | ------ | Area to DD16 |
| 34 | Combine | 60.64 | 1 | 724 | 186,379 | 32, 33 | ------ | ------ | DD16 |

# Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022

| Hyd. No. | Hydrograph type (origin) | Peak flow (cfs) | Time interval (min) | Time to Peak (min) | Hyd. volume (cuft) | Inflow hyd(s) | Maximum elevation (ft) | Total strge used (cuft) | Hydrograph Description |
|---|---|---|---|---|---|---|---|---|---|
| 35 | SCS Runoff | 15.73 | 1 | 725 | 51,727 | ------ | ------ | ------ | Area to DD17 |
| 36 | Combine | 75.87 | 1 | 724 | 238,106 | 34, 35 | ------ | ------ | DD17 |
| 37 | SCS Runoff | 9.453 | 1 | 736 | 46,422 | ------ | ------ | ------ | Area to Ditch No. 4 |
| 38 | Combine | 287.24 | 1 | 725 | 1,058,406 | 23, 36, 37 | ------ | ------ | Ditch No. 4 |
| 39 | SCS Runoff | 7.608 | 1 | 733 | 34,141 | ------ | ------ | ------ | DD18 |
| 40 | SCS Runoff | 9.730 | 1 | 723 | 28,737 | ------ | ------ | ------ | Area to DD19 |
| 41 | Combine | 14.81 | 1 | 724 | 62,879 | 39, 40 | ------ | ------ | DD19 |
| 42 | SCS Runoff | 12.64 | 1 | 723 | 37,334 | ------ | ------ | ------ | Area to DD20 |
| 43 | Combine | 27.24 | 1 | 724 | 100,213 | 41, 42 | ------ | ------ | DD20 |
| 44 | SCS Runoff | 13.56 | 1 | 724 | 42,807 | ------ | ------ | ------ | Area to DD21 |
| 45 | Combine | 40.80 | 1 | 724 | 143,019 | 43, 44 | ------ | ------ | DD21 |
| 46 | SCS Runoff | 17.57 | 1 | 724 | 55,472 | ------ | ------ | ------ | DD22 |
| 47 | SCS Runoff | 16.93 | 1 | 724 | 53,445 | ------ | ------ | ------ | Area to DD23 |
| 48 | Combine | 34.50 | 1 | 724 | 108,917 | 46, 47 | ------ | ------ | DD23 |
| 49 | SCS Runoff | 18.36 | 1 | 725 | 60,349 | ------ | ------ | ------ | Area to DD24 |
| 50 | Combine | 52.80 | 1 | 725 | 169,265 | 48, 49 | ------ | ------ | DD24 |
| 51 | SCS Runoff | 21.12 | 1 | 725 | 69,449 | ------ | ------ | ------ | Area to DD25 |
| 52 | Combine | 73.92 | 1 | 725 | 238,714 | 50, 51 | ------ | ------ | DD25 |
| 53 | Combine | 401.00 | 1 | 725 | 1,440,139 | 38, 45, 52 | ------ | ------ | DI. 1101 |
| 54 | SCS Runoff | 53.98 | 1 | 722 | 150,135 | ------ | ------ | ------ | Area to Pond No. 11 |
| 55 | Combine | 454.38 | 1 | 725 | 1,636,586 | 53, 54 | ------ | ------ | Pond No. 11 Total Inflow |
| 56 | Reservoir | 80.20 | 1 | 757 | 1,604,348 | 55 | 221.40 | 849,414 | Pond No. 11 perm pool |
| 57 | Reservoir | 174.96 | 1 | 744 | 1,636,585 | 55 | 222.88 | 447,280 | Pond No. 11 riser |

**Table 2-2a** Runoff curve numbers for urban areas [1]

| Cover description | | Curve numbers for hydrologic soil group | | | |
|---|---|---|---|---|---|
| Cover type and hydrologic condition | Average percent impervious area [2] | A | B | C | D |
| *Fully developed urban areas (vegetation established)* | | | | | |
| Open space (lawns, parks, golf courses, cemeteries, etc.) [3]: | | | | | |
| Poor condition (grass cover < 50%) | | 68 | 79 | 86 | 89 |
| Fair condition (grass cover 50% to 75%) | | 49 | 69 | 79 | 84 |
| Good condition (grass cover > 75%) | | 39 | 61 | 74 | 80 |
| Impervious areas: | | | | | |
| Paved parking lots, roofs, driveways, etc. (excluding right-of-way) | | 98 | 98 | 98 | 98 |
| Streets and roads: | | | | | |
| Paved; curbs and storm sewers (excluding right-of-way) | | 98 | 98 | 98 | 98 |
| Paved; open ditches (including right-of-way) | | 83 | 89 | 92 | 93 |
| Gravel (including right-of-way) | | 76 | 85 | 89 | 91 |
| Dirt (including right-of-way) | | 72 | 82 | 87 | 89 |
| Western desert urban areas: | | | | | |
| Natural desert landscaping (pervious areas only) [4] | | 63 | 77 | 85 | 88 |
| Artificial desert landscaping (impervious weed barrier, desert shrub with 1- to 2-inch sand or gravel mulch and basin borders) | | 96 | 96 | 96 | 96 |
| Urban districts: | | | | | |
| Commercial and business | 85 | 89 | 92 | 94 | 95 |
| Industrial | 72 | 81 | 88 | 91 | 93 |
| Residential districts by average lot size: | | | | | |
| 1/8 acre or less (town houses) | 65 | 77 | 85 | 90 | 92 |
| 1/4 acre | 38 | 61 | 75 | 83 | 87 |
| 1/3 acre | 30 | 57 | 72 | 81 | 86 |
| 1/2 acre | 25 | 54 | 70 | 80 | 85 |
| 1 acre | 20 | 51 | 68 | 79 | 84 |
| 2 acres | 12 | 46 | 65 | 77 | 82 |
| *Developing urban areas* | | | | | |
| Newly graded areas (pervious areas only, no vegetation) [5] | | 77 | 86 | 91 | 94 |
| Idle lands (CN's are determined using cover types similar to those in table 2-2c). | | | | | |

1 Average runoff condition, and $I_a = 0.2S$.

2 The average percent impervious area shown was used to develop the composite CN's. Other assumptions are as follows: impervious areas are directly connected to the drainage system, impervious areas have a CN of 98, and pervious areas are considered equivalent to open space in good hydrologic condition. CN's for other combinations of conditions may be computed using figure 2-3 or 2-4.

3 CN's shown are equivalent to those of pasture. Composite CN's may be computed for other combinations of open space cover type.

4 Composite CN's for natural desert landscaping should be computed using figures 2-3 or 2-4 based on the impervious area percentage (CN = 98) and the pervious area CN. The pervious area CN's are assumed equivalent to desert shrub in poor hydrologic condition.

5 Composite CN's to use for the design of temporary measures during grading and construction should be computed using figure 2-3 or 2-4 based on the degree of development (impervious area percentage) and the CN's for the newly graded pervious areas.

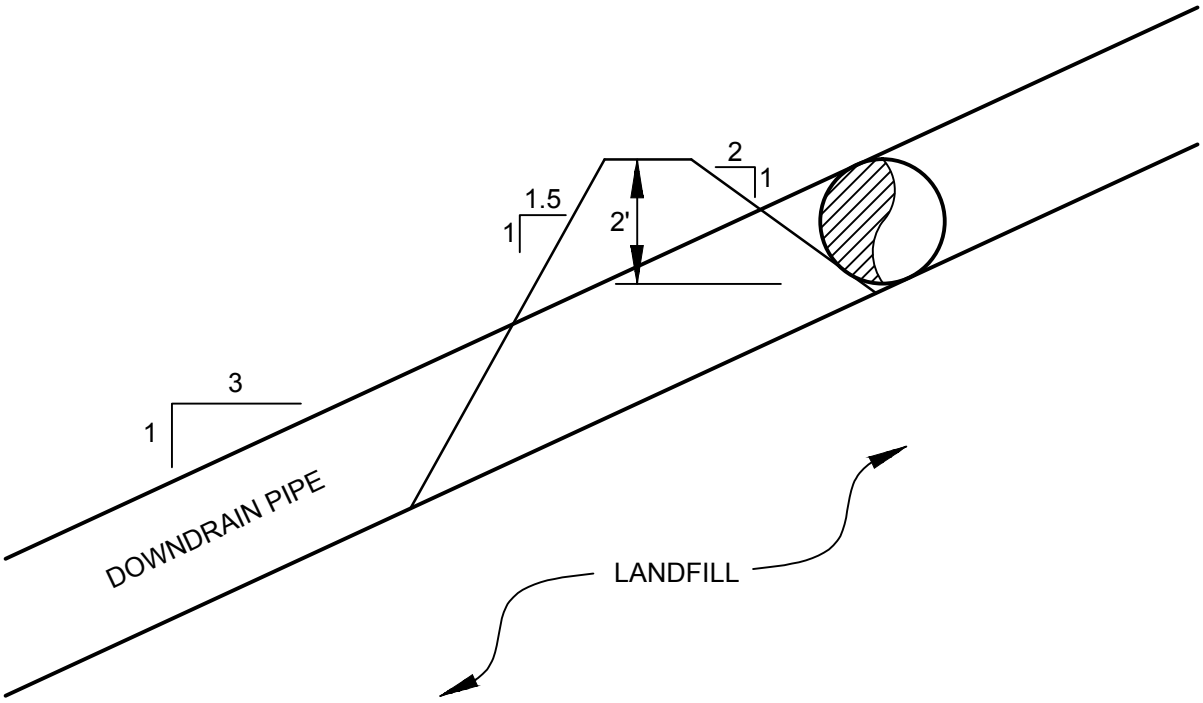
**b. Landfill Side Slope Drainage Berm**

The flow in each drainage berm is calculated using the SCS Method, and is based on the 24 hour – 25 year storm event.

The following sketch shows a typical cross section for the side slope drainage berm to be utilized. Using Manning's Equation with "HydraFlow Express Extension for AutoCAD Civil 3D-2022" computer program, it is determined that this berm will carry 19.79 cfs at a depth of 1.25 feet. The maximum flow carried in any one berm is only 16.85 cfs and the maximum depth of stormwater in the berm is approximately 1.25 feet. Therefore, a 2.0 high berm will provide an acceptable factor of safety, and the berm design is sufficient.

It should be noted that estimated flows actually represent the total flow being directed into each downdrain section. This flow is being directed to the downdrain pipes with sideslope drainage berms from both sides of the downdrain pipe. In all cases, the estimated flows listed above are coming from two different directions by two different berms and in many cases each berm will only have to handle roughly half of the total estimated flow.

# SIDE SLOPE DRAINAGE BERM




# DRAINAGE BERM DESIGN

Q MAXIMUM FOR DRAINAGE BERM @ SLOPE
AND DEPTH OF FOR ≤ 1.25 FEET = 19.79 CFS

Q MAXIMUM FOR DRAINAGE BERMS @
ARROWHEAD LANDFILL = 16.85 CFS

# Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Monday, Dec 2 2024

## Qmax for Side Slope Drainage Berm

**Triangular**

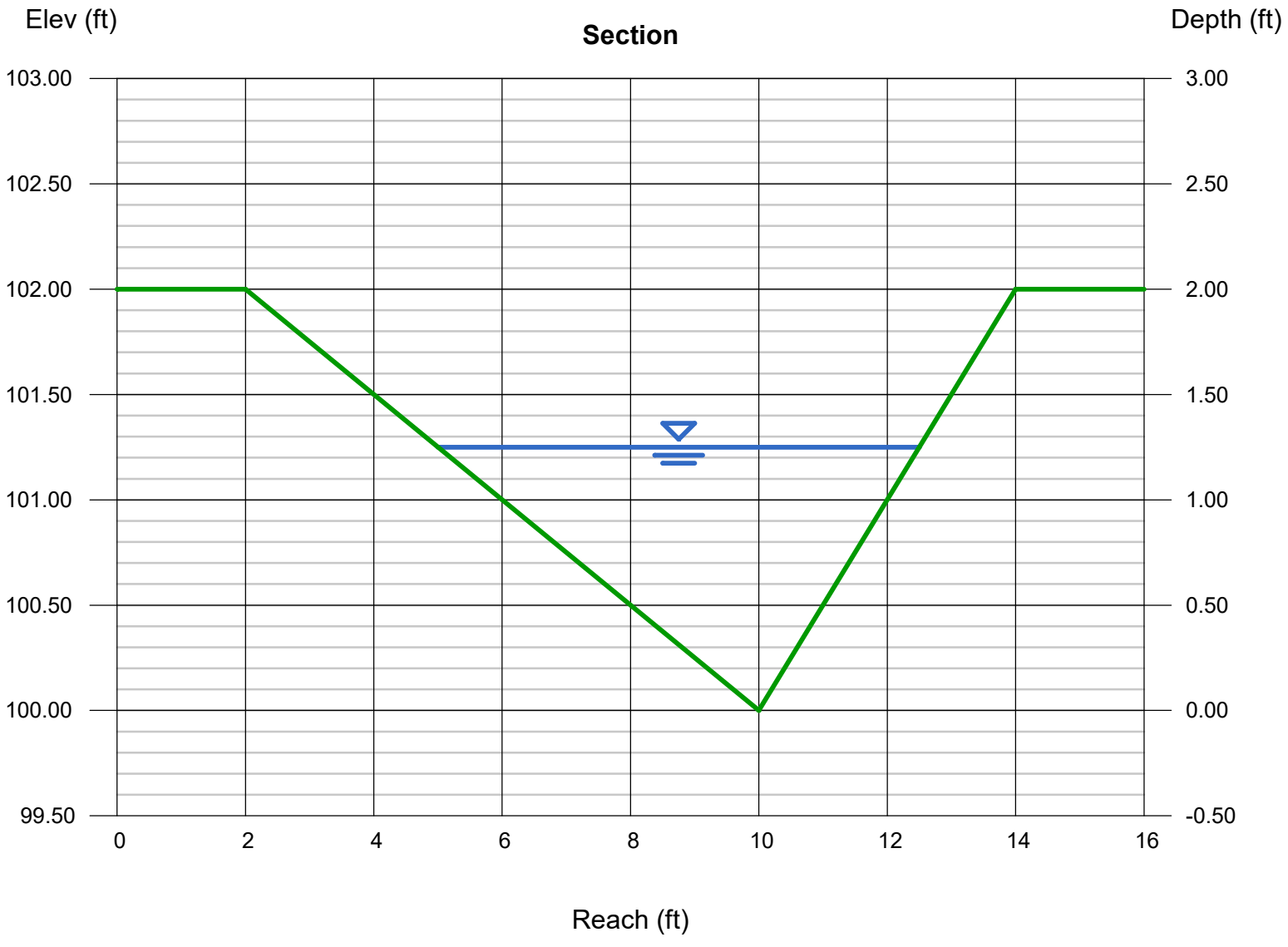
| | |
|---|---|
| Side Slopes (z:1) | = 4.00, 2.00 |
| Total Depth (ft) | = 2.00 |
| Invert Elev (ft) | = 100.00 |
| Slope (%) | = 2.00 |
| N-Value | = 0.035 |

**Calculations**

| | |
|---|---|
| Compute by: | Known Depth |
| Known Depth (ft) | = 1.25 |

**Highlighted**

| | |
|---|---|
| Depth (ft) | = 1.25 |
| Q (cfs) | = 19.79 |
| Area (sqft) | = 4.69 |
| Velocity (ft/s) | = 4.22 |
| Wetted Perim (ft) | = 7.95 |
| Crit Depth, Yc (ft) | = 1.23 |
| Top Width (ft) | = 7.50 |
| EGL (ft) | = 1.53 |



# Channel Report



## Worst Case Flow for Side Slope Drainage Berm

**Triangular**

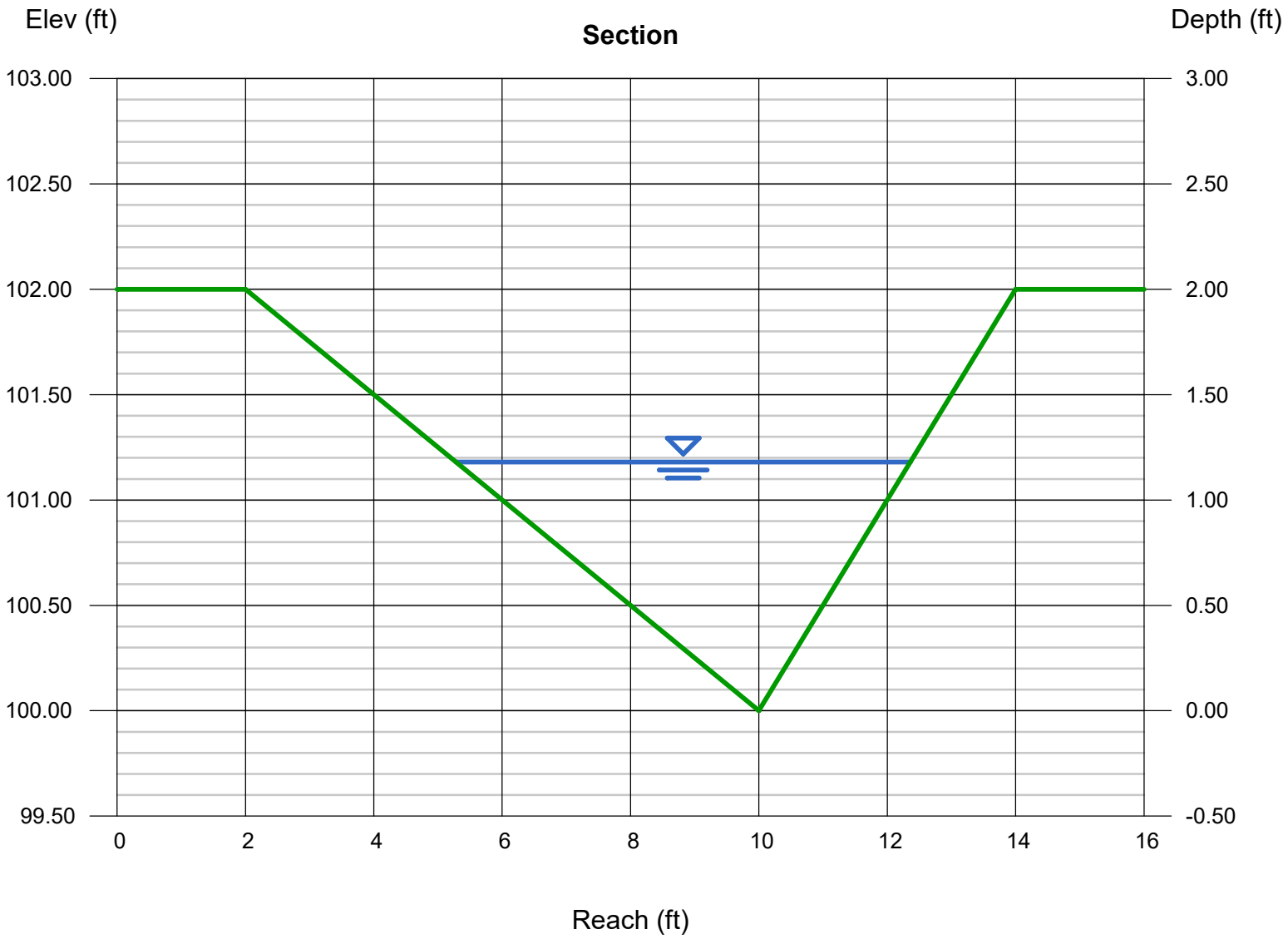
| | |
|---|---|
| Side Slopes (z:1) | = 4.00, 2.00 |
| Total Depth (ft) | = 2.00 |
| Invert Elev (ft) | = 100.00 |
| Slope (%) | = 2.00 |
| N-Value | = 0.035 |

**Calculations**

| | |
|---|---|
| Compute by: | Known Q |
| Known Q (cfs) | = 16.85 |

**Highlighted**

| | |
|---|---|
| Depth (ft) | = 1.18 |
| Q (cfs) | = 16.85 |
| Area (sqft) | = 4.18 |
| Velocity (ft/s) | = 4.03 |
| Wetted Perim (ft) | = 7.50 |
| Crit Depth, Yc (ft) | = 1.15 |
| Top Width (ft) | = 7.08 |
| EGL (ft) | = 1.43 |



**c. Side Slope Downdrains**

The flow in each downdrain pipe is calculated using the SCS Method, and is based on the 24 hour - 25 year storm event.

The diameter of all downdrain pipes will be 24", and the maximum flow will be kept to less than or equal to 65% of the capacity of the pipe.

The capacity of a 24" diameter corrugated plastic downdrain pipe at a 3H:1V (or 33.3%) slope and flowing at 65% of the total depth is 64.50 cfs. Where the flow exceeds 65% of the capacity of a single 24" diameter pipe, an additional 24" diameter downdrain pipe will be installed to keep the maximum flow in each pipe less than or equal to 64.50 cfs. From Table 1, the maximum flow in any downdrain pipe will be 58.66 cfs.

If the total flow routed to one downdrain exceeds 64.50 cfs an additional downdrain will be installed to carry the additional flow. There are several cases where it was necessary for this scenario to be implemented. The particular downdrains have been marked with an asterisk in Table 1 to indicate the addition of a separate 24" diameter downdrain pipe.

TABLE NO. 1 - DOWNDRAIN CALCULATIONS

| DOWN DRAIN NO. | PEAK DISCHARGE (cfs) | SIZE OF DOWNDRAIN (in) | % FULL |
|---|---|---|---|
| **Tract 1** | | | |
| 1 | 5.45 | 24 | 17.50 |
| 2 | 15.23 | 24 | 29.00 |
| 3 | 24.63 | 24 | 37.00 |
| 4 | 29.21 | 24 | 40.50 |
| 5 | 38.23 | 24 | 47.00 |
| 6 | 31.14 | 24 | 42.00 |
| 7 | 14.83 | 24 | 28.50 |
| 8 | 20.47 | 24 | 33.50 |
| 9 | 28.16 | 24 | 40.00 |
| 10 | 36.53 | 24 | 46.00 |
| 11 | 45.25 | 24 | 52.00 |
| 12 | 11.20 | 24 | 24.50 |
| 13 | 22.69 | 24 | 35.50 |
| 14 | 33.05 | 24 | 43.50 |
| 15 | 43.60 | 24 | 51.00 |
| 16 | 54.36 | 24 | 58.50 |
| 17 | 8.83 | 24 | 22.00 |
| 18 | 18.12 | 24 | 31.50 |
| 19 | 28.53 | 24 | 40.00 |
| 20 | 34.95 | 24 | 44.50 |
| 21 | 5.80 | 24 | 18.00 |
| 22 | 17.45 | 24 | 31.00 |
| 23 | 25.03 | 24 | 37.50 |
| 24 | 34.87 | 24 | 44.50 |
| 25 | 47.71 | 24 | 53.50 |
| 26 | 58.66 | 24 | 61.50 |
| 27 | 8.32 | 24 | 21.50 |
| 28 | 9.40 | 24 | 22.50 |
| 29 | 20.85 | 24 | 34.00 |
| 30 | 32.73 | 24 | 43.00 |
| 31 | 43.00 | 24 | 50.50 |
| 32 | 16.85 | 24 | 30.50 |
| 33 | 30.17 | 24 | 41.50 |
| 34 | 44.03 | 24 | 51.00 |
| 35 | 57.88 | 24 | 60.50 |
| 36* | 72.05 | 24 | 71.00 |
| 37 | 15.23 | 24 | 29.00 |
| 38 | 26.28 | 24 | 38.50 |
| 39 | 39.43 | 24 | 48.00 |

| | | | |
|---|---|---|---|
| 40 | 52.95 | 24 | 57.50 |
| 41* | 66.77 | 24 | 67.00 |
| 42 | 6.57 | 24 | 19.00 |
| 43 | 15.20 | 24 | 28.50 |
| 44 | 9.29 | 24 | 0.00 |
| 45 | 15.58 | 24 | 29.00 |
| 46 | 26.99 | 24 | 39.00 |
| 47 | 6.42 | 24 | 19.00 |
| 48 | 16.33 | 24 | 30.00 |
| 49 | 7.86 | 24 | 21.00 |
| 50 | 16.29 | 24 | 30.00 |

*Signifies flow through separate 24" dia. Downdrain pipe.

TABLE NO. 1(cont'd) - DOWNDRAIN CALCULATIONS

| DOWN DRAIN NO. | PEAK DISCHARGE (cfs) | SIZE OF DOWNDRAIN (in) | % FULL |
|---|---|---|---|
| **Tract 2** | | | |
| 1 | 6.79 | 24 | 21.00 |
| 2 | 15.85 | 24 | 31.50 |
| 3 | 28.33 | 24 | 43.00 |
| 4* | 13.59 | 24 | 29.50 |
| 5* | 24.74 | 24 | 40.00 |
| 6* | 36.12 | 24 | 49.50 |
| 7 | 8.10 | 24 | 22.50 |
| 8 | 18.16 | 24 | 34.50 |
| 9 | 9.66 | 24 | 24.50 |
| 10 | 18.59 | 24 | 34.50 |
| 11 | 29.68 | 24 | 44.00 |
| 12 | 43.20 | 24 | 55.00 |
| 13* | 12.92 | 24 | 28.50 |
| 14* | 26.53 | 24 | 42.00 |
| 15 | 6.68 | 24 | 20.50 |
| 16 | 15.25 | 24 | 31.00 |
| 17 | 25.11 | 24 | 40.50 |
| 18 | 36.62 | 24 | 50.00 |
| 19 | 49.52 | 24 | 60.00 |
| 20 | 14.31 | 24 | 30.00 |
| 21 | 23.21 | 24 | 39.00 |
| 22 | 33.53 | 24 | 47.50 |
| 23 | 45.21 | 24 | 57.00 |
| 24* | 12.58 | 24 | 28.00 |
| 25* | 25.50 | 24 | 41.00 |
| 26 | 11.91 | 24 | 27.50 |

| | | | |
|---|---|---|---|
| 27 | 21.47 | 24 | 37.00 |
| 28 | 34.18 | 24 | 48.00 |
| 29* | 13.30 | 24 | 29.00 |
| 30* | 26.19 | 24 | 41.50 |
| 31 | 6.52 | 24 | 20.50 |
| 32 | 11.76 | 24 | 27.00 |
| 33 | 20.13 | 24 | 36.00 |
| 34 | 30.81 | 24 | 45.00 |
| 35 | 39.80 | 24 | 52.50 |
| 36 | 50.14 | 24 | 60.50 |
| 37 | 9.17 | 24 | 24.00 |
| 38 | 19.65 | 24 | 35.50 |
| 39 | 5.28 | 24 | 18.50 |
| 40 | 12.96 | 24 | 28.50 |
| 41 | 23.08 | 24 | 38.50 |
| 42 | 30.92 | 24 | 45.50 |
| 43 | 40.83 | 24 | 53.50 |
| 44 | 6.68 | 24 | 20.50 |
| 45 | 14.38 | 24 | 30.00 |
| 46 | 23.77 | 24 | 39.50 |
| 47 | 35.32 | 24 | 49.00 |
| 48 | 47.39 | 24 | 58.50 |
| 49* | 13.71 | 24 | 29.50 |
| 50 | 6.62 | 24 | 20.50 |
| 51 | 14.37 | 24 | 30.00 |
| 52 | 23.42 | 24 | 39.00 |
| 53 | 34.06 | 24 | 48.00 |
| 54 | 45.73 | 24 | 57.00 |
| 55* | 13.15 | 24 | 28.50 |
| 56 | 9.30 | 24 | 24.00 |
| 57 | 22.55 | 24 | 38.00 |
| 58 | 36.42 | 24 | 50.00 |
| 59 | 49.72 | 24 | 60.50 |
| 60* | 11.72 | 24 | 27.00 |
| 61 | 14.18 | 24 | 30.00 |
| 62 | 25.24 | 24 | 40.50 |
| 63 | 37.72 | 24 | 51.00 |
| 64* | 11.04 | 24 | 26.00 |
| 65* | 22.59 | 24 | 38.00 |
| 66* | 34.59 | 24 | 48.50 |
| 67 | 8.27 | 24 | 23.00 |
| 68 | 17.55 | 24 | 33.50 |
| 69 | 29.09 | 24 | 43.50 |

*Signifies flow through separate 24" dia. Downdrain pipe.

*Signifies flow through separate 24" dia. Downdrain pipe.

TABLE NO. 1(cont'd) - DOWNDRAIN CALCULATIONS

| DOWN DRAIN NO. | PEAK DISCHARGE (cfs) | SIZE OF DOWNDRAIN (in) | % FULL |
|---|---|---|---|
| **Tract 3** | | | |
| 1 | 9.57 | 24 | 23.00 |
| 2 | 20.15 | 24 | 33.50 |
| 3 | 31.63 | 24 | 42.50 |
| 4 | 6.76 | 24 | 19.00 |
| 5 | 16.25 | 24 | 30.00 |
| 6 | 28.03 | 24 | 40.00 |
| 7 | 40.35 | 24 | 48.50 |
| 8* | 13.56 | 24 | 27.00 |
| 9* | 26.96 | 24 | 39.00 |
| 10* | 40.47 | 24 | 48.50 |
| 11 | 5.34 | 24 | 17.50 |
| 12 | 9.74 | 24 | 23.00 |
| 13 | 16.78 | 24 | 30.50 |
| 14 | 23.59 | 24 | 36.00 |
| 15 | 32.43 | 24 | 43.00 |
| 16 | 42.84 | 24 | 50.50 |
| 17 | 53.55 | 24 | 57.50 |
| 18 | 5.36 | 24 | 17.50 |
| 19 | 10.40 | 24 | 24.00 |
| 20 | 19.19 | 24 | 32.50 |
| 21 | 28.75 | 24 | 40.50 |
| 22* | 12.40 | 24 | 26.00 |
| 23* | 24.34 | 24 | 37.00 |
| 24* | 37.29 | 24 | 46.50 |
| 25* | 52.18 | 24 | 56.50 |
| 26 | 9.40 | 24 | 22.50 |
| 27 | 18.64 | 24 | 32.00 |
| 28 | 28.86 | 24 | 40.50 |
| 29 | 40.47 | 24 | 48.50 |
| 30* | 12.22 | 24 | 26.00 |
| 31* | 25.47 | 24 | 37.50 |
| 32* | 39.44 | 24 | 48.00 |
| 33 | 12.40 | 24 | 26.00 |
| 34 | 16.37 | 24 | 30.00 |
| 35 | 24.57 | 24 | 37.00 |
| 36 | 32.94 | 24 | 43.50 |
| 37 | 44.69 | 24 | 51.50 |
| 38* | 12.68 | 24 | 26.00 |

| | | | |
|---|---|---|---|
| 39* | 23.26 | 24 | 36.00 |
| 40* | 34.20 | 24 | 44.00 |
| 41 | 8.80 | 24 | 22.00 |
| 42 | 17.81 | 24 | 31.00 |
| 43 | 7.16 | 24 | 20.00 |
| 44 | 14.14 | 24 | 28.00 |
| 45 | 22.97 | 24 | 35.50 |
| 46 | 32.19 | 24 | 42.50 |
| 47 | 42.07 | 24 | 50.00 |
| 48 | 12.83 | 24 | 26.50 |
| 49 | 20.53 | 24 | 33.50 |
| 50 | 31.55 | 24 | 42.00 |
| 51 | 42.09 | 24 | 50.00 |
| 52* | 10.76 | 24 | 24.50 |
| 53* | 21.23 | 24 | 34.00 |
| 54* | 31.59 | 24 | 42.50 |
| 55* | 41.90 | 24 | 49.50 |
| 56 | 15.05 | 24 | 28.50 |
| 57 | 24.55 | 24 | 37.00 |
| 58 | 30.77 | 24 | 42.00 |
| 59 | 42.17 | 24 | 50.00 |
| 60 | 50.59 | 24 | 55.50 |
| 61* | 12.57 | 24 | 26.00 |
| 62* | 25.31 | 24 | 37.50 |
| 63* | 39.69 | 24 | 48.00 |
| 64 | 9.09 | 24 | 22.00 |
| 65 | 17.02 | 24 | 30.50 |
| 66 | 27.89 | 24 | 39.50 |
| 67 | 37.94 | 24 | 47.00 |

*Signifies flow through separate 24" dia. Downdrain pipe.

# Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Friday, Jan 31 2025

## Qmax Available for Side Slope Downdrain

**Circular**

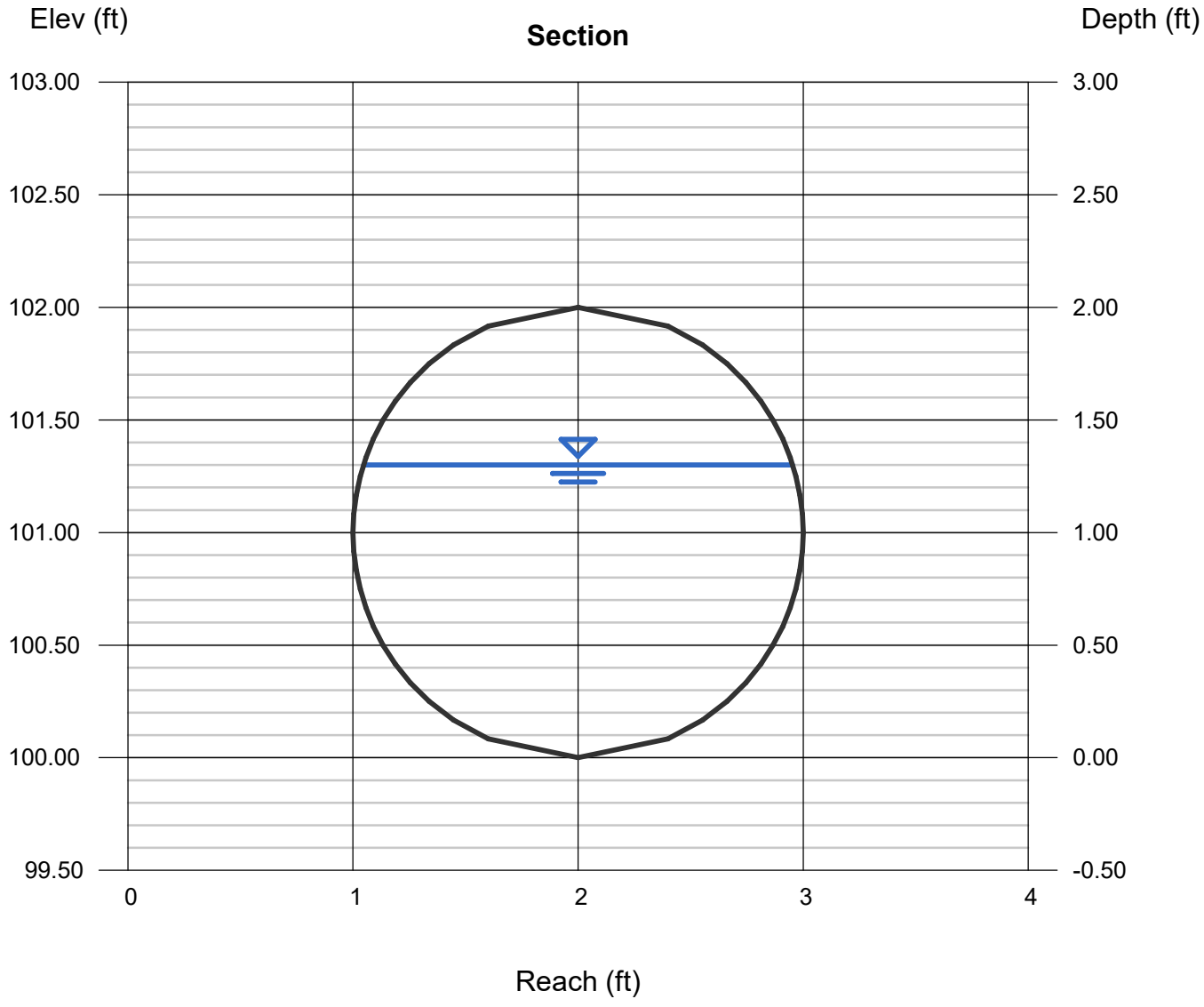
| | |
|---|---|
| Diameter (ft) | = 2.00 |
| Invert Elev (ft) | = 100.00 |
| Slope (%) | = 33.33 |
| N-Value | = 0.020 |

**Calculations**

| | |
|---|---|
| Compute by: | Known Depth |
| Known Depth (ft) | = 1.30 |

**Highlighted**

| | |
|---|---|
| Depth (ft) | = 1.30 |
| Q (cfs) | = 64.50 |
| Area (sqft) | = 2.17 |
| Velocity (ft/s) | = 29.73 |
| Wetted Perim (ft) | = 3.76 |
| Crit Depth, Yc (ft) | = 2.00 |
| Top Width (ft) | = 1.91 |
| EGL (ft) | = 15.04 |



# Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Friday, Jan 31 2025

## Worst Case for Side Slope Downdrain

**Circular**

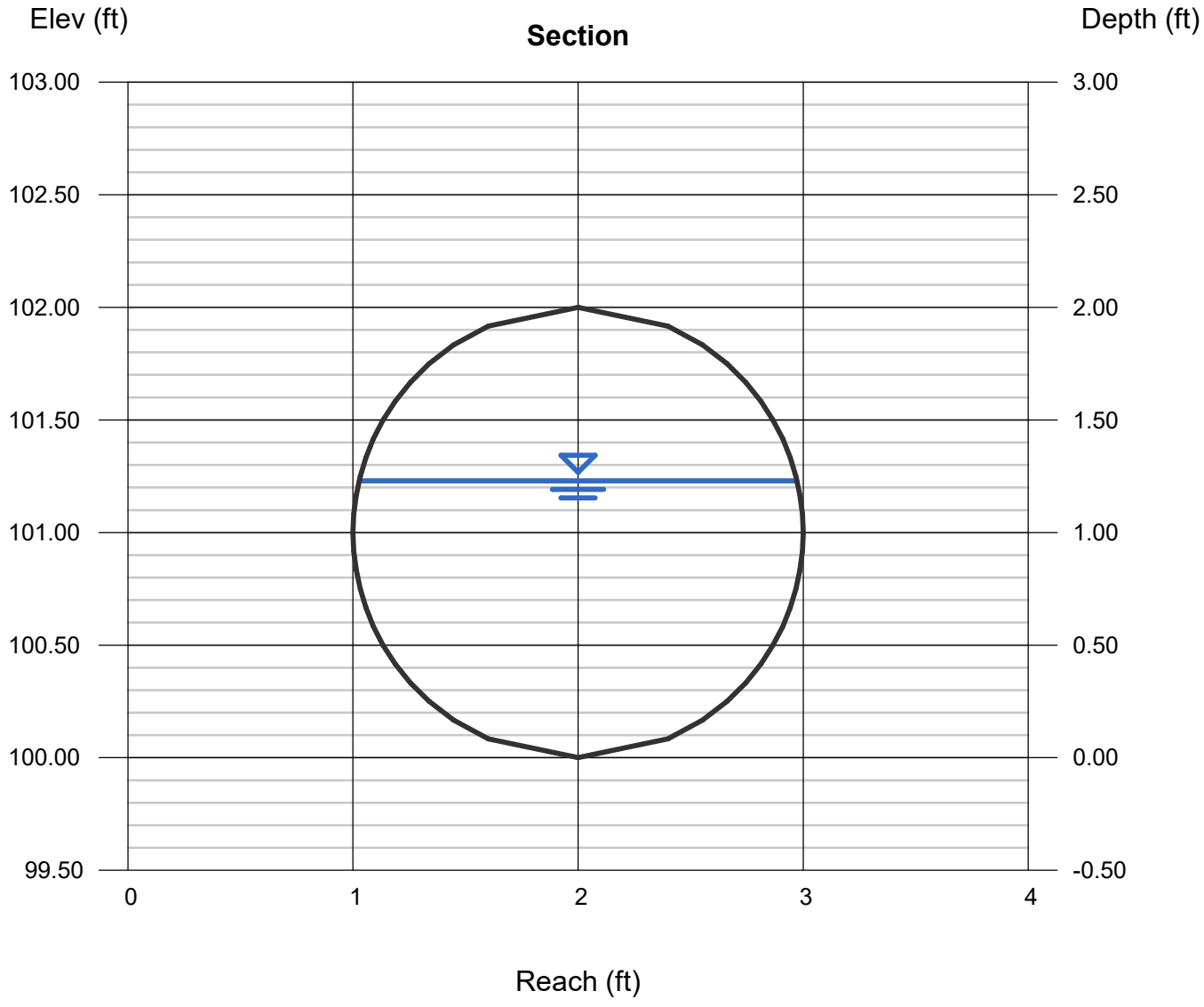
| | |
|---|---|
| Diameter (ft) | = 2.00 |
| Invert Elev (ft) | = 100.00 |
| Slope (%) | = 33.33 |
| N-Value | = 0.020 |

**Calculations**

| | |
|---|---|
| Compute by: | Known Q |
| Known Q (cfs) | = 58.66 |

**Highlighted**

| | |
|---|---|
| Depth (ft) | = 1.23 |
| Q (cfs) | = 58.66 |
| Area (sqft) | = 2.03 |
| Velocity (ft/s) | = 28.89 |
| Wetted Perim (ft) | = 3.61 |
| Crit Depth, Yc (ft) | = 1.99 |
| Top Width (ft) | = 1.95 |
| EGL (ft) | = 14.20 |



**d. Drainage Ditches**

The objectives of this section are to design the shape of each ditch to handle the calculated stormwater discharge and to determine if any ditch protection is required to prevent erosion. Ditches may need temporary protection to allow time for vegetation to grow and protect the ditch. A more permanent material may be required if the velocities are too great for vegetation. Regardless of the material selected, the ditch must be protected to prevent erosion. Erosion will increase the maintenance costs for the landfill owner and will increase the amount of sediment carried to the sediment basin. Since the sediment basin must be cleaned out periodically, every effort is used to reduce the amount of sediment entering the sediment basin.

Table No. 2 summarizes each design parameter of each drainage ditch as shown on the Erosion and Sedimentation Control Plan of the Design and Operation Plan. The selected ditch slope, bottom width and side slopes are listed as well as peak flow for a 24 hour - 25 year storm event. The selected shape, Manning's “n,” slope, and the calculated flow is entered into a computer program, "HydraFlow Express Extension for AutoCAD Civil 3D 2022", which calculates the depth of flow and velocity based on Manning's Open Channel Flow Equation. If the velocity is less than 2.0 fps, then no temporary ditch protection is required. If the velocity is greater than 2.0 fps, then ditch protection is required. A list of various ditch protection materials including their Manning's “n” values and the maximum allowable shear stresses is attached.

## Tractive Force Procedure

The design of riprap-lined channels and temporary channel linings is based on analysis of tractive force.

**NOTE: This procedure is for uniform flow in channels and is *not* to be used for design of deenergizing devices.**

To calculate the required size of an open channel, assume the design flow is uniform and does not vary with time. Since actual flow conditions change through the length of a channel, subdivide the channel into design reaches as appropriate.

### PERMISSIBLE SHEAR STRESS

The permissible shear stress, $T_d$, is the force required to initiate movement of the lining material. Permissible shear stress for the liner is not related to the erodibility of the underlying soil. However, if the lining is eroded or broken, the bed material will be exposed to the erosive force of the flow.

### COMPUTING NORMAL DEPTH

**The first step in selecting an appropriate lining is to compute the design flow depth (the normal depth) and determine the shear stress.**

Normal depths can be calculated by Manning's equation as shown for trapezoidal channels in Figure 8.05d. Values of the Manning's roughness coefficient for different ranges of depth are provided in Table 8.05e for temporary linings and Table 8.05f for riprap. The coefficient of roughness generally decreases with increasing flow depth.

**Table 8.05e**
**Manning's Roughness Coefficients for Temporary Lining Materials**

| Lining Type | *n* value for Depth Ranges 0-0.5 ft | 0.5-2.0 ft | >2.0 ft |
|---|---|---|---|
| Woven Paper Net | 0.016 | 0.015 | 0.015 |
| Jute Net | 0.028 | 0.022 | 0.019 |
| Fiberglass Roving | 0.028 | 0.021 | 0.019 |
| Straw with Net | 0.065 | 0.033 | 0.025 |
| Curled Wood Mat | 0.066 | 0.035 | 0.028 |
| Synthetic Mat | 0.036 | 0.025 | 0.021 |

## Table 8.05f
## Manning's Roughness Coefficient for Riprap and Gravel

| Material | $d_{50}$ (inches) | *n* value for Depth Ranges 0-0.5 ft | 0.5-1.0 ft | 1.0-2.0 ft | > 2.0 ft |
|---|---|---|---|---|---|
| Gravel | 1 | 0.033 | 0.028 | 0.026 | 0.025 |
| | 2 | 0.045 | 0.034 | 0.034 | 0.031 |
| Riprap | 6 | 0.106 | 0.054 | 0.044 | 0.041 |
| | 9 | 0.215 | 0.068 | 0.062 | 0.047 |
| | 12 | 0.797 | 0.084 | 0.060 | 0.053 |
| | 15 | — | 0.104 | 0.068 | 0.059 |
| | 18 | — | 0.127 | 0.076 | 0.064 |
| | 21 | — | 0.158 | 0.085 | 0.070 |
| | 24 | — | 0.199 | 0.095 | 0.076 |

### DETERMINING SHEAR STRESS

Shear stress, T, at normal depth is computed for the lining by the following equation:

$$T = yds$$

where:

- T = shear stress in $lb/ft^2$
- y = unit weight of water, 62.4 $lb/ft^3$
- d = flow depth in ft
- s = channel gradient in ft/ft.

If the permissible shear stress, $T_d$, given in Table 8.05g is greater than the computed shear stress, the riprap or temporary lining is considered acceptable. If a lining is unacceptable, select a lining with a higher permissible shear stress and repeat the calculations for normal depth and shear stress. In some cases it may be necessary to alter channel dimensions to reduce the shear stress.

Computing tractive force around a channel bend requires special considerations because the change in flow direction imposes higher shear stress on the channel bottom and banks. The maximum shear stress in a bend, $T_b$, is given by the following equation:

$$T_b = K_b T$$

where:

- $T_b$ = bend shear stress in $lb/ft^2$
- $K_b$ = bend factor
- T = computed stress for straight channel in $lb/ft^2$

The value of $K_b$ is related to the radius of curvature of the channel at its center line, $R_c$, and the bottom width of the channel, B, Figure 8.05e. The length of channel requiring protection downstream from a bend, $L_p$, is a function of the roughness of the lining material and the hydraulic radius as shown in Figure 8.05f.

**Table 8.05g**
**Permissible Shear Stresses for Riprap and Temporary Liners**

| Lining Category | Permissible Unit Shear Stress, $T_d$ Lining Type | ($lb/ft^2$) |
|---|---|---|
| Temporary | Woven Paper Net | 0.15 |
| | Jute Net | 0.45 |
| | Fiberglass Roving: | |
| | Single | 0.60 |
| | Double | 0.85 |
| | Straw with Net | 1.45 |
| | Curled Wood mat | 1.55 |
| | Synthetic Mat | 2.00 |
| | $d_{50}$ Stone Size (inches) | |
| Gravel Riprap | 1 | 0.40 |
| | 2 | 0.80 |
| Rock Riprap | 6 | 2.50 |
| | 9 | 3.80 |
| | 12 | 5.00 |
| | 15 | 6.30 |
| | 18 | 7.50 |
| | 21 | 8.80 |
| | 24 | 10.00 |

## Design Procedure-Temporary Liners

The following is a step-by-step procedure for designing a temporary liner for a channel. Because temporary liners have a short period of service, the design Q may be reduced. For liners that are needed for six months or less, the 2-yr frequency storm is recommended.

**Step 1.** Select a liner material suitable for site conditions and application. Determine roughness coefficient from manufacturer's specifications or Table 8.05e.

**Step 2.** Calculate the normal flow depth using Manning's equation (Figure 8.05d). Check to see that depth is consistent with that assumed for selection of Manning's *n* in Figure 8.05d.

**Step 3.** Calculate shear stress at normal depth.

**Step 4.** Compare computed shear stress with the permissible shear stress for the liner.

**Step 5.** If computed shear is greater than permissible shear, adjust channel dimensions to reduce shear or select a more resistant lining and repeat steps 1 through 4.

Design of a channel with temporary lining is illustrated in Sample Problem 8.05b.

# TABLE NO. 2 - STORMWATER DRAINAGE DITCH CALCULATIONS

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Consulting Engineers

## TRACT 1 DRAINAGE DITCH CALCULATIONS

| DESIGN DATA | Ditch No. 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| Bottom Width (ft) | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| Left Side Slope | 3:1 | 3:1 | 3:1 | 3:1 | 3:1 | 3:1 | 3:1 | 3:1 | 3:1 | 3:1 |
| Right Side Slope | 3:1 | 3:1 | 3:1 | 3:1 | 3:1 | 3:1 | 3:1 | 3:1 | 3:1 | 3:1 |
| Starting Elevation | 283.4 | 276.5 | 274.6 | 270.4 | 262 | 262 | 266 | 278.81 | 279 | 270.5 |
| Ending Elevation | 276.5 | 274.6 | 270.4 | 262 | 261.5 | 261.5 | 261.5 | 266 | 270.21 | 250 |
| Length (ft) | 345 | 377 | 845 | 1055 | 100 | 71 | 139 | 558 | 293 | 684 |
| Slope (ft/ft) | 0.0200 | 0.0050 | 0.0050 | 0.0080 | 0.0050 | 0.0070 | 0.0324 | 0.0230 | 0.0300 | 0.0300 |
| Discharge (cfs) | 5.61 | 10.02 | 61 | 82.67 | 1.696 | 1.988 | 9.623 | 7.972 | 3.85 | 83.68 |
| Manning's "n" | 0.066 | 0.035 | 0.033 | 0.033 | 0.066 | 0.066 | 0.066 | 0.066 | 0.066 | 0.062 |
| Depth (ft) | 0.56 | 0.78 | 1.90 | 1.97 | 0.42 | 0.42 | 0.65 | 0.65 | 0.40 | 1.90 |
| Velocity (ft/s) | 1.76 | 2.03 | 3.31 | 4.23 | 0.77 | 0.90 | 2.49 | 2.06 | 1.85 | 4.54 |
| Shear Stress ($lb/ft^2$) | 0.70 | 0.25 | 0.59 | 0.98 | 0.13 | 0.18 | 1.31 | 0.93 | 0.75 | 3.55 |
| Type of Protection | Excelsior | Excelsior | Excelsior | Excelsior | Excelsior | Excelsior | Excelsior | Excelsior | Excelsior | 9" Riprap |

| DESIGN DATA | Ditch No. 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|---|---|---|---|---|---|---|---|---|---|---|
| Bottom Width (ft) | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| Left Side Slope | 3:1 | 3:1 | 3:1 | 3:1 | 3:1 | 3:1 | 3:1 | 3:1 | 3:1 | 3:1 |
| Right Side Slope | 3:1 | 3:1 | 3:1 | 3:1 | 3:1 | 3:1 | 3:1 | 3:1 | 3:1 | 3:1 |
| Starting Elevation | 250 | 248 | 244.85 | 254 | 256.83 | 258 | 268.71 | 280 | 280 | 279.25 |
| Ending Elevation | 248 | 244.75 | 242 | 242 | 254 | 256.83 | 258 | 268.71 | 279.25 | 276 |
| Length (ft) | 400 | 542 | 575 | 921 | 283 | 117 | 536 | 564 | 151 | 653 |
| Slope (ft/ft) | 0.0050 | 0.0060 | 0.0050 | 0.0130 | 0.0100 | 0.0100 | 0.0200 | 0.0200 | 0.0050 | 0.0050 |
| Discharge (cfs) | 129.84 | 134.4 | 5.913 | 9.084 | 2.699 | 74.9 | 72.94 | 8.328 | 2.164 | 48.98 |
| Manning's "n" | 0.03 | 0.03 | 0.035 | 0.035 | 0.066 | 0.033 | 0.033 | 0.066 | 0.066 | 0.033 |
| Depth (ft) | 2.43 | 2.37 | 0.59 | 0.57 | 0.45 | 1.78 | 1.49 | 0.69 | 0.48 | 1.72 |
| Velocity (ft/s) | 4.73 | 5.10 | 1.74 | 2.79 | 1.12 | 4.51 | 5.78 | 1.99 | 0.83 | 3.11 |
| Shear Stress ($lb/ft^2$) | 0.76 | 0.89 | 0.18 | 0.46 | 0.28 | 1.11 | 1.86 | 0.86 | 0.15 | 0.53 |
| Type of Protection | Excelsior | Excelsior | Excelsior | Excelsior | Excelsior | Excelsior | Excelsior | Excelsior | Excelsior | Excelsior |

| DESIGN DATA | Ditch No. 21 | - | - | - | - | - | - | - | - | - |
|---|---|---|---|---|---|---|---|---|---|---|
| Bottom Width (ft) | 4 | - | - | - | - | - | - | - | - | - |
| Left Side Slope | 3:1 | - | - | - | - | - | - | - | - | - |
| Right Side Slope | 3:1 | - | - | - | - | - | - | - | - | - |
| Starting Elevation | 283 | - | - | - | - | - | - | - | - | - |
| Ending Elevation | 277 | - | - | - | - | - | - | - | - | - |
| Length (ft) | 600 | - | - | - | - | - | - | - | - | - |
| Slope (ft/ft) | 0.0100 | - | - | - | - | - | - | - | - | - |
| Discharge (cfs) | 27.11 | - | - | - | - | - | - | - | - | - |
| Manning's "n" | 0.035 | - | - | - | - | - | - | - | - | - |
| Depth (ft) | 1.09 | - | - | - | - | - | - | - | - | - |
| Velocity (ft/s) | 3.42 | - | - | - | - | - | - | - | - | - |
| Shear Stress ($lb/ft^2$) | 0.68 | - | - | - | - | - | - | - | - | - |
| Type of Protection | Excelsior | - | - | - | - | - | - | - | - | - |

# Arrowhead - Tract 2

HHNT
HODGES, HARBIN, NEWBERRY & TRIBBLE, INC.
Consulting Engineers

TABLE NO. 1 - Ditch Protection Calcs

| DESIGN DATA | Ditch No. 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| Bottom Width (ft) | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| Left Side Slope | 3:1 | 3:1 | 3:1 | 3:1 | 3:1 | 3:1 | 3:1 | 3:1 | 3:1 | 3:1 |
| Right Side Slope | 3:1 | 3:1 | 3:1 | 3:1 | 3:1 | 3:1 | 3:1 | 3:1 | 3:1 | 3:1 |
| Starting Elevation | 280.3 | 285.5 | 288 | 288 | 283.5 | 279 | 279.75 | 282 | 282 | 272.6 |
| Ending Elevation | 272.9 | 280.3 | 285.5 | 283.5 | 279 | 276 | 276 | 279.75 | 272.6 | 229.5 |
| Length (ft) | 923 | 650 | 313 | 840 | 825 | 550 | 745 | 452 | 226 | 1145 |
| Slope (ft/ft) | 0.0080 | 0.0080 | 0.0080 | 0.0054 | 0.0055 | 0.0055 | 0.0050 | 0.0050 | 0.0416 | 0.0376 |
| Discharge (cfs) | 95.4 | 24.97 | 3.17 | 6.669 | 78.73 | 5.808 | 82.08 | 5.348 | 3.76 | 74.94 |
| Manning's "n" | 0.033 | 0.035 | 0.066 | 0.035 | 0.033 | 0.035 | 0.041 | 0.035 | 0.066 | 0.06 |
| Depth (ft) | 2.10 | 1.10 | 0.52 | 0.62 | 2.10 | 0.57 | 2.34 | 0.56 | 0.36 | 1.68 |
| Velocity (ft/s) | 4.41 | 3.11 | 1.10 | 1.84 | 3.64 | 1.78 | 3.18 | 1.68 | 2.06 | 4.93 |
| Shear Stress ($lb/ft^2$) | 1.05 | 0.55 | 0.26 | 0.21 | 0.71 | 0.19 | 0.73 | 0.17 | 0.93 | 3.95 |
| Type of Protection | Excelsior | Excelsior | Excelsior | Excelsior | Excelsior | Excelsior | 6" Riprap | Excelsior | Excelsior | 12" Riprap |

| DESIGN DATA | Ditch No. 11 | 12 | 13 | 14 | 15 | 16 | 17 | - | - | - |
|---|---|---|---|---|---|---|---|---|---|---|
| Bottom Width (ft) | 4 | 4 | 4 | 4 | 4 | 4 | 4 | - | - | - |
| Left Side Slope | 3:1 | 3:1 | 3:1 | 3:1 | 3:1 | 3:1 | 3:1 | - | - | - |
| Right Side Slope | 3:1 | 3:1 | 3:1 | 3:1 | 3:1 | 3:1 | 3:1 | - | - | - |
| Starting Elevation | 229.5 | 226.25 | 232.5 | 247 | 266 | 268.2 | 272.9 | - | - | - |
| Ending Elevation | 226.25 | 222 | 222 | 232.5 | 247 | 266 | 268.2 | - | - | - |
| Length (ft) | 645 | 825 | 1055 | 1042 | 951 | 440 | 880 | - | - | - |
| Slope (ft/ft) | 0.0050 | 0.0052 | 0.0100 | 0.0139 | 0.0200 | 0.0050 | 0.0053 | - | - | - |
| Discharge (cfs) | 8.69 | 36.25 | 211.73 | 142.1 | 77.95 | 9.46 | 131.3 | - | - | - |
| Manning's "n" | 0.035 | 0.033 | 0.03 | 0.041 | 0.033 | 0.035 | 0.03 | - | - | - |
| Depth (ft) | 0.72 | 1.48 | 2.59 | 2.38 | 1.54 | 0.76 | 2.40 | - | - | - |
| Velocity (ft/s) | 1.96 | 2.90 | 6.95 | 5.36 | 5.87 | 1.98 | 4.88 | - | - | - |
| Shear Stress ($lb/ft^2$) | 0.23 | 0.48 | 1.61 | 2.07 | 1.92 | 0.24 | 0.80 | - | - | - |
| Type of Protection | Excelsior | Excelsior | Excelsior | 6" Riprap | Excelsior | Excelsior | Excelsior | - | - | - |

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Consulting Engineers

TABLE NO. 1 - Ditch Protection Calcs

| DESIGN DATA | Ditch No. 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| Bottom Width (ft) | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| Left Side Slope | 3:1 | 3:1 | 3:1 | 3:1 | 3:1 | 3:1 | 3:1 | 3:1 | 3:1 | 3:1 |
| Right Side Slope | 3:1 | 3:1 | 3:1 | 3:1 | 3:1 | 3:1 | 3:1 | 3:1 | 3:1 | 3:1 |
| Starting Elevation | 256 | 252 | 243.5 | 234.5 | 230.25 | 224 | 220.75 | 226 | 226 | 227 |
| Ending Elevation | 252 | 243.5 | 234.5 | 230.25 | 224 | 216 | 216 | 220.75 | 224 | 224 |
| Length (ft) | 395 | 852 | 1091 | 926 | 1082 | 1078 | 597 | 642 | 400 | 525 |
| Slope (ft/ft) | 0.0101 | 0.0100 | 0.0082 | 0.0046 | 0.0058 | 0.0074 | 0.0080 | 0.0082 | 0.0050 | 0.0057 |
| Discharge (cfs) | 5.86 | 48.11 | 98.4 | 153.78 | 7.79 | 90.95 | 6.98 | 6.85 | 4.67 | 51.09 |
| Manning's "n" | 0.066 | 0.033 | 0.041 | 0.03 | 0.035 | 0.033 | 0.035 | 0.035 | 0.066 | 0.033 |
| Depth (ft) | 0.68 | 1.44 | 2.27 | 2.67 | 0.66 | 2.09 | 0.57 | 0.56 | 0.73 | 1.70 |
| Velocity (ft/s) | 1.43 | 4.02 | 4.01 | 4.80 | 1.97 | 4.24 | 2.14 | 2.15 | 1.03 | 3.30 |
| Shear Stress ($lb/ft^2$) | 0.43 | 0.90 | 1.17 | 0.76 | 0.24 | 0.97 | 0.28 | 0.29 | 0.23 | 0.61 |
| Type of Protection | Excelsior | Excelsior | 6" Riprap | Excelsior | Excelsior | Excelsior | Excelsior | Excelsior | Excelsior | Excelsior |

| DESIGN DATA | Ditch No. 11 | 12 | 13 | 14 | - | - | - | - | - | - |
|---|---|---|---|---|---|---|---|---|---|---|
| Bottom Width (ft) | 4 | 4 | 4 | 4 | - | - | - | - | - | - |
| Left Side Slope | 3:1 | 3:1 | 3:1 | 3:1 | - | - | - | - | - | - |
| Right Side Slope | 3:1 | 3:1 | 3:1 | 3:1 | - | - | - | - | - | - |
| Starting Elevation | 230 | 230 | 245.5 | 256 | - | - | - | - | - | - |
| Ending Elevation | 227 | 228 | 228 | 245.5 | - | - | - | - | - | - |
| Length (ft) | 500 | 300 | 811 | 1008 | - | - | - | - | - | - |
| Slope (ft/ft) | 0.0060 | 0.0067 | 0.0216 | 0.0104 | - | - | - | - | - | - |
| Discharge (cfs) | 5.14 | 3.35 | 55.68 | 12.08 | - | - | - | - | - | - |
| Manning's "n" | 0.066 | 0.066 | 0.033 | 0.035 | - | - | - | - | - | - |
| Depth (ft) | 0.73 | 0.57 | 1.28 | 0.71 | - | - | - | - | - | - |
| Velocity (ft/s) | 1.14 | 1.03 | 5.55 | 2.78 | - | - | - | - | - | - |
| Shear Stress ($lb/ft^2$) | 0.27 | 0.24 | 1.72 | 0.46 | - | - | - | - | - | - |
| Type of Protection | Excelsior | Excelsior | Excelsior | Excelsior | - | - | - | - | - | - |

**e. Storm Drainage Pipe Structures**

The flow in each storm drainage pipe is calculated using the SCS Method, and is based on the 24 hour – 25 year storm event.

Included are sketches detailing the construction of each storm drainage pipe. The locations of all of these structures can be found in the Design and Operation Plan.

Each sketch shows the discharge or flow rate required to be handled by the pipe and the design calculations performed to adequately size each structure to handle the anticipated flow.

**TABLE 3**
**DRAINAGE STRUCTURES**

| PIPE NO. | SIZE | LENGTH | SLOPE | MATERIAL | AVAILABLE HEAD | ACTUAL HEAD |
|---|---|---|---|---|---|---|
| 100* | 30" | 191' | 2.62% | RCP | 6.00' | 4.30' |
| 101 | 48" | 98' | 1.00% | RCP | 5.00' | 4.73' |
| 102 | 30" | 94' | 1.00% | RCP | 8.60' | 6.94' |
| 103 | 30" | 93' | 5.40% | RCP | 5.00' | 3.75' |
| 200* | 42" | 120' | 0.89% | RCP | 7.00' | 5.74' |
| 201 | 2-36" | 79' | 1.90% | RCP | 5.50' | 3.45' |
| 202 | 42" | 65' | 2.31% | RCP | 5.50' | 5.18' |
| 300* | 36" | 100' | 11.00% | RCP | 6.00' | 4.48' |
| 301 | 42" | 98' | 1.00% | RCP | 10.00' | 7.70' |
| 400* | 48" | 81' | 4.94% | RCP | 6.00' | 4.46' |
| 401 | 30" | 125' | 1.20% | RCP | 14.50' | 11.95' |
| 402 | 48" | 112' | 10.00% | RCP | 11.80' | 7.80' |
| 500* | 48" | 92' | 8.70% | RCP | 6.00' | 4.62' |
| 501 | 42" | 105' | 1.00% | RCP | 12.00' | 9.30' |
| 502 | 36" | 118' | 1.00% | RCP | 8.80' | 6.12' |
| 600* | 54" | 87' | 6.90% | RCP | 6.00' | 4.75' |
| 601 | 60" | 96' | 1.00% | RCP | 9.00' | 7.85' |
| 700* | 48" | 109' | 2.75% | RCP | 10.00' | 5.58' |
| 701 | 2 - 60" | 167' | 1.00% | RCP | 6.30' | 5.60' |
| 702 | 42" | 136' | 1.00% | RCP | 13.60' | 9.85' |
| 800* | 42" | 72' | 1.39% | RCP | 8.00' | 6.25' |
| 801 | 66" | 88' | 1.00% | RCP | 7.10' | 6.13' |
| 900* | 42" | 93' | 9.68% | RCP | 6.00' | 4.42' |
| 901 | 54" | 90' | 1.00% | RCP | 7.10' | 6.45' |
| 1000* | 36" | 87' | 8.05% | RCP | 6.00' | 4.07' |
| 1001 | 54" | 120' | 1.00% | RCP | 10.80' | 7.88' |
| 1002 | 24" | 117' | 8.55% | RCP | 6.00' | 3.64' |
| 1100* | 54" | 75' | 4.00% | RCP | 6.00' | 4.07' |
| 1101 | 60" | 109' | 1.00% | RCP | 14.40' | 12.50' |

* *- Detailed calculations for pipe numbers 100, 200, 300, 400, 500, 600, 700, 800, 900, 1000, and 1100 are located in their respective sediment pond sections. These pipes have also been sized to safely pass the 100 year storm event.*

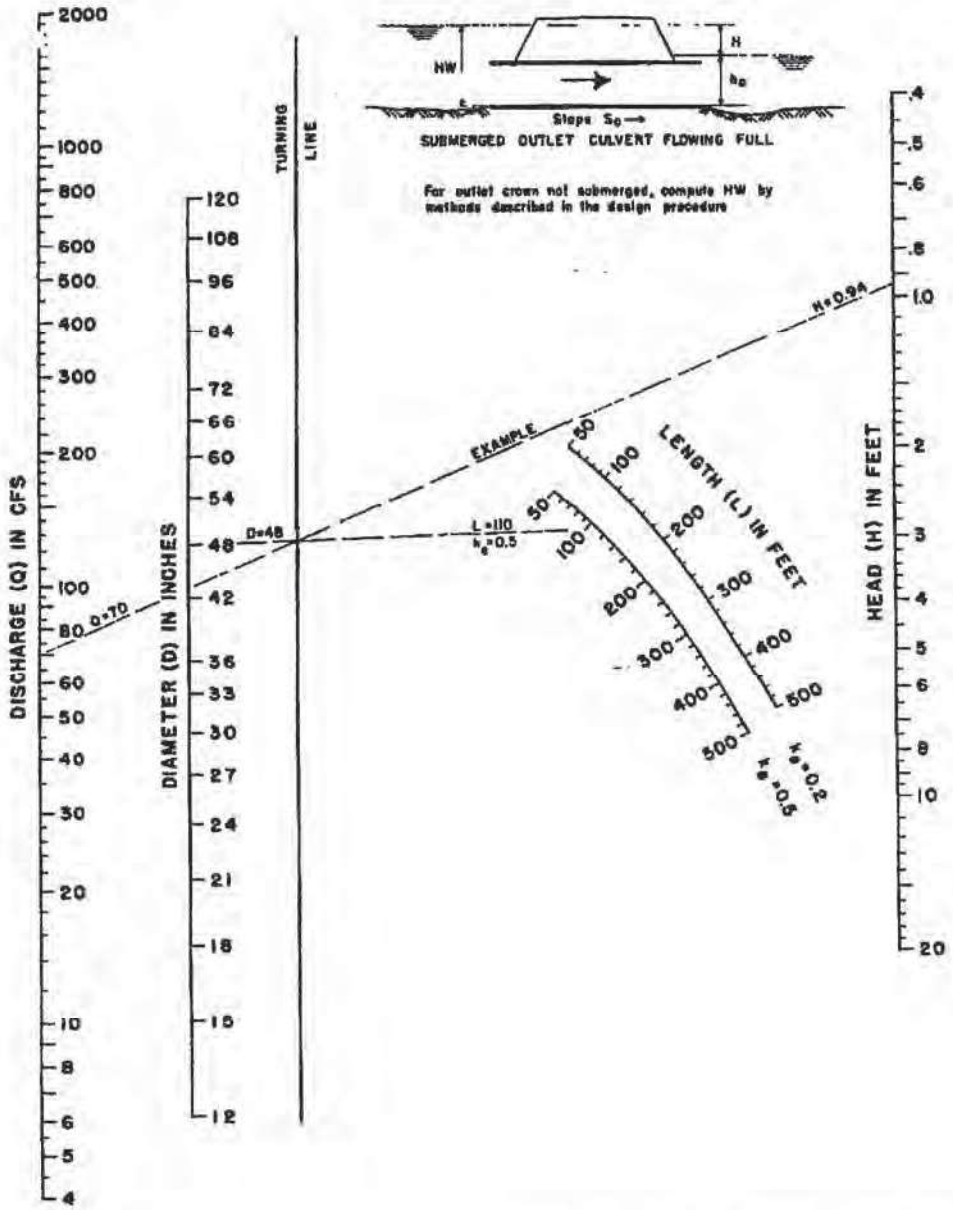
**TABLE 3**
**DRAINAGE STRUCTURES**

| DROP INLET NO. | TOP ELEV. | THROAT ELEV. | INVERT ELEV. |
|---|---|---|---|
| 101 | 278.00 | 276.00 | 270.98 |
| 102 | 281.50 | 279.50 | 270.94 |
| 301 | 259.00 | 257.00 | 246.98 |
| 401 | 244.00 | 242.00 | 227.50 |
| 402 | 247.00 | 245.00 | 235.20 |
| 501 | 280.99 | 278.99 | 267.05 |
| 502 | 278.00 | 276.00 | 267.18 |
| 601 | 270.16 | 268.16 | 258.96 |
| 701 | 224.00 | 222.00 | 215.67 |
| 702 | 231.65 | 229.65 | 215.36 |
| 801 | 230.00 | 228.00 | 220.90 |
| 901 | 226.00 | 224.00 | 216.90 |
| 1001 | 218.00 | 216.00 | 205.20 |
| 1002 | 222.75 | 220.75 | 214.00 |
| 1101 | 232.25 | 230.25 | 217.09 |

| HEADWALL NO. | INVERT ELEV. |
|---|---|
| 100 | 271.00 |
| 101 | 270.00 |
| 102 | 270.00 |
| 103 | 276.00 |
| 200 | 259.00 |
| 201 | 261.50 |
| 202 | 260.00 |
| 203 | 261.50 |
| 204 | 260.00 |
| 300 | 247.00 |
| 301 | 246.00 |
| 400 | 226.00 |
| 401 | 226.00 |
| 402 | 224.00 |
| 500 | 266.00 |
| 501 | 266.00 |

| HEADWALL NO. | INVERT ELEV. |
|---|---|
| 502 | 266.00 |
| 600 | 258.00 |
| 601 | 258.00 |
| 700 | 215.00 |
| 701 | 214.00 |
| 702 | 214.00 |
| 800 | 221.00 |
| 801 | 220.00 |
| 900 | 217.00 |
| 901 | 216.00 |
| 1000 | 205.00 |
| 1001 | 204.00 |
| 1002 | 204.00 |
| 1100 | 215.00 |
| 1101 | 216.00 |

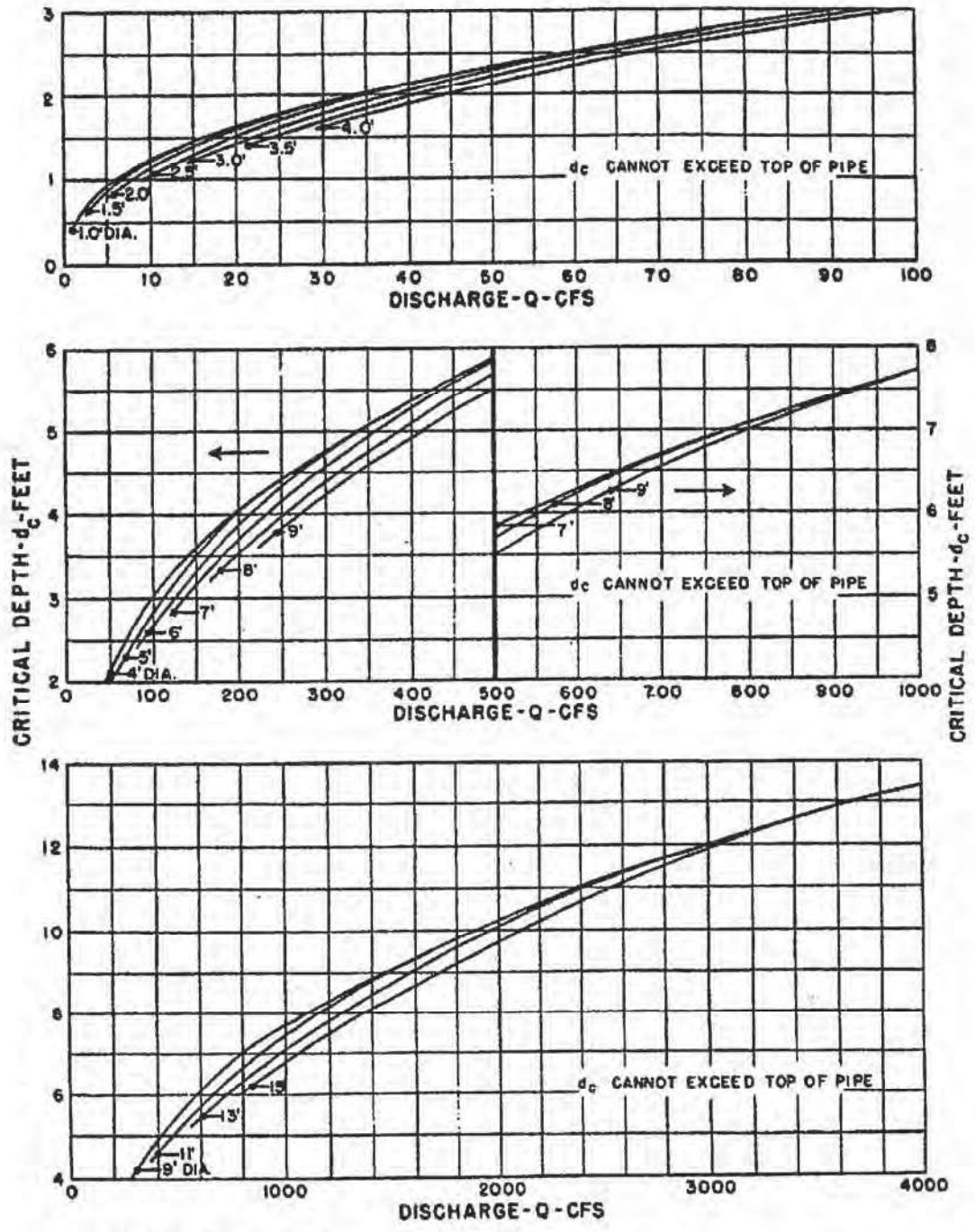
# CHART 5B




HEAD FOR
CONCRETE PIPE CULVERTS
FLOWING FULL
n=0.012

BUREAU OF PUBLIC ROADS JAN. 1963

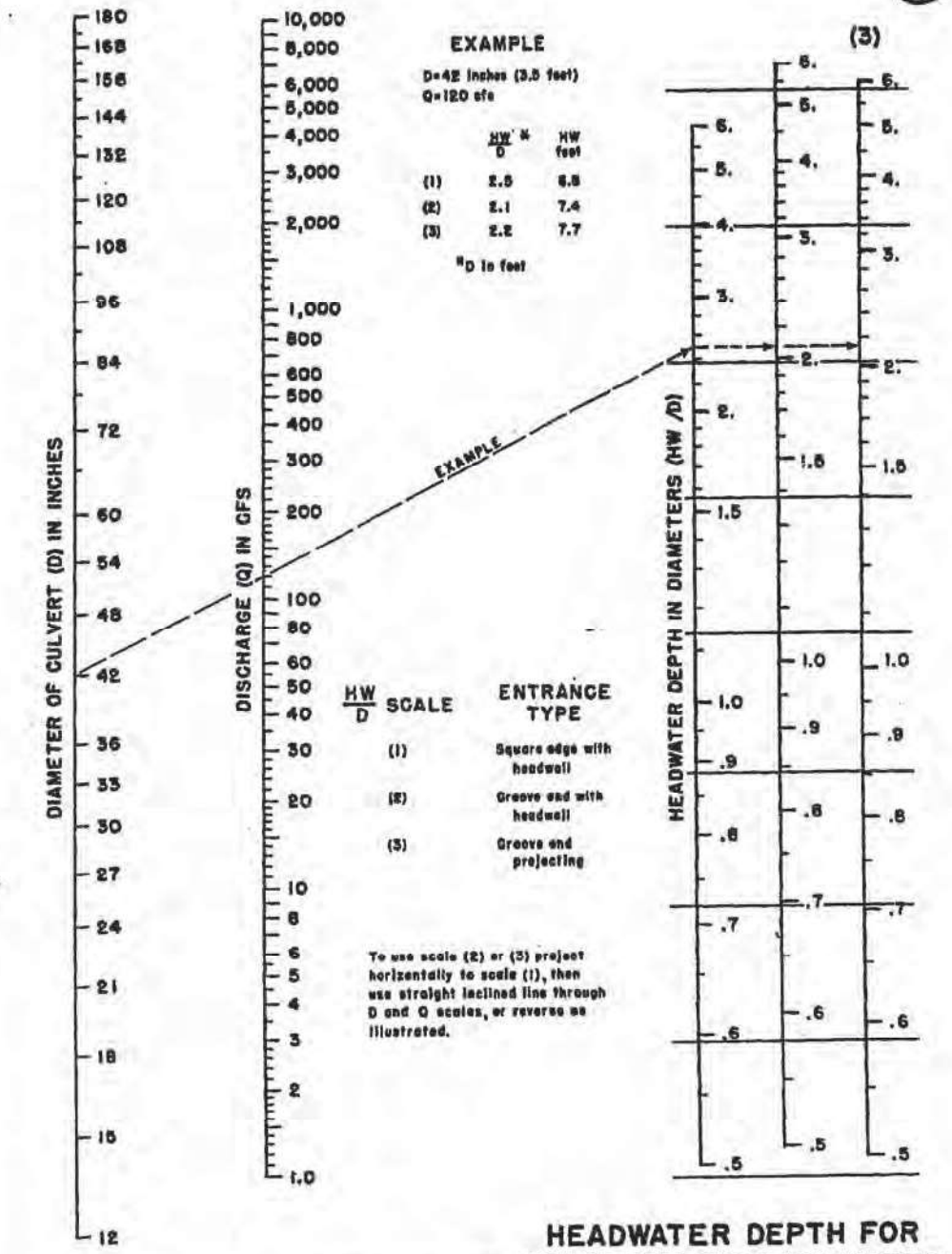
# CHART 4B




BUREAU OF PUBLIC ROADS
JAN. 1964

## CRITICAL DEPTH
## CIRCULAR PIPE

# CHART 1B




HEADWATER DEPTH FOR CONCRETE PIPE CULVERTS WITH INLET CONTROL

HEADWATER SCALES 2&3
REVISED MAY 1964

BUREAU OF PUBLIC ROADS JAN. 1963

# PIPE NO. 101

$Q_{25}$ = 75 cfs

Allowable Headwater = 5.0'

Inlet Control:

Assume: 48 " dia. RCP at 75 cfs

Headwater: 4' x 1.02' = 4.08'

Outlet Control:

Find Critical Depth ($d_c$) = 2.65'

$h_o = \frac{d_c + D}{2}$ = 3.33' or 274.68 - 270 = 4.68. USE 4.68

H = head = 1.03'

L = length = 98'

$S_o$ = slope = 1.00%

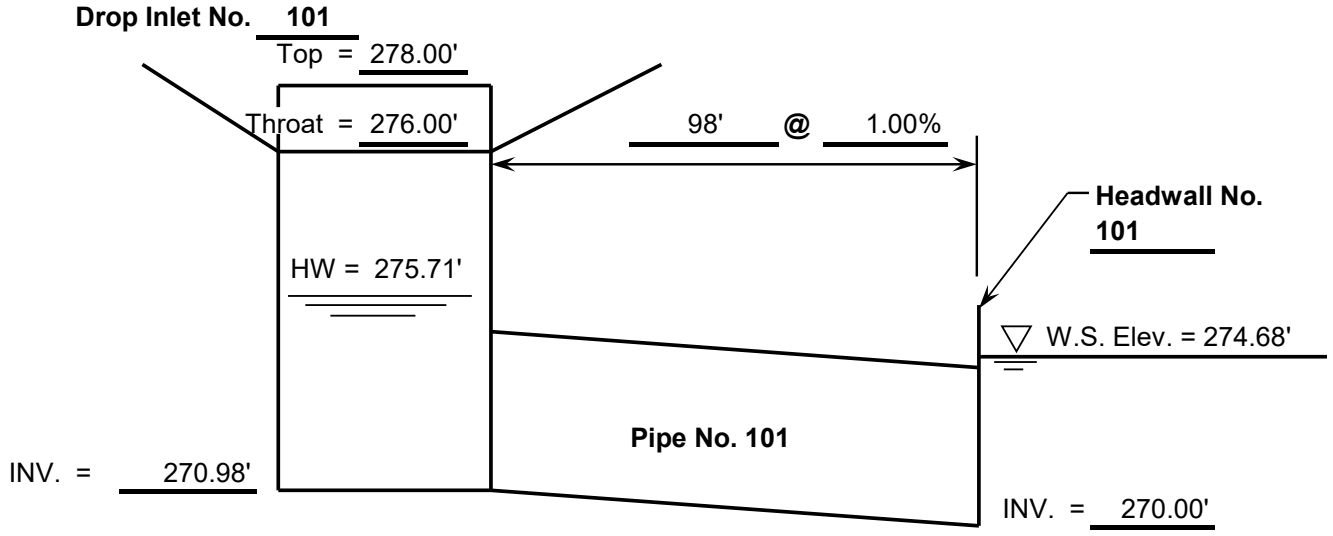
Headwater = H + $h_o$ - L*So = 4.73' OUTLET CONTROL

Final Pipe Selection:

48 " dia. RCP at 75 cfs

Length = 98'

Slope = 1.00%



# PIPE NO. 102

$Q_{25}$ = 47 cfs

Allowable Headwater = 8.6'

Inlet Control:

Assume: 30 " dia. RCP at 47 cfs

Headwater: 2.5' x 2.08' = 5.2'

Outlet Control:

Find Critical Depth ($d_c$) = 2.3'

$h_o = \frac{d_c + D}{2}$ = 2.40' or 274.68 - 270 = 4.68. USE 4.68

H = head = 3.2'

L = length = 94'

$S_o$ = slope = 1.00%

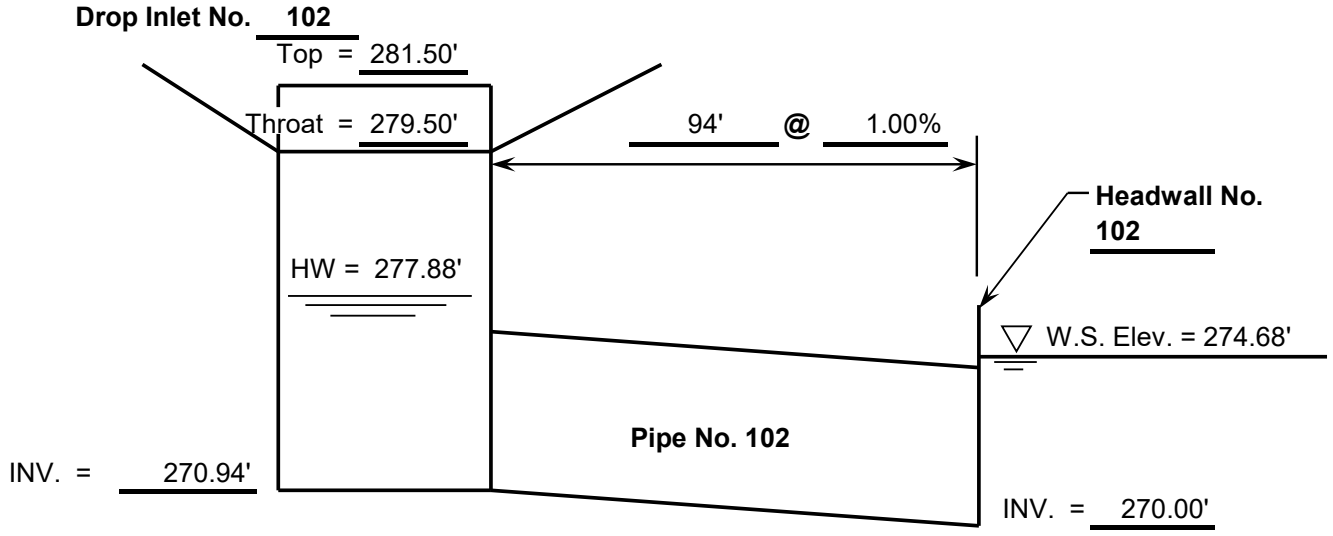
Headwater = H + $h_o$ - L*So = 6.94' OUTLET CONTROL

Final Pipe Selection:

30 " dia. RCP at 47 cfs

Length = 94'

Slope = 1.00%



# PIPE NO. 103

$Q_{25}$ = 27 cfs

Allowable Headwater = 5.0'

Inlet Control:

Assume: 30 " dia. RCP at 27 cfs

Headwater: 2.5' x 1.5' = 3.75' INLET CONTROL

Outlet Control:

Find Critical Depth ($d_c$) = 2'

$h_o = \frac{d_c + D}{2}$ = 2.25'

H = head = 1.68'

L = length = 93'

$S_o$ = slope = 5.40%

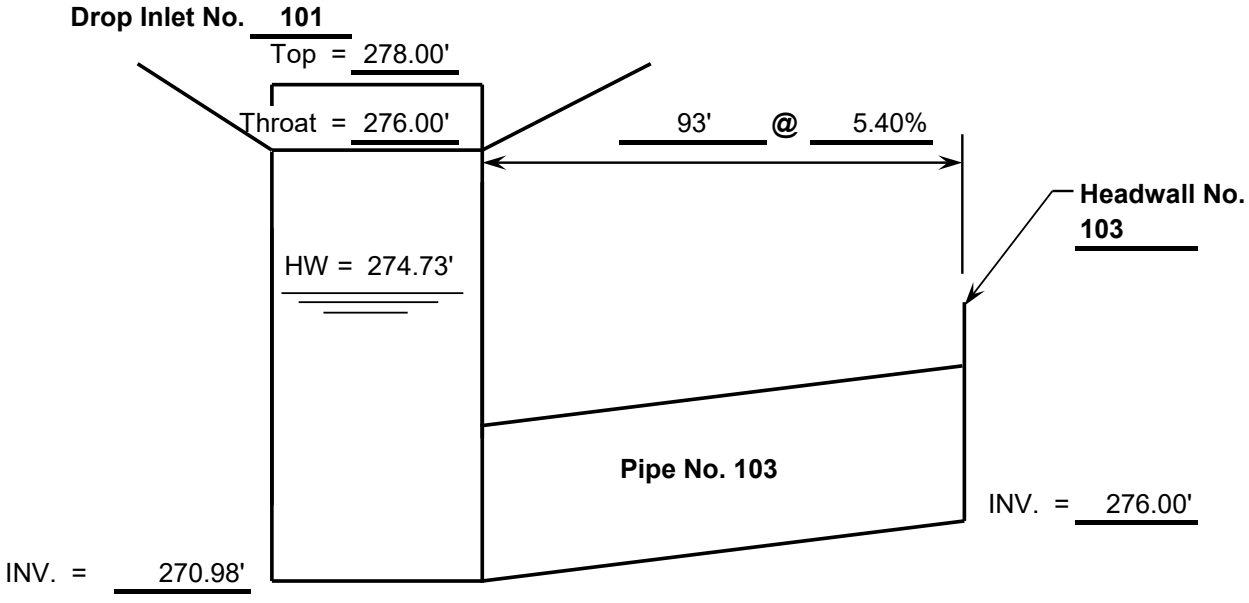
Headwater = H + $h_o$ - L*So = -1.09'

Final Pipe Selection:

30 " dia. RCP at 27 cfs

Length = 93'

Slope = 5.40%



# PIPE NO. 201

$Q_{25}$ = 84 cfs (42 cfs through each pipe)

Allowable Headwater = 5.5'

**Inlet Control:**

Assume: 36 " dia. 2 - RCP at 84 cfs

Headwater: 3' x 1.15' = 3.45' INLET CONTROL

**Outlet Control:**

Find Critical Depth ($d_c$) = 2.55'

$h_o = \frac{d_c + D}{2}$ = 2.78' or 262.98 - 260 = 2.98. USE 2.98

H = head = 1.05'

L = length = 79'

$S_o$ = slope = 1.90%

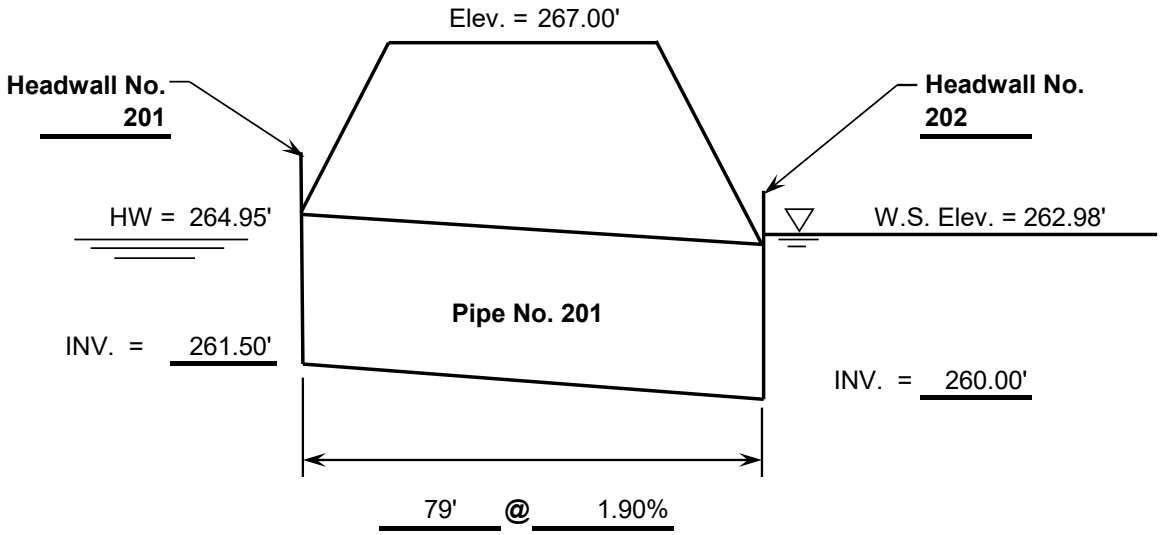
Headwater = H + $h_o$ - L*So = 2.53'

**Final Pipe Selection:**

36 " dia. 2 - RCP at 84 cfs

Length = 79'

Slope = 1.90%



# PIPE NO. 202

$Q_{25}$ = 78 cfs

Allowable Headwater = 5.5'

Inlet Control:

Assume: 42 " dia. RCP at 78 cfs

Headwater: 3.5' x 1.48' = 5.18' INLET CONTROL

Outlet Control:

Find Critical Depth ($d_c$) = 2.75'

$h_o = \frac{d_c + D}{2}$ = 3.13'

H = head = 1.8'

L = length = 65'

$S_o$ = slope = 2.31%

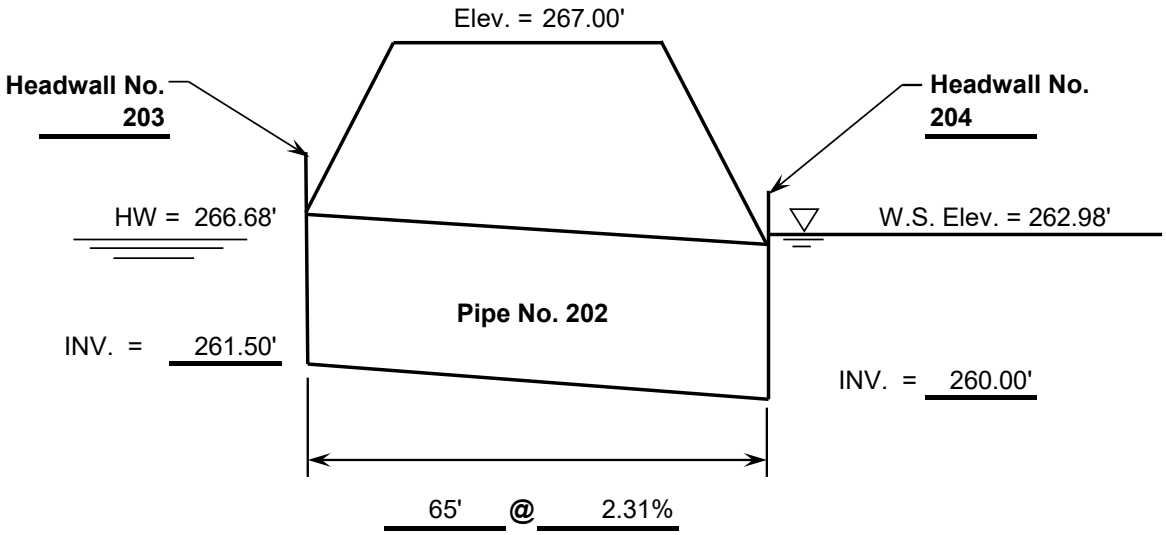
Headwater = H + $h_o$ - L*So = 3.42'

Final Pipe Selection:

42 " dia. RCP at 78 cfs

Length = 65'

Slope = 2.31%



# PIPE NO. 301

$Q_{25}$ = 110 cfs

Allowable Headwater = 10.0'

Inlet Control:

Assume: 42 " dia. RCP at 110 cfs

Headwater: 3.5' x 2.2' = 7.7' INLET CONTROL

Outlet Control:

Find Critical Depth ($d_c$) = 3.2'

$h_o = \frac{d_c + D}{2}$ = 4.65'

H = head = 3.93'

L = length = 98'

$S_o$ = slope = 1.00%

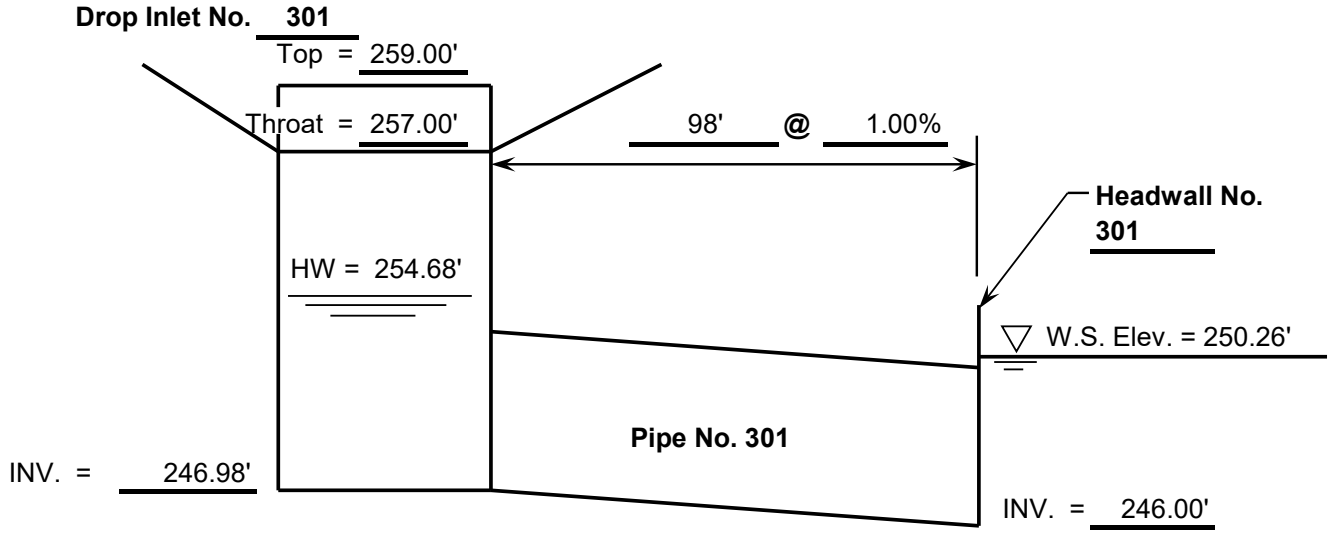
Headwater = H + $h_o$ - L*So = 7.60'

Final Pipe Selection:

42 " dia. RCP at 110 cfs

Length = 98'

Slope = 1.00%



# PIPE NO. 401

$Q_{25}$ = 73 cfs

Allowable Headwater = 14.5'

Inlet Control:

Assume: 30 " dia. RCP at 73 cfs

Headwater: 2.5' x 4.2' = 10.5'

Outlet Control:

Find Critical Depth ($d_c$) = 2.75'

$h_o = \frac{d_c + D}{2}$ = 2.63' or 230.75 - 226 = 4.75. USE 4.75

H = head = 8.7'

L = length = 125'

$S_o$ = slope = 1.20%

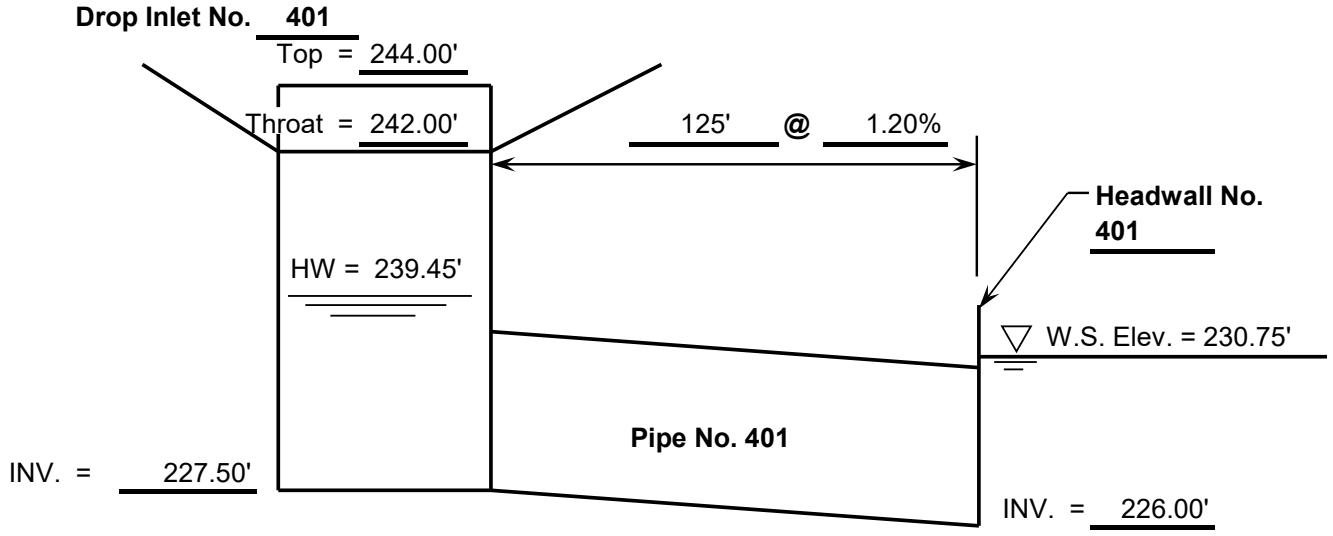
Headwater = H + $h_o$ - L*So = 11.95' OUTLET CONTROL

Final Pipe Selection:

30 " dia. RCP at 73 cfs

Length = 125'

Slope = 1.20%



# PIPE NO. 402

$Q_{25}$ = 142 cfs

Allowable Headwater = 9.8'

Inlet Control:

Assume: 48 " dia. RCP at 142 cfs

Headwater: 4' x 1.95' = 7.8' INLET CONTROL

Outlet Control:

Find Critical Depth ($d_c$) = 3.6'

$h_o = \frac{d_c + D}{2}$ = 3.50' or 230.75 - 224 = 6.75. USE 6.75

H = head = 3.95'

L = length = 112'

$S_o$ = slope = 10.00%

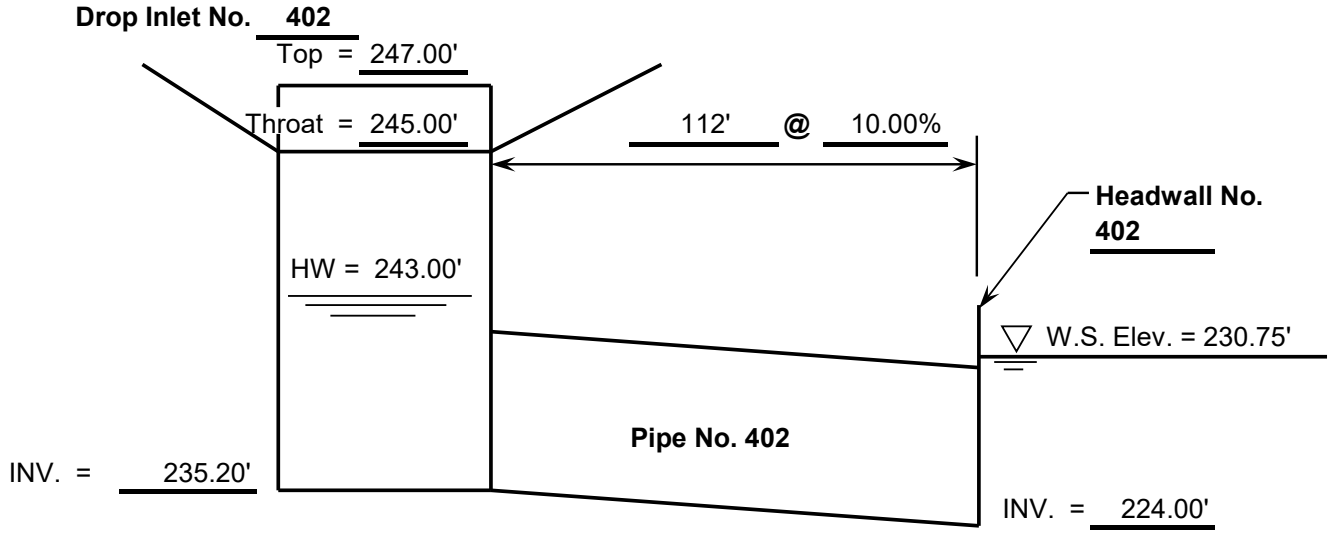
Headwater = H + $h_o$ - L*So = -0.50'

Final Pipe Selection:

48 " dia. RCP at 142 cfs

Length = 112'

Slope = 10.00%



# PIPE NO. 501

$Q_{25}$ = 128 cfs

Allowable Headwater = 11.9'

Inlet Control:

Assume: 42 " dia. RCP at 128 cfs

Headwater: 3.5' x 2.5' = 8.75'

Outlet Control:

Find Critical Depth ($d_c$) = 3.4'

$h_o = \frac{d_c + D}{2}$ = 3.45' or 270.75 - 266 = 4.75. USE 4.75

H = head = 5.6'

L = length = 105'

$S_o$ = slope = 1.00%

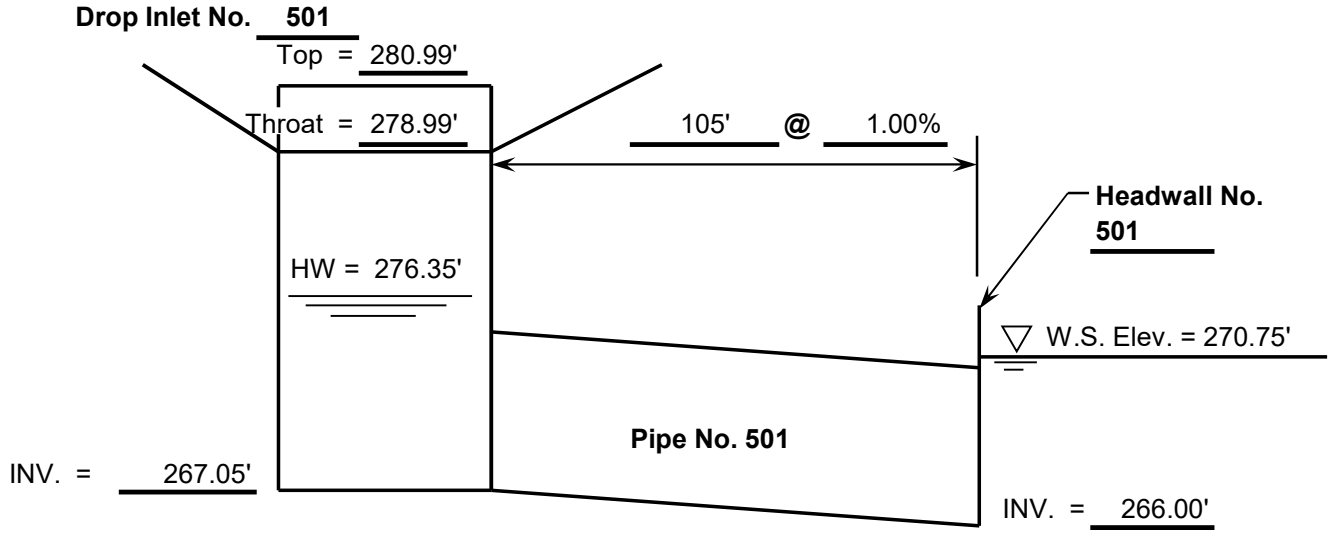
Headwater = H + $h_o$ - L*So = 9.30' OUTLET CONTROL

Final Pipe Selection:

42 " dia. RCP at 128 cfs

Length = 105'

Slope = 1.00%



# PIPE NO. 502

$Q_{25}$ = 88 cfs

Allowable Headwater = 8.8'

Inlet Control:

Assume: 42 " dia. RCP at 88 cfs

Headwater: 3.5' x 1.62' = 5.67'

Outlet Control:

Find Critical Depth ($d_c$) = 2.9'

$h_o = \frac{d_c + D}{2}$ = 3.20' or 270.75 - 266 = 4.75. USE 4.75

H = head = 2.55'

L = length = 118'

$S_o$ = slope = 1.00%

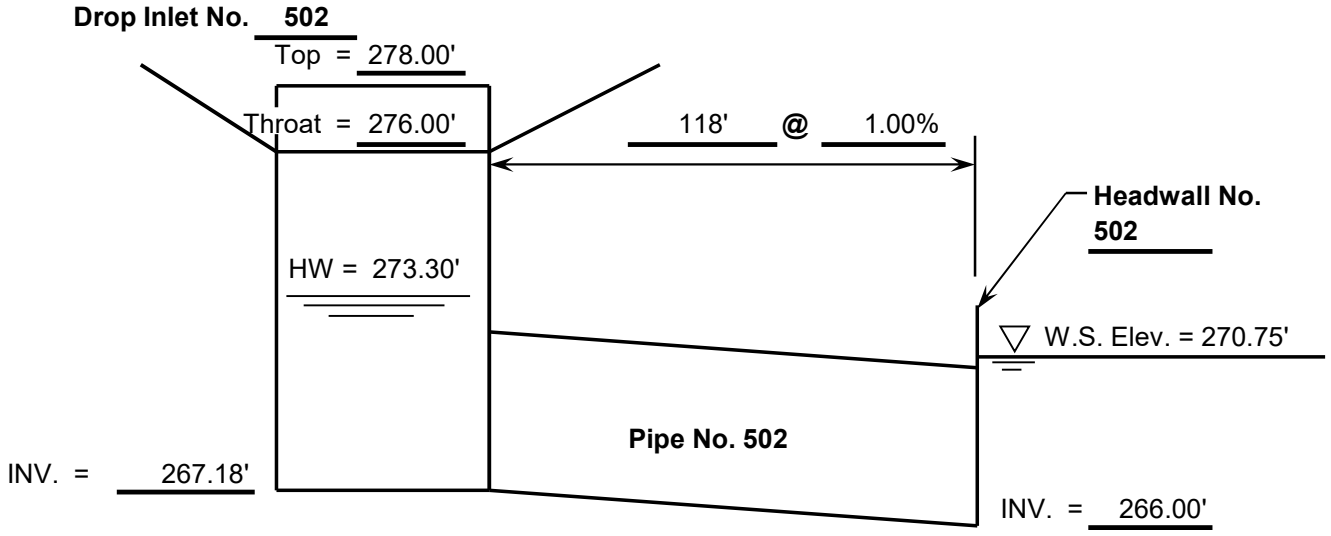
Headwater = H + $h_o$ - L*So = 6.12' OUTLET CONTROL

Final Pipe Selection:

42 " dia. RCP at 88 cfs

Length = 118'

Slope = 1.00%



# PIPE NO. 601

$Q_{25}$ = 202 cfs

Allowable Headwater = 9.2'

Inlet Control:

Assume: 60 " dia. RCP at 202 cfs

Headwater: 5' x 1.57' = 7.85' INLET CONTROL

Outlet Control:

Find Critical Depth ($d_c$) = 4.1'

$h_o = \frac{d_c + D}{2}$ = 4.55' or 262.66 - 258 = 4.66. USE 4.66

H = head = 3'

L = length = 96'

$S_o$ = slope = 1.00%

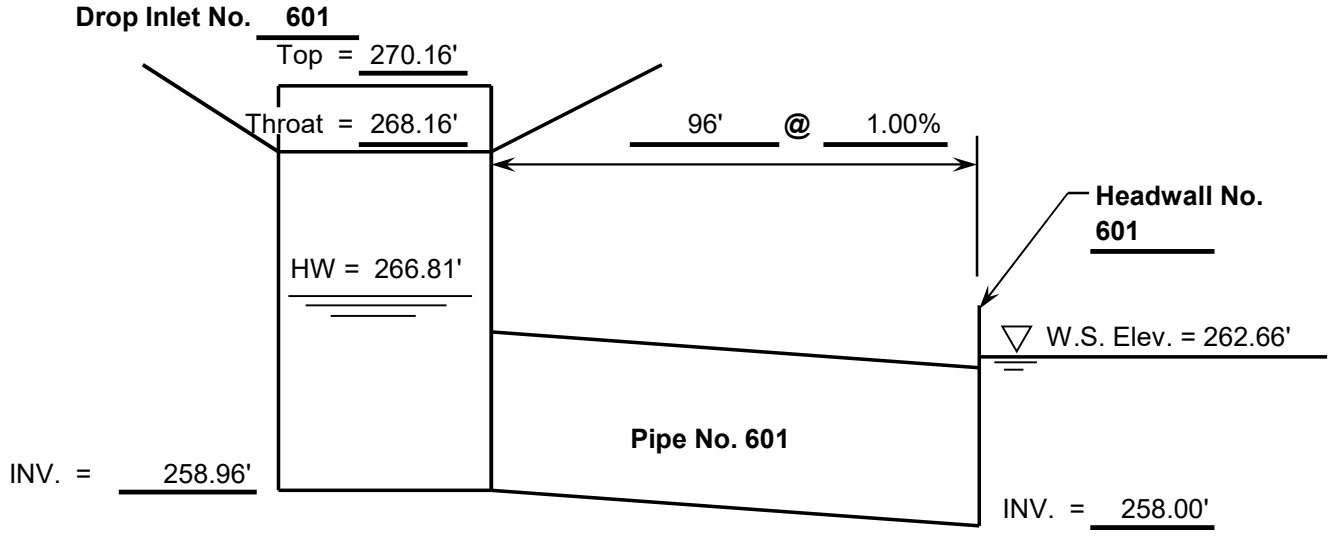
Headwater = H + $h_o$ - L*So = 6.70'

Final Pipe Selection:

60 " dia. RCP at 202 cfs

Length = 96'

Slope = 1.00%



# PIPE NO. 701

$Q_{25}$ = 144 cfs through each pipe

Allowable Headwater = 6.3'

Inlet Control:

Assume: 60 " dia. 2 - RCP at 144 cfs

Headwater: 5' x 1.12' = 5.6' INLET CONTROL

Outlet Control:

Find Critical Depth ($d_c$) = 3.4'

$h_o = \frac{d_c + D}{2}$ = 4.20' or 219.31 - 214 = 5.31. USE 5.31

H = head = 1.65'

L = length = 163'

$S_o$ = slope = 1.02%

Headwater = H + $h_o$ - L*So = 5.30'

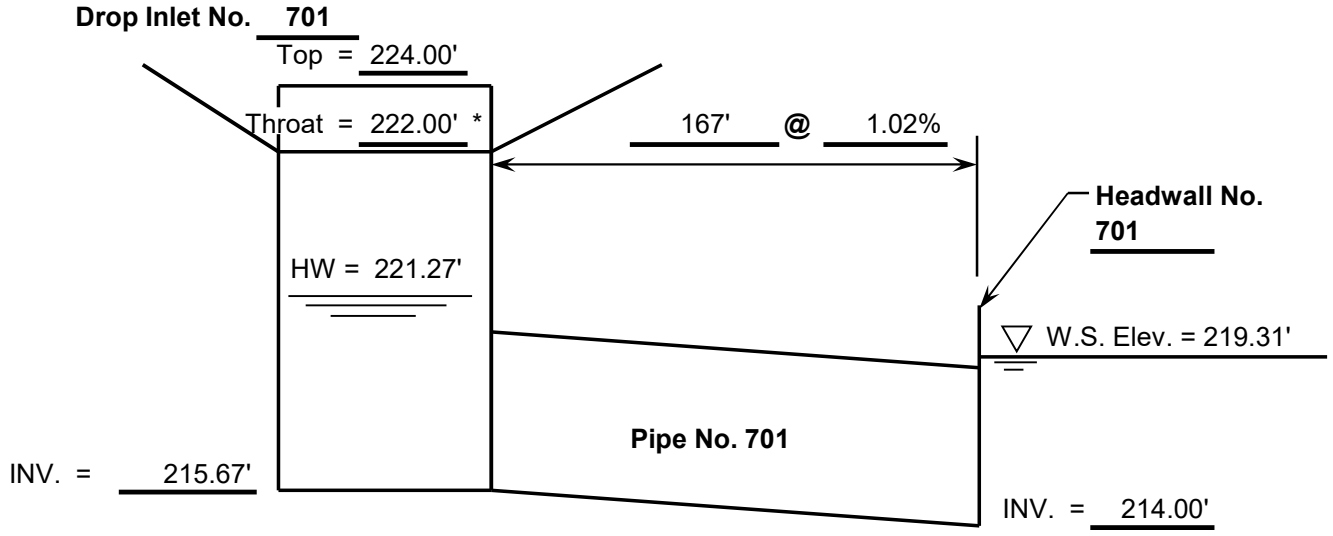
Final Pipe Selection:

60 " dia. 2 - RCP at 144 cfs

Length = 167'

Slope = 1.02%

* Water will be allowed to back up in the ditch.



# PIPE NO. 702

$Q_{25}$ = 125 cfs

Allowable Headwater = 14.3'

Inlet Control:

Assume: 42 " dia. RCP at 125 cfs

Headwater: 3.5' x 2.6' = 9.1'

Outlet Control:

Find Critical Depth ($d_c$) = 3.5'

$h_o = \frac{d_c + D}{2}$ = 3.50' or 219.31 - 214 = 5.31. USE 5.31

H = head = 5.9'

L = length = 136'

$S_o$ = slope = 1.00%

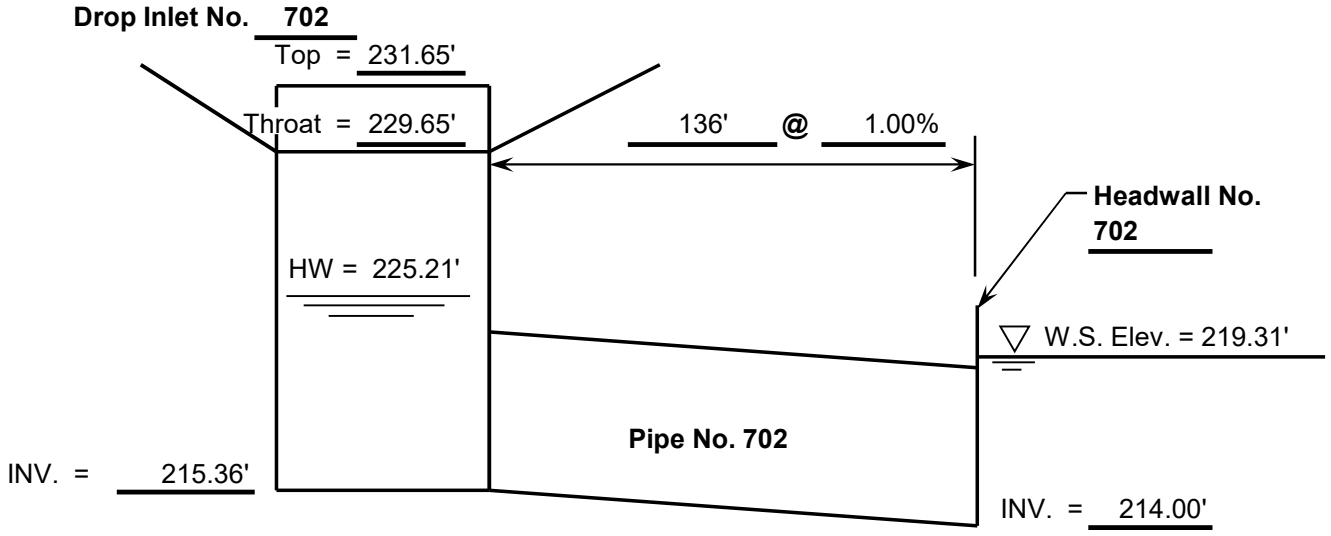
Headwater = H + $h_o$ - L*So = 9.85' OUTLET CONTROL

Final Pipe Selection:

42 " dia. RCP at 125 cfs

Length = 136'

Slope = 1.00%



# PIPE NO. 801

$Q_{25}$ = 140 cfs

Allowable Headwater = 7.1'

Inlet Control:

Assume: 66 " dia. RCP at 140 cfs

Headwater: 5.5' x 0.905' = 4.9775'

Outlet Control:

Find Critical Depth ($d_c$) = 3.25'

$h_o = \frac{d_c + D}{2}$ = 4.38' or 226.08 - 220 = 6.08. USE 6.08

H = head = 0.95'

L = length = 90'

$S_o$ = slope = 1.00%

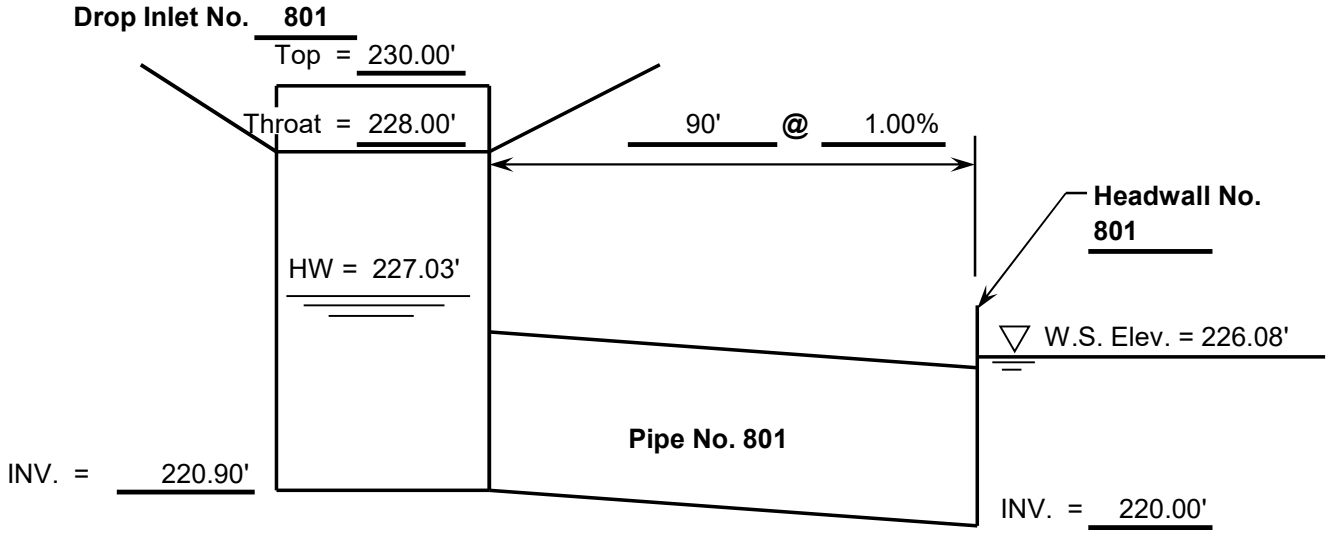
Headwater = H + $h_o$ - L*So = 6.13' OUTLET CONTROL

Final Pipe Selection:

66 " dia. RCP at 140 cfs

Length = 90'

Slope = 1.00%



# PIPE NO. 901

$Q_{25}$ = 143 cfs

Allowable Headwater = 7.1'

Inlet Control:

Assume: 54 " dia. RCP at 143 cfs

Headwater: 4.5' x 1.43' = 6.435'

Outlet Control:

Find Critical Depth ($d_c$) = 3.5'

$h_o = \frac{d_c + D}{2}$ = 4.00' or 220.8 - 216 = 4.8. USE 4.8

H = head = 2.55'

L = length = 90'

$S_o$ = slope = 1.00%

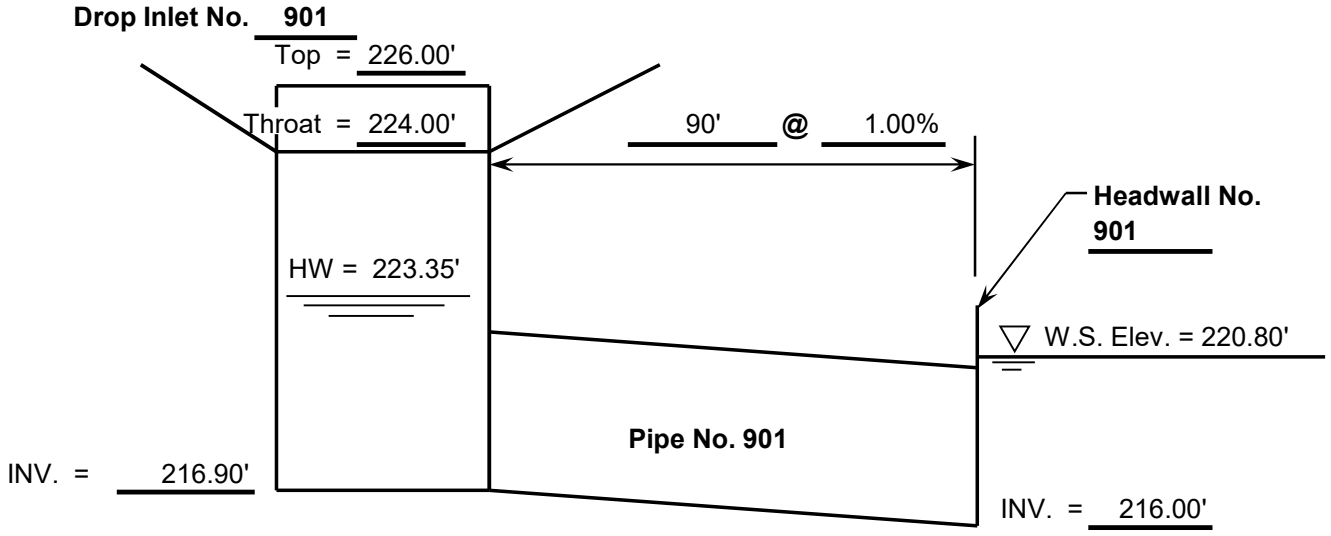
Headwater = H + $h_o$ - L*So = 6.45' OUTLET CONTROL

Final Pipe Selection:

54 " dia. RCP at 143 cfs

Length = 90'

Slope = 1.00%



# PIPE NO. 1001

$Q_{25}$ = 171 cfs

Allowable Headwater = 10.8'

Inlet Control:

Assume: 54 " dia. RCP at 171 cfs

Headwater: 4.5' x 1.75' = 7.875' INLET CONTROL

Outlet Control:

Find Critical Depth ($d_c$) = 0.8'

$h_o = \frac{d_c + D}{2}$ = 2.65' or 207.82 - 204 = 3.82. USE 3.82

H = head = 3.35'

L = length = 120'

$S_o$ = slope = 1.00%

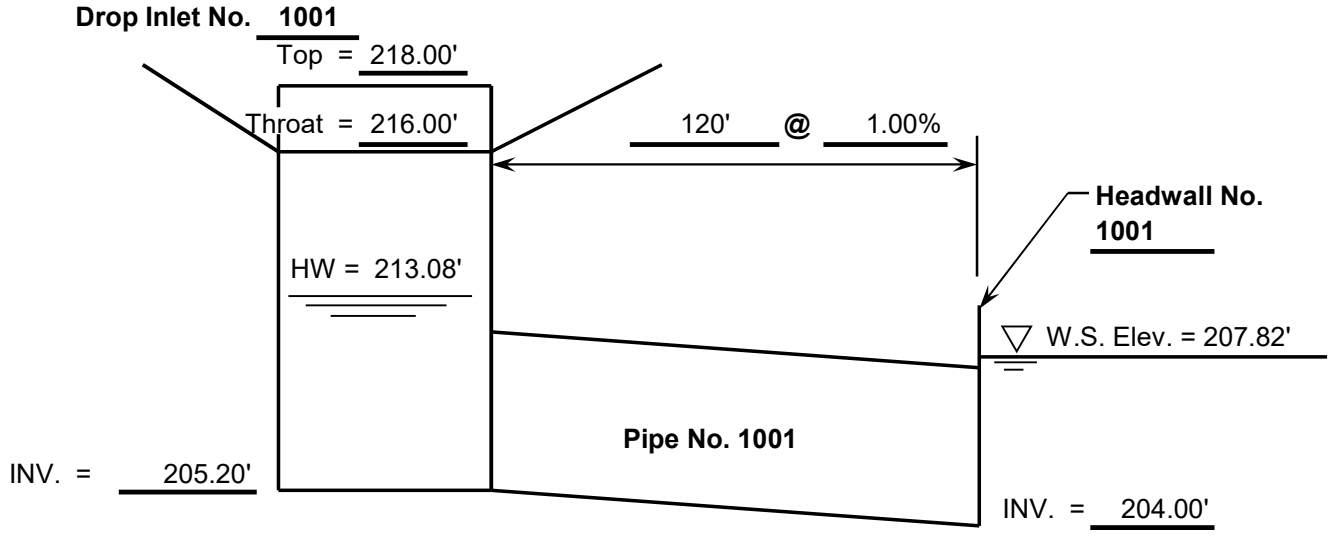
Headwater = H + $h_o$ - L*So = 5.97'

Final Pipe Selection:

54 " dia. RCP at 171 cfs

Length = 120'

Slope = 1.00%



# PIPE NO. 1002

$Q_{25}$ = 24 cfs

Allowable Headwater = 6.8'

Inlet Control:

Assume: 24 " dia. RCP at 24 cfs

Headwater: 2' x 1.82' = 3.64' INLET CONTROL

Outlet Control:

Find Critical Depth ($d_c$) = 1.75'

$h_o = \frac{d_c + D}{2}$ = 1.88' or 207.82 - 204 = 3.82. USE 3.82

H = head = 2.55'

L = length = 117'

$S_o$ = slope = 8.55%

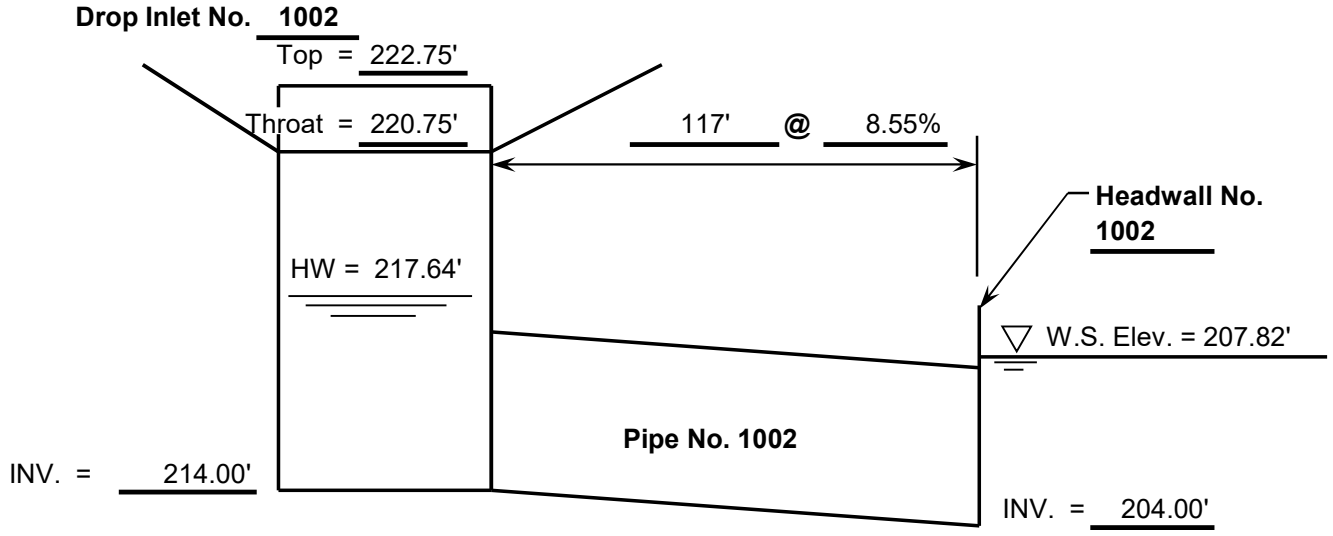
Headwater = H + $h_o$ - L*So = -3.63'

Final Pipe Selection:

24 " dia. RCP at 24 cfs

Length = 117'

Slope = 8.55%



# PIPE NO. 1101

$Q_{25}$ = 291 cfs

Allowable Headwater = 13.2'

Inlet Control:

Assume: 60 " dia. RCP at 291 cfs

Headwater: 5' x 2.5' = 12.5' INLET CONTROL

Outlet Control:

Find Critical Depth ($d_c$) = 4.7'

$h_o = \frac{d_c + D}{2}$ = 4.85'

H = head = 6.4'

L = length = 109'

$S_o$ = slope = 1.00%

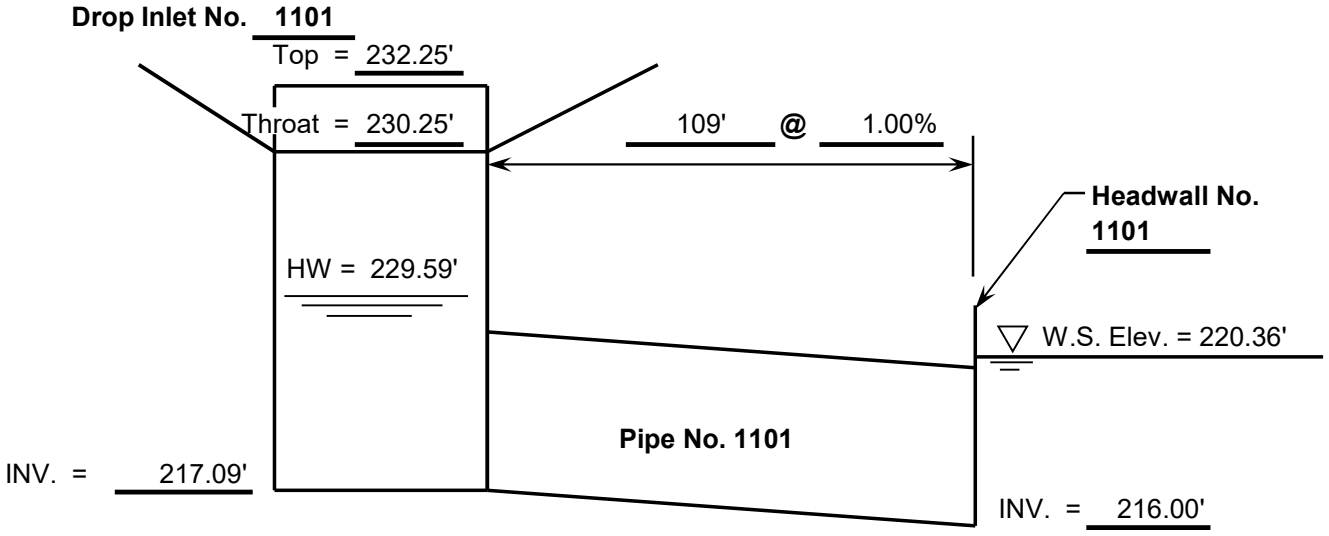
Headwater = H + $h_o$ - L*So = 10.16'

Final Pipe Selection:

60 " dia. RCP at 291 cfs

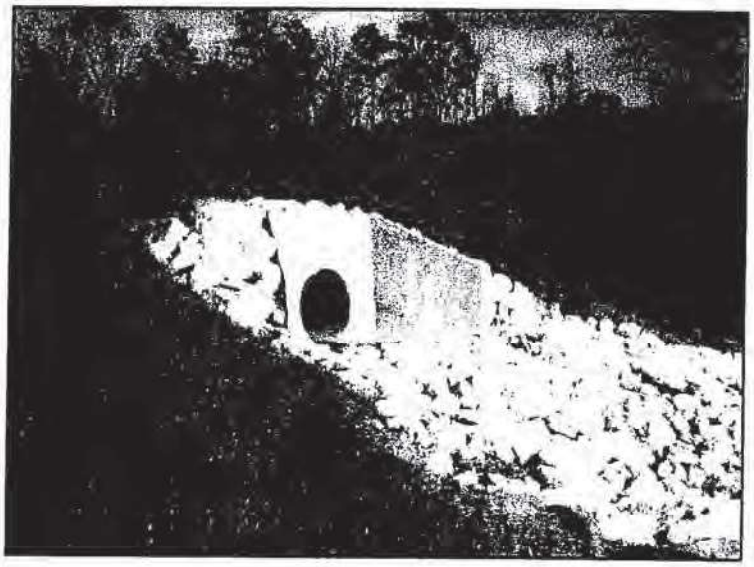
Length = 109'

Slope = 1.00%



**f. Outlet Protection**

# Outlet Protection (OP)



## Practice Description

This practice is designed to prevent erosion at the outlet of a channel or conduit by reducing the velocity of flow and dissipating the energy. Outlet protection measures usually consist of a riprap-lined apron, a reinforced concrete flume with concrete baffles or a reinforced concrete box with chambers or baffles. This practice applies wherever high velocity discharge must be released on erodible material.

## Planning Considerations

The outlets of pipes and structurally lined channels are points of critical erosion potential. Stormwater which is transported through man-made conveyance systems at design capacity generally reaches a velocity which exceeds the ability of the receiving channel or area to resist erosion. To prevent scour at stormwater outlets, a flow transition structure is required which will absorb the initial impact of the flow and reduce the flow velocity to a level which will not erode the receiving channel or area.

The most commonly used structure for outlet protection is an erosion resistant lined apron. These aprons are generally lined with loose rock riprap, grouted riprap or concrete. They are constructed at zero grade for a distance which is related to the outlet flow rate and the tailwater level. Criteria for designing these structures are

contained in this practice. Several outlet conditions are shown in Figure OP-1. Example design problems for outlet protection are found at the end of this practice.

Where the flow is excessive for the economical use of an apron, excavated stilling basins may be used. Acceptable designs for stilling basins may be found in the following documents available from the U. S. Government Printing Office.

1) Hydraulic Design of Energy Dissipaters for Culverts and Channels, Hydraulics Engineering Circular No.14, U. S. Department of Transportation, Federal Highway Administration.

2) Hydraulic Design of Stilling Basins and Energy Dissipaters, Engineering Monograph No.25 U. S. Department of Interior-Bureau of Reclamation.

## Design Criteria

Structurally lined aprons at the outlets of pipes and paved channel sections should be designed according to the following criteria:

***Pipe Outlets***

Capacity

The structurally lined apron should have the capacity to carry the peak stormflow from the 25-year 24-hour frequency storm or the storm specified in state laws or local ordinances or the design discharge of the water conveyance structure, whichever is greatest.

Tailwater

The depth of tailwater immediately below the pipe outlet must be determined for the design capacity of the pipe. Manning's Equation may be used to determine tailwater depth. Manning's Equation may be found in the practice Grass Swales. If the tailwater depth is less than half the diameter of the outlet pipe, it shall be classified as a Minimum Tailwater Condition. If the tailwater depth is greater than half the pipe diameter, it shall be classified as a Maximum Tailwater Condition. Pipes which outlet to flat areas, with no defined channel, may be assumed to have a Minimum Tailwater Condition.

Apron Length

The apron length should be determined from Figure OP-2 or OP-3 according to the tailwater condition.

Apron Thickness

The apron thickness should be determined by the maximum stone size (dmax), when the apron is lined with riprap. The maximum stone size shall be 1.5 x $d_{50}$ (median stone size), as determined from Figure OP-2 or OP-3. The apron thickness shall be 1.5 x dmax.

When the apron is lined with concrete, the minimum thickness of the concrete shall be 4".

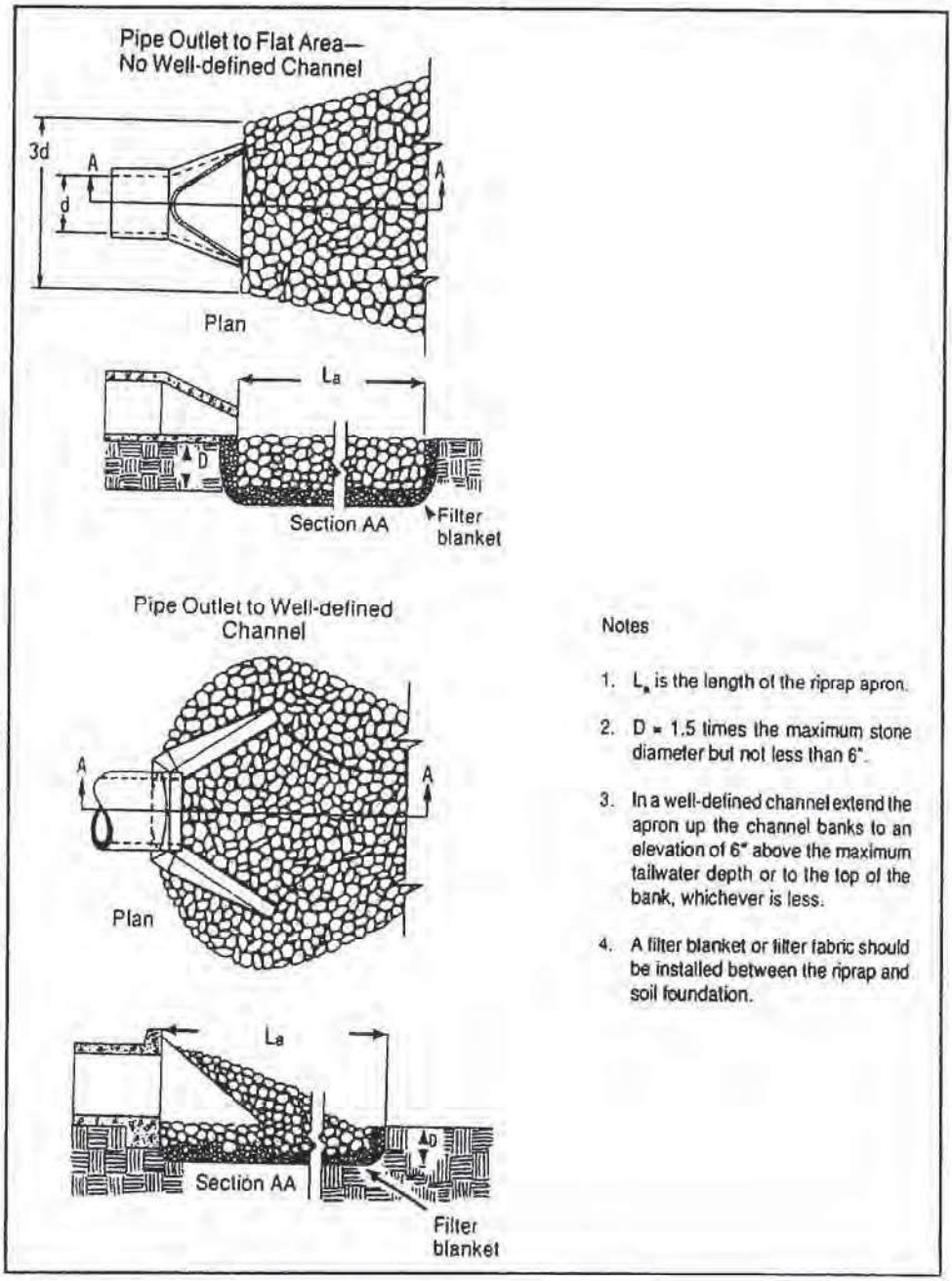



Figure OP-1 Pipe Outlet Conditions

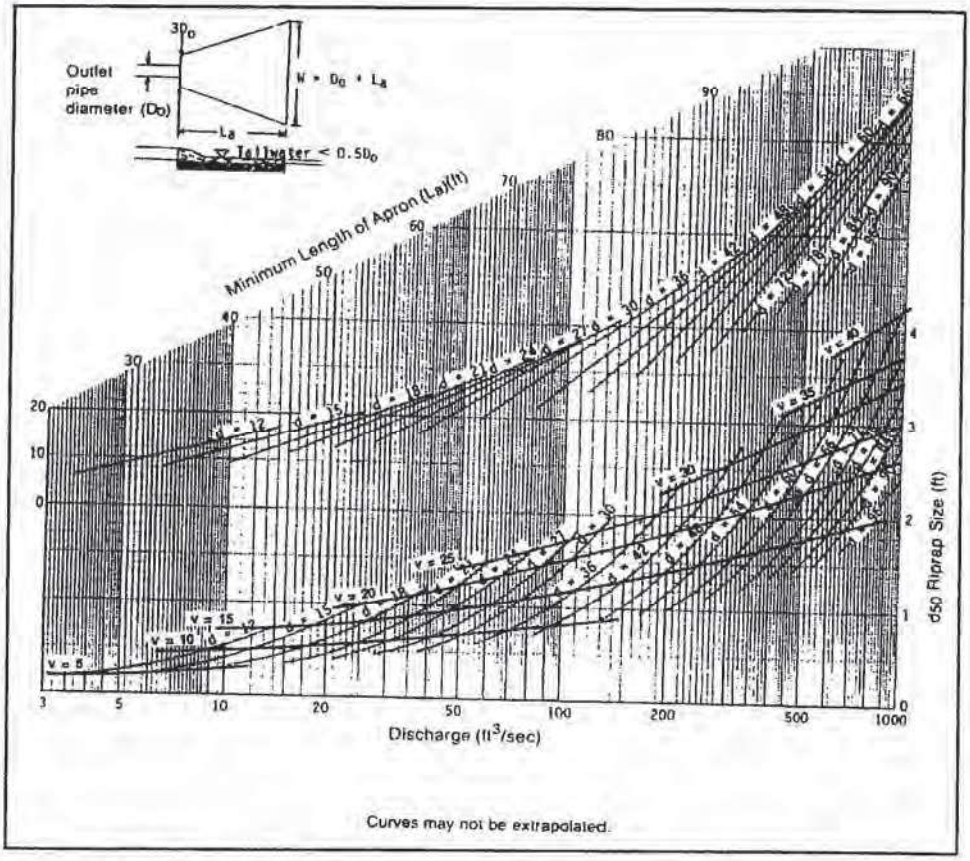


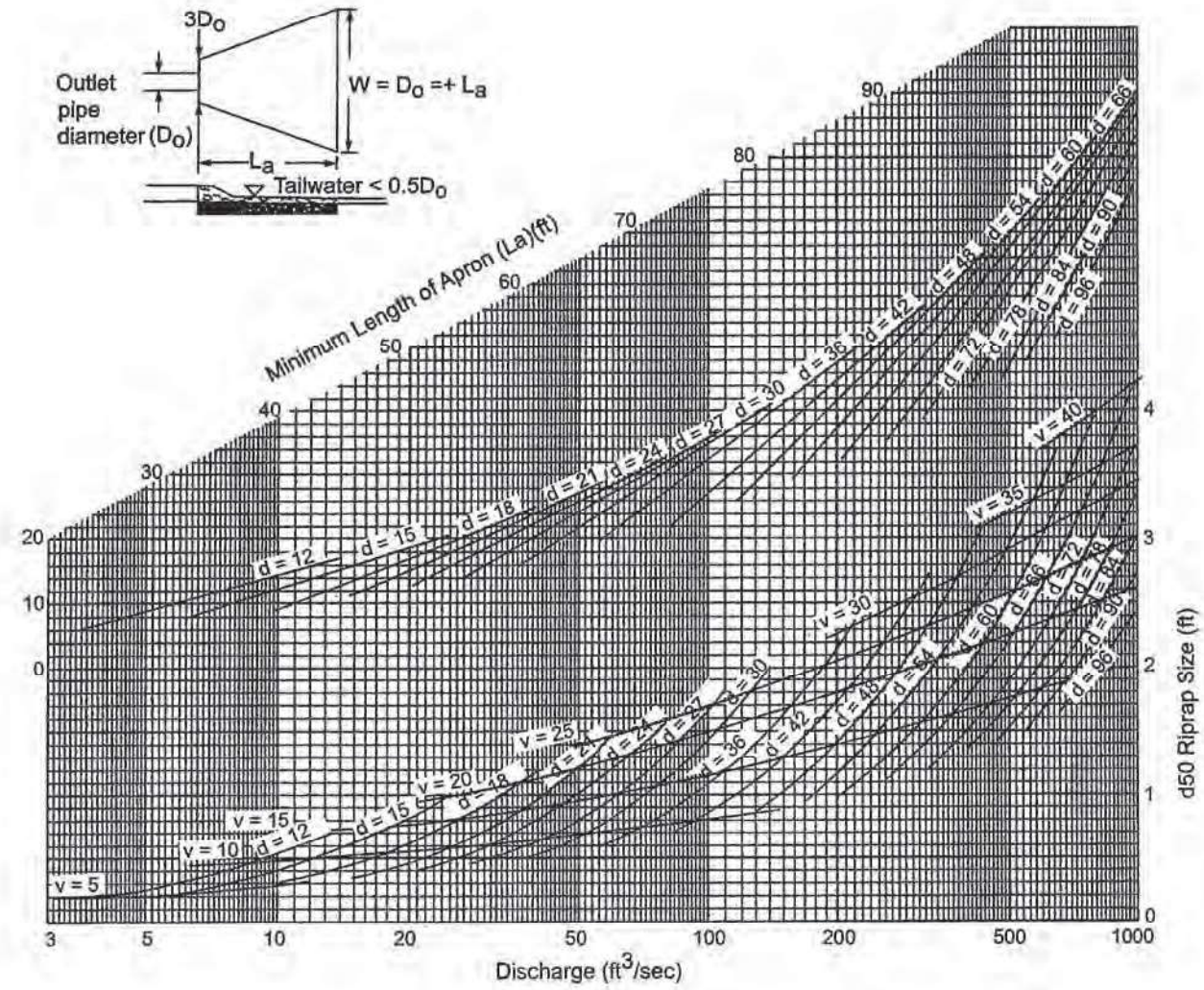

Figure OP-2 Outlet Protection Design for Tailwater < 0.5 Diameter

## Apron Width

If the pipe discharges directly into a well-defined channel, the apron should extend across the channel bottom and up the channel banks to an elevation 1 foot above the maximum tailwater depth or to the top of the bank, whichever is the least.

If the pipe discharges onto a flat area with no defined channel, the width of the apron should be determined as follows:

- The upstream end of the apron, adjacent to the pipe, should have a width 3 times the diameter of the outlet pipe.
- For a Minimum Tailwater Condition, the downstream end of the apron should have a width equal to the pipe diameter plus the length of the apron obtained from the figures.




Curves may not be extrapolated.

**Figure 6-24.1 - Design of Outlet Protection From a Round Pipe Flowing Full, Minimum Tailwater Condition (Tw < 0.5 Diameter)**

- For a Maximum Tailwater Condition, the downstream end shall have a width equal to the pipe diameter plus 0.4 times the length of the apron from Figures OP-2 or OP-3.

### Bottom Grade

The apron should be constructed with no slope along its length (0.0% grade). The invert elevation of the downstream end of the apron shall be equal to the elevation of the invert of the receiving channel. There shall be no overfall at the end of the apron.

### Side Slope

If the pipe discharges into a well-defined channel, the side slopes of the channel should not be steeper than 2:1 (Horizontal:Vertical).

### Alignment

The apron should be located so that there are no bends in the horizontal alignment.

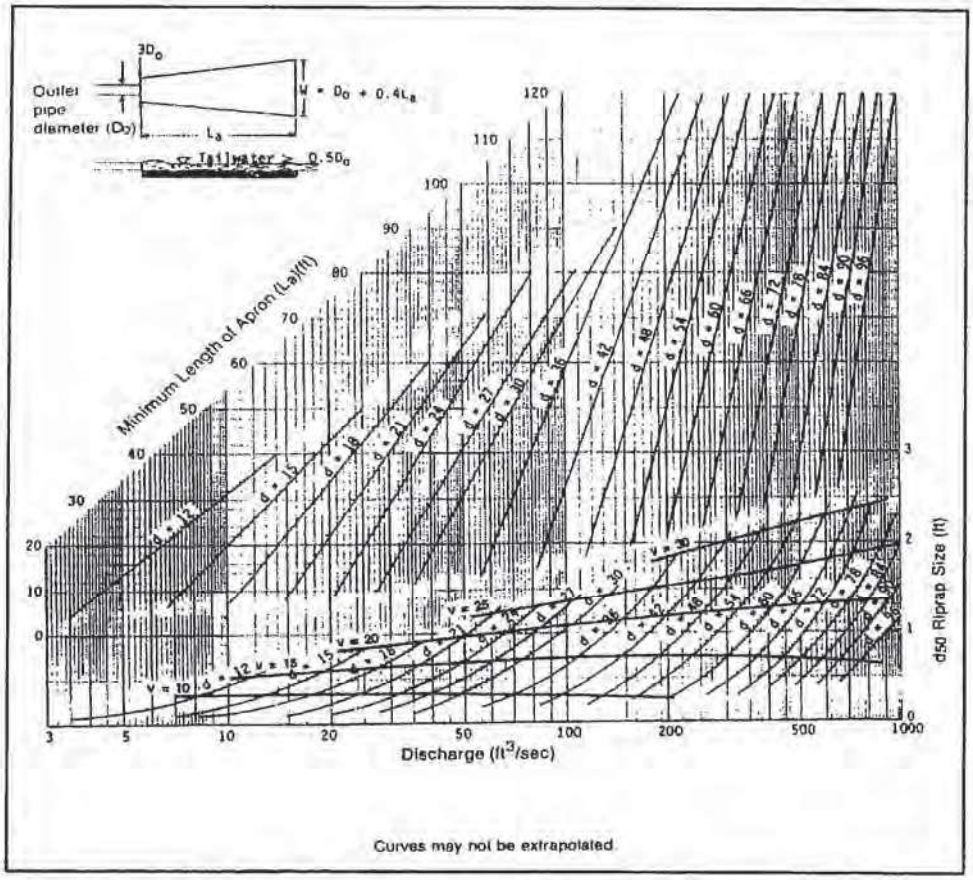
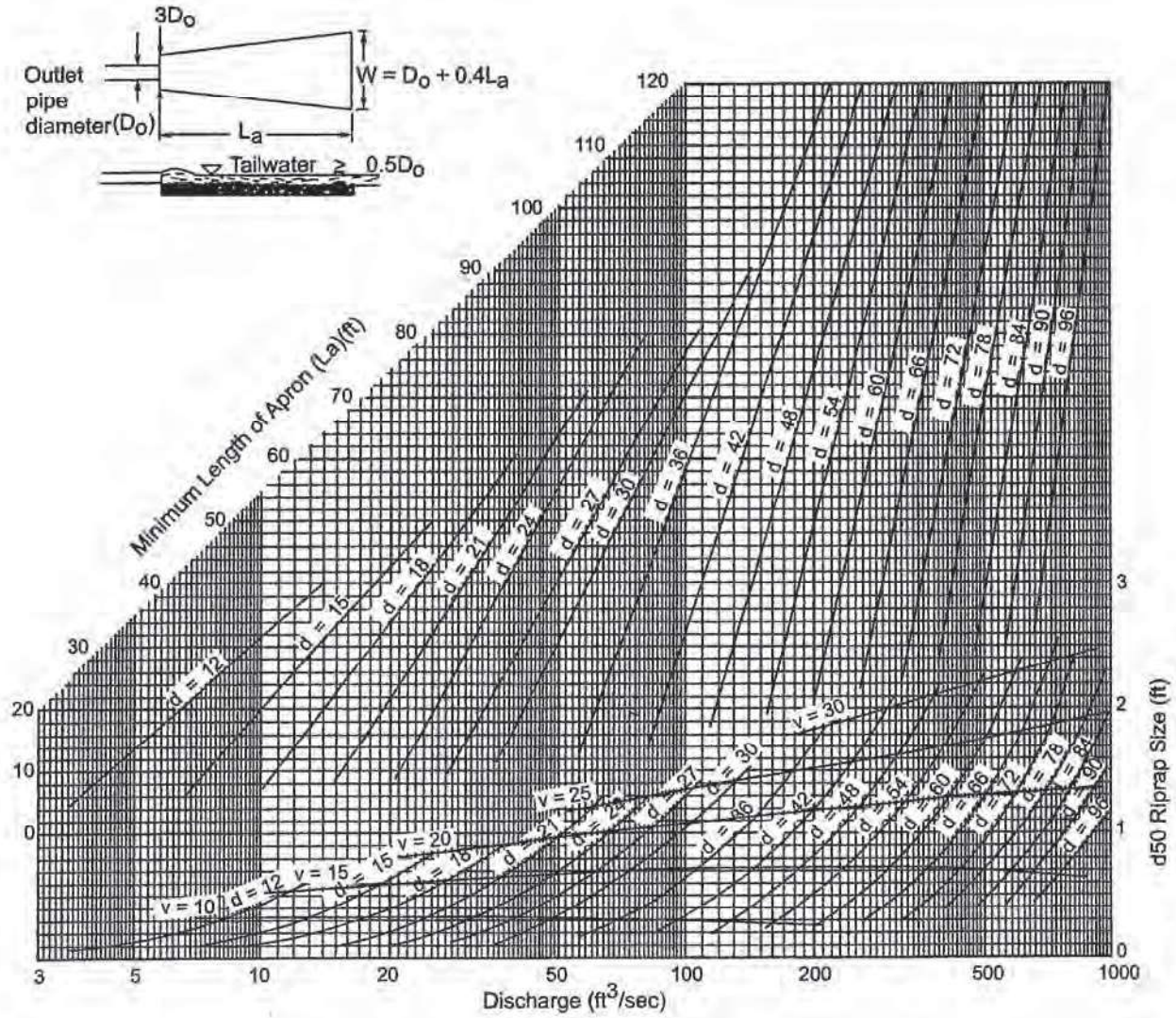



Figure OP-3 Outlet Protection Design for Tailwater ≥ 0.5 Diameter




Curves may not be extrapolated.

**Figure 6-24.2 - Design of Outlet Protection From a Round Pipe Flowing Full, Maximum Tailwater Condition (Tw > 0.5 Diameter)**

## Geotextile

When riprap is used to line the apron, geotextile should be used as a separator between the graded stone, the soil subgrade, and the abutments. Geotextile should be placed immediately adjacent to the subgrade without any voids between the fabric and the subgrade. The geotextile will prevent the migration of soil particles from the subgrade into the graded stone. The geotextile shall meet the requirements shown in the table below for class I geotextile:

Table OP-1 Requirements for Nonwoven Geotextile

| Property | Test method | Class I | Class II | Class III | Class IV [1] |
|---|---|---|---|---|---|
| Tensile strength (lb) [2] | ASTM D 4632 grab test | 180 minimum | 120 minimum | 90 minimum | 115 minimum |
| Elongation at failure (%) [2] | ASTM D4632 | ≥ 50 | ≥ 50 | ≥ 50 | ≥ 50 |
| Puncture (pounds) | ASTM D4833 | 80 minimum | 60 minimum | 40 minimum | 40 minimum |
| Ultraviolet light (% residual tensile strength) | ASTM D4355 150-hr exposure | 70 minimum | 70 minimum | 70 minimum | 70 minimum |
| Apparent opening size (AOS) | ASTM D4751 | As specified max. no.40 [3] | As specified max. no.40 [3] | As specified max. no.40 [3] | As specified max. no.40 [3] |
| Permittivity $sec^{-1}$ | ASTM D4491 | 0.70 minimum | 0.70 minimum | 0.70 minimum | 0.10 minimum |

Table copied from NRCS Material Specification 592.

1 Heat-bonded or resin-bonded geotextile may be used for classes III and IV. They are particularly well suited to class IV. Needle-punched geotextile are required for all other classes.
2 Minimum average roll value (weakest principal direction).
3 U.S. standard sieve size.

## Materials

The apron may be lined with loose rock riprap, grouted riprap, or concrete. The median sized stone for riprap should be determined from the curves on Figure OP-2 and OP-3 according to the tailwater condition.

After the median stone size is determined, the gradation of rock to be used should be specified using Tables OP-2 and OP-3. Table OP-2 is used to determine the weight of the median stone size ($d_{50}$). Using this median weight, a gradation can be selected from Table OP-3, which shows the commercially available riprap gradations as classified by the Alabama Department of Transportation.

Stone for riprap should consist of field stone or rough unhewn quarry stone of approximately rectangular shape. The stone should be hard and angular and of such quality that it will not disintegrate on exposure to water or weathering and it shall be suitable in all other respects for the purpose intended. The specific gravity of the individual stones should be at least 2.5.

When the apron is lined with concrete, the concrete should have a minimum compressive strength at 28 days of 3000 pounds per square inch. American Concrete Institute guidelines should be used to design concrete structures and reinforcement. As a minimum, the concrete should be reinforced with steel welded wire fabric.

Table OP-2 Size of Riprap Stones

| Weight | Mean Spherical Diameter (feet) | Rectangular Shape | |
|---|---|---|---|
| | | Length | Width, Height (feet) |
| 50 | 0.8 | 1.4 | 0.5 |
| 100 | 1.1 | 1.75 | 0.6 |
| 150 | 1.3 | 2.0 | 0.67 |
| 300 | 1.6 | 2.6 | 0.9 |
| 500 | 1.9 | 3.0 | 1.0 |
| 1000 | 2.2 | 3.7 | 1.25 |
| 1500 | 2.6 | 4.7 | 1.5 |
| 2000 | 2.75 | 5.4 | 1.8 |
| 4000 | 3.6 | 6.0 | 2.0 |
| 6000 | 4.0 | 6.9 | 2.3 |
| 8000 | 4.5 | 7.6 | 2.5 |
| 20000 | 6.1 | 10.0 | 3.3 |

Table OP-3 Graded Riprap

| Class | Weight (lbs.) | | | | | |
|---|---|---|---|---|---|---|
| | $d_{10}$ | $d_{15}$ | $d_{25}$ | $d_{50}$ | $d_{75}$ | $d_{90}$ |
| 1 | 10 | - | - | 50 | - | 100 |
| 2 | 10 | - | - | 80 | - | 200 |
| 3 | - | 25 | - | 200 | - | 500 |
| 4 | - | - | 50 | 500 | 1000 | - |
| 5 | - | - | 200 | 1000 | - | 2000 |

***Paved Channel Outlets (Figure OP-4)***

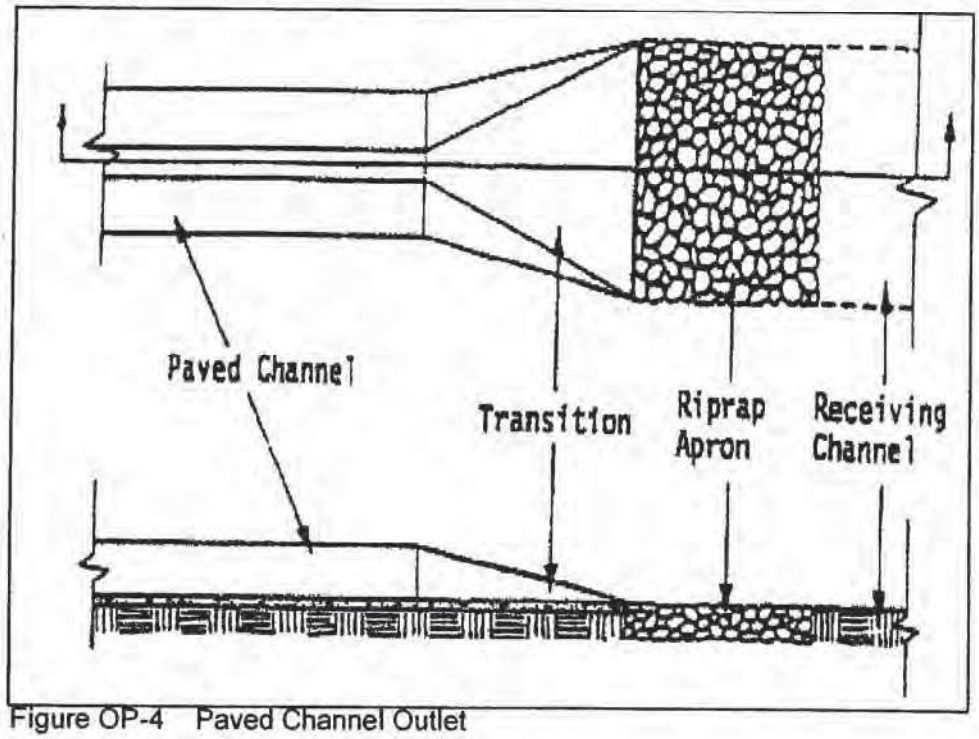



Figure OP-4 Paved Channel Outlet

1) The flow velocity at the outlet of paved channels flowing at design capacity should not exceed the velocity, which will cause erosion and instability in the receiving channel.

2) The end of the paved channel should merge smoothly with the receiving channel section. There should be no overfall at the end of the paved section. Where the bottom width of the paved channel is narrower than the bottom

width of the receiving channel, a transition section should be provided. The maximum side divergence of the transition shall be 1 in 3F where

F = v/gd , and
F = Froude no.
V = Velocity at beginning of transition (ft./sec.)
d = Dept of flow at beginning of transition (feet.)
g = 32.2 ft./sec.$^2$

3) Bends or curves in the horizontal alignment of the transition are not allowed unless the Froude no. (F) is 0.8 or less, or the section is specifically designed for turbulent flow.

### *Example Design Problems*

#### Example 1

Given: An 18" pipe discharges 24 cu. ft/sec at design capacity onto a grassy slope (no defined channel).

Find: The required length, width and median stone size ($d_{50}$) for a riprap-lined apron.

#### Solution

Since the pipe discharges onto a grassy slope with no defined channel, a Minimum Tailwater Condition may be assumed.

From Figure OP-2, an apron length (La) of 20 feet and a median stone size ($d_{50}$) of 0.8 feet is determined.

The upstream apron width equals 3 times the pipe diameter: 3 x 1.5 feet = 4.5 feet.

The downstream apron width equals the apron length plus the pipe diameter:
20 feet + 1.5 foot.= 21.5 feet.

#### Example 2

Given: The pipe in example No. 1 discharges into a channel with a triangular cross section, 2 feet deep and 2:1 side slopes. The channel has a 2% slope and an "n" coefficient of 0.045.

Find: The required length, width and the median stone size ($d_{50}$) for a riprap lining.

Solution

Determine the tailwater depth using Manning's Equation and the Continuity Equation.

$$Q = 1.49/n \; R^{2/3} S^{1/2} A$$

$$24 = 1.49/n \; [2d/4.47]^{2/3} (.02)^{1/2} (2d^2)$$

where, d = depth of tailwater
d = 1.74 feet. *

*Since d is greater than half the pipe diameter, a Maximum Tailwater Condition exists.

From Figure OP-3, a median stone size ($d_{50}$) of 0.5 feet. and an apron length (La) of 41 feet. is determined.

The entire channel cross section should be lined, since the maximum tailwater depth is within 1 foot of the top of the channel.

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Consulting Engineers

# OUTLET PROTECTION CALCULATIONS

Site: Arrowhead
Name: AHC
Date: 12/2/2024

## STORMWATER DRAINAGE PIPES

| Pipe No. | $Q_{25}$ ($ft^3$/sec) | $D_o$ (in) | La (ft) | $d_{50}$ (ft) | $W_1$ (ft) | $W_2$ (ft) | Riprap (S.Y.) | $d_{50,design}$ (in) |
|---|---|---|---|---|---|---|---|---|
| 100* | 69.64 | 36 | 24 | 0.7 | 9.0 | 27.4 | 49 | 9 |
| 101 | 75.07 | 48 | 26 | 0.9 | 12.0 | 30.1 | 61 | 12 |
| 102 | 46.90 | 30 | 21 | 0.6 | 7.5 | 23.1 | 35 | 9 |
| 103 | 27.11 | 30 | 16 | 0.5 | 7.5 | 18.4 | 23 | 6 |
| 200* | 105.39 | 42 | 28 | 0.9 | 10.5 | 31.9 | 67 | 12 |
| 201** | 83.96 | 36 | 29 | 0.9 | 13.7 | 36.2 | 79 | 12 |
| 202 | 77.66 | 42 | 22 | 0.7 | 10.5 | 25.5 | 44 | 9 |
| 300* | 68.22 | 36 | 24 | 0.7 | 9.0 | 27.0 | 48 | 9 |
| 301 | 109.84 | 42 | 29 | 0.9 | 10.5 | 33.0 | 71 | 12 |
| 400* | 129.99 | 48 | 29 | 0.9 | 12.0 | 32.8 | 72 | 12 |
| 401 | 72.63 | 30 | 29 | 1.0 | 7.5 | 31.2 | 62 | 12 |
| 402 | 142.42 | 48 | 32 | 1.0 | 12.0 | 35.5 | 83 | 12 |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |

**Where:**

$Q_{25}$ = 25-year storm flow rate existing downdrain

$D_o$ = Pipe diameter

La = Length of apron from chart

$d_{50}$ = Size of Riprap from chart

$W_1$ = Length of Riprap at the pipe outlet

$W_2$ = Length of Riprap at the full length of apron

Riprap = Area of Riprap required

$d_{50,design}$ = Riprap sizing in inches and rounded to nominal Riprap size

* = $Q_{100}$ is used

** =Through 2 pipes

**Formulas:**

$W_1$ = 3 x Do

$W_2$ = Do + La

Riprap = (($W_1$+$W_2$) x La) / 18

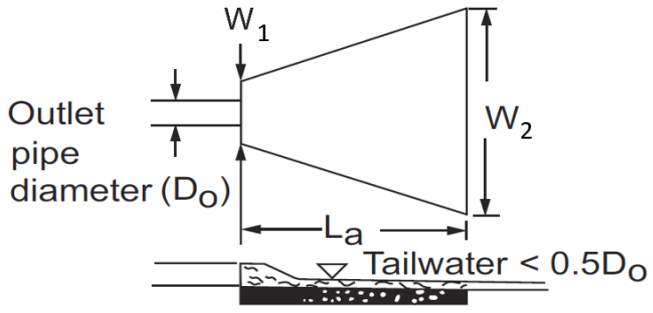


Figure 1. Riprap Area Diagram

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Consulting Engineers

# OUTLET PROTECTION CALCULATIONS

Site: Arrowhead
Name: HAR
Date: 1/9/2025

## STORMWATER DRAINAGE PIPES

| Pipe No. | $Q_{25}$ ($ft^3$/sec) | $D_o$ (in) | La (ft) | $d_{50}$ (ft) | $W_1$ (ft) | $W_2$ (ft) | Riprap (S.Y.) | $d_{50,design}$ (in) |
|---|---|---|---|---|---|---|---|---|
| 500* | 132.53 | 48 | 29 | 0.9 | 12.0 | 33.4 | 74 | 12 |
| 501 | 128.26 | 42 | 35 | 1.0 | 10.5 | 38.5 | 95 | 12 |
| 502 | 87.53 | 42 | 24 | 0.7 | 10.5 | 27.2 | 50 | 9 |
| 600* | 154.21 | 54 | 29 | 1.0 | 13.5 | 33.5 | 76 | 12 |
| 601 | 202.24 | 60 | 32 | 1.0 | 15.0 | 37.3 | 94 | 12 |
| 700* | 145.05 | 48 | 32 | 1.0 | 12.0 | 36.1 | 86 | 12 |
| 2 - 701 | 144.20 | 2 - 60 | 32 | 1.0 | 15.0 | 37.3 | 94 | 12 |
| 702 | 125.08 | 36 | 37 | 1.3 | 9.0 | 40.2 | 102 | 18 |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |

**Where:**

$Q_{25}$ = 25-year storm flow rate existing downdrain

$D_o$ = Pipe diameter

La = Length of apron from chart

$d_{50}$ = Size of Riprap from chart

$W_1$ = Length of Riprap at the pipe outlet

$W_2$ = Length of Riprap at the full length of apron

Riprap = Area of Riprap required

$d_{50,design}$ = Riprap sizing in inches and rounded to nominal Riprap size

* = $Q_{100}$ is used

**Formulas:**

$W_1 = 3 \times Do$

$W_2 = Do + La$

$Riprap = ((W_1+W_2) \times La) / 18$

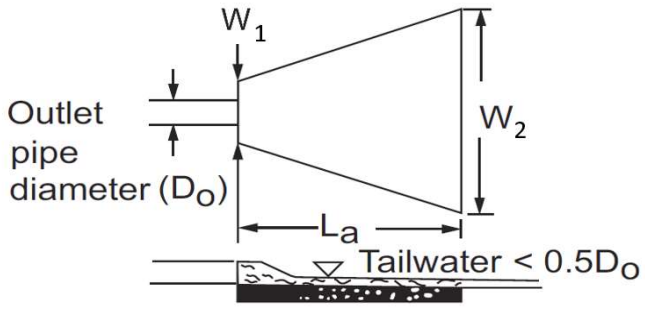


Figure 1. Riprap Area Diagram

# OUTLET PROTECTION CALCULATIONS

Site: Arrowhead
Name: HAR
Date: 1/15/2025

## STORMWATER DRAINAGE PIPES

| Pipe No. | $Q_{25}$ ($ft^3$/sec) | $D_o$ (in) | La (ft) | $d_{50}$ (ft) | $W_1$ (ft) | $W_2$ (ft) | Riprap (S.Y.) | $d_{50,design}$ (in) |
|---|---|---|---|---|---|---|---|---|
| 800* | 107.08 | 42 | 29 | 0.9 | 10.5 | 32.3 | 69 | 12 |
| 801 | 139.85 | 66 | 35 | 1.0 | 16.5 | 40.5 | 111 | 12 |
| 900* | 89.60 | 42 | 24 | 0.8 | 10.5 | 27.8 | 52 | 9 |
| 901 | 143.23 | 54 | 29 | 1.0 | 13.5 | 33.5 | 76 | 12 |
| 1000* | 69.96 | 36 | 25 | 0.7 | 9.0 | 27.5 | 50 | 9 |
| 1001 | 170.83 | 54 | 32 | 1.0 | 13.5 | 36.2 | 88 | 12 |
| 1002 | 23.66 | 24 | 15 | 0.5 | 6.0 | 17.1 | 19 | 6 |
| 1100* | 174.96 | 54 | 33 | 1.0 | 13.5 | 37.0 | 91 | 12 |
| 1101 | 291.33 | 60 | 45 | 1.5 | 15.0 | 50.3 | 164 | 18 |
| | | | | | | | | |
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| | | | | | | | | |
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| | | | | | | | | |

**Where:**

$Q_{25}$ = 25-year storm flow rate existing downdrain

$D_o$ = Pipe diameter

La = Length of apron from chart

$d_{50}$ = Size of Riprap from chart

$W_1$ = Length of Riprap at the pipe outlet

$W_2$ = Length of Riprap at the full length of apron

Riprap = Area of Riprap required

$d_{50,design}$ = Riprap sizing in inches and rounded to nominal Riprap size

* = $Q_{100}$ is used

**Formulas:**

$W_1 = 3 \times Do$

$W_2 = Do + La$

$Riprap = ((W_1+W_2) \times La) / 18$

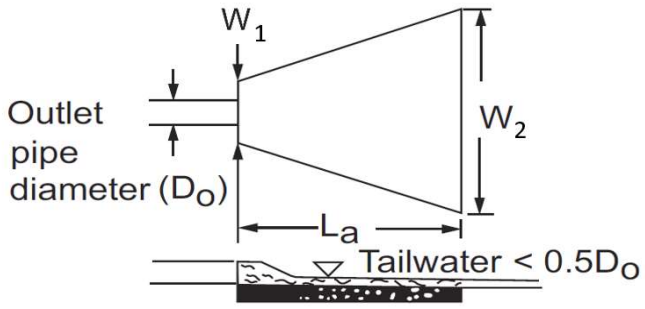


Figure 1. Riprap Area Diagram

# OUTLET PROTECTION CALCULATIONS

HHNT
HODGES, HARBIN, NEWBERRY & TRIBBLE, INC.
*Consulting Engineers*

Site: Arrowhead
Name: AHC
Date: 12/2/2024

TRACT 1

## DOWNDRAIN OR DITCH

| DD No. | $Q_{25}$ ($ft^3$/sec) | $D_o$ (in) | La (ft) | $d_{50}$ (ft) | $W_1$ (ft) | $W_2$ (ft) | Riprap (S.Y.) | $W'_1$ (ft) | $W'_2$ (ft) | $La_{Ditch}$ (ft) | $d_{50,design}$ (in) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 5 | 38.23 | 24 | 22.0 | 0.8 | 6.0 | 24.0 | 37 | 28 | 28 | 11.8 | 9 |
| 16 | 54.36 | 24 | 27 | 1.1 | 6.0 | 29.1 | 53 | 28 | 28 | 16.9 | 15 |
| 31 | 43.00 | 24 | 24 | 0.9 | 6.0 | 25.7 | 42 | 28 | 28 | 13.4 | 12 |
| 35 & 36 | 72.05 | 24 | 31 | 1.4 | 9.5 | 36.6 | 80 | 28 | 28 | 25.6 | 18 |
| 40 & 41 | 66.77 | 24 | 30 | 1.3 | 9.5 | 35.5 | 75 | 28 | 28 | 24.1 | 18 |
| 43 | 15.20 | 24 | 13 | 0.4 | 6.0 | 15.2 | 16 | 28 | 28 | 5.0 | 6 |
| 46 | 26.99 | 24 | 17 | 0.5 | 6.0 | 19.0 | 24 | 28 | 28 | 7.6 | 6 |
| 48 | 16.33 | 24 | 13 | 0.4 | 6.0 | 15.2 | 16 | 28 | 28 | 5.0 | 6 |
| 50 | 16.29 | 24 | 13 | 0.4 | 6.0 | 15.2 | 16 | 28 | 28 | 5.0 | 6 |
| | | | | | | | | | | | |
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| | | | | | | | | | | | |

**Where:**

$Q_{25}$ = 25-year storm flow rate existing downdrain

$D_o$ = Pipe diameter

La = Length of apron from chart

$d_{50}$ = Size of Riprap from chart

$W_1$ = Length of Riprap at the pipe outlet

$W_2$ = Length of Riprap at the full length of apron

Riprap = Area of Riprap required

$W'_1$ = Width of ditch

$W'_2$ = Width of ditch

$La_{Ditch}$ = New length of apron for rectuangular ditch geometery

$d_{50,design}$ = Riprap sizing in inches and rounded to nominal Riprap size

**Formulas:**

$W_1 = 3 \times Do$

$W_2 = Do + La$

$Riprap = ((W_1+W_2) \times La) / 18$

$La_{Ditch} = (Riprap \times 9) / W'_1$

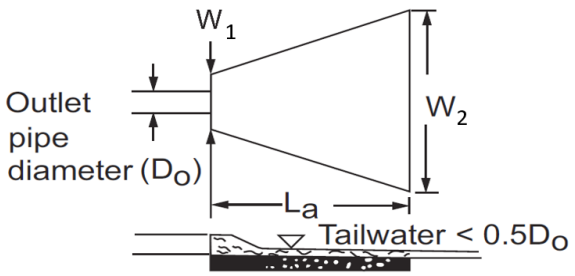


Figure 1. Riprap Area Diagram

HHNT
HODGES, HARBIN, NEWBERRY & TRIBBLE, INC.
Consulting Engineers

# OUTLET PROTECTION CALCULATIONS

Site: Arrowhead
Name: HAR
Date: 1/17/2025

## DOWNDRAIN OR DITCH

| DD No. | $Q_{25}$ ($ft^3$/sec) | $D_o$ (in) | La (ft) | $d_{50}$ (ft) | $W_1$ (ft) | $W_2$ (ft) | Riprap (S.Y.) | $W'_1$ (ft) | $W'_2$ (ft) | $La_{Ditch}$ (ft) | $d_{50,design}$ (in) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 3 | 28.33 | 24 | 17.7 | 0.6 | 6.0 | 19.7 | 25 | | | | 9 |
| 6 | 36.12 | 24 | 21 | 0.7 | 6.0 | 23.2 | 34 | | | | 9 |
| 8 | 18.16 | 24 | 13 | 0.4 | 6.0 | 15.2 | 16 | | | | 6 |
| 12 | 43.20 | 24 | 24 | 0.9 | 6.0 | 25.8 | 42 | | | | 12 |
| 14 | 26.53 | 24 | 17 | 0.5 | 6.0 | 18.8 | 23 | | | | 6 |
| 23 | 45.21 | 24 | 24 | 0.9 | 6.0 | 26.4 | 44 | | | | 12 |
| 25 | 25.50 | 24 | 16 | 0.5 | 6.0 | 18.2 | 22 | | | | 6 |
| 28 | 34.18 | 24 | 20 | 0.7 | 6.0 | 22.4 | 32 | | | | 9 |
| 30 | 26.19 | 24 | 17 | 0.5 | 6.0 | 18.6 | 23 | | | | 6 |
| 38 | 19.65 | 24 | 13 | 0.4 | 6.0 | 15.2 | 16 | | | | 6 |
| 48 | 47.39 | 24 | 25 | 1.0 | 6.0 | 27.1 | 46 | | | | 12 |
| 49 | 13.71 | 24 | 13.2 | 0.4 | 6.0 | 15.2 | 16 | | | | 6 |
| 54 | 45.73 | 24 | 24.6 | 0.9 | 6.0 | 26.6 | 44 | | | | 12 |
| 55 | 13.15 | 24 | 13.2 | 0.4 | 6.0 | 15.2 | 16 | | | | 6 |
| 59 | 49.72 | 24 | 26.0 | 1.0 | 6.0 | 27.8 | 48 | | | | 12 |
| 60 | 11.72 | 24 | 13.2 | 0.4 | 6.0 | 15.2 | 16 | | | | 6 |
| 69 | 29.09 | 24 | 18.1 | 0.6 | 6.0 | 20.1 | 26 | | | | 9 |

**Where:**

$Q_{25}$ = 25-year storm flow rate existing downdrain

$D_o$ = Pipe diameter

La = Length of apron from chart

$d_{50}$ = Size of Riprap from chart

$W_1$ = Length of Riprap at the pipe outlet

$W_2$ = Length of Riprap at the full length of apron

Riprap = Area of Riprap required

$W'_1$ = Width of ditch

$W'_2$ = Width of ditch

$La_{Ditch}$ = New length of apron for rectuangular ditch geometery

$d_{50,design}$ = Riprap sizing in inches and rounded to nominal Riprap size

**Formulas:**

$W_1 = 3 \times Do$

$W_2 = Do + La$

$Riprap = ((W_1+W_2) \times La) / 18$

$La_{Ditch} = (Riprap \times 9) / W'_1$

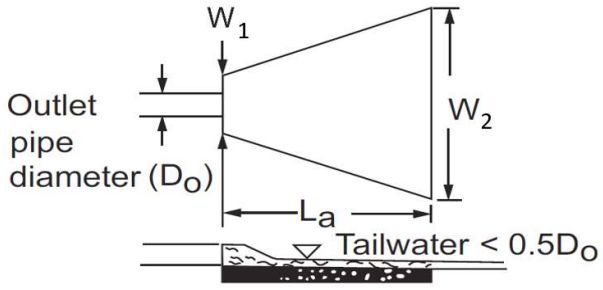


Figure 1. Riprap Area Diagram

# OUTLET PROTECTION CALCULATIONS

HHNT
HODGES, HARBIN, NEWBERRY & TRIBBLE, INC.
*Consulting Engineers*

Site: Arrowhead
Name: HAR
Date: 1/31/2025

## DOWNDRAIN OR DITCH

| DD No. | $Q_{25}$ ($ft^3$/sec) | $D_o$ (in) | La (ft) | $d_{50}$ (ft) | $W_1$ (ft) | $W_2$ (ft) | Riprap (S.Y.) | $W'_1$ (ft) | $W'_2$ (ft) | $La_{Ditch}$ (ft) | $d_{50,design}$ (in) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 3 | 31.63 | 24 | 19.3 | 0.6 | 6.0 | 21.3 | 29 | | | | 9 |
| 7 | 40.35 | 24 | 23 | 0.8 | 6.0 | 24.8 | 39 | | | | 12 |
| 10 | 40.47 | 24 | 23 | 0.8 | 6.0 | 24.8 | 39 | | | | 12 |
| 17 | 53.55 | 24 | 27 | 1.1 | 6.0 | 28.8 | 52 | | | | 15 |
| 29 | 40.47 | 24 | 23 | 0.8 | 6.0 | 24.8 | 39 | | | | 12 |
| 32 | 39.44 | 24 | 22 | 0.8 | 6.0 | 24.5 | 38 | | | | 9 |
| 51 | 42.09 | 24 | 23 | 0.9 | 6.0 | 25.4 | 41 | | | | 12 |
| 55 | 41.90 | 24 | 23 | 0.9 | 6.0 | 25.3 | 41 | | | | 12 |
| 67 | 37.94 | 24 | 22 | 0.8 | 6.0 | 23.9 | 36 | | | | 9 |
| | | | | | | | | | | | |
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| | | | | | | | | | | | |

**Where:**

$Q_{25}$ = 25-year storm flow rate existing downdrain

$D_o$ = Pipe diameter

La = Length of apron from chart

$d_{50}$ = Size of Riprap from chart

$W_1$ = Length of Riprap at the pipe outlet

$W_2$ = Length of Riprap at the full length of apron

Riprap = Area of Riprap required

$W'_1$ = Width of ditch

$W'_2$ = Width of ditch

$La_{Ditch}$ = New length of apron for rectuangular ditch geometery

$d_{50,design}$ = Riprap sizing in inches and rounded to nominal Riprap size

**Formulas:**

$W_1 = 3 \times Do$

$W_2 = Do + La$

$Riprap = ((W_1+W_2) \times La) / 18$

$La_{Ditch} = (Riprap \times 9) / W'_1$

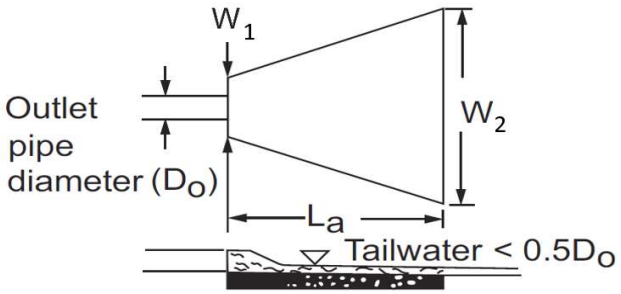



Figure 1. Riprap Area Diagram

# 2. EXISTING SEDIMENT POND NO. 1

## a. Sediment Storage and Settling Efficiency Calculations

Sediment Pond No. 1 was constructed in early 2007 during the initial site development. This pond was constructed as designed and has been routinely maintained since being constructed. The existing outlet control structure will remain in place. The calculations following are being presented to demonstrate that the existing pond will function adequately throughout the life of the site.

As required in the "Alabama Handbook for Erosion Control, Sediment Control and Stormwater Management on Construction Sites and Urban Area", the sediment storage volume of the pond shall be at least 67 cubic yards per acre for the disturbed area draining into the pond (67 cubic yards is equivalent to ½ inch of sediment per acre of drainage area). The peak inflow rate for the 25 year storm event has also been used to calculate the minimum pond surface area needed for adequate settling efficiency. These calculations for the existing sediment pond are included below.

Sediment Storage Calculation

Assume maximum sediment from 32 disturbed acres.

32 Acres x 67 c.y./acre = 2,144 c.y. = 57,888 c.f.

This sediment volume corresponds to a depth of 0.63' or Elev. 268.66.

Dewatering opening is set at Elev. 271.00. Therefore, ample sediment storage volume is available.

Settling Efficiency Calculations

- Use 25 year storm event, Q25 Flow = 156 cfs
- Minimum Surface Area = .01 acre / cfs x Q25 Flow
  = .01 acre / cfs x 156 cfs
  = 1.56 acres = 67,954 s.f.

- Top of Overflow Structure = Elev. 275.00
  Surface Area @ Elev. 275.00 = 119,277 s.f.

- Adequate surface area is available for settling in the existing pond.

# Pond Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022 Monday, 12 / 2 / 2024

## Pond No. 1 - Sediment Pond No. 1

### Pond Data

**Contours -**User-defined contour areas. Average end area method used for volume calculation. Begining Elevation = 268.00 ft

### Stage / Storage Table

| Stage (ft) | Elevation (ft) | Contour area (sqft) | Incr. Storage (cuft) | Total storage (cuft) |
|---|---|---|---|---|
| 0.00 | 268.00 | 85,734 | 0 | 0 |
| 2.00 | 270.00 | 95,075 | 180,809 | 180,809 |
| 4.00 | 272.00 | 104,690 | 199,765 | 380,574 |
| 6.00 | 274.00 | 114,339 | 219,029 | 599,603 |
| 8.00 | 276.00 | 124,215 | 238,554 | 838,157 |
| 10.00 | 278.00 | 134,317 | 258,532 | 1,096,689 |

### Culvert / Orifice Structures

| | [A] | [B] | [C] | [PrfRsr] |
|---|---|---|---|---|
| **Rise (in)** | = 30.00 | 6.00 | Inactive | Inactive |
| **Span (in)** | = 30.00 | 12.00 | 0.00 | 0.00 |
| **No. Barrels** | = 1 | 1 | 0 | 0 |
| **Invert El. (ft)** | = 271.00 | 271.10 | 0.00 | 0.00 |
| **Length (ft)** | = 191.00 | 0.00 | 0.00 | 0.00 |
| **Slope (%)** | = 2.62 | 0.00 | 0.00 | n/a |
| **N-Value** | = .013 | .013 | .013 | n/a |
| **Orifice Coeff.** | = 0.60 | 0.60 | 0.60 | 0.60 |
| **Multi-Stage** | = n/a | Yes | No | No |

### Weir Structures

| | [A] | [B] | [C] | [D] |
|---|---|---|---|---|
| **Crest Len (ft)** | = 16.00 | Inactive | Inactive | Inactive |
| **Crest El. (ft)** | = 275.00 | 0.00 | 0.00 | 0.00 |
| **Weir Coeff.** | = 3.33 | 3.33 | 3.33 | 3.33 |
| **Weir Type** | = 1 | --- | --- | --- |
| **Multi-Stage** | = Yes | No | No | No |

**Exfil.(in/hr)** = 0.000 (by Wet area)

**TW Elev. (ft)** = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).

### Stage / Storage / Discharge Table

| Stage ft | Storage cuft | Elevation ft | Clv A cfs | Clv B cfs | Clv C cfs | PrfRsr cfs | Wr A cfs | Wr B cfs | Wr C cfs | Wr D cfs | Exfil cfs | User cfs | Total cfs |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.00 | 0 | 268.00 | 0.00 | 0.00 | --- | --- | 0.00 | --- | --- | --- | --- | --- | 0.000 |
| 2.00 | 180,809 | 270.00 | 0.00 | 0.00 | --- | --- | 0.00 | --- | --- | --- | --- | --- | 0.000 |
| 4.00 | 380,574 | 272.00 | 1.76 ic | 1.70 ic | --- | --- | 0.00 | --- | --- | --- | --- | --- | 1.703 |
| 6.00 | 599,603 | 274.00 | 3.64 ic | 3.62 ic | --- | --- | 0.00 | --- | --- | --- | --- | --- | 3.623 |
| 8.00 | 838,157 | 276.00 | 43.28 ic | 1.52 ic | --- | --- | 41.76 s | --- | --- | --- | --- | --- | 43.28 |
| 10.00 | 1,096,689 | 278.00 | 56.51 ic | 0.43 ic | --- | --- | 56.03 s | --- | --- | --- | --- | --- | 56.46 |

**b. Total Pond Dewatering at Top of Riser (Elev. 275.00)**

Retention time within the basin is an important factor in effective sediment retention. The existing overflow structure has been designed as specified below.

The 4' x 4' square concrete overflow structure has one 6" (h) x 12" (w) dewatering weir at Elevation 271.00

The calculation below has been performed to confirm that the dewatering (retention) time within the pond is between 24 and 72 hours. This dewatering time will ensure the storm water is retained for an adequate length of time to allow the sediment to settle (minimum 24 hours) and is also discharged gradually in an acceptable length of time to allow storage for future storm events (maximum 72 hours).

The dewatering time is calculated as follows:

$$T = \frac{A_s \times (2h)^{1/2}}{A_O \times C_d \times (20{,}428)}$$

$A_O$ = Surface Area of Dewatering Holes ($ft^2$)

$A_s$ = Surface Area Corresponding to top of riser elevation ($ft^2$)

h = Head of water above dewatering hole (ft)

$C_d$ = Coefficient of contraction for an orifice (use 0.6)

T = Time to dewater

T = 24 to 72 hours

$A_O$ = 0.50 s.f. = 1 - 6"x 12" rectangular opening @ elev. 271.00

$A_s$ = 119,277 s.f. @ elev. 275.00

h = 275.00 – 271.00 = 4.00'

$$T = \frac{119{,}277\ (2 \times 4.00)^{1/2}}{(0.50)\ (0.6)\ (20428)} = 55 \text{ hours}$$

**(Okay between 24- 72 hours)**

**c. Reservoir Routing**

Reservoir routing is determined by using the HydraFlow Hydrographs Extension for AutoCad Civil 3D 2022 Computer Program.

Peak inflow rates (Q) are determined using the SCS Method and in the computer program above. Peak inflow rates are calculated for the 25 year and 100 year storm events and are summarized below.

$Q_{25}$ = 138 cfs

$Q_{100}$ = 196 cfs

The bottom of the pond has been set at 268.00. Dewatering of the pond is accomplished by a 6"x 12" rectangular opening beginning at an invert elevation of 271.00.

For routing calculations, a 4'x 4' rectangular riser with a 6"x 12" rectangular opening at an invert elevation of 271.00 is used. The top of the riser is at an elevation of 275.00. The bottom of the pond is elev. 268.00. The invert of the carrier pipe is elev. 271.00. The top of the levee around the sediment pond is at an elevation of 278.00.

The maximum height of sediment is elevation 268.66 which is below the elevation of the dewatering opening (Elev. 271.00).

Based on the above information the reservoir routing calculations are performed and summarized below.

| STORM YEAR | PEAK INFLOW CFS | PEAK OUTFLOW CFS | PEAK ELEV. FEET |
|---|---|---|---|
| 25 | 138 | 4.09 | 274.68 |
| 100 | 196 | 17.62 | 275.40 |

Based on these routing calculations, the riser is large enough and the pond has sufficient storage volume to retain the sediment from 32 disturbed acres and the 25 year storm event from the entire drainage area below the crest of the riser (Elev. 275.00).

# Pond Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022 Monday, 12 / 2 / 2024

## Pond No. 2 - Sediment Pond No. 1 - perm pool

### Pond Data

**Contours -**User-defined contour areas. Average end area method used for volume calculation. Begining Elevation = 271.00 ft

### Stage / Storage Table

| Stage (ft) | Elevation (ft) | Contour area (sqft) | Incr. Storage (cuft) | Total storage (cuft) |
|---|---|---|---|---|
| 0.00 | 271.00 | 99,883 | 0 | 0 |
| 1.00 | 272.00 | 104,690 | 102,287 | 102,287 |
| 3.00 | 274.00 | 114,339 | 219,029 | 321,316 |
| 5.00 | 276.00 | 124,215 | 238,554 | 559,870 |
| 7.00 | 278.00 | 134,317 | 258,532 | 818,402 |

### Culvert / Orifice Structures

| | [A] | [B] | [C] | [PrfRsr] |
|---|---|---|---|---|
| **Rise (in)** | = 30.00 | 6.00 | Inactive | Inactive |
| **Span (in)** | = 30.00 | 12.00 | 0.00 | 0.00 |
| **No. Barrels** | = 1 | 1 | 0 | 0 |
| **Invert El. (ft)** | = 271.00 | 271.10 | 0.00 | 0.00 |
| **Length (ft)** | = 191.00 | 0.00 | 0.00 | 0.00 |
| **Slope (%)** | = 2.62 | 0.00 | 0.00 | n/a |
| **N-Value** | = .013 | .013 | .013 | n/a |
| **Orifice Coeff.** | = 0.60 | 0.60 | 0.60 | 0.60 |
| **Multi-Stage** | = n/a | Yes | No | No |

### Weir Structures

| | [A] | [B] | [C] | [D] |
|---|---|---|---|---|
| **Crest Len (ft)** | = 16.00 | 0.00 | 0.00 | 0.00 |
| **Crest El. (ft)** | = 275.00 | 0.00 | 0.00 | 0.00 |
| **Weir Coeff.** | = 3.33 | 3.33 | 3.33 | 3.33 |
| **Weir Type** | = 1 | --- | --- | --- |
| **Multi-Stage** | = Yes | No | No | No |

**Exfil.(in/hr)** = 0.000 (by Wet area)

**TW Elev. (ft)** = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).

### Stage / Storage / Discharge Table

| Stage ft | Storage cuft | Elevation ft | Clv A cfs | Clv B cfs | Clv C cfs | PrfRsr cfs | Wr A cfs | Wr B cfs | Wr C cfs | Wr D cfs | Exfil cfs | User cfs | Total cfs |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.00 | 0 | 271.00 | 0.00 | 0.00 | --- | --- | 0.00 | --- | --- | --- | --- | --- | 0.000 |
| 1.00 | 102,287 | 272.00 | 1.76 ic | 1.70 ic | --- | --- | 0.00 | --- | --- | --- | --- | --- | 1.703 |
| 3.00 | 321,316 | 274.00 | 3.64 ic | 3.62 ic | --- | --- | 0.00 | --- | --- | --- | --- | --- | 3.623 |
| 5.00 | 559,870 | 276.00 | 43.28 ic | 1.52 ic | --- | --- | 41.76 s | --- | --- | --- | --- | --- | 43.28 |
| 7.00 | 818,402 | 278.00 | 56.51 ic | 0.43 ic | --- | --- | 56.04 s | --- | --- | --- | --- | --- | 56.47 |

# Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022

| Hyd. No. | Hydrograph type (origin) | Peak flow (cfs) | Time interval (min) | Time to Peak (min) | Hyd. volume (cuft) | Inflow hyd(s) | Maximum elevation (ft) | Total strge used (cuft) | Hydrograph Description |
|---|---|---|---|---|---|---|---|---|---|
| 1 | SCS Runoff | 5.447 | 1 | 727 | 18,818 | ------ | ------ | ------ | DD No. 1 |
| 2 | SCS Runoff | 10.15 | 1 | 730 | 40,373 | ------ | ------ | ------ | Area to DD No. 2 |
| 3 | Combine | 15.23 | 1 | 729 | 59,190 | 1, 2 | ------ | ------ | DD No. 2 |
| 4 | SCS Runoff | 10.47 | 1 | 734 | 48,187 | ------ | ------ | ------ | Area to DD No. 3 |
| 5 | Combine | 24.63 | 1 | 730 | 107,378 | 3, 4 | ------ | ------ | DD No. 3 |
| 6 | SCS Runoff | 5.649 | 1 | 725 | 18,347 | ------ | ------ | ------ | Area to DD No. 4 |
| 7 | Combine | 29.21 | 1 | 729 | 125,725 | 5, 6 | ------ | ------ | DD No. 4 |
| 8 | SCS Runoff | 3.110 | 1 | 723 | 9,067 | ------ | ------ | ------ | Area to DD No. 6 |
| 9 | Combine | 31.14 | 1 | 728 | 134,792 | 7, 8 | ------ | ------ | DD No. 6 |
| 10 | SCS Runoff | 7.091 | 1 | 728 | 25,945 | ------ | ------ | ------ | Area to DD No. 5 |
| 11 | Combine | 38.23 | 1 | 728 | 160,736 | 9, 10 | ------ | ------ | DD No. 5 |
| 12 | SCS Runoff | 11.33 | 1 | 731 | 47,113 | ------ | ------ | ------ | Area to Ditch 20 |
| 13 | Combine | 48.98 | 1 | 729 | 207,849 | 11, 12 | ------ | ------ | Ditch 20 |
| 14 | SCS Runoff | 7.857 | 1 | 725 | 25,519 | ------ | ------ | ------ | DD No. 49 |
| 15 | SCS Runoff | 8.436 | 1 | 725 | 26,286 | ------ | ------ | ------ | Area to DD No. 50 |
| 16 | Combine | 16.29 | 1 | 725 | 51,805 | 14, 15 | ------ | ------ | DD No. 50 |
| 17 | SCS Runoff | 11.91 | 1 | 729 | 45,130 | ------ | ------ | ------ | Area to Ditch 21 |
| 18 | Combine | 27.11 | 1 | 726 | 96,936 | 16, 17 | ------ | ------ | Ditch 21 / Pipe No. 103 |
| 19 | Combine | 75.07 | 1 | 727 | 304,785 | 13, 18 | ------ | ------ | Pipe No. 101 |
| 20 | SCS Runoff | 14.83 | 1 | 731 | 61,662 | ------ | ------ | ------ | DD No. 7 |
| 21 | SCS Runoff | 7.926 | 1 | 725 | 24,698 | ------ | ------ | ------ | Area to DD No. 8 |
| 22 | Combine | 20.47 | 1 | 727 | 86,360 | 20, 21 | ------ | ------ | DD No. 8 |
| 23 | SCS Runoff | 8.209 | 1 | 725 | 25,580 | ------ | ------ | ------ | Area to DD No. 9 |
| 24 | Combine | 28.16 | 1 | 726 | 111,941 | 22, 23 | ------ | ------ | DD No. 9 |
| 25 | SCS Runoff | 8.605 | 1 | 725 | 26,815 | ------ | ------ | ------ | Area to DD No. 10 |
| 26 | Combine | 36.53 | 1 | 725 | 138,756 | 24, 25 | ------ | ------ | DD No. 10 |
| 27 | SCS Runoff | 8.719 | 1 | 725 | 27,168 | ------ | ------ | ------ | Area to DD No. 11 |
| 28 | Combine | 45.25 | 1 | 725 | 165,924 | 26, 27 | ------ | ------ | DD No. 11 |
| 29 | SCS Runoff | 2.164 | 1 | 722 | 5,934 | ------ | ------ | ------ | Ditch 19 |
| 30 | Combine | 46.90 | 1 | 725 | 171,858 | 28, 29 | ------ | ------ | Pipe 102 |
| 31 | SCS Runoff | 25.44 | 1 | 722 | 69,764 | ------ | ------ | ------ | Area to Pond No. 1 |
| 32 | Combine | 138.23 | 1 | 725 | 546,408 | 19, 30, 31 | ------ | ------ | Total Pond 1 Inflow |
| 33 | SCS Runoff | 15.23 | 1 | 728 | 55,720 | ------ | ------ | ------ | DD No. 37 |
| 34 | SCS Runoff | 11.50 | 1 | 725 | 37,362 | ------ | ------ | ------ | Area to DD No. 38 |

# Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022

| Hyd. No. | Hydrograph type (origin) | Peak flow (cfs) | Time interval (min) | Time to Peak (min) | Hyd. volume (cuft) | Inflow hyd(s) | Maximum elevation (ft) | Total strge used (cuft) | Hydrograph Description |
|---|---|---|---|---|---|---|---|---|---|
| 69 | SCS Runoff | 11.20 | 1 | 729 | 42,436 | ------ | ------ | ------ | DD No. 12 |
| 70 | SCS Runoff | 12.17 | 1 | 725 | 39,530 | ------ | ------ | ------ | Area to DD No.13 |
| 71 | Combine | 22.69 | 1 | 727 | 81,966 | 69, 70 | ------ | ------ | DD No. 13 |
| 72 | SCS Runoff | 10.81 | 1 | 725 | 33,695 | ------ | ------ | ------ | Area to DD No. 14 |
| 73 | Combine | 33.05 | 1 | 726 | 115,661 | 71, 72 | ------ | ------ | DD No. 14 |
| 74 | SCS Runoff | 10.76 | 1 | 725 | 33,519 | ------ | ------ | ------ | Area to DD No. 15 |
| 75 | Combine | 43.60 | 1 | 725 | 149,180 | 73, 74 | ------ | ------ | DD No. 15 |
| 76 | SCS Runoff | 10.76 | 1 | 725 | 33,519 | ------ | ------ | ------ | Area to DD No. 16 |
| 77 | Combine | 54.36 | 1 | 725 | 182,700 | 75, 76 | ------ | ------ | DD No. 16 |
| 78 | SCS Runoff | 8.328 | 1 | 728 | 30,472 | ------ | ------ | ------ | Ditch No.18 |
| 79 | SCS Runoff | 11.14 | 1 | 727 | 38,491 | ------ | ------ | ------ | Area to Ditch No. 17 |
| 80 | Combine | 72.94 | 1 | 726 | 251,662 | 77, 78, 79 | ------ | ------ | Ditch No. 17 |
| 81 | SCS Runoff | 2.749 | 1 | 722 | 7,538 | ------ | ------ | ------ | Area to Ditch No. 16 |
| 82 | Combine | 74.90 | 1 | 725 | 259,200 | 80, 81 | ------ | ------ | Ditch No. 16 |
| 83 | SCS Runoff | 8.832 | 1 | 725 | 27,521 | ------ | ------ | ------ | DD No. 17 |
| 84 | SCS Runoff | 9.285 | 1 | 725 | 28,932 | ------ | ------ | ------ | Area to DD No. 18 |
| 85 | Combine | 18.12 | 1 | 725 | 56,453 | 83, 84 | ------ | ------ | DD No. 18 |
| 86 | SCS Runoff | 10.42 | 1 | 725 | 32,460 | ------ | ------ | ------ | Area to DD No. 19 |
| 87 | Combine | 28.53 | 1 | 725 | 88,914 | 85, 86 | ------ | ------ | DD No. 19 |
| 88 | SCS Runoff | 6.635 | 1 | 727 | 22,923 | ------ | ------ | ------ | Area to DD No. 20 |
| 89 | Combine | 34.95 | 1 | 725 | 111,837 | 87, 88 | ------ | ------ | DD No. 20 |
| 90 | Combine | 109.84 | 1 | 725 | 371,036 | 82, 89 | ------ | ------ | Pipe No. 301 |
| 91 | SCS Runoff | 16.24 | 1 | 727 | 56,111 | ------ | ------ | ------ | Area to Pond No. 3 |
| 92 | Combine | 125.54 | 1 | 725 | 427,148 | 90, 91 | ------ | ------ | Total Pond No. 3 Inflow |
| 94 | Reservoir | 4.089 | 1 | 1044 | 426,678 | 32 | 274.68 | 402,260 | Pond No. 1 - Perm Pool |
| 95 | Reservoir | 47.08 | 1 | 750 | 546,400 | 32 | 276.41 | 174,201 | Pond No. 1 - Riser |
| 96 | Reservoir | 6.346 | 1 | 968 | 577,268 | 68 | 262.98 | 443,094 | Pond No. 2 - perm pool |
| 97 | Reservoir | 90.13 | 1 | 739 | 640,845 | 68 | 265.75 | 160,287 | Pond No. 2 - riser |
| 98 | Reservoir | 3.837 | 1 | 994 | 368,221 | 92 | 250.26 | 302,667 | Pond No. 3 - perm pool |
| 99 | Reservoir | 60.39 | 1 | 738 | 427,140 | 92 | 252.49 | 107,855 | Pond No. 3 - riser |

# Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022

| Hyd. No. | Hydrograph type (origin) | Peak flow (cfs) | Time interval (min) | Time to Peak (min) | Hyd. volume (cuft) | Inflow hyd(s) | Maximum elevation (ft) | Total strge used (cuft) | Hydrograph Description |
|---|---|---|---|---|---|---|---|---|---|
| 1 | SCS Runoff | 7.713 | 1 | 727 | 27,018 | ------ | ------ | ------ | DD No. 1 |
| 2 | SCS Runoff | 14.40 | 1 | 730 | 57,966 | ------ | ------ | ------ | Area to DD No. 2 |
| 3 | Combine | 21.62 | 1 | 728 | 84,984 | 1, 2 | ------ | ------ | DD No. 2 |
| 4 | SCS Runoff | 14.87 | 1 | 734 | 69,187 | ------ | ------ | ------ | Area to DD No. 3 |
| 5 | Combine | 34.99 | 1 | 730 | 154,171 | 3, 4 | ------ | ------ | DD No. 3 |
| 6 | SCS Runoff | 8.012 | 1 | 725 | 26,343 | ------ | ------ | ------ | Area to DD No. 4 |
| 7 | Combine | 41.49 | 1 | 729 | 180,513 | 5, 6 | ------ | ------ | DD No. 4 |
| 8 | SCS Runoff | 4.408 | 1 | 723 | 13,018 | ------ | ------ | ------ | Area to DD No. 6 |
| 9 | Combine | 44.25 | 1 | 728 | 193,531 | 7, 8 | ------ | ------ | DD No. 6 |
| 10 | SCS Runoff | 10.05 | 1 | 728 | 37,251 | ------ | ------ | ------ | Area to DD No. 5 |
| 11 | Combine | 54.30 | 1 | 728 | 230,782 | 9, 10 | ------ | ------ | DD No. 5 |
| 12 | SCS Runoff | 16.08 | 1 | 731 | 67,644 | ------ | ------ | ------ | Area to Ditch 20 |
| 13 | Combine | 69.54 | 1 | 728 | 298,425 | 11, 12 | ------ | ------ | Ditch 20 |
| 14 | SCS Runoff | 11.14 | 1 | 725 | 36,640 | ------ | ------ | ------ | DD No. 49 |
| 15 | SCS Runoff | 11.96 | 1 | 724 | 37,741 | ------ | ------ | ------ | Area to DD No. 50 |
| 16 | Combine | 23.08 | 1 | 725 | 74,381 | 14, 15 | ------ | ------ | DD No. 50 |
| 17 | SCS Runoff | 16.89 | 1 | 729 | 64,797 | ------ | ------ | ------ | Area to Ditch 21 |
| 18 | Combine | 38.45 | 1 | 726 | 139,179 | 16, 17 | ------ | ------ | Ditch 21 / Pipe No. 103 |
| 19 | Combine | 106.69 | 1 | 727 | 437,604 | 13, 18 | ------ | ------ | Pipe No. 101 |
| 20 | SCS Runoff | 21.05 | 1 | 731 | 88,533 | ------ | ------ | ------ | DD No. 7 |
| 21 | SCS Runoff | 11.23 | 1 | 724 | 35,461 | ------ | ------ | ------ | Area to DD No. 8 |
| 22 | Combine | 29.12 | 1 | 727 | 123,995 | 20, 21 | ------ | ------ | DD No. 8 |
| 23 | SCS Runoff | 11.64 | 1 | 724 | 36,728 | ------ | ------ | ------ | Area to DD No. 9 |
| 24 | Combine | 40.02 | 1 | 726 | 160,722 | 22, 23 | ------ | ------ | DD No. 9 |
| 25 | SCS Runoff | 12.20 | 1 | 724 | 38,501 | ------ | ------ | ------ | Area to DD No. 10 |
| 26 | Combine | 51.94 | 1 | 725 | 199,223 | 24, 25 | ------ | ------ | DD No. 10 |
| 27 | SCS Runoff | 12.36 | 1 | 724 | 39,007 | ------ | ------ | ------ | Area to DD No. 11 |
| 28 | Combine | 64.28 | 1 | 725 | 238,231 | 26, 27 | ------ | ------ | DD No. 11 |
| 29 | SCS Runoff | 3.063 | 1 | 722 | 8,520 | ------ | ------ | ------ | Ditch 19 |
| 30 | Combine | 66.59 | 1 | 725 | 246,751 | 28, 29 | ------ | ------ | Pipe 102 |
| 31 | SCS Runoff | 36.01 | 1 | 722 | 100,167 | ------ | ------ | ------ | Area to Pond No. 1 |
| 32 | Combine | 196.46 | 1 | 725 | 784,521 | 19, 30, 31 | ------ | ------ | Total Pond 1 Inflow |
| 33 | SCS Runoff | 21.58 | 1 | 728 | 80,002 | ------ | ------ | ------ | DD No. 37 |
| 34 | SCS Runoff | 16.32 | 1 | 725 | 53,643 | ------ | ------ | ------ | Area to DD No. 38 |

# Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022

| Hyd. No. | Hydrograph type (origin) | Peak flow (cfs) | Time interval (min) | Time to Peak (min) | Hyd. volume (cuft) | Inflow hyd(s) | Maximum elevation (ft) | Total strge used (cuft) | Hydrograph Description |
|---|---|---|---|---|---|---|---|---|---|
| 69 | SCS Runoff | 15.88 | 1 | 729 | 60,929 | ------ | ------ | ------ | DD No. 12 |
| 70 | SCS Runoff | 17.26 | 1 | 725 | 56,756 | ------ | ------ | ------ | Area to DD No.13 |
| 71 | Combine | 32.15 | 1 | 727 | 117,685 | 69, 70 | ------ | ------ | DD No. 13 |
| 72 | SCS Runoff | 15.33 | 1 | 724 | 48,379 | ------ | ------ | ------ | Area to DD No. 14 |
| 73 | Combine | 46.84 | 1 | 726 | 166,065 | 71, 72 | ------ | ------ | DD No. 14 |
| 74 | SCS Runoff | 15.25 | 1 | 724 | 48,126 | ------ | ------ | ------ | Area to DD No. 15 |
| 75 | Combine | 61.87 | 1 | 725 | 214,191 | 73, 74 | ------ | ------ | DD No. 15 |
| 76 | SCS Runoff | 15.25 | 1 | 724 | 48,126 | ------ | ------ | ------ | Area to DD No. 16 |
| 77 | Combine | 77.09 | 1 | 725 | 262,316 | 75, 76 | ------ | ------ | DD No. 16 |
| 78 | SCS Runoff | 11.80 | 1 | 728 | 43,751 | ------ | ------ | ------ | Ditch No.18 |
| 79 | SCS Runoff | 15.78 | 1 | 727 | 55,264 | ------ | ------ | ------ | Area to Ditch No. 17 |
| 80 | Combine | 103.35 | 1 | 725 | 361,332 | 77, 78, 79 | ------ | ------ | Ditch No. 17 |
| 81 | SCS Runoff | 3.891 | 1 | 722 | 10,823 | ------ | ------ | ------ | Area to Ditch No. 16 |
| 82 | Combine | 106.29 | 1 | 725 | 372,155 | 80, 81 | ------ | ------ | Ditch No. 16 |
| 83 | SCS Runoff | 12.52 | 1 | 724 | 39,514 | ------ | ------ | ------ | DD No. 17 |
| 84 | SCS Runoff | 13.16 | 1 | 724 | 41,540 | ------ | ------ | ------ | Area to DD No. 18 |
| 85 | Combine | 25.68 | 1 | 724 | 81,054 | 83, 84 | ------ | ------ | DD No. 18 |
| 86 | SCS Runoff | 14.76 | 1 | 724 | 46,606 | ------ | ------ | ------ | Area to DD No. 19 |
| 87 | Combine | 40.44 | 1 | 724 | 127,661 | 85, 86 | ------ | ------ | DD No. 19 |
| 88 | SCS Runoff | 9.396 | 1 | 727 | 32,913 | ------ | ------ | ------ | Area to DD No. 20 |
| 89 | Combine | 49.49 | 1 | 725 | 160,573 | 87, 88 | ------ | ------ | DD No. 20 |
| 90 | Combine | 155.78 | 1 | 725 | 532,728 | 82, 89 | ------ | ------ | Pipe No. 301 |
| 91 | SCS Runoff | 23.00 | 1 | 727 | 80,563 | ------ | ------ | ------ | Area to Pond No. 3 |
| 92 | Combine | 178.11 | 1 | 725 | 613,291 | 90, 91 | ------ | ------ | Total Pond No. 3 Inflow |
| 94 | Reservoir | 17.62 | 1 | 811 | 636,597 | 32 | 275.40 | 488,875 | Pond No. 1 - Perm Pool |
| 95 | Reservoir | 51.87 | 1 | 753 | 784,514 | 32 | 277.14 | 269,027 | Pond No. 1 - Riser |
| 96 | Reservoir | 10.59 | 1 | 935 | 796,183 | 68 | 264.62 | 643,075 | Pond No. 2 - perm pool |
| 97 | Reservoir | 105.39 | 1 | 743 | 920,117 | 68 | 266.33 | 236,670 | Pond No. 2 - riser |
| 98 | Reservoir | 6.626 | 1 | 944 | 501,109 | 92 | 251.60 | 439,224 | Pond No. 3 - perm pool |
| 99 | Reservoir | 69.77 | 1 | 742 | 613,284 | 92 | 252.97 | 160,388 | Pond No. 3 - riser |

**d. Emergency Spillway**

Worst Case

Assume the dewatering opening in the overflow structure is not operating and the starting water surface elevation is at the top of the riser (275.00) at the start of a 100 year storm event.

| | | |
|---|---|---|
| Top of Pond | = | 278.00 |
| Less Required Freeboard | = | 1.00 |
| Maximum Allowable Water Surface Elevation in Emergency Spillway | = | 277.00 |

Re-route the 100 year storm event through the 4'x 4' square overflow structure and 30" diameter carrier pipe.

From Hydrograph Summary Report, Line 95, the maximum flow out of the pond will be 52 cfs. The maximum water surface elevation is 277.14 which is more than the maximum allowable water surface elevation of 277.00. However, the berm can be raised 0.14' to be able to hold the maximum water surface evaluation.

Therefore, the existing overflow structure and carrier pipe will safely pass the 100-year storm event with a starting water surface elevation at 275.00.

# Pond Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022 Monday, 12 / 2 / 2024

## Pond No. 3 - Sediment Pond No. 1 - riser

### Pond Data

**Contours -**User-defined contour areas. Average end area method used for volume calculation. Begining Elevation = 275.00 ft

### Stage / Storage Table

| Stage (ft) | Elevation (ft) | Contour area (sqft) | Incr. Storage (cuft) | Total storage (cuft) |
|---|---|---|---|---|
| 0.00 | 275.00 | 119,277 | 0 | 0 |
| 1.00 | 276.00 | 124,215 | 121,746 | 121,746 |
| 3.00 | 278.00 | 134,317 | 258,532 | 380,278 |

### Culvert / Orifice Structures

| | [A] | [B] | [C] | [PrfRsr] |
|---|---|---|---|---|
| **Rise (in)** | = 30.00 | 0.00 | 0.00 | 0.00 |
| **Span (in)** | = 30.00 | 0.00 | 0.00 | 0.00 |
| **No. Barrels** | = 1 | 0 | 0 | 0 |
| **Invert El. (ft)** | = 271.00 | 0.00 | 0.00 | 0.00 |
| **Length (ft)** | = 191.00 | 0.00 | 0.00 | 0.00 |
| **Slope (%)** | = 2.62 | 0.00 | 0.00 | n/a |
| **N-Value** | = .013 | .013 | .013 | n/a |
| **Orifice Coeff.** | = 0.60 | 0.60 | 0.60 | 0.60 |
| **Multi-Stage** | = n/a | No | No | No |

### Weir Structures

| | [A] | [B] | [C] | [D] |
|---|---|---|---|---|
| **Crest Len (ft)** | = 16.00 | 0.00 | 0.00 | 0.00 |
| **Crest El. (ft)** | = 275.00 | 0.00 | 0.00 | 0.00 |
| **Weir Coeff.** | = 3.33 | 3.33 | 3.33 | 3.33 |
| **Weir Type** | = 1 | --- | --- | --- |
| **Multi-Stage** | = Yes | No | No | No |

**Exfil.(in/hr)** = 0.000 (by Wet area)

**TW Elev. (ft)** = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).

### Stage / Storage / Discharge Table

| Stage ft | Storage cuft | Elevation ft | Clv A cfs | Clv B cfs | Clv C cfs | PrfRsr cfs | Wr A cfs | Wr B cfs | Wr C cfs | Wr D cfs | Exfil cfs | User cfs | Total cfs |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.00 | 0 | 275.00 | 0.00 | --- | --- | --- | 0.00 | --- | --- | --- | --- | --- | 0.000 |
| 1.00 | 121,746 | 276.00 | 43.03 ic | --- | --- | --- | 43.03 s | --- | --- | --- | --- | --- | 43.03 |
| 3.00 | 380,278 | 278.00 | 56.51 ic | --- | --- | --- | 56.46 s | --- | --- | --- | --- | --- | 56.46 |

# Hydrograph Summary Report

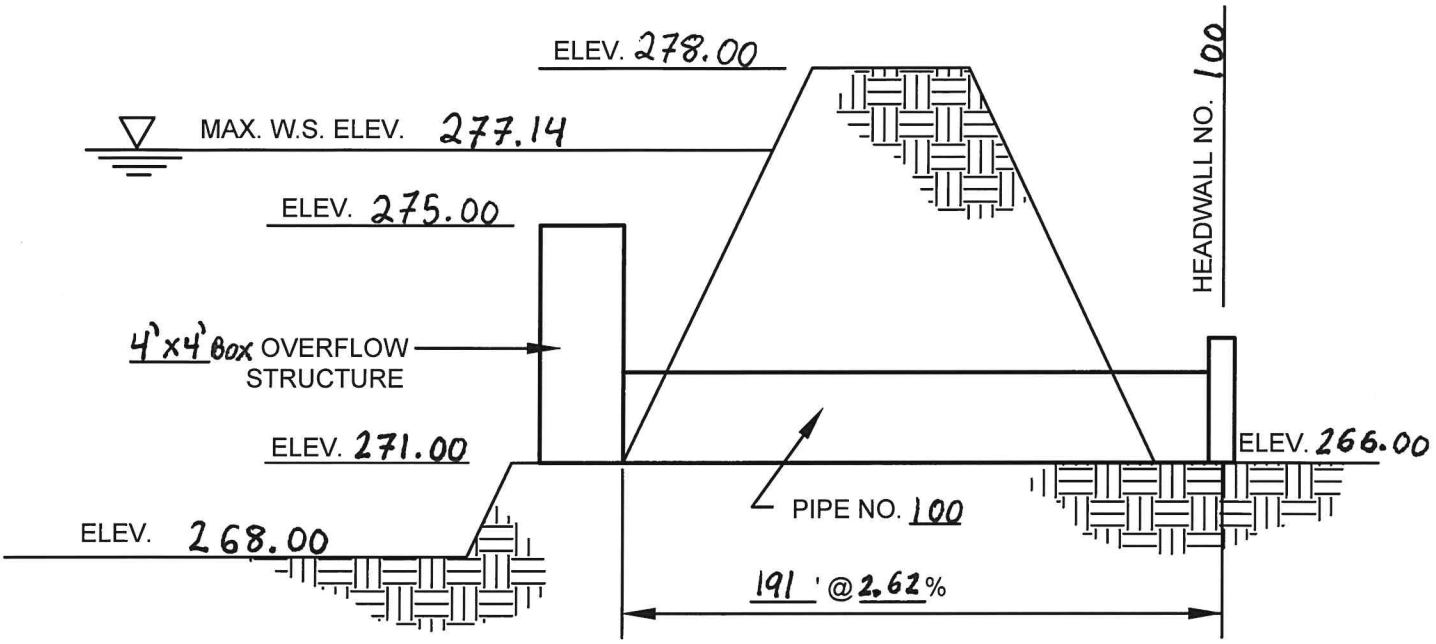
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022

| Hyd. No. | Hydrograph type (origin) | Peak flow (cfs) | Time interval (min) | Time to Peak (min) | Hyd. volume (cuft) | Inflow hyd(s) | Maximum elevation (ft) | Total strge used (cuft) | Hydrograph Description |
|---|---|---|---|---|---|---|---|---|---|
| 69 | SCS Runoff | 15.88 | 1 | 729 | 60,929 | ------ | ------ | ------ | DD No. 12 |
| 70 | SCS Runoff | 17.26 | 1 | 725 | 56,756 | ------ | ------ | ------ | Area to DD No.13 |
| 71 | Combine | 32.15 | 1 | 727 | 117,685 | 69, 70 | ------ | ------ | DD No. 13 |
| 72 | SCS Runoff | 15.33 | 1 | 724 | 48,379 | ------ | ------ | ------ | Area to DD No. 14 |
| 73 | Combine | 46.84 | 1 | 726 | 166,065 | 71, 72 | ------ | ------ | DD No. 14 |
| 74 | SCS Runoff | 15.25 | 1 | 724 | 48,126 | ------ | ------ | ------ | Area to DD No. 15 |
| 75 | Combine | 61.87 | 1 | 725 | 214,191 | 73, 74 | ------ | ------ | DD No. 15 |
| 76 | SCS Runoff | 15.25 | 1 | 724 | 48,126 | ------ | ------ | ------ | Area to DD No. 16 |
| 77 | Combine | 77.09 | 1 | 725 | 262,316 | 75, 76 | ------ | ------ | DD No. 16 |
| 78 | SCS Runoff | 11.80 | 1 | 728 | 43,751 | ------ | ------ | ------ | Ditch No.18 |
| 79 | SCS Runoff | 15.78 | 1 | 727 | 55,264 | ------ | ------ | ------ | Area to Ditch No. 17 |
| 80 | Combine | 103.35 | 1 | 725 | 361,332 | 77, 78, 79 | ------ | ------ | Ditch No. 17 |
| 81 | SCS Runoff | 3.891 | 1 | 722 | 10,823 | ------ | ------ | ------ | Area to Ditch No. 16 |
| 82 | Combine | 106.29 | 1 | 725 | 372,155 | 80, 81 | ------ | ------ | Ditch No. 16 |
| 83 | SCS Runoff | 12.52 | 1 | 724 | 39,514 | ------ | ------ | ------ | DD No. 17 |
| 84 | SCS Runoff | 13.16 | 1 | 724 | 41,540 | ------ | ------ | ------ | Area to DD No. 18 |
| 85 | Combine | 25.68 | 1 | 724 | 81,054 | 83, 84 | ------ | ------ | DD No. 18 |
| 86 | SCS Runoff | 14.76 | 1 | 724 | 46,606 | ------ | ------ | ------ | Area to DD No. 19 |
| 87 | Combine | 40.44 | 1 | 724 | 127,661 | 85, 86 | ------ | ------ | DD No. 19 |
| 88 | SCS Runoff | 9.396 | 1 | 727 | 32,913 | ------ | ------ | ------ | Area to DD No. 20 |
| 89 | Combine | 49.49 | 1 | 725 | 160,573 | 87, 88 | ------ | ------ | DD No. 20 |
| 90 | Combine | 155.78 | 1 | 725 | 532,728 | 82, 89 | ------ | ------ | Pipe No. 301 |
| 91 | SCS Runoff | 23.00 | 1 | 727 | 80,563 | ------ | ------ | ------ | Area to Pond No. 3 |
| 92 | Combine | 178.11 | 1 | 725 | 613,291 | 90, 91 | ------ | ------ | Total Pond No. 3 Inflow |
| 94 | Reservoir | 17.62 | 1 | 811 | 636,597 | 32 | 275.40 | 488,875 | Pond No. 1 - Perm Pool |
| 95 | Reservoir | 51.87 | 1 | 753 | 784,514 | 32 | 277.14 | 269,027 | Pond No. 1 - Riser |
| 96 | Reservoir | 10.59 | 1 | 935 | 796,183 | 68 | 264.62 | 643,075 | Pond No. 2 - perm pool |
| 97 | Reservoir | 105.39 | 1 | 743 | 920,117 | 68 | 266.33 | 236,670 | Pond No. 2 - riser |
| 98 | Reservoir | 6.626 | 1 | 944 | 501,109 | 92 | 251.60 | 439,224 | Pond No. 3 - perm pool |
| 99 | Reservoir | 69.77 | 1 | 742 | 613,284 | 92 | 252.97 | 160,388 | Pond No. 3 - riser |

**e. Overflow Structure and Carrier Pipe Design**

In order to confirm that the existing overflow structure, carrier pipe and emergency spillway pipe have been designed adequately to pass the maximum flow as modeled in the HydraFlow Hydrographs Extension for AutoCad Civil 3D 2022 Computer Program, the following design calculations have been included.

# OVERFLOW STRUCTURE NO. 1 (Ex.)




## DESIGN OF OVERFLOW STRUCTURE AS EMERGENCY SPILLWAY

FLOW (Q) WORST CASE = 100 YEAR STORM EVENT OCCURS WHEN WATER SURFACE ELEVATION AT TOP OF OVERFLOW STRUCTURE AND ALL DEWATERING HOLES ARE PLUGGED

FLOW (Q) MAXIMUM = 52 CFS

HEAD (H) MAXIMUM = MAXIMUM WATER SURFACE ELEVATION WITH 1' OF FREEBOARD MINUS THE ELEVATION AT THE CREST OF THE OVERFLOW STRUCTURE

= 277.14 - 275.00 = 2.14 FEET

BASED ON ABOVE HEAD, USE Existing 4'x4' Box OVERFLOW STRUCTURE

A 4'x4' Box ≈ 60" dia. Pipe (Based on weir flow)

(SEE CHART ON NEXT PAGE)

## WEIR FLOW (Q) OVER RISER CREST FOR CIRCULAR RISERS WITH TRASH RACK

$Q = CLh^{3/2}$

$Q = 3.1 \times (\pi) \times (D/12) \times h^{3/2}$

Riser Diameter ($D_r$) in inches

| HEAD-h in feet | 12 | 18 | 24 | 30 | 36 | 48 | 54 | 60 | HEAD-h in feet |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Flow In Cubic Feet Per Second | | | | | |
| 0.1 | 0.3 | 0.5 | 0.6 | 0.8 | 0.9 | 1.2 | 1.4 | 1.5 | 0.1 |
| 0.2 | 0.9 | 1.3 | 1.7 | 2.2 | 2.6 | 3.5 | 3.9 | 4.4 | 0.2 |
| 0.3 | 1.6 | 2.4 | 3.2 | 4.0 | 4.8 | 6.4 | 7.2 | 8.0 | 0.3 |
| 0.4 | 2.5 | 3.7 | 4.9 | 6.2 | 7.4 | 9.9 | 11.1 | 12.3 | 0.4 |
| 0.6 | 4.5 | 6.8 | 9.1 | 11.3 | 13.6 | 18.1 | 20.4 | 22.6 | 0.6 |
| 0.8 | | 10.5 | 13.9 | 17.4 | 20.9 | 27.9 | 31.4 | 34.8 | 0.8 |
| 1.0 | | | 19.5 | 24.3 | 29.2 | 39.0 | 43.8 | 48.7 | 1.0 |
| 1.2 | | | 25.6 | 32.0 | 38.4 | 51.2 | 57.6 | 64.0 | 1.2 |
| 1.4 | | | | 40.3 | 48.4 | 64.5 | 72.6 | 80.7 | 1.4 |
| 1.6 | | | | 49.3 | 59.1 | 78.8 | 88.7 | 98.6 | 1.6 |
| 1.8 | | | | | 70.6 | 94.1 | 105.8 | 117.6 | 1.8 |
| 2.0 | | | | | 82.6 | 110.2 | 124.0 | 137.7 | 2.0 |
| 2.2 | | | | | | 127.1 | 143.0 | 158.9 | 2.2 |
| 2.4 | | | | | | | 162.9 | 181.0 | 2.4 |
| 2.6 | | | | | | | 183.7 | 204.1 | 2.6 |
| 2.8 | | | | | | | | 228.1 | 2.8 |
| 3.0 | | | | | | | | 253.0 | 3.0 |

Table 6-22.2

### Pipe, Riser, and Trash Rack Proportions

Eq. 6-10 $D_r \geq (1.50)(D_{ps})$

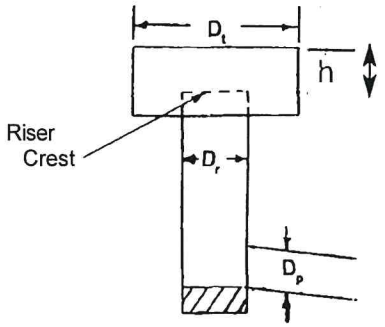
where $D_r$ = diameter of riser

$D_{ps}$ = diameter of principal spillway

Eq. 6-11 $D_t \geq (1.4)(D_r)$

where $D_t$ = diameter of trash rack

$D_r$ = diameter of riser




EXAMPLE: The peak runoff for a 2-year, 24-hour rain is 32 cfs. Select a pipe size for a head of 12 feet and length of 100 feet. From Table 6-15.1, 38.2 x 0.89 = 34 cfs discharge for a 24-inch diameter pipe.

Using Equation 6-10 $D_r \geq (1.5)(D_p)$

$D_r \geq (1.5)(24) \geq$ 36 inch diameter riser

Using Equation 6-11 $D_t \geq (1.4)(D_r)$

$D_t \geq (1.4)(36) \geq$ 50 inch diameter (Use 54 inch)

Determine h - From Table 6-15.2

$Q$ = 34 cfs $D_r$ = 36" h = 1.2'

NOTE: h = minimum distance between the crest of the riser and the crest of the emergency spillway.

# CARRIER PIPE NO. 100 (EX.)

Q = 52 CFS WORST CASE

MAXIMUM HEADWATER = TOP OF LEEVE ELEVATION MINUS 1' FREEBOARD
= 278.00 - 1.00 = 277.00

HEAD (H) = MAXIMUM WATER ELEVATION ALLOWED MINUS THE CENTERLINE ELEVATION AT THE DOWNSTREAM END OF THE CARRIER PIPE
= 277.00 - 267.25 = 9.75'

LENGTH (L) = 191.00'

LENGTH FACTOR = 0.86 FOR LENGTHS OTHER THAN 70'

Q (AVAILABLE) = Q FROM TABLE TIMES LENGTH FACTOR
= 81 X 0.86 = 70

Q (AVAILABLE) MUST BE GREATER THAN Q WORST CASE

**USE Existing 30 " DIAMETER RCP CARRIER PIPE**

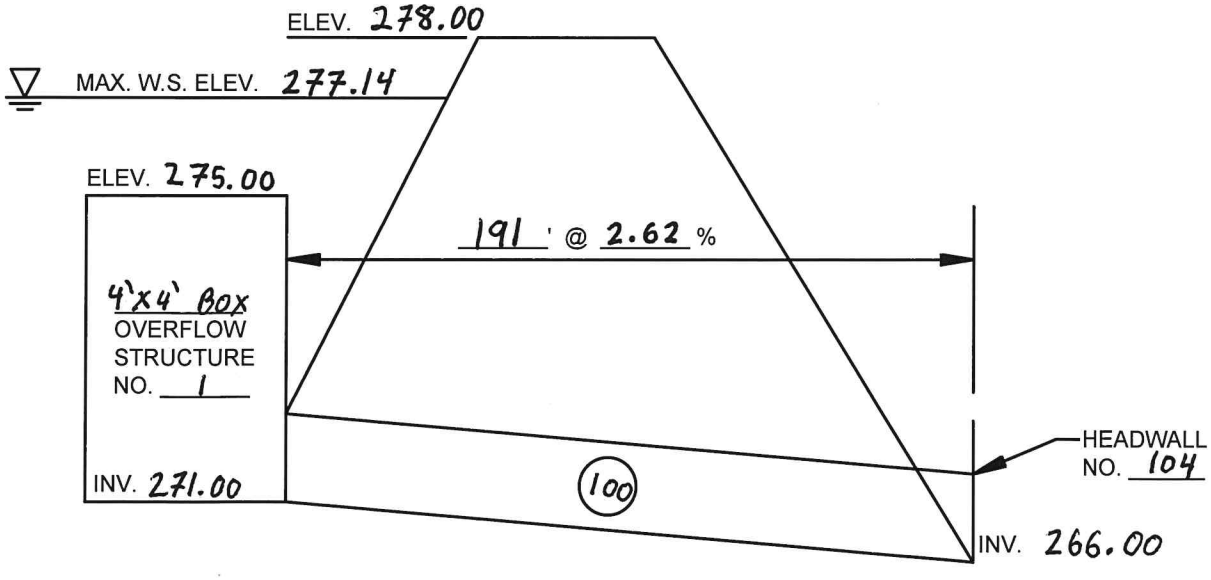


Table 6-25

PIPE FLOW CHART n = 0.025

FOR CORRUGATED METAL PIPE INLET $K_a = K_e + K_i = 1.0$ AND 70 FEET OF CORRUGATED METAL PIPE CONDUIT (full flow assumed)

Note correction factors for pipe lengths other than 70 feet

diameter of pipe in inches

| H, in feet | 12" | 15" | 18" | 21" | 24" | 30" | 36" | 42" | 48" | 54" | 60" | 66" | 72" | 78" | 84" | 90" | 96" | 102" |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3.22 | 5.44 | 8.29 | 11.8 | 15.9 | 26.0 | 38.6 | 53.8 | 71.4 | 91.5 | 114 | 139 | 167 | 197 | 229 | 264 | 302 | 342 |
| 2 | 4.55 | 7.69 | 11.7 | 16.7 | 22.5 | 36.8 | 54.6 | 76.0 | 101 | 129 | 161 | 197 | 236 | 278 | 324 | 374 | 427 | 483 |
| 3 | 5.57 | 9.42 | 14.4 | 20.4 | 27.5 | 45.0 | 66.9 | 93.1 | 124 | 159 | 198 | 241 | 289 | 341 | 397 | 458 | 523 | 592 |
| 4 | 6.43 | 10.9 | 16.6 | 23.5 | 31.8 | 52.0 | 77.3 | 108 | 143 | 183 | 228 | 278 | 334 | 394 | 459 | 529 | 604 | 683 |
| 5 | 7.19 | 12.2 | 18.5 | 26.3 | 35.5 | 58.1 | 86.4 | 120 | 160 | 205 | 255 | 311 | 373 | 440 | 513 | 591 | 675 | 764 |
| 6 | 7.88 | 13.3 | 20.3 | 28.8 | 38.9 | 67.7 | 94.6 | 132 | 175 | 224 | 280 | 341 | 409 | 482 | 562 | 647 | 739 | 837 |
| 7 | 8.51 | 14.4 | 21.9 | 31.1 | 42.0 | 68.8 | 102 | 142 | 189 | 242 | 302 | 368 | 441 | 521 | 607 | 699 | 798 | 904 |
| 8 | 9.10 | 15.4 | 23.5 | 33.3 | 44.9 | 73.5 | 109 | 152 | 202 | 259 | 323 | 394 | 472 | 557 | 685 | 748 | 854 | 966 |
| 9 | 9.65 | 16.3 | 24.9 | 35.3 | 47.7 | 76.0 | 116 | 161 | 214 | 275 | 342 | 418 | 500 | 590 | 688 | 793 | 905 | 1025 |
| 10 | 10.2 | 17.2 | 26.2 | 37.2 | 50.2 | 82.2 | 122 | 170 | 228 | 289 | 361 | 440 | 527 | 622 | 725 | 836 | 954 | 1080 |
| 11 | 10.7 | 18.0 | 27.5 | 39.0 | 52.7 | 86.2 | 128 | 178 | 237 | 304 | 379 | 462 | 553 | 653 | 761 | 877 | 1001 | 1133 |
| 12 | 11.1 | 18.9 | 28.7 | 40.6 | 55.0 | 90.1 | 134 | 186 | 247 | 317 | 395 | 482 | 578 | 682 | 794 | 916 | 1045 | 1184 |
| 13 | 11.6 | 19.8 | 29.9 | 42.4 | 57.3 | 93.7 | 139 | 194 | 257 | 330 | 411 | 502 | 601 | 710 | 827 | 953 | 1088 | 1232 |
| 14 | 12.0 | 20.4 | 31.0 | 44.1 | 59.4 | 97.3 | 145 | 201 | 267 | 342 | 427 | 521 | 624 | 736 | 858 | 989 | 1129 | 1278 |
| 15 | 12.5 | 21.1 | 32.1 | 45.6 | 61.5 | 101 | 150 | 208 | 277 | 354 | 442 | 539 | 646 | 762 | 886 | 1024 | 1169 | 1323 |
| 16 | 12.9 | 21.8 | 33.2 | 47.1 | 63.5 | 104 | 155 | 215 | 286 | 366 | 457 | 557 | 667 | 787 | 917 | 1057 | 1207 | 1367 |
| 17 | 13.3 | 22.4 | 34.2 | 48.5 | 65.5 | 107 | 159 | 222 | 294 | 377 | 471 | 574 | 688 | 812 | 946 | 1090 | 1244 | 1409 |
| 18 | 13.7 | 23.1 | 35.2 | 49.9 | 67.4 | 110 | 164 | 228 | 303 | 388 | 484 | 591 | 708 | 835 | 973 | 1121 | 1280 | 1450 |
| 19 | 14.0 | 23.6 | 36.1 | 51.3 | 69.2 | 113 | 168 | 234 | 311 | 399 | 497 | 607 | 727 | 858 | 1000 | 1152 | 1315 | 1489 |
| 20 | 14.4 | 24.3 | 37.1 | 52.6 | 71.0 | 116 | 173 | 240 | 319 | 409 | 510 | 623 | 746 | 880 | 1026 | 1182 | 1350 | 1528 |
| 21 | 14.7 | 24.9 | 38.0 | 53.9 | 72.8 | 119 | 177 | 246 | 327 | 419 | 523 | 638 | 764 | 902 | 1051 | 1211 | 1383 | 1566 |
| 22 | 15.1 | 25.5 | 38.9 | 55.2 | 74.5 | 122 | 181 | 252 | 335 | 429 | 535 | 653 | 782 | 923 | 1076 | 1240 | 1415 | 1603 |
| 23 | 15.4 | 26.1 | 39.8 | 56.5 | 76.2 | 125 | 188 | 258 | 342 | 439 | 547 | 668 | 800 | 944 | 1100 | 1268 | 1447 | 1639 |
| 24 | 15.8 | 26.7 | 40.6 | 57.7 | 77.8 | 127 | 189 | 263 | 350 | 448 | 559 | 682 | 817 | 964 | 1123 | 1295 | 1478 | 1674 |
| 25 | 16.1 | 27.2 | 41.5 | 58.9 | 79.4 | 130 | 193 | 269 | 357 | 458 | 571 | 696 | 834 | 984 | 1147 | 1322 | 1509 | 1708 |
| 26 | 16.4 | 27.7 | 42.3 | 60.0 | 81.0 | 133 | 197 | 274 | 364 | 467 | 582 | 710 | 850 | 1004 | 1169 | 1348 | 1539 | 1742 |
| 27 | 16.7 | 28.3 | 43.1 | 61.2 | 82.5 | 135 | 201 | 279 | 371 | 476 | 593 | 723 | 867 | 1023 | 1192 | 1373 | 1568 | 1775 |
| 28 | 17.0 | 28.8 | 43.9 | 62.3 | 84.1 | 138 | 204 | 285 | 378 | 484 | 604 | 737 | 883 | 1041 | 1214 | 1399 | 1597 | 1808 |
| 29 | 17.3 | 29.3 | 44.7 | 63.4 | 85.5 | 140 | 208 | 290 | 384 | 493 | 615 | 750 | 898 | 1060 | 1235 | 1423 | 1625 | 1840 |
| 30 | 17.8 | 29.8 | 45.4 | 64.5 | 87.0 | 142 | 212 | 294 | 391 | 501 | 625 | 763 | 913 | 1078 | 1256 | 1448 | 1653 | 1871 |
| L, in feet | Correction Factors For Other Pipe Lengths | | | | | | | | | | | | | | | | | |
| 20 | 1.30 | 1.24 | 1.21 | 1.18 | 1.15 | 1.12 | 1.10 | 1.08 | 1.07 | 1.06 | 1.05 | 1.05 | 1.04 | 1.04 | 1.03 | 1.03 | 1.03 | 1.03 |
| 30 | 1.22 | 1.18 | 1.15 | 1.13 | 1.12 | 1.09 | 1.08 | 1.06 | 1.05 | 1.05 | 1.04 | 1.04 | 1.03 | 1.03 | 1.03 | 1.02 | 1.02 | 1.02 |
| 40 | 1.15 | 1.13 | 1.11 | 1.10 | 1.08 | 1.07 | 1.05 | 1.05 | 1.04 | 1.03 | 1.03 | 1.03 | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 |
| 50 | 1.09 | 1.08 | 1.07 | 1.06 | 1.05 | 1.04 | 1.04 | 1.03 | 1.03 | 1.02 | 1.02 | 1.02 | 1.02 | 1.01 | 1.01 | 1.01 | 1.01 | 1.01 |
| 60 | 1.04 | 1.04 | 1.03 | 1.03 | 1.03 | 1.02 | 1.02 | 1.02 | 1.01 | 1.01 | 1.01 | 1.01 | 1.01 | 1.01 | 1.01 | 1.01 | 1.01 | 1.01 |
| 70 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 80 | .96 | .97 | .97 | .97 | .98 | .98 | .98 | .99 | .99 | .99 | .99 | .99 | .99 | .99 | .99 | .99 | .99 | .99 |
| 90 | .93 | .94 | .94 | .95 | .95 | .96 | .97 | .97 | .98 | .98 | .98 | .98 | .98 | .99 | .99 | .99 | .99 | .99 |
| 100 | .90 | .91 | .92 | .93 | .93 | .95 | .95 | .96 | .97 | .97 | .97 | .98 | .98 | .98 | .98 | .98 | .98 | .99 |
| 120 | .84 | .86 | .87 | .89 | .90 | .91 | .93 | .94 | .94 | .95 | .96 | .96 | .96 | .97 | .97 | .97 | .97 | .98 |
| 140 | .80 | .82 | .83 | .85 | .86 | .86 | .90 | .91 | .92 | .93 | .94 | .94 | .95 | .95 | .96 | .96 | .96 | .97 |
| 160 | .78 | .78 | .80 | .82 | .83 | .86 | .88 | .89 | .90 | .91 | .92 | .93 | .94 | .94 | .95 | .95 | .95 | .96 |

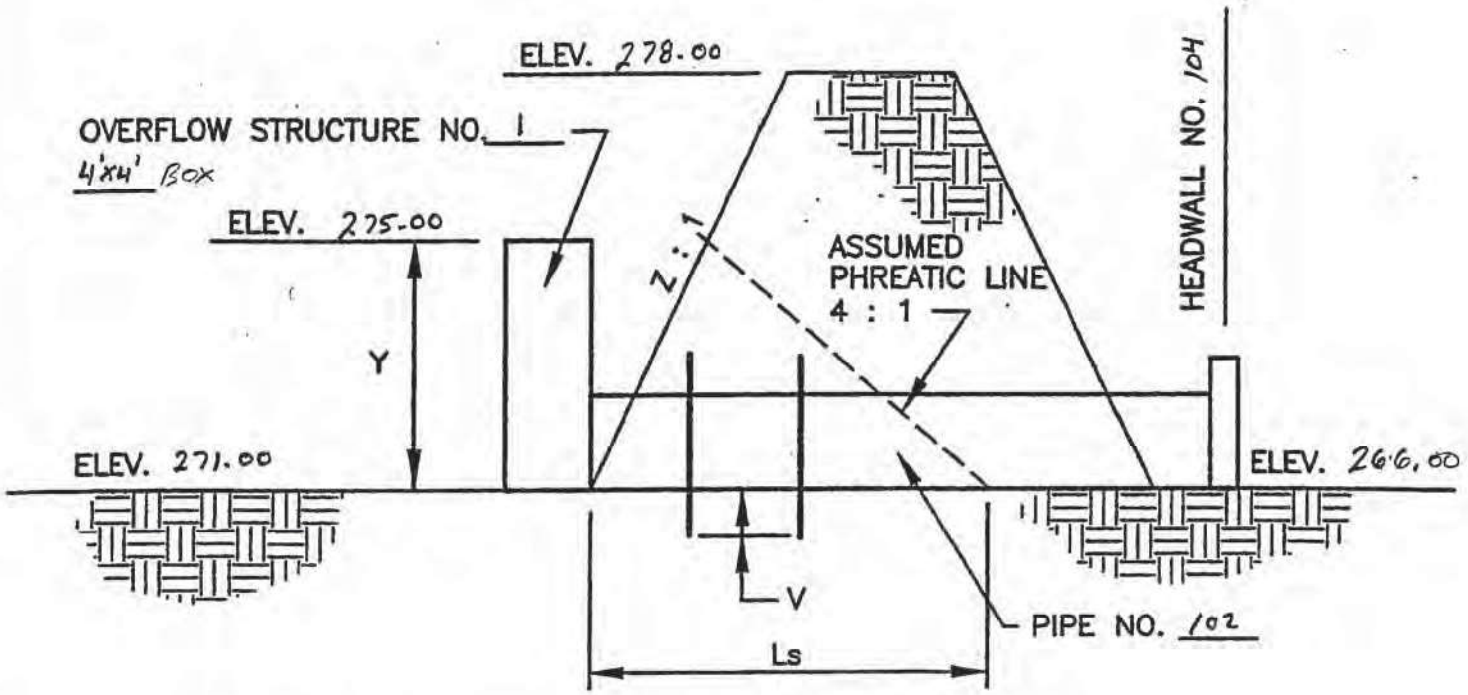
Source: USDA - SCS

**f. Anti-Seep Collar Design**

The seepage of water through the existing sediment pond dam along the carrier pipe could result in dam failure.

The existing anti-seep collars have been designed to be located at intervals within the zone of saturation along the carrier pipe to increase the seepage length along the carrier pipe and thereby prevent piping or seepage along the carrier pipe.

# ANTI – SEEP COLLAR DESIGN




Ls = LENGTH IN SATURATION ZONE

Y = OVERFLOW STRUCTURE HEIGHT = 4.0 FEET

Z = INSIDE SLOPE OF LEVEE = 3

PIPE SLOPE = 2.62 % = 0.0262 FEET/FEET

$$Ls = Y ( Z + 4 ) \left( 1 + \frac{\text{PIPE SLOPE}}{0.25 - \text{PIPE SLOPE}} \right)$$

Ls = 31 FEET

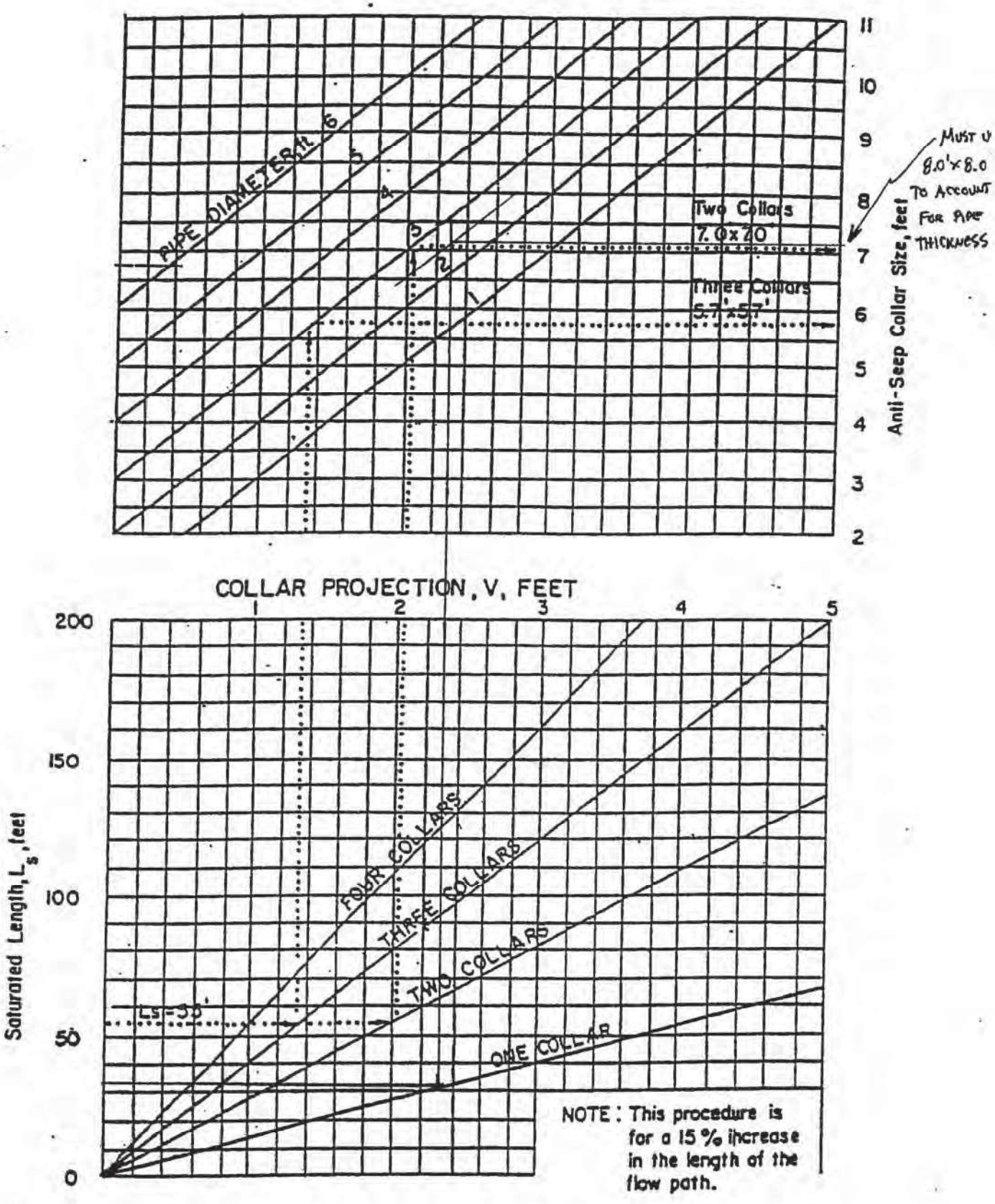
FROM ANTI – SEEP COLLAR DESIGN CHART ON THE NEXT PAGE :

V = COLLAR PROJECTION = 2.3 FEET

DIMENSIONS OF 12" THICK COLLAR = 8.0' × 8.0'

NUMBER OF REQUIRED COLLARS = 1

# ANTI-SEEP COLLAR DESIGN



**g. Overflow Structure Base Foundation Design**

The existing overflow structure and carrier pipe will be subject to a certain amount of buoyant force when the sediment pond is filled with storm water. In order to overcome this buoyant force and prevent the flotation of the overflow structure and carrier pipe, a concrete overflow structure base foundation and concrete carrier pipe encasement have been designed. The design calculations for the concrete overflow structure base foundation and carrier pipe encasement are included in this section.

**OVERFLOW STRUCTURE BASE FOUNDATION DESIGN**

A certain volume of concrete will be used to overcome the buoyancy of an empty overflow structure and carrier pipe that are below the assumed phreatic water surface. This volume is equal to:

Overflow Structure

= (L)(w)(h)(62.4) L = w = 4.0' inside = 4.83' outside

= (4.83)(4.83)(4.00)(62.4) h = height = 4.0'

= 5,823 #

Carrier Pipe = 3.1416($R_2^2$)(Ls)(62.4) Ls = length in saturation zone = 31'

= 3.1416(1.54)(1.54)(31)(62.4) $R_2$ = outside radius = 18.5" = 1.54'

= 14,412 # $r_2$ = inside radius = 15" = 1.25'

TOTAL WEIGHT

= 20,235 # x 1.5 (SAFETY FACTOR)

= 30,353 #

TOTAL REVISED VOLUME OF CONCRETE =

TOTAL WEIGHT / WEIGHT OF CONC. IN WATER

= 30,353/87.6 pcf (87.6 pcf = Wt. of conc. in submerged water)

= 347 C.F.

This volume of concrete will be made up from five areas.

1. Overflow Structures
2. Anti-Seep Collars
3. Carrier Pipe
4. Overflow Structure Base
5. Carrier Pipe Encasement

1. Overflow Structure = $(L_2 - l_2)h$

   $(4.83^2 – 4.0^2)(4.0)$ = 29 C.F.

   L = outside dimension of box = 4.83’

   l = inside dimension of box = 4.0’

   h = height of overflow structures = 4.0’

2. Anti-seep collars = area of square collar around carrier pipe x 12" thick x # of collars

   = [( 8.0' x 8.0' ) - $(3.1416)(R_2^2)$

   x 1' x 1

   = 56 C.F.

   $R_2$ = outside radius of carrier pipe = 18.5" = 1.54’

   $r_2$ = inside radius of carrier pipe = 15" = 1.25’

3. Carrier Pipe

   = $3.1416 (R_2^2 - r_2^2)$ L = 78 C.F.  L = length in saturation = 31’

4. Overflow Structure Base = Volume to handle riser bouyance x 1.2

   = (L)(w)h(62.4)(1.2)/weight of conc. in water

   L = w = 4.83’ outside

   h = height = 4.0’

   = (4.83’)(4.83’)(4.0)(62.4)(1.2)/87.6

   = 80 C.F.

   Use 7' x 7' x 2' = 98 C.F.

5. Carrier Pipe Encasement

   Must extend 5’ into dam. Distance from overflow structure to dam is equal to 12.0’. Therefore, encasement length will be 17.0’:

   Use 4.0’ x 5.5’ x 17.0’ long

   Carrier pipe encasement volume = 247 C.F.

**TOTAL REQUIRED VOLUME = 347 C.F.**

Actual Total Volume:

| | |
|---|---|
| Overflow Structure | = 29 C.F. |
| Anti-Seep Collars | = 56 C.F. |
| Carrier Pipe | = 78 C.F. |
| Overflow Structure Base | = 98 C.F. |
| Carrier Pipe Encasement | = 247 C.F. |
| **TOTAL** | **= 508 C.F. => Okay** |

# 3. EXPANDED SEDIMENT POND NO. 2

## a. Sediment Storage and Settling Efficiency Calculations

Sediment Pond No. 2 was constructed in early 2010 during the Tract 1 West site development. This pond was constructed as originally designed and has been routinely maintained since being constructed. The expansion of Tract No. 1 will require re-grading of this pond. However, the existing outlet control structure will remain in place. The calculations following are being presented to demonstrate that the expanded pond will function adequately throughout the life of the site.

As required in the "Alabama Handbook for Erosion Control, Sediment Control and Stormwater Management on Construction Sites and Urban Area", the sediment storage volume of the pond shall be at least 67 cubic yards per acre for the disturbed area draining into the pond (67 cubic yards is equivalent to ½ inch of sediment per acre of drainage area). The peak inflow rate for the 25 year storm event has also been used to calculate the minimum pond surface area needed for adequate settling efficiency. These calculations for the existing sediment pond are included below.

Sediment Storage Calculation

Assume maximum sediment from 38 disturbed acres.

38 Acres x 67 c.y./acre = 2,546c.y. = 68,742 c.f.

This sediment volume corresponds to a depth of 0.74' or Elev. 256.74.

Dewatering opening is set at Elev. 259.00. Therefore, ample sediment storage volume is available.

Settling Efficiency Calculations

- Use 25 year storm event, Q25 Flow = 172 cfs
- Minimum Surface Area = .01 acre / cfs x Q25 Flow
  = .01 acre / cfs x 172 cfs
  = 1.72 acres = 74.923 s.f.
- Top of Overflow Structure = Elev. 264.50
  Surface Area @ Elev. 264.50 = 125,049 s.f.
- Adequate surface area is available for settling in the existing pond.

# Pond Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022 Tuesday, 12 / 3 / 2024

## Pond No. 4 - Pond No. 2

### Pond Data

**Contours -**User-defined contour areas. Average end area method used for volume calculation. Begining Elevation = 256.00 ft

### Stage / Storage Table

| Stage (ft) | Elevation (ft) | Contour area (sqft) | Incr. Storage (cuft) | Total storage (cuft) |
|---|---|---|---|---|
| 0.00 | 256.00 | 91,131 | 0 | 0 |
| 2.00 | 258.00 | 98,528 | 189,659 | 189,659 |
| 4.00 | 260.00 | 106,868 | 205,396 | 395,055 |
| 6.00 | 262.00 | 114,843 | 221,711 | 616,766 |
| 8.00 | 264.00 | 122,947 | 237,790 | 854,556 |
| 10.00 | 266.00 | 131,353 | 254,300 | 1,108,856 |
| 11.00 | 267.00 | 135,650 | 133,502 | 1,242,358 |
| 11.50 | 267.50 | 136,761 | 68,103 | 1,310,460 |

### Culvert / Orifice Structures

| | [A] | [B] | [C] | [PrfRsr] |
|---|---|---|---|---|
| **Rise (in)** | = 42.00 | 6.00 | 0.00 | 0.00 |
| **Span (in)** | = 42.00 | 18.00 | 0.00 | 0.00 |
| **No. Barrels** | = 1 | 1 | 0 | 0 |
| **Invert El. (ft)** | = 259.00 | 259.10 | 0.00 | 0.00 |
| **Length (ft)** | = 120.00 | 0.00 | 0.00 | 0.00 |
| **Slope (%)** | = 0.83 | 0.00 | 0.00 | n/a |
| **N-Value** | = .013 | .013 | .013 | n/a |
| **Orifice Coeff.** | = 0.60 | 0.60 | 0.60 | 0.60 |
| **Multi-Stage** | = n/a | Yes | No | No |

### Weir Structures

| | [A] | [B] | [C] | [D] |
|---|---|---|---|---|
| **Crest Len (ft)** | = 20.00 | 0.00 | 0.00 | 0.00 |
| **Crest El. (ft)** | = 264.50 | 0.00 | 0.00 | 0.00 |
| **Weir Coeff.** | = 3.33 | 3.33 | 3.33 | 3.33 |
| **Weir Type** | = 1 | --- | --- | --- |
| **Multi-Stage** | = Yes | No | No | No |

**Exfil.(in/hr)** = 0.000 (by Wet area)

**TW Elev. (ft)** = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).

### Stage / Storage / Discharge Table

| Stage ft | Storage cuft | Elevation ft | Clv A cfs | Clv B cfs | Clv C cfs | PrfRsr cfs | Wr A cfs | Wr B cfs | Wr C cfs | Wr D cfs | Exfil cfs | User cfs | Total cfs |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.00 | 0 | 256.00 | 0.00 | 0.00 | --- | --- | 0.00 | --- | --- | --- | --- | --- | 0.000 |
| 2.00 | 189,659 | 258.00 | 0.00 | 0.00 | --- | --- | 0.00 | --- | --- | --- | --- | --- | 0.000 |
| 4.00 | 395,055 | 260.00 | 2.44 ic | 2.44 ic | --- | --- | 0.00 | --- | --- | --- | --- | --- | 2.442 |
| 6.00 | 616,766 | 262.00 | 5.41 ic | 5.34 ic | --- | --- | 0.00 | --- | --- | --- | --- | --- | 5.341 |
| 8.00 | 854,556 | 264.00 | 7.34 ic | 7.26 ic | --- | --- | 0.00 | --- | --- | --- | --- | --- | 7.263 |
| 10.00 | 1,108,856 | 266.00 | 99.74 ic | 2.83 ic | --- | --- | 96.90 s | --- | --- | --- | --- | --- | 99.73 |
| 11.00 | 1,242,358 | 267.00 | 114.06 ic | 1.56 ic | --- | --- | 112.48 s | --- | --- | --- | --- | --- | 114.04 |
| 11.50 | 1,310,460 | 267.50 | 119.24 ic | 1.27 ic | --- | --- | 117.94 s | --- | --- | --- | --- | --- | 119.20 |

**b. Total Pond Dewatering at Top of Riser (Elev. 264.50)**

Retention time within the basin is an important factor in effective sediment retention. The existing overflow structure has been designed as specified below.

The 5' x 5' square concrete overflow structure has one 6" (h) x 18" (w) dewatering weir at Elevation 259.00

The calculation below has been performed to confirm that the dewatering (retention) time within the pond is between 24 and 72 hours. This dewatering time will ensure the storm water is retained for an adequate length of time to allow the sediment to settle (minimum 24 hours) and is also discharged gradually in an acceptable length of time to allow storage for future storm events (maximum 72 hours).

The dewatering time is calculated as follows:

$$T = \frac{A_s \times (2h)^{1/2}}{A_O \times C_d \times (20{,}428)}$$

$A_O$ = Surface Area of Dewatering Holes ($ft^2$)

$A_s$ = Surface Area Corresponding to top of riser elevation (ft2)

h = Head of water above dewatering hole (ft)

$C_d$ = Coefficient of contraction for an orifice (use 0.6)

T = Time to dewater

T = 24 to 72 hours

$A_O$ = 0.75 s.f. = 1 - 6"x 18" rectangular opening @ elev. 259.00

$A_s$ = 125,049 s.f. @ elev. 264.50

h = 264.50 – 259.00 = 5.5'

$$T = \frac{125{,}049\ (2 \times 5.5)^{½}}{(0.75)\ (0.6)\ (20428)} = 45 \text{ hours}$$

**(Okay between 24- 72 hours)**

**c. Reservoir Routing**

Reservoir routing is determined by using the HydraFlow Hydrographs Extension for AutoCad Civil 3D 2022 Computer Program.

Peak inflow rates (Q) are determined using the SCS Method and in the computer program above. Peak inflow rates are calculated for the 25 year and 100 year storm events and are summarized below.

$Q_{25}$ = 172 cfs

$Q_{100}$ = 244 cfs

The bottom of the pond has been set at 256.00. Dewatering of the pond is accomplished by a 6"x 18" rectangular opening beginning at an invert elevation of 259.00.

For routing calculations, a 5'x 5' rectangular riser with a 6"x 18" rectangular opening at an invert elevation of 259.00 is used. The top of the riser is at an elevation of 264.50. The bottom of the pond is elev. 256.00. The invert of the carrier pipe is elev. 259.00. The top of the levee around the sediment pond is at an elevation of 267.50.

The maximum height of sediment is elevation 256.74 which is below the elevation of the dewatering opening (Elev. 259.00).

Based on the above information the reservoir routing calculations are performed and summarized below.

| STORM YEAR | PEAK INFLOW CFS | PEAK OUTFLOW CFS | PEAK ELEV. FEET |
|---|---|---|---|
| 25 | 172 | 6.35 | 262.98 |
| 100 | 244 | 10.59 | 264.62 |

Based on these routing calculations, the riser is large enough and the pond has sufficient storage volume to retain the sediment from 38 disturbed acres plus the 25 year storm event from the entire drainage area below the crest of the riser (elev. 264.50).

# Pond Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022 Tuesday, 12 / 3 / 2024

## Pond No. 5 - Pond No. 2-perm pool

### Pond Data

**Contours -**User-defined contour areas. Average end area method used for volume calculation. Begining Elevation = 259.00 ft

### Stage / Storage Table

| Stage (ft) | Elevation (ft) | Contour area (sqft) | Incr. Storage (cuft) | Total storage (cuft) |
|---|---|---|---|---|
| 0.00 | 259.00 | 102,698 | 0 | 0 |
| 1.00 | 260.00 | 106,868 | 104,783 | 104,783 |
| 3.00 | 262.00 | 114,843 | 221,711 | 326,494 |
| 5.00 | 264.00 | 122,947 | 237,790 | 564,284 |
| 7.00 | 266.00 | 131,353 | 254,300 | 818,584 |
| 8.00 | 267.00 | 135,650 | 133,502 | 952,086 |
| 8.50 | 267.50 | 136,761 | 68,103 | 1,020,188 |

### Culvert / Orifice Structures

| | [A] | [B] | [C] | [PrfRsr] |
|---|---|---|---|---|
| **Rise (in)** | = 42.00 | 6.00 | 0.00 | 0.00 |
| **Span (in)** | = 42.00 | 18.00 | 0.00 | 0.00 |
| **No. Barrels** | = 1 | 1 | 0 | 0 |
| **Invert El. (ft)** | = 259.00 | 259.10 | 0.00 | 0.00 |
| **Length (ft)** | = 120.00 | 0.00 | 0.00 | 0.00 |
| **Slope (%)** | = 0.83 | 0.00 | 0.00 | n/a |
| **N-Value** | = .013 | .013 | .013 | n/a |
| **Orifice Coeff.** | = 0.60 | 0.60 | 0.60 | 0.60 |
| **Multi-Stage** | = n/a | Yes | No | No |

### Weir Structures

| | [A] | [B] | [C] | [D] |
|---|---|---|---|---|
| **Crest Len (ft)** | = 20.00 | 0.00 | 0.00 | 0.00 |
| **Crest El. (ft)** | = 264.50 | 0.00 | 0.00 | 0.00 |
| **Weir Coeff.** | = 3.33 | 3.33 | 3.33 | 3.33 |
| **Weir Type** | = 1 | --- | --- | --- |
| **Multi-Stage** | = Yes | No | No | No |

**Exfil.(in/hr)** = 0.000 (by Wet area)

**TW Elev. (ft)** = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).

### Stage / Storage / Discharge Table

| Stage ft | Storage cuft | Elevation ft | Clv A cfs | Clv B cfs | Clv C cfs | PrfRsr cfs | Wr A cfs | Wr B cfs | Wr C cfs | Wr D cfs | Exfil cfs | User cfs | Total cfs |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.00 | 0 | 259.00 | 0.00 | 0.00 | --- | --- | 0.00 | --- | --- | --- | --- | --- | 0.000 |
| 1.00 | 104,783 | 260.00 | 2.44 ic | 2.44 ic | --- | --- | 0.00 | --- | --- | --- | --- | --- | 2.442 |
| 3.00 | 326,494 | 262.00 | 5.41 ic | 5.34 ic | --- | --- | 0.00 | --- | --- | --- | --- | --- | 5.341 |
| 5.00 | 564,284 | 264.00 | 7.34 ic | 7.26 ic | --- | --- | 0.00 | --- | --- | --- | --- | --- | 7.263 |
| 7.00 | 818,584 | 266.00 | 99.74 ic | 2.83 ic | --- | --- | 96.90 s | --- | --- | --- | --- | --- | 99.73 |
| 8.00 | 952,086 | 267.00 | 114.06 ic | 1.56 ic | --- | --- | 112.48 s | --- | --- | --- | --- | --- | 114.04 |
| 8.50 | 1,020,188 | 267.50 | 119.24 ic | 1.27 ic | --- | --- | 117.94 s | --- | --- | --- | --- | --- | 119.20 |

# Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022

| Hyd. No. | Hydrograph type (origin) | Peak flow (cfs) | Time interval (min) | Time to Peak (min) | Hyd. volume (cuft) | Inflow hyd(s) | Maximum elevation (ft) | Total strge used (cuft) | Hydrograph Description |
|---|---|---|---|---|---|---|---|---|---|
| 35 | Combine | 26.28 | 1 | 727 | 93,082 | 33, 34 | ------ | ------ | DD No. 38 |
| 36 | SCS Runoff | 13.20 | 1 | 725 | 42,866 | ------ | ------ | ------ | Area to DD No. 39 |
| 37 | Combine | 39.43 | 1 | 726 | 135,947 | 35, 36 | ------ | ------ | DD No. 39 |
| 38 | SCS Runoff | 13.57 | 1 | 727 | 46,873 | ------ | ------ | ------ | Area to DD No.40 |
| 39 | Combine | 52.95 | 1 | 726 | 182,821 | 37, 38 | ------ | ------ | DD No. 40 |
| 40 | SCS Runoff | 13.86 | 1 | 727 | 47,900 | ------ | ------ | ------ | Area to DD No. 41 |
| 41 | Combine | 66.77 | 1 | 726 | 230,720 | 39, 40 | ------ | ------ | DD No. 41 |
| 42 | SCS Runoff | 7.972 | 1 | 727 | 27,542 | ------ | ------ | ------ | Ditch No. 8 |
| 43 | SCS Runoff | 2.515 | 1 | 722 | 6,896 | ------ | ------ | ------ | Area to Ditch No. 7 |
| 44 | Combine | 9.623 | 1 | 725 | 34,438 | 42, 43 | ------ | ------ | Ditch No. 7 |
| 45 | SCS Runoff | 1.988 | 1 | 722 | 5,453 | ------ | ------ | ------ | Ditch No. 6 |
| 46 | Combine | 77.66 | 1 | 726 | 270,611 | 41, 44, 45 | ------ | ------ | Pipe 202 |
| 47 | SCS Runoff | 6.572 | 1 | 723 | 19,160 | ------ | ------ | ------ | DD No. 42 |
| 48 | SCS Runoff | 8.625 | 1 | 723 | 25,147 | ------ | ------ | ------ | Area to DD No. 43 |
| 49 | Combine | 15.20 | 1 | 723 | 44,307 | 47, 48 | ------ | ------ | DD No. 43 |
| 50 | SCS Runoff | 9.292 | 1 | 730 | 36,951 | ------ | ------ | ------ | DD No. 44 |
| 51 | SCS Runoff | 7.087 | 1 | 725 | 23,017 | ------ | ------ | ------ | Area to DD No. 45 |
| 52 | Combine | 15.58 | 1 | 727 | 59,969 | 50, 51 | ------ | ------ | DD No. 45 |
| 53 | SCS Runoff | 12.06 | 1 | 725 | 37,577 | ------ | ------ | ------ | Area to DD No. 46 |
| 54 | Combine | 26.99 | 1 | 726 | 97,545 | 52, 53 | ------ | ------ | DD No. 46 |
| 55 | SCS Runoff | 9.667 | 1 | 732 | 41,267 | ------ | ------ | ------ | Area to DD Ditch 3 |
| 56 | SCS Runoff | 6.419 | 1 | 725 | 20,849 | ------ | ------ | ------ | DD No. 47 |
| 57 | SCS Runoff | 9.912 | 1 | 725 | 32,191 | ------ | ------ | ------ | Area to DD No. 48 |
| 58 | Combine | 16.33 | 1 | 725 | 53,040 | 56, 57 | ------ | ------ | DD No.48 |
| 59 | SCS Runoff | 5.605 | 1 | 725 | 17,465 | ------ | ------ | ------ | Ditch No. 1 |
| 60 | SCS Runoff | 4.417 | 1 | 725 | 14,344 | ------ | ------ | ------ | Area to Ditch No. 2 |
| 61 | Combine | 10.02 | 1 | 725 | 31,809 | 59, 60 | ------ | ------ | Ditch No. 2 |
| 62 | Combine | 61.00 | 1 | 726 | 223,662 | 54, 55, 58, 61 | ------ | ------ | Ditch No.3 |
| 63 | SCS Runoff | 11.79 | 1 | 736 | 55,440 | ------ | ------ | ------ | Area to Ditch No. 4 |
| 64 | SCS Runoff | 1.696 | 1 | 722 | 4,651 | ------ | ------ | ------ | Ditch No. 5 |
| 65 | Combine | 82.67 | 1 | 725 | 323,409 | 49, 62, 63, | ------ | ------ | Ditch No. 4 |
| 66 | Combine | 83.96 | 1 | 725 | 328,060 | 64, 65 | ------ | ------ | Pipe 201 |
| 67 | SCS Runoff | 15.38 | 1 | 722 | 42,179 | ------ | ------ | ------ | Area to Pond No. 2 |
| 68 | Combine | 172.09 | 1 | 725 | 640,851 | 46, 66, 67 | ------ | ------ | Total Pond No. 2 Inflow |

# Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022

| Hyd. No. | Hydrograph type (origin) | Peak flow (cfs) | Time interval (min) | Time to Peak (min) | Hyd. volume (cuft) | Inflow hyd(s) | Maximum elevation (ft) | Total strge used (cuft) | Hydrograph Description |
|---|---|---|---|---|---|---|---|---|---|
| 69 | SCS Runoff | 11.20 | 1 | 729 | 42,436 | ------ | ------ | ------ | DD No. 12 |
| 70 | SCS Runoff | 12.17 | 1 | 725 | 39,530 | ------ | ------ | ------ | Area to DD No.13 |
| 71 | Combine | 22.69 | 1 | 727 | 81,966 | 69, 70 | ------ | ------ | DD No. 13 |
| 72 | SCS Runoff | 10.81 | 1 | 725 | 33,695 | ------ | ------ | ------ | Area to DD No. 14 |
| 73 | Combine | 33.05 | 1 | 726 | 115,661 | 71, 72 | ------ | ------ | DD No. 14 |
| 74 | SCS Runoff | 10.76 | 1 | 725 | 33,519 | ------ | ------ | ------ | Area to DD No. 15 |
| 75 | Combine | 43.60 | 1 | 725 | 149,180 | 73, 74 | ------ | ------ | DD No. 15 |
| 76 | SCS Runoff | 10.76 | 1 | 725 | 33,519 | ------ | ------ | ------ | Area to DD No. 16 |
| 77 | Combine | 54.36 | 1 | 725 | 182,700 | 75, 76 | ------ | ------ | DD No. 16 |
| 78 | SCS Runoff | 8.328 | 1 | 728 | 30,472 | ------ | ------ | ------ | Ditch No.18 |
| 79 | SCS Runoff | 11.14 | 1 | 727 | 38,491 | ------ | ------ | ------ | Area to Ditch No. 17 |
| 80 | Combine | 72.94 | 1 | 726 | 251,662 | 77, 78, 79 | ------ | ------ | Ditch No. 17 |
| 81 | SCS Runoff | 2.749 | 1 | 722 | 7,538 | ------ | ------ | ------ | Area to Ditch No. 16 |
| 82 | Combine | 74.90 | 1 | 725 | 259,200 | 80, 81 | ------ | ------ | Ditch No. 16 |
| 83 | SCS Runoff | 8.832 | 1 | 725 | 27,521 | ------ | ------ | ------ | DD No. 17 |
| 84 | SCS Runoff | 9.285 | 1 | 725 | 28,932 | ------ | ------ | ------ | Area to DD No. 18 |
| 85 | Combine | 18.12 | 1 | 725 | 56,453 | 83, 84 | ------ | ------ | DD No. 18 |
| 86 | SCS Runoff | 10.42 | 1 | 725 | 32,460 | ------ | ------ | ------ | Area to DD No. 19 |
| 87 | Combine | 28.53 | 1 | 725 | 88,914 | 85, 86 | ------ | ------ | DD No. 19 |
| 88 | SCS Runoff | 6.635 | 1 | 727 | 22,923 | ------ | ------ | ------ | Area to DD No. 20 |
| 89 | Combine | 34.95 | 1 | 725 | 111,837 | 87, 88 | ------ | ------ | DD No. 20 |
| 90 | Combine | 109.84 | 1 | 725 | 371,036 | 82, 89 | ------ | ------ | Pipe No. 301 |
| 91 | SCS Runoff | 16.24 | 1 | 727 | 56,111 | ------ | ------ | ------ | Area to Pond No. 3 |
| 92 | Combine | 125.54 | 1 | 725 | 427,148 | 90, 91 | ------ | ------ | Total Pond No. 3 Inflow |
| 94 | Reservoir | 4.089 | 1 | 1044 | 426,678 | 32 | 274.68 | 402,260 | Pond No. 1 - Perm Pool |
| 95 | Reservoir | 47.08 | 1 | 750 | 546,400 | 32 | 276.41 | 174,201 | Pond No. 1 - Riser |
| 96 | Reservoir | 6.346 | 1 | 968 | 577,268 | 68 | 262.98 | 443,094 | Pond No. 2 - perm pool |
| 97 | Reservoir | 90.13 | 1 | 739 | 640,845 | 68 | 265.75 | 160,287 | Pond No. 2 - riser |
| 98 | Reservoir | 3.837 | 1 | 994 | 368,221 | 92 | 250.26 | 302,667 | Pond No. 3 - perm pool |
| 99 | Reservoir | 60.39 | 1 | 738 | 427,140 | 92 | 252.49 | 107,855 | Pond No. 3 - riser |

# Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022

| Hyd. No. | Hydrograph type (origin) | Peak flow (cfs) | Time interval (min) | Time to Peak (min) | Hyd. volume (cuft) | Inflow hyd(s) | Maximum elevation (ft) | Total strge used (cuft) | Hydrograph Description |
|---|---|---|---|---|---|---|---|---|---|
| 35 | Combine | 37.25 | 1 | 726 | 133,645 | 33, 34 | ------ | ------ | DD No. 38 |
| 36 | SCS Runoff | 18.72 | 1 | 725 | 61,546 | ------ | ------ | ------ | Area to DD No. 39 |
| 37 | Combine | 55.91 | 1 | 726 | 195,191 | 35, 36 | ------ | ------ | DD No. 39 |
| 38 | SCS Runoff | 19.21 | 1 | 727 | 67,300 | ------ | ------ | ------ | Area to DD No.40 |
| 39 | Combine | 75.10 | 1 | 726 | 262,490 | 37, 38 | ------ | ------ | DD No. 40 |
| 40 | SCS Runoff | 19.63 | 1 | 727 | 68,773 | ------ | ------ | ------ | Area to DD No. 41 |
| 41 | Combine | 94.71 | 1 | 726 | 331,264 | 39, 40 | ------ | ------ | DD No. 41 |
| 42 | SCS Runoff | 11.29 | 1 | 727 | 39,545 | ------ | ------ | ------ | Ditch No. 8 |
| 43 | SCS Runoff | 3.560 | 1 | 722 | 9,902 | ------ | ------ | ------ | Area to Ditch No. 7 |
| 44 | Combine | 13.65 | 1 | 725 | 49,446 | 42, 43 | ------ | ------ | Ditch No. 7 |
| 45 | SCS Runoff | 2.815 | 1 | 722 | 7,829 | ------ | ------ | ------ | Ditch No. 6 |
| 46 | Combine | 110.11 | 1 | 726 | 388,539 | 41, 44, 45 | ------ | ------ | Pipe 202 |
| 47 | SCS Runoff | 9.314 | 1 | 723 | 27,509 | ------ | ------ | ------ | DD No. 42 |
| 48 | SCS Runoff | 12.22 | 1 | 723 | 36,106 | ------ | ------ | ------ | Area to DD No. 43 |
| 49 | Combine | 21.54 | 1 | 723 | 63,615 | 47, 48 | ------ | ------ | DD No. 43 |
| 50 | SCS Runoff | 13.18 | 1 | 730 | 53,054 | ------ | ------ | ------ | DD No. 44 |
| 51 | SCS Runoff | 10.05 | 1 | 725 | 33,048 | ------ | ------ | ------ | Area to DD No. 45 |
| 52 | Combine | 22.12 | 1 | 727 | 86,102 | 50, 51 | ------ | ------ | DD No. 45 |
| 53 | SCS Runoff | 17.09 | 1 | 724 | 53,952 | ------ | ------ | ------ | Area to DD No. 46 |
| 54 | Combine | 38.27 | 1 | 726 | 140,053 | 52, 53 | ------ | ------ | DD No. 46 |
| 55 | SCS Runoff | 13.72 | 1 | 732 | 59,250 | ------ | ------ | ------ | Area to DD Ditch 3 |
| 56 | SCS Runoff | 9.105 | 1 | 725 | 29,935 | ------ | ------ | ------ | DD No. 47 |
| 57 | SCS Runoff | 14.06 | 1 | 725 | 46,219 | ------ | ------ | ------ | Area to DD No. 48 |
| 58 | Combine | 23.16 | 1 | 725 | 76,154 | 56, 57 | ------ | ------ | DD No.48 |
| 59 | SCS Runoff | 7.944 | 1 | 724 | 25,076 | ------ | ------ | ------ | Ditch No. 1 |
| 60 | SCS Runoff | 6.264 | 1 | 725 | 20,595 | ------ | ------ | ------ | Area to Ditch No. 2 |
| 61 | Combine | 14.19 | 1 | 725 | 45,671 | 59, 60 | ------ | ------ | Ditch No. 2 |
| 62 | Combine | 86.54 | 1 | 726 | 321,129 | 54, 55, 58, 61 | ------ | ------ | Ditch No.3 |
| 63 | SCS Runoff | 16.75 | 1 | 735 | 79,600 | ------ | ------ | ------ | Area to Ditch No. 4 |
| 64 | SCS Runoff | 2.401 | 1 | 722 | 6,678 | ------ | ------ | ------ | Ditch No. 5 |
| 65 | Combine | 117.56 | 1 | 725 | 464,344 | 49, 62, 63, | ------ | ------ | Ditch No. 4 |
| 66 | Combine | 119.38 | 1 | 725 | 471,023 | 64, 65 | ------ | ------ | Pipe 201 |
| 67 | SCS Runoff | 21.77 | 1 | 722 | 60,560 | ------ | ------ | ------ | Area to Pond No. 2 |
| 68 | Combine | 244.40 | 1 | 725 | 920,123 | 46, 66, 67 | ------ | ------ | Total Pond No. 2 Inflow |

# Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022

| Hyd. No. | Hydrograph type (origin) | Peak flow (cfs) | Time interval (min) | Time to Peak (min) | Hyd. volume (cuft) | Inflow hyd(s) | Maximum elevation (ft) | Total strge used (cuft) | Hydrograph Description |
|---|---|---|---|---|---|---|---|---|---|
| 69 | SCS Runoff | 15.88 | 1 | 729 | 60,929 | ------ | ------ | ------ | DD No. 12 |
| 70 | SCS Runoff | 17.26 | 1 | 725 | 56,756 | ------ | ------ | ------ | Area to DD No.13 |
| 71 | Combine | 32.15 | 1 | 727 | 117,685 | 69, 70 | ------ | ------ | DD No. 13 |
| 72 | SCS Runoff | 15.33 | 1 | 724 | 48,379 | ------ | ------ | ------ | Area to DD No. 14 |
| 73 | Combine | 46.84 | 1 | 726 | 166,065 | 71, 72 | ------ | ------ | DD No. 14 |
| 74 | SCS Runoff | 15.25 | 1 | 724 | 48,126 | ------ | ------ | ------ | Area to DD No. 15 |
| 75 | Combine | 61.87 | 1 | 725 | 214,191 | 73, 74 | ------ | ------ | DD No. 15 |
| 76 | SCS Runoff | 15.25 | 1 | 724 | 48,126 | ------ | ------ | ------ | Area to DD No. 16 |
| 77 | Combine | 77.09 | 1 | 725 | 262,316 | 75, 76 | ------ | ------ | DD No. 16 |
| 78 | SCS Runoff | 11.80 | 1 | 728 | 43,751 | ------ | ------ | ------ | Ditch No.18 |
| 79 | SCS Runoff | 15.78 | 1 | 727 | 55,264 | ------ | ------ | ------ | Area to Ditch No. 17 |
| 80 | Combine | 103.35 | 1 | 725 | 361,332 | 77, 78, 79 | ------ | ------ | Ditch No. 17 |
| 81 | SCS Runoff | 3.891 | 1 | 722 | 10,823 | ------ | ------ | ------ | Area to Ditch No. 16 |
| 82 | Combine | 106.29 | 1 | 725 | 372,155 | 80, 81 | ------ | ------ | Ditch No. 16 |
| 83 | SCS Runoff | 12.52 | 1 | 724 | 39,514 | ------ | ------ | ------ | DD No. 17 |
| 84 | SCS Runoff | 13.16 | 1 | 724 | 41,540 | ------ | ------ | ------ | Area to DD No. 18 |
| 85 | Combine | 25.68 | 1 | 724 | 81,054 | 83, 84 | ------ | ------ | DD No. 18 |
| 86 | SCS Runoff | 14.76 | 1 | 724 | 46,606 | ------ | ------ | ------ | Area to DD No. 19 |
| 87 | Combine | 40.44 | 1 | 724 | 127,661 | 85, 86 | ------ | ------ | DD No. 19 |
| 88 | SCS Runoff | 9.396 | 1 | 727 | 32,913 | ------ | ------ | ------ | Area to DD No. 20 |
| 89 | Combine | 49.49 | 1 | 725 | 160,573 | 87, 88 | ------ | ------ | DD No. 20 |
| 90 | Combine | 155.78 | 1 | 725 | 532,728 | 82, 89 | ------ | ------ | Pipe No. 301 |
| 91 | SCS Runoff | 23.00 | 1 | 727 | 80,563 | ------ | ------ | ------ | Area to Pond No. 3 |
| 92 | Combine | 178.11 | 1 | 725 | 613,291 | 90, 91 | ------ | ------ | Total Pond No. 3 Inflow |
| 94 | Reservoir | 17.62 | 1 | 811 | 636,597 | 32 | 275.40 | 488,875 | Pond No. 1 - Perm Pool |
| 95 | Reservoir | 51.87 | 1 | 753 | 784,514 | 32 | 277.14 | 269,027 | Pond No. 1 - Riser |
| 96 | Reservoir | 10.59 | 1 | 935 | 796,183 | 68 | 264.62 | 643,075 | Pond No. 2 - perm pool |
| 97 | Reservoir | 105.39 | 1 | 743 | 920,117 | 68 | 266.33 | 236,670 | Pond No. 2 - riser |
| 98 | Reservoir | 6.626 | 1 | 944 | 501,109 | 92 | 251.60 | 439,224 | Pond No. 3 - perm pool |
| 99 | Reservoir | 69.77 | 1 | 742 | 613,284 | 92 | 252.97 | 160,388 | Pond No. 3 - riser |

**d. Emergency Spillway**

Worst Case

Assume the dewatering opening in the overflow structure is not operating and the starting water surface elevation is at the top of the riser (264.50) at the start of a 100 year storm event.

| | | |
|---|---|---|
| Top of Pond | = | 267.50 |
| Less Required Freeboard | = | 1.00 |
| Maximum Allowable Water Surface Elevation in Emergency Spillway | = | 266.50 |

Re-route the 100 year storm event through the existing 5'x 5' square overflow structure and 42" diameter carrier pipe.

From Hydrograph Summary Report, Line 97, the maximum flow out of the pond will be 105 cfs. The maximum water surface elevation is 266.33 which is less than to the maximum allowable water surface elevation.

Therefore, the existing overflow structure and carrier pipe will safely pass the 100-year storm event with a starting water surface elevation at 264.50.

# Pond Report



## Pond No. 6 - Pond No. 2-riser

### Pond Data

**Contours -**User-defined contour areas. Average end area method used for volume calculation. Begining Elevation = 264.50 ft

### Stage / Storage Table

| Stage (ft) | Elevation (ft) | Contour area (sqft) | Incr. Storage (cuft) | Total storage (cuft) |
|---|---|---|---|---|
| 0.00 | 264.50 | 125,049 | 0 | 0 |
| 1.50 | 266.00 | 131,353 | 192,302 | 192,302 |
| 2.50 | 267.00 | 135,650 | 133,502 | 325,803 |
| 3.00 | 267.50 | 136,761 | 68,103 | 393,906 |

### Culvert / Orifice Structures

| | [A] | [B] | [C] | [PrfRsr] |
|---|---|---|---|---|
| **Rise (in)** | = 42.00 | Inactive | Inactive | Inactive |
| **Span (in)** | = 42.00 | 0.00 | 0.00 | 0.00 |
| **No. Barrels** | = 1 | 1 | 0 | 0 |
| **Invert El. (ft)** | = 259.00 | 0.00 | 0.00 | 0.00 |
| **Length (ft)** | = 120.00 | 0.00 | 0.00 | 0.00 |
| **Slope (%)** | = 0.83 | 0.00 | 0.00 | n/a |
| **N-Value** | = .013 | .013 | .013 | n/a |
| **Orifice Coeff.** | = 0.60 | 0.60 | 0.60 | 0.60 |
| **Multi-Stage** | = n/a | No | No | No |

### Weir Structures

| | [A] | [B] | [C] | [D] |
|---|---|---|---|---|
| **Crest Len (ft)** | = 20.00 | 0.00 | 0.00 | 0.00 |
| **Crest El. (ft)** | = 264.50 | 0.00 | 0.00 | 0.00 |
| **Weir Coeff.** | = 3.33 | 3.33 | 3.33 | 3.33 |
| **Weir Type** | = 1 | --- | --- | --- |
| **Multi-Stage** | = Yes | No | No | No |

**Exfil.(in/hr)** = 0.000 (by Wet area)

**TW Elev. (ft)** = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).

### Stage / Storage / Discharge Table

| Stage ft | Storage cuft | Elevation ft | Clv A cfs | Clv B cfs | Clv C cfs | PrfRsr cfs | Wr A cfs | Wr B cfs | Wr C cfs | Wr D cfs | Exfil cfs | User cfs | Total cfs |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.00 | 0 | 264.50 | 0.00 | --- | --- | --- | 0.00 | --- | --- | --- | --- | --- | 0.000 |
| 1.50 | 192,302 | 266.00 | 99.24 ic | --- | --- | --- | 99.24 s | --- | --- | --- | --- | --- | 99.24 |
| 2.50 | 325,803 | 267.00 | 114.00 ic | --- | --- | --- | 113.98 s | --- | --- | --- | --- | --- | 113.98 |
| 3.00 | 393,906 | 267.50 | 119.21 ic | --- | --- | --- | 119.19 s | --- | --- | --- | --- | --- | 119.19 |

# Hydrograph Summary Report

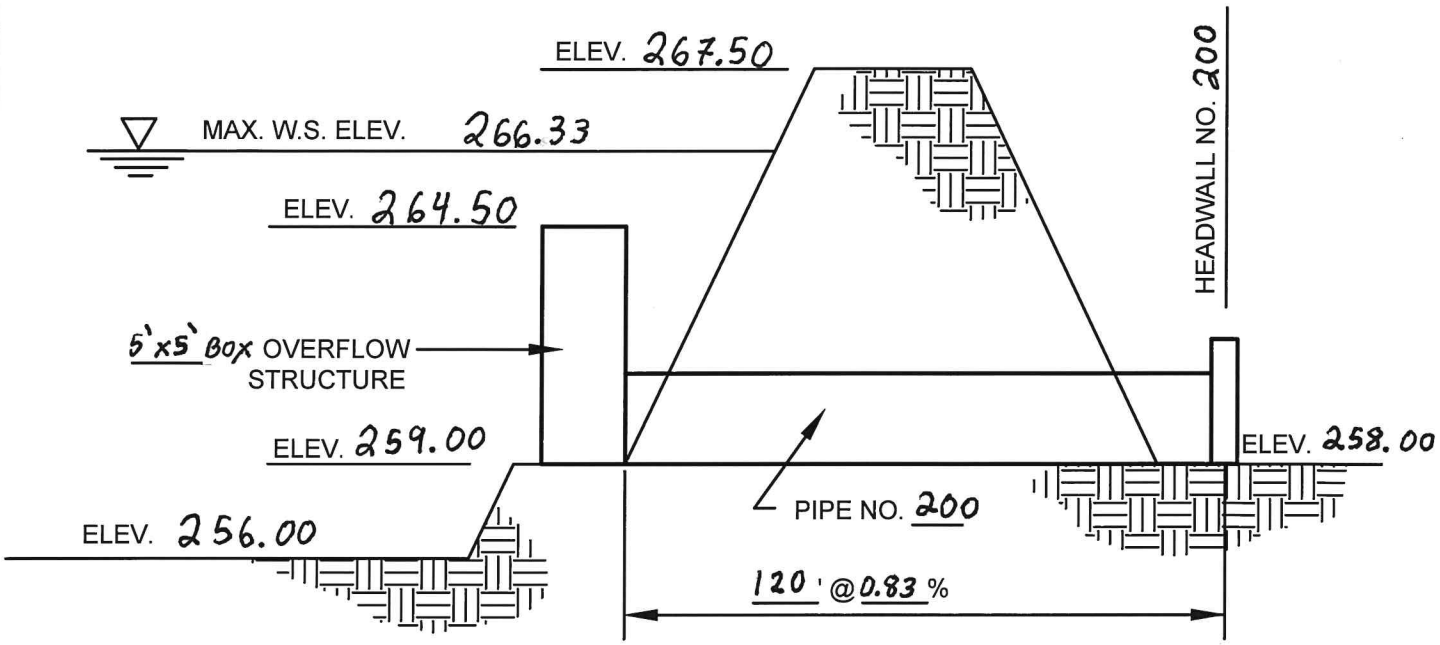
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022

| Hyd. No. | Hydrograph type (origin) | Peak flow (cfs) | Time interval (min) | Time to Peak (min) | Hyd. volume (cuft) | Inflow hyd(s) | Maximum elevation (ft) | Total strge used (cuft) | Hydrograph Description |
|---|---|---|---|---|---|---|---|---|---|
| 69 | SCS Runoff | 15.88 | 1 | 729 | 60,929 | ------ | ------ | ------ | DD No. 12 |
| 70 | SCS Runoff | 17.26 | 1 | 725 | 56,756 | ------ | ------ | ------ | Area to DD No.13 |
| 71 | Combine | 32.15 | 1 | 727 | 117,685 | 69, 70 | ------ | ------ | DD No. 13 |
| 72 | SCS Runoff | 15.33 | 1 | 724 | 48,379 | ------ | ------ | ------ | Area to DD No. 14 |
| 73 | Combine | 46.84 | 1 | 726 | 166,065 | 71, 72 | ------ | ------ | DD No. 14 |
| 74 | SCS Runoff | 15.25 | 1 | 724 | 48,126 | ------ | ------ | ------ | Area to DD No. 15 |
| 75 | Combine | 61.87 | 1 | 725 | 214,191 | 73, 74 | ------ | ------ | DD No. 15 |
| 76 | SCS Runoff | 15.25 | 1 | 724 | 48,126 | ------ | ------ | ------ | Area to DD No. 16 |
| 77 | Combine | 77.09 | 1 | 725 | 262,316 | 75, 76 | ------ | ------ | DD No. 16 |
| 78 | SCS Runoff | 11.80 | 1 | 728 | 43,751 | ------ | ------ | ------ | Ditch No.18 |
| 79 | SCS Runoff | 15.78 | 1 | 727 | 55,264 | ------ | ------ | ------ | Area to Ditch No. 17 |
| 80 | Combine | 103.35 | 1 | 725 | 361,332 | 77, 78, 79 | ------ | ------ | Ditch No. 17 |
| 81 | SCS Runoff | 3.891 | 1 | 722 | 10,823 | ------ | ------ | ------ | Area to Ditch No. 16 |
| 82 | Combine | 106.29 | 1 | 725 | 372,155 | 80, 81 | ------ | ------ | Ditch No. 16 |
| 83 | SCS Runoff | 12.52 | 1 | 724 | 39,514 | ------ | ------ | ------ | DD No. 17 |
| 84 | SCS Runoff | 13.16 | 1 | 724 | 41,540 | ------ | ------ | ------ | Area to DD No. 18 |
| 85 | Combine | 25.68 | 1 | 724 | 81,054 | 83, 84 | ------ | ------ | DD No. 18 |
| 86 | SCS Runoff | 14.76 | 1 | 724 | 46,606 | ------ | ------ | ------ | Area to DD No. 19 |
| 87 | Combine | 40.44 | 1 | 724 | 127,661 | 85, 86 | ------ | ------ | DD No. 19 |
| 88 | SCS Runoff | 9.396 | 1 | 727 | 32,913 | ------ | ------ | ------ | Area to DD No. 20 |
| 89 | Combine | 49.49 | 1 | 725 | 160,573 | 87, 88 | ------ | ------ | DD No. 20 |
| 90 | Combine | 155.78 | 1 | 725 | 532,728 | 82, 89 | ------ | ------ | Pipe No. 301 |
| 91 | SCS Runoff | 23.00 | 1 | 727 | 80,563 | ------ | ------ | ------ | Area to Pond No. 3 |
| 92 | Combine | 178.11 | 1 | 725 | 613,291 | 90, 91 | ------ | ------ | Total Pond No. 3 Inflow |
| 94 | Reservoir | 17.62 | 1 | 811 | 636,597 | 32 | 275.40 | 488,875 | Pond No. 1 - Perm Pool |
| 95 | Reservoir | 51.87 | 1 | 753 | 784,514 | 32 | 277.14 | 269,027 | Pond No. 1 - Riser |
| 96 | Reservoir | 10.59 | 1 | 935 | 796,183 | 68 | 264.62 | 643,075 | Pond No. 2 - perm pool |
| 97 | Reservoir | 105.39 | 1 | 743 | 920,117 | 68 | 266.33 | 236,670 | Pond No. 2 - riser |
| 98 | Reservoir | 6.626 | 1 | 944 | 501,109 | 92 | 251.60 | 439,224 | Pond No. 3 - perm pool |
| 99 | Reservoir | 69.77 | 1 | 742 | 613,284 | 92 | 252.97 | 160,388 | Pond No. 3 - riser |

**e. Overflow Structure and Carrier Pipe Design**

In order to confirm that the existing overflow structure, carrier pipe and emergency spillway pipe have been designed adequately to pass the maximum flow as modeled in the HydraFlow Hydrographs Extension for AutoCad Civil 3D 2022 Computer Program, the following design calculations have been included.

# OVERFLOW STRUCTURE NO. 2 (EX.)




## DESIGN OF OVERFLOW STRUCTURE AS EMERGENCY SPILLWAY

FLOW (Q) WORST CASE = 100 YEAR STORM EVENT OCCURS WHEN WATER SURFACE ELEVATION AT TOP OF OVERFLOW STRUCTURE AND ALL DEWATERING HOLES ARE PLUGGED

FLOW (Q) MAXIMUM = 105 CFS

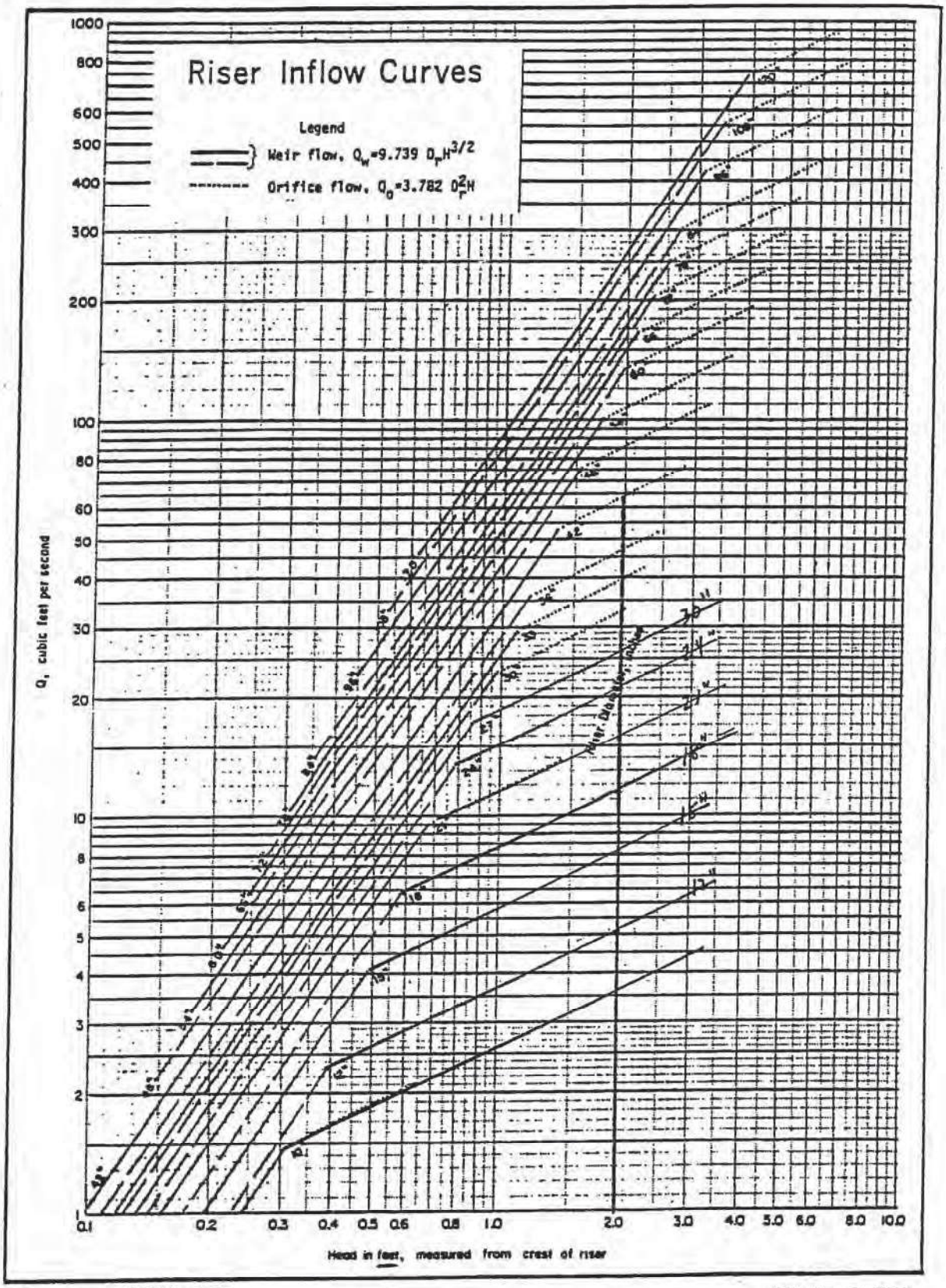
HEAD (H) MAXIMUM = MAXIMUM WATER SURFACE ELEVATION WITH 1' OF FREEBOARD MINUS THE ELEVATION AT THE CREST OF THE OVERFLOW STRUCTURE

= 266.33 - 264.50 = 1.83 FEET

BASED ON ABOVE HEAD, USE Existing 5'x5' Box OVERFLOW STRUCTURE

(SEE CHART ON NEXT PAGE)

Entrance ... & stand pipes




Source: USDA-SCS

Plate 1.26h

FIGURE A-10

# CARRIER PIPE NO. 200 (Ex.)

Q = 105 CFS WORST CASE

MAXIMUM HEADWATER = TOP OF LEEVE ELEVATION MINUS 1' FREEBOARD
= 267.50 - 1.00 = 266.50

HEAD (H) = MAXIMUM WATER ELEVATION ALLOWED MINUS THE CENTERLINE ELEVATION AT THE DOWNSTREAM END OF THE CARRIER PIPE
= 266.50 - 259.75 = 6.75'

LENGTH (L) = 120'

LENGTH FACTOR = 0.94 FOR LENGTHS OTHER THAN 70'

Q (AVAILABLE) = Q FROM TABLE TIMES LENGTH FACTOR
= 139.5 X 0.94 = 131

Q (AVAILABLE) MUST BE GREATER THAN Q WORST CASE

**USE Existing 42 " DIAMETER RCP CARRIER PIPE**

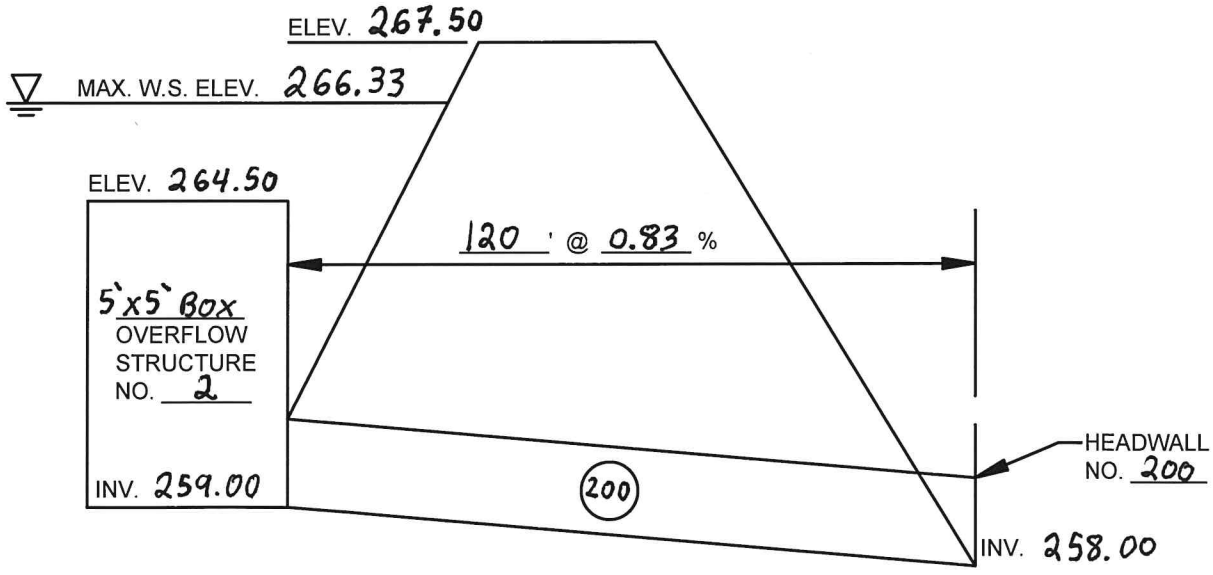


Table 6-25

PIPE FLOW CHART n = 0.025

FOR CORRUGATED METAL PIPE INLET $K_a = K_e + K_b = 1.0$ AND 70 FEET OF CORRUGATED METAL PIPE CONDUIT (full flow assumed)

Note correction factors for pipe lengths other than 70 feet

| H, in feet | diameter of pipe in inches | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 12" | 15" | 18" | 21" | 24" | 30" | 36" | 42" | 48" | 54" | 60" | 66" | 72" | 78" | 84" | 90" | 96" | 102" |
| 1 | 3.22 | 5.44 | 8.29 | 11.8 | 15.9 | 26.0 | 38.6 | 53.8 | 71.4 | 91.5 | 114 | 139 | 167 | 197 | 229 | 264 | 302 | 342 |
| 2 | 4.55 | 7.69 | 11.7 | 16.7 | 22.5 | 36.8 | 54.6 | 76.0 | 101 | 129 | 161 | 197 | 236 | 278 | 324 | 374 | 427 | 483 |
| 3 | 5.57 | 9.42 | 14.4 | 20.4 | 27.5 | 45.0 | 66.9 | 93.1 | 124 | 159 | 198 | 241 | 289 | 341 | 397 | 458 | 523 | 592 |
| 4 | 6.43 | 10.9 | 16.6 | 23.5 | 31.8 | 52.0 | 77.3 | 108 | 143 | 183 | 228 | 278 | 334 | 394 | 459 | 529 | 604 | 683 |
| 5 | 7.19 | 12.2 | 18.5 | 26.3 | 35.5 | 58.1 | 86.4 | 120 | 160 | 205 | 255 | 311 | 373 | 440 | 513 | 591 | 675 | 764 |
| 6 | 7.88 | 13.3 | 20.3 | 28.8 | 38.9 | 67.7 | 94.6 | 132 | 175 | 224 | 280 | 341 | 409 | 482 | 562 | 647 | 739 | 837 |
| 7 | 8.51 | 14.4 | 21.9 | 31.1 | 42.0 | 68.8 | 102 | 142 | 189 | 242 | 302 | 368 | 441 | 521 | 607 | 699 | 798 | 904 |
| 8 | 9.10 | 15.4 | 23.5 | 33.3 | 44.9 | 73.5 | 109 | 152 | 202 | 259 | 323 | 394 | 472 | 557 | 685 | 748 | 854 | 966 |
| 9 | 9.65 | 16.3 | 24.9 | 35.3 | 47.7 | 78.0 | 116 | 161 | 214 | 275 | 342 | 418 | 500 | 590 | 688 | 793 | 905 | 1025 |
| 10 | 10.2 | 17.2 | 26.2 | 37.2 | 50.2 | 82.2 | 122 | 170 | 226 | 289 | 361 | 440 | 527 | 622 | 725 | 836 | 954 | 1080 |
| 11 | 10.7 | 18.0 | 27.5 | 39.0 | 52.7 | 86.2 | 128 | 178 | 237 | 304 | 379 | 462 | 553 | 653 | 761 | 877 | 1001 | 1133 |
| 12 | 11.1 | 18.9 | 28.7 | 40.8 | 55.0 | 90.1 | 134 | 186 | 247 | 317 | 395 | 482 | 578 | 682 | 794 | 916 | 1045 | 1184 |
| 13 | 11.6 | 19.6 | 29.9 | 42.4 | 57.3 | 93.7 | 139 | 194 | 257 | 330 | 411 | 502 | 601 | 710 | 827 | 953 | 1086 | 1232 |
| 14 | 12.0 | 20.4 | 31.0 | 44.1 | 59.4 | 97.3 | 145 | 201 | 267 | 342 | 427 | 521 | 624 | 736 | 858 | 989 | 1129 | 1278 |
| 15 | 12.5 | 21.1 | 32.1 | 45.8 | 61.5 | 101 | 150 | 208 | 277 | 354 | 442 | 539 | 646 | 762 | 888 | 1024 | 1169 | 1323 |
| 16 | 12.9 | 21.8 | 33.2 | 47.1 | 63.5 | 104 | 155 | 215 | 286 | 366 | 457 | 557 | 667 | 787 | 917 | 1057 | 1207 | 1367 |
| 17 | 13.3 | 22.4 | 34.2 | 48.5 | 65.5 | 107 | 159 | 222 | 294 | 377 | 471 | 574 | 688 | 812 | 946 | 1090 | 1244 | 1409 |
| 18 | 13.7 | 23.1 | 35.2 | 49.9 | 67.4 | 110 | 164 | 228 | 303 | 388 | 484 | 591 | 708 | 835 | 973 | 1121 | 1280 | 1450 |
| 19 | 14.0 | 23.8 | 36.1 | 51.3 | 69.2 | 113 | 168 | 234 | 311 | 399 | 497 | 607 | 727 | 858 | 1000 | 1152 | 1315 | 1489 |
| 20 | 14.4 | 24.3 | 37.1 | 52.6 | 71.0 | 116 | 173 | 240 | 319 | 409 | 510 | 623 | 746 | 880 | 1026 | 1182 | 1350 | 1528 |
| 21 | 14.7 | 24.9 | 38.0 | 53.9 | 72.8 | 119 | 177 | 246 | 327 | 419 | 523 | 638 | 764 | 902 | 1051 | 1211 | 1383 | 1566 |
| 22 | 15.1 | 25.5 | 38.9 | 55.2 | 74.5 | 122 | 181 | 252 | 335 | 429 | 535 | 653 | 782 | 923 | 1076 | 1240 | 1415 | 1603 |
| 23 | 15.4 | 26.1 | 39.8 | 56.5 | 76.2 | 125 | 186 | 258 | 342 | 439 | 547 | 668 | 800 | 944 | 1100 | 1268 | 1447 | 1639 |
| 24 | 15.8 | 26.7 | 40.6 | 57.7 | 77.8 | 127 | 189 | 263 | 350 | 448 | 559 | 682 | 817 | 964 | 1123 | 1295 | 1478 | 1674 |
| 25 | 16.1 | 27.2 | 41.5 | 58.9 | 79.4 | 130 | 193 | 269 | 357 | 458 | 571 | 696 | 834 | 984 | 1147 | 1322 | 1509 | 1708 |
| 26 | 16.4 | 27.7 | 42.3 | 60.0 | 81.0 | 133 | 197 | 274 | 364 | 467 | 582 | 710 | 850 | 1004 | 1169 | 1348 | 1539 | 1742 |
| 27 | 16.7 | 28.3 | 43.1 | 61.2 | 82.5 | 135 | 201 | 279 | 371 | 476 | 593 | 723 | 867 | 1023 | 1192 | 1373 | 1568 | 1775 |
| 28 | 17.0 | 28.8 | 43.9 | 62.3 | 84.1 | 138 | 204 | 285 | 378 | 484 | 604 | 737 | 883 | 1041 | 1214 | 1399 | 1597 | 1808 |
| 29 | 17.3 | 29.3 | 44.7 | 63.4 | 85.5 | 140 | 208 | 290 | 384 | 493 | 615 | 750 | 898 | 1060 | 1235 | 1423 | 1625 | 1840 |
| 30 | 17.8 | 29.8 | 45.4 | 64.5 | 87.0 | 142 | 212 | 294 | 391 | 501 | 625 | 763 | 913 | 1078 | 1256 | 1448 | 1653 | 1871 |
| L, in feet | Correction Factors For Other Pipe Lengths | | | | | | | | | | | | | | | | | |
| 20 | 1.30 | 1.24 | 1.21 | 1.18 | 1.15 | 1.12 | 1.10 | 1.08 | 1.07 | 1.06 | 1.05 | 1.05 | 1.04 | 1.04 | 1.03 | 1.03 | 1.03 | 1.03 |
| 30 | 1.22 | 1.18 | 1.15 | 1.13 | 1.12 | 1.09 | 1.08 | 1.06 | 1.05 | 1.05 | 1.04 | 1.04 | 1.03 | 1.03 | 1.03 | 1.02 | 1.02 | 1.02 |
| 40 | 1.15 | 1.13 | 1.11 | 1.10 | 1.08 | 1.07 | 1.05 | 1.05 | 1.04 | 1.03 | 1.03 | 1.03 | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 |
| 50 | 1.09 | 1.08 | 1.07 | 1.06 | 1.05 | 1.04 | 1.04 | 1.03 | 1.03 | 1.02 | 1.02 | 1.02 | 1.02 | 1.01 | 1.01 | 1.01 | 1.01 | 1.01 |
| 60 | 1.04 | 1.04 | 1.03 | 1.03 | 1.03 | 1.02 | 1.02 | 1.02 | 1.01 | 1.01 | 1.01 | 1.01 | 1.01 | 1.01 | 1.01 | 1.01 | 1.01 | 1.01 |
| 70 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 80 | .96 | .97 | .97 | .97 | .98 | .98 | .98 | .99 | .99 | .99 | .99 | .99 | .99 | .99 | .99 | .99 | .99 | .99 |
| 90 | .93 | .94 | .94 | .95 | .95 | .96 | .97 | .97 | .98 | .98 | .98 | .98 | .98 | .99 | .99 | .99 | .99 | .99 |
| 100 | .90 | .91 | .92 | .93 | .93 | .95 | .95 | .96 | .97 | .97 | .97 | .98 | .98 | .98 | .98 | .98 | .98 | .99 |
| 120 | .84 | .86 | .87 | .89 | .90 | .91 | .93 | .94 | .94 | .95 | .96 | .96 | .96 | .97 | .97 | .97 | .97 | .98 |
| 140 | .80 | .82 | .83 | .85 | .86 | .88 | .90 | .91 | .92 | .93 | .94 | .94 | .95 | .95 | .96 | .96 | .96 | .97 |
| 160 | .76 | .78 | .80 | .82 | .83 | .86 | .88 | .89 | .90 | .91 | .92 | .93 | .94 | .94 | .95 | .95 | .95 | .96 |

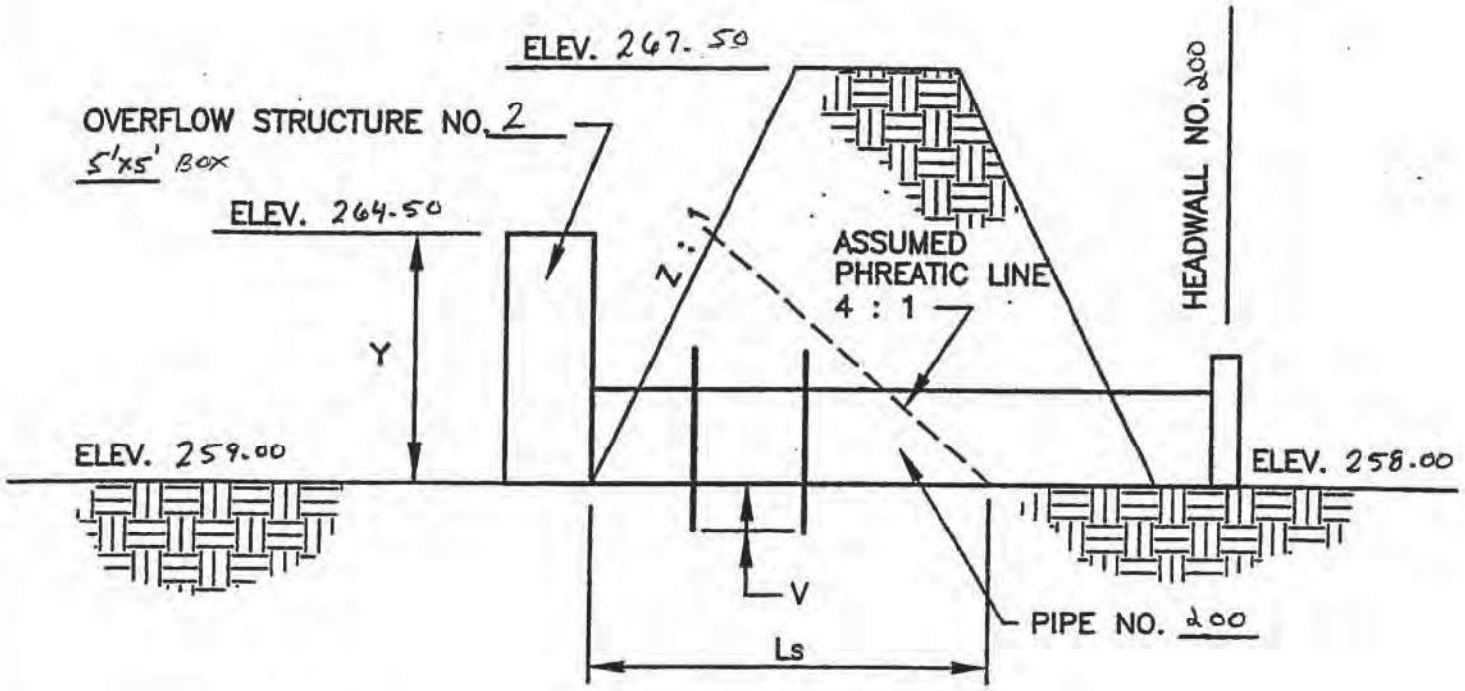
Source: USDA - SCS

**f. Anti-Seep Collar Design**

The seepage of water through the existing sediment pond dam along the carrier pipe could result in dam failure.

The existing anti-seep collars have been designed to be located at intervals within the zone of saturation along the carrier pipe to increase the seepage length along the carrier pipe and thereby prevent piping or seepage along the carrier pipe.

# ANTI – SEEP COLLAR DESIGN




Ls = LENGTH IN SATURATION ZONE

Y = OVERFLOW STRUCTURE HEIGHT = 5.5 FEET

Z = INSIDE SLOPE OF LEVEE = 3

PIPE SLOPE = 0.83 % = 0.0083 FEET/FEET

$$Ls = Y ( Z + 4 ) \left( 1 + \frac{\text{PIPE SLOPE}}{0.25 - \text{PIPE SLOPE}} \right)$$

Ls = 40 FEET

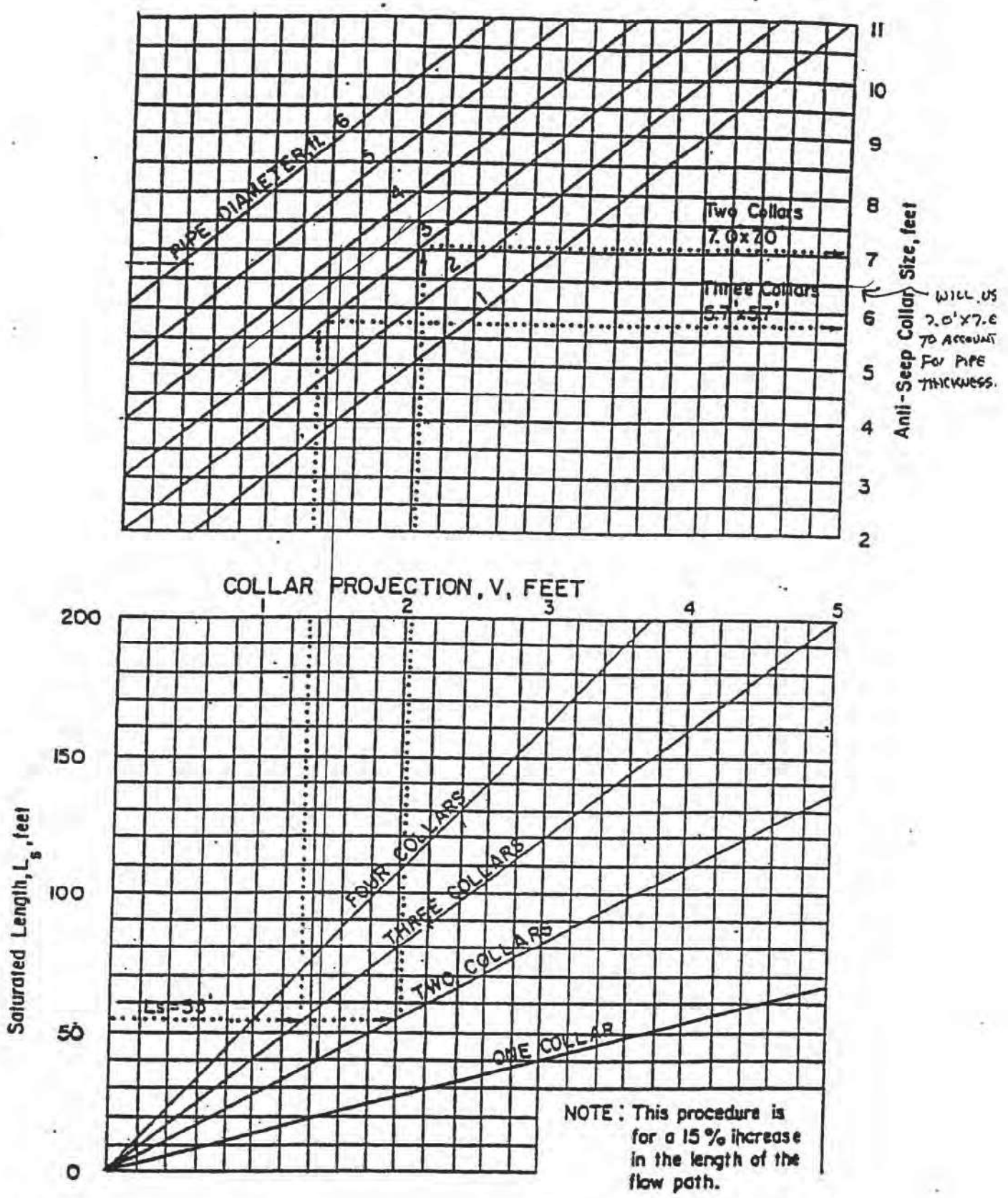
FROM ANTI – SEEP COLLAR DESIGN CHART ON THE NEXT PAGE :

V = COLLAR PROJECTION = 1.45 FEET

DIMENSIONS OF 12" THICK COLLAR = 7.0' x 7.0'

NUMBER OF REQUIRED COLLARS = 2

# ANTI-SEEP COLLAR DESIGN



**g. Overflow Structure Base Foundation Design**

The existing overflow structure and carrier pipe will be subject to a certain amount of buoyant force when the sediment pond is filled with storm water. In order to overcome this buoyant force and prevent the flotation of the overflow structure and carrier pipe, a concrete overflow structure base foundation and concrete carrier pipe encasement have been designed. The design calculations for the concrete overflow structure base foundation and carrier pipe encasement are included in this section.

**OVERFLOW STRUCTURE BASE FOUNDATION DESIGN**

A certain volume of concrete will be used to overcome the buoyancy of an empty overflow structure and carrier pipe that are below the assumed phreatic water surface. This volume is equal to:

Overflow Structure

= (L)(w)(h)(62.4) L = w = 5.0' inside = 6.0' outside

= (6.0)(6.0)(5.5)(62.4) h = height = 5.5'

= 12,355 #

Carrier Pipe = 3.1416($R_2^2$)(Ls)(62.4) Ls = length in saturation zone = 40'

= 3.1416(2.13)(2.13)(40)(62.4) $R_2$ = outside radius = 25.5" = 2.13'

= 35,576 # $r_2$ = inside radius = 21" = 1.75'

TOTAL WEIGHT

= 47,931 # x 1.5 (SAFETY FACTOR)

= 71,896 #

TOTAL REVISED VOLUME OF CONCRETE =

TOTAL WEIGHT / WEIGHT OF CONC. IN WATER

= 71,896/87.6 pcf (87.6 pcf = Wt. of conc. in submerged water)

= 820 C.F.

This volume of concrete will be made up from six areas.

1. Overflow Structures
2. Anti-Seep Collars
3. Carrier Pipe
4. Overflow Structure Base
5. Carrier Pipe Encasement
6. Weight of Saturated Soil Directly Above Carrier Pipe

1. Overflow Structure = $(L_2 - l_2)h$

   $(6.0^2 – 5.0^2)(5.5)$ = 60.5 C.F.

   L = outside dimension of box = 6.0’

   l = inside dimension of box = 5.0’

   h = height of overflow structures = 5.5’

2. Anti-seep collars = area of square collar around carrier pipe x 12" thick x # of collars

   = [( 7.0' x 7.0' ) - $(3.1416)(R_2^2)$

   x 1' x 2

   = 69.5 C.F.

   $R_2$ = outside radius of carrier pipe = 25.5" = 2.13’

   $r_2$ = inside radius of carrier pipe = 21" = 1.75’

3. Carrier Pipe

   = $3.1416 (R_2^2 - r_2^2)$ L = 185 C.F.

   L = length in saturation = 40’

4. Overflow Structure Base = Volume to handle riser bouyance x 1.2

   = (L)(w)h(62.4)(1.2)/weight of conc. in water

   L = w = 6.0’ outside

   h = height = 5.5’

   = (6.0’)(6.0’)(5.5)(62.4)(1.2)/87.6

   = 169 C.F.

   Use 10' x 10' x 2' = 200 C.F.

5. Carrier Pipe Encasement

   Must extend 5’ into dam. Distance from overflow structure to dam is equal to roughly 20.0’. Therefore, encasement length will be 25.0’:

   Use 5.5’ x 3.5’ x 25.0’ long

   Carrier pipe encasement volume = 304 C.F.

*Note: As shown in the construction detail, this encasement extends to the midpoint of the carrier pipe and therefore the entire pipe area is not subtracted from the encasement area.*

6. Weight of Saturated Soil in the Length of Saturation =

   a. Weight of Soil = 100 lbs/C.F.

   b. Weight of Saturated Soil = 100 lbs/C.F. – 62.4 lbs/C.F. = 37 lbs/C.F.

c. Volume of Soil in Length of Saturation over Carrier Pipe = 16 s.f. x 4.26' = 68 C.F.

d. 68 C.F. x 37 lbs/C.F. = 2,522 lbs

e. 2,522 lbs ÷ 87.6 lbs/C.F. = 29 C.F. (equivalent of submerged concrete)

**TOTAL REQUIRED VOLUME = 820 C.F.**

Actual Total Volume:

| | | |
|---|---|---|
| Overflow Structure | = | 60.5 C.F. |
| Anti-Seep Collars | = | 69.5 C.F. |
| Carrier Pipe | = | 185 C.F. |
| Overflow Structure Base | = | 200 C.F. |
| Carrier Pipe Encasement | = | 304 C.F. |
| Weight of Saturated Soil | = | 29.0 C.F. |
| **TOTAL** | **=** | **848 C.F. => Okay** |

# 4. PROPOSED SEDIMENT POND NO. 3

## a. Sediment Storage and Settling Efficiency Calculations

As required in the "Alabama Handbook for Erosion Control, Sediment Control and Stormwater Management on Construction Sites and Urban Area", the sediment storage volume of the pond shall be at least 67 cubic yards per acre for the disturbed area draining into the pond (67 cubic yards is equivalent to ½ inch of sediment per acre of drainage area). The peak inflow rate for the 25 year storm event has also been used to calculate the minimum pond surface area needed for adequate settling efficiency. These calculations for the sediment pond are included below.

Sediment Storage Calculation

Assume maximum sediment from 25 disturbed acres.

25 Acres x 67 c.y./acre = 1,675 c.y. = 45,225 c.f.

This sediment volume corresponds to a depth of 0.58' or Elev. 244.58.

Dewatering opening is set at Elev. 247.00. Therefore, ample sediment storage volume is available.

Settling Efficiency Calculations

- Use 25 year storm event, Q25 Flow = 126 cfs
- Minimum Surface Area = .01 acre / cfs x Q25 Flow
  = .01 acre / cfs x 126 cfs
  = 1.26 acres = 54,886 s.f.
- Top of Overflow Structure = Elev. 251.50
  Surface Area @ Elev. 251.50 = 104,665 s.f.
- Adequate surface area is available for settling

# Pond Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022 Monday, 11 / 4 / 2024

## Pond No. 8 - Pond No. 3

### Pond Data

**Contours -**User-defined contour areas. Average end area method used for volume calculation. Begining Elevation = 244.00 ft

### Stage / Storage Table

| Stage (ft) | Elevation (ft) | Contour area (sqft) | Incr. Storage (cuft) | Total storage (cuft) |
|---|---|---|---|---|
| 0.00 | 244.00 | 74,139 | 0 | 0 |
| 2.00 | 246.00 | 82,017 | 156,156 | 156,156 |
| 3.00 | 247.00 | 86,093 | 84,055 | 240,211 |
| 4.00 | 248.00 | 90,169 | 88,131 | 328,342 |
| 6.00 | 250.00 | 98,356 | 188,525 | 516,867 |
| 7.50 | 251.50 | 104,665 | 152,266 | 669,133 |
| 8.00 | 252.00 | 106,768 | 52,858 | 721,991 |
| 10.00 | 254.00 | 115,442 | 222,210 | 944,201 |

### Culvert / Orifice Structures

| | [A] | [B] | [C] | [PrfRsr] |
|---|---|---|---|---|
| **Rise (in)** | = 36.00 | 6.00 | 0.00 | 0.00 |
| **Span (in)** | = 36.00 | 12.00 | 0.00 | 0.00 |
| **No. Barrels** | = 1 | 1 | 0 | 0 |
| **Invert El. (ft)** | = 247.00 | 247.10 | 0.00 | 0.00 |
| **Length (ft)** | = 100.00 | 0.00 | 0.00 | 0.00 |
| **Slope (%)** | = 11.00 | 0.00 | 0.00 | n/a |
| **N-Value** | = .013 | .013 | .013 | n/a |
| **Orifice Coeff.** | = 0.60 | 0.60 | 0.60 | 0.60 |
| **Multi-Stage** | = n/a | Yes | No | No |

### Weir Structures

| | [A] | [B] | [C] | [D] |
|---|---|---|---|---|
| **Crest Len (ft)** | = 20.00 | 0.00 | 0.00 | 0.00 |
| **Crest El. (ft)** | = 251.50 | 0.00 | 0.00 | 0.00 |
| **Weir Coeff.** | = 3.33 | 3.33 | 3.33 | 3.33 |
| **Weir Type** | = 1 | --- | --- | --- |
| **Multi-Stage** | = Yes | No | No | No |

**Exfil.(in/hr)** = 0.000 (by Wet area)

**TW Elev. (ft)** = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).

### Stage / Storage / Discharge Table

| Stage ft | Storage cuft | Elevation ft | Clv A cfs | Clv B cfs | Clv C cfs | PrfRsr cfs | Wr A cfs | Wr B cfs | Wr C cfs | Wr D cfs | Exfil cfs | User cfs | Total cfs |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.00 | 0 | 244.00 | 0.00 | 0.00 | --- | --- | 0.00 | --- | --- | --- | --- | --- | 0.000 |
| 2.00 | 156,156 | 246.00 | 0.00 | 0.00 | --- | --- | 0.00 | --- | --- | --- | --- | --- | 0.000 |
| 3.00 | 240,211 | 247.00 | 0.00 | 0.00 | --- | --- | 0.00 | --- | --- | --- | --- | --- | 0.000 |
| 4.00 | 328,342 | 248.00 | 1.76 ic | 1.75 ic | --- | --- | 0.00 | --- | --- | --- | --- | --- | 1.747 |
| 6.00 | 516,867 | 250.00 | 3.68 ic | 3.65 ic | --- | --- | 0.00 | --- | --- | --- | --- | --- | 3.654 |
| 7.50 | 669,133 | 251.50 | 4.76 ic | 4.63 ic | --- | --- | 0.00 | --- | --- | --- | --- | --- | 4.632 |
| 8.00 | 721,991 | 252.00 | 27.60 ic | 4.05 ic | --- | --- | 23.55 | --- | --- | --- | --- | --- | 27.60 |
| 10.00 | 944,201 | 254.00 | 79.28 ic | 0.65 ic | --- | --- | 78.60 s | --- | --- | --- | --- | --- | 79.25 |

**b. Total Pond Dewatering at Top of Riser (Elev. 251.50)**

Retention time within the basin is an important factor in effective sediment retention. The overflow structure has been designed as specified below.

The 5' x 5' square concrete overflow structure has one 6" (h) x 12" (w) dewatering weir at elevation 247.00.

The calculation below has been performed to confirm that the dewatering (retention) time within the pond is between 24 and 72 hours. This dewatering time will ensure the storm water is retained for an adequate length of time to allow the sediment to settle (minimum 24 hours) and is also discharged gradually in an acceptable length of time to allow storage for future storm events (maximum 72 hours).

The dewatering time is calculated as follows:

$$T = \frac{A_s \times (2h)^{1/2}}{A_O \times C_d \times (20{,}428)}$$

$A_O$ = Surface Area of Dewatering Holes ($ft^2$)

$A_s$ = Surface Area Corresponding to top of riser elevation ($ft^2$)

h = Head of water above dewatering hole (ft)

$C_d$ = Coefficient of contraction for an orifice (use 0.6)

T = Time to dewater

T = 24 to 72 hours

$A_O$ = 0.50 s.f. = 1 – 6" x 12" rectangular opening at elev. 247.00

$A_s$ = 125,049 s.f. @ Elev. 251.50

h = 251.50 – 247.00 = 4.5'

$$T = \frac{125{,}049\ (2 \times 4.5)^{1/2}}{(0.5)\ (0.6)\ (20{,}428)} = 61.2 \text{ hours}$$

**(Okay between 24- 72 hours)**

**c. Reservoir Routing**

Reservoir routing is determined by using the HydraFlow Hydrographs Extension for AutoCad Civil 3D 2022 Computer Program.

Peak inflow rates (Q) are determined using the SCS Method and HydraFlow Hydrographs Extension for AutoCad Civil 3D 2022 Computer Program. Peak inflow rates are calculated for the 25 year and 100 year storm events and are summarized below.

Q25 = 126 cfs

Q100 = 178 cfs

The bottom of the pond has been set at 244.00. Dewatering of the pond is accomplished by one 6" x 12" rectangular opening beginning at an invert elevation of 247.00.

For routing calculations, a 5'x 5' rectangular riser with one 6" x 12" rectangular opening at an invert elevation of 247.00 was used. The top of the riser is at an elevation of 251.50. The bottom of the pond is elev. 244.00. The invert of the carrier pipe is elev. 247.00. The top of the levee around the sediment pond is at an elevation of 254.00.

The maximum height of sediment is elevation 244.58 which is below the elevation of the first dewatering opening (Elev. 247.00).

Based on the above information the reservoir routing calculations are performed and summarized below.

| STORM YEAR | PEAK INFLOW CFS | PEAK OUTFLOW CFS | PEAK ELEV. FEET |
|---|---|---|---|
| 25 | 126 | 3.8 | 250.26 |
| 100 | 178 | 6.6 | 251.60 |

Based on these routing calculations, the riser is large enough and the pond has sufficient storage volume to retain the sediment from 25 disturbed acres plus the 25 year storm event from the entire drainage area below the crest of the riser (elev. 251.50).

# Pond Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022 Monday, 11 / 4 / 2024

## Pond No. 9 - Pond No. 3-perm pool

### Pond Data

**Contours -**User-defined contour areas. Average end area method used for volume calculation. Begining Elevation = 247.00 ft

### Stage / Storage Table

| Stage (ft) | Elevation (ft) | Contour area (sqft) | Incr. Storage (cuft) | Total storage (cuft) |
|---|---|---|---|---|
| 0.00 | 247.00 | 86,093 | 0 | 0 |
| 1.00 | 248.00 | 90,169 | 88,131 | 88,131 |
| 3.00 | 250.00 | 98,356 | 188,525 | 276,656 |
| 4.50 | 251.50 | 104,665 | 152,266 | 428,922 |
| 5.00 | 252.00 | 106,768 | 52,858 | 481,780 |
| 7.00 | 254.00 | 115,442 | 222,210 | 703,990 |

### Culvert / Orifice Structures

| | [A] | [B] | [C] | [PrfRsr] |
|---|---|---|---|---|
| **Rise (in)** | = 36.00 | 6.00 | 0.00 | 0.00 |
| **Span (in)** | = 36.00 | 12.00 | 0.00 | 0.00 |
| **No. Barrels** | = 1 | 1 | 0 | 0 |
| **Invert El. (ft)** | = 247.00 | 247.10 | 0.00 | 0.00 |
| **Length (ft)** | = 100.00 | 0.00 | 0.00 | 0.00 |
| **Slope (%)** | = 11.00 | 0.00 | 0.00 | n/a |
| **N-Value** | = .013 | .013 | .013 | n/a |
| **Orifice Coeff.** | = 0.60 | 0.60 | 0.60 | 0.60 |
| **Multi-Stage** | = n/a | Yes | No | No |

### Weir Structures

| | [A] | [B] | [C] | [D] |
|---|---|---|---|---|
| **Crest Len (ft)** | = 20.00 | 0.00 | 0.00 | 0.00 |
| **Crest El. (ft)** | = 251.50 | 0.00 | 0.00 | 0.00 |
| **Weir Coeff.** | = 3.33 | 3.33 | 3.33 | 3.33 |
| **Weir Type** | = 1 | --- | --- | --- |
| **Multi-Stage** | = Yes | No | No | No |

**Exfil.(in/hr)** = 0.000 (by Wet area)

**TW Elev. (ft)** = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).

### Stage / Storage / Discharge Table

| Stage ft | Storage cuft | Elevation ft | Clv A cfs | Clv B cfs | Clv C cfs | PrfRsr cfs | Wr A cfs | Wr B cfs | Wr C cfs | Wr D cfs | Exfil cfs | User cfs | Total cfs |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.00 | 0 | 247.00 | 0.00 | 0.00 | --- | --- | 0.00 | --- | --- | --- | --- | --- | 0.000 |
| 1.00 | 88,131 | 248.00 | 1.76 ic | 1.75 ic | --- | --- | 0.00 | --- | --- | --- | --- | --- | 1.747 |
| 3.00 | 276,656 | 250.00 | 3.68 ic | 3.65 ic | --- | --- | 0.00 | --- | --- | --- | --- | --- | 3.654 |
| 4.50 | 428,922 | 251.50 | 4.76 ic | 4.63 ic | --- | --- | 0.00 | --- | --- | --- | --- | --- | 4.632 |
| 5.00 | 481,780 | 252.00 | 27.60 ic | 4.05 ic | --- | --- | 23.55 | --- | --- | --- | --- | --- | 27.60 |
| 7.00 | 703,990 | 254.00 | 79.28 ic | 0.65 ic | --- | --- | 78.60 s | --- | --- | --- | --- | --- | 79.25 |

# Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022

| Hyd. No. | Hydrograph type (origin) | Peak flow (cfs) | Time interval (min) | Time to Peak (min) | Hyd. volume (cuft) | Inflow hyd(s) | Maximum elevation (ft) | Total strge used (cuft) | Hydrograph Description |
|---|---|---|---|---|---|---|---|---|---|
| 69 | SCS Runoff | 11.20 | 1 | 729 | 42,436 | ------ | ------ | ------ | DD No. 12 |
| 70 | SCS Runoff | 12.17 | 1 | 725 | 39,530 | ------ | ------ | ------ | Area to DD No.13 |
| 71 | Combine | 22.69 | 1 | 727 | 81,966 | 69, 70 | ------ | ------ | DD No. 13 |
| 72 | SCS Runoff | 10.81 | 1 | 725 | 33,695 | ------ | ------ | ------ | Area to DD No. 14 |
| 73 | Combine | 33.05 | 1 | 726 | 115,661 | 71, 72 | ------ | ------ | DD No. 14 |
| 74 | SCS Runoff | 10.76 | 1 | 725 | 33,519 | ------ | ------ | ------ | Area to DD No. 15 |
| 75 | Combine | 43.60 | 1 | 725 | 149,180 | 73, 74 | ------ | ------ | DD No. 15 |
| 76 | SCS Runoff | 10.76 | 1 | 725 | 33,519 | ------ | ------ | ------ | Area to DD No. 16 |
| 77 | Combine | 54.36 | 1 | 725 | 182,700 | 75, 76 | ------ | ------ | DD No. 16 |
| 78 | SCS Runoff | 8.328 | 1 | 728 | 30,472 | ------ | ------ | ------ | Ditch No.18 |
| 79 | SCS Runoff | 11.14 | 1 | 727 | 38,491 | ------ | ------ | ------ | Area to Ditch No. 17 |
| 80 | Combine | 72.94 | 1 | 726 | 251,662 | 77, 78, 79 | ------ | ------ | Ditch No. 17 |
| 81 | SCS Runoff | 2.749 | 1 | 722 | 7,538 | ------ | ------ | ------ | Area to Ditch No. 16 |
| 82 | Combine | 74.90 | 1 | 725 | 259,200 | 80, 81 | ------ | ------ | Ditch No. 16 |
| 83 | SCS Runoff | 8.832 | 1 | 725 | 27,521 | ------ | ------ | ------ | DD No. 17 |
| 84 | SCS Runoff | 9.285 | 1 | 725 | 28,932 | ------ | ------ | ------ | Area to DD No. 18 |
| 85 | Combine | 18.12 | 1 | 725 | 56,453 | 83, 84 | ------ | ------ | DD No. 18 |
| 86 | SCS Runoff | 10.42 | 1 | 725 | 32,460 | ------ | ------ | ------ | Area to DD No. 19 |
| 87 | Combine | 28.53 | 1 | 725 | 88,914 | 85, 86 | ------ | ------ | DD No. 19 |
| 88 | SCS Runoff | 6.635 | 1 | 727 | 22,923 | ------ | ------ | ------ | Area to DD No. 20 |
| 89 | Combine | 34.95 | 1 | 725 | 111,837 | 87, 88 | ------ | ------ | DD No. 20 |
| 90 | Combine | 109.84 | 1 | 725 | 371,036 | 82, 89 | ------ | ------ | Pipe No. 301 |
| 91 | SCS Runoff | 16.24 | 1 | 727 | 56,111 | ------ | ------ | ------ | Area to Pond No. 3 |
| 92 | Combine | 125.54 | 1 | 725 | 427,148 | 90, 91 | ------ | ------ | Total Pond No. 3 Inflow |
| 94 | Reservoir | 4.089 | 1 | 1044 | 426,678 | 32 | 274.68 | 402,260 | Pond No. 1 - Perm Pool |
| 95 | Reservoir | 47.08 | 1 | 750 | 546,400 | 32 | 276.41 | 174,201 | Pond No. 1 - Riser |
| 96 | Reservoir | 6.346 | 1 | 968 | 577,268 | 68 | 262.98 | 443,094 | Pond No. 2 - perm pool |
| 97 | Reservoir | 90.13 | 1 | 739 | 640,845 | 68 | 265.75 | 160,287 | Pond No. 2 - riser |
| 98 | Reservoir | 3.837 | 1 | 994 | 368,221 | 92 | 250.26 | 302,667 | Pond No. 3 - perm pool |
| 99 | Reservoir | 60.39 | 1 | 738 | 427,140 | 92 | 252.49 | 107,855 | Pond No. 3 - riser |

# Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022

| Hyd. No. | Hydrograph type (origin) | Peak flow (cfs) | Time interval (min) | Time to Peak (min) | Hyd. volume (cuft) | Inflow hyd(s) | Maximum elevation (ft) | Total strge used (cuft) | Hydrograph Description |
|---|---|---|---|---|---|---|---|---|---|
| 69 | SCS Runoff | 15.88 | 1 | 729 | 60,929 | ------ | ------ | ------ | DD No. 12 |
| 70 | SCS Runoff | 17.26 | 1 | 725 | 56,756 | ------ | ------ | ------ | Area to DD No.13 |
| 71 | Combine | 32.15 | 1 | 727 | 117,685 | 69, 70 | ------ | ------ | DD No. 13 |
| 72 | SCS Runoff | 15.33 | 1 | 724 | 48,379 | ------ | ------ | ------ | Area to DD No. 14 |
| 73 | Combine | 46.84 | 1 | 726 | 166,065 | 71, 72 | ------ | ------ | DD No. 14 |
| 74 | SCS Runoff | 15.25 | 1 | 724 | 48,126 | ------ | ------ | ------ | Area to DD No. 15 |
| 75 | Combine | 61.87 | 1 | 725 | 214,191 | 73, 74 | ------ | ------ | DD No. 15 |
| 76 | SCS Runoff | 15.25 | 1 | 724 | 48,126 | ------ | ------ | ------ | Area to DD No. 16 |
| 77 | Combine | 77.09 | 1 | 725 | 262,316 | 75, 76 | ------ | ------ | DD No. 16 |
| 78 | SCS Runoff | 11.80 | 1 | 728 | 43,751 | ------ | ------ | ------ | Ditch No.18 |
| 79 | SCS Runoff | 15.78 | 1 | 727 | 55,264 | ------ | ------ | ------ | Area to Ditch No. 17 |
| 80 | Combine | 103.35 | 1 | 725 | 361,332 | 77, 78, 79 | ------ | ------ | Ditch No. 17 |
| 81 | SCS Runoff | 3.891 | 1 | 722 | 10,823 | ------ | ------ | ------ | Area to Ditch No. 16 |
| 82 | Combine | 106.29 | 1 | 725 | 372,155 | 80, 81 | ------ | ------ | Ditch No. 16 |
| 83 | SCS Runoff | 12.52 | 1 | 724 | 39,514 | ------ | ------ | ------ | DD No. 17 |
| 84 | SCS Runoff | 13.16 | 1 | 724 | 41,540 | ------ | ------ | ------ | Area to DD No. 18 |
| 85 | Combine | 25.68 | 1 | 724 | 81,054 | 83, 84 | ------ | ------ | DD No. 18 |
| 86 | SCS Runoff | 14.76 | 1 | 724 | 46,606 | ------ | ------ | ------ | Area to DD No. 19 |
| 87 | Combine | 40.44 | 1 | 724 | 127,661 | 85, 86 | ------ | ------ | DD No. 19 |
| 88 | SCS Runoff | 9.396 | 1 | 727 | 32,913 | ------ | ------ | ------ | Area to DD No. 20 |
| 89 | Combine | 49.49 | 1 | 725 | 160,573 | 87, 88 | ------ | ------ | DD No. 20 |
| 90 | Combine | 155.78 | 1 | 725 | 532,728 | 82, 89 | ------ | ------ | Pipe No. 301 |
| 91 | SCS Runoff | 23.00 | 1 | 727 | 80,563 | ------ | ------ | ------ | Area to Pond No. 3 |
| 92 | Combine | 178.11 | 1 | 725 | 613,291 | 90, 91 | ------ | ------ | Total Pond No. 3 Inflow |
| 94 | Reservoir | 17.62 | 1 | 811 | 636,597 | 32 | 275.40 | 488,875 | Pond No. 1 - Perm Pool |
| 95 | Reservoir | 51.87 | 1 | 753 | 784,514 | 32 | 277.14 | 269,027 | Pond No. 1 - Riser |
| 96 | Reservoir | 10.59 | 1 | 935 | 796,183 | 68 | 264.62 | 643,075 | Pond No. 2 - perm pool |
| 97 | Reservoir | 105.39 | 1 | 743 | 920,117 | 68 | 266.33 | 236,670 | Pond No. 2 - riser |
| 98 | Reservoir | 6.626 | 1 | 944 | 501,109 | 92 | 251.60 | 439,224 | Pond No. 3 - perm pool |
| 99 | Reservoir | 69.77 | 1 | 742 | 613,284 | 92 | 252.97 | 160,388 | Pond No. 3 - riser |

**d. Emergency Spillway**

Worst Case

Assume the dewatering opening in the overflow structure is not operating and the starting water surface elevation is at the top of the riser (251.50) at the start of a 100 year storm event.

| | | |
|---|---|---|
| Top of Pond | = | 254.00 |
| Less Required Freeboard | = | 1.00 |
| Maximum Allowable Water Surface Elevation in Emergency Spillway | = | 253.00 |

Re-route the 100 year storm event through the 5'x 5' square overflow structure and 36" diameter carrier pipe.

From Hydrograph Summary Report, Line 99, the maximum flow out of the pond will be 69.8 cfs. The maximum water surface elevation is 252.97 which is less than the maximum allowable water surface elevation of 253.00.

Therefore, the overflow structure and carrier pipe will safely pass the 100 year storm event with a starting water surface elevation at 251.50.

# Pond Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022 Monday, 11 / 4 / 2024

## Pond No. 10 - Pond No. 3-riser

### Pond Data

**Contours -**User-defined contour areas. Average end area method used for volume calculation. Begining Elevation = 251.50 ft

### Stage / Storage Table

| Stage (ft) | Elevation (ft) | Contour area (sqft) | Incr. Storage (cuft) | Total storage (cuft) |
|---|---|---|---|---|
| 0.00 | 251.50 | 104,665 | 0 | 0 |
| 0.50 | 252.00 | 106,768 | 52,858 | 52,858 |
| 2.50 | 254.00 | 115,442 | 222,210 | 275,068 |

### Culvert / Orifice Structures

| | [A] | [B] | [C] | [PrfRsr] |
|---|---|---|---|---|
| **Rise (in)** | = 36.00 | Inactive | Inactive | Inactive |
| **Span (in)** | = 36.00 | 0.00 | 0.00 | 0.00 |
| **No. Barrels** | = 1 | 1 | 0 | 0 |
| **Invert El. (ft)** | = 247.00 | 0.00 | 0.00 | 0.00 |
| **Length (ft)** | = 100.00 | 0.00 | 0.00 | 0.00 |
| **Slope (%)** | = 11.00 | 0.00 | 0.00 | n/a |
| **N-Value** | = .013 | .013 | .013 | n/a |
| **Orifice Coeff.** | = 0.60 | 0.60 | 0.60 | 0.60 |
| **Multi-Stage** | = n/a | Yes | No | No |

### Weir Structures

| | [A] | [B] | [C] | [D] |
|---|---|---|---|---|
| **Crest Len (ft)** | = 20.00 | 0.00 | 0.00 | 0.00 |
| **Crest El. (ft)** | = 251.50 | 0.00 | 0.00 | 0.00 |
| **Weir Coeff.** | = 3.33 | 3.33 | 3.33 | 3.33 |
| **Weir Type** | = 1 | --- | --- | --- |
| **Multi-Stage** | = Yes | No | No | No |

**Exfil.(in/hr)** = 0.000 (by Wet area)

**TW Elev. (ft)** = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).

### Stage / Storage / Discharge Table

| Stage ft | Storage cuft | Elevation ft | Clv A cfs | Clv B cfs | Clv C cfs | PrfRsr cfs | Wr A cfs | Wr B cfs | Wr C cfs | Wr D cfs | Exfil cfs | User cfs | Total cfs |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.00 | 0 | 251.50 | 0.00 | --- | --- | --- | 0.00 | --- | --- | --- | --- | --- | 0.000 |
| 0.50 | 52,858 | 252.00 | 58.94 ic | --- | --- | --- | 23.55 | --- | --- | --- | --- | --- | 23.55 |
| 2.50 | 275,068 | 254.00 | 79.27 ic | --- | --- | --- | 79.25 s | --- | --- | --- | --- | --- | 79.25 |

# Hydrograph Summary Report

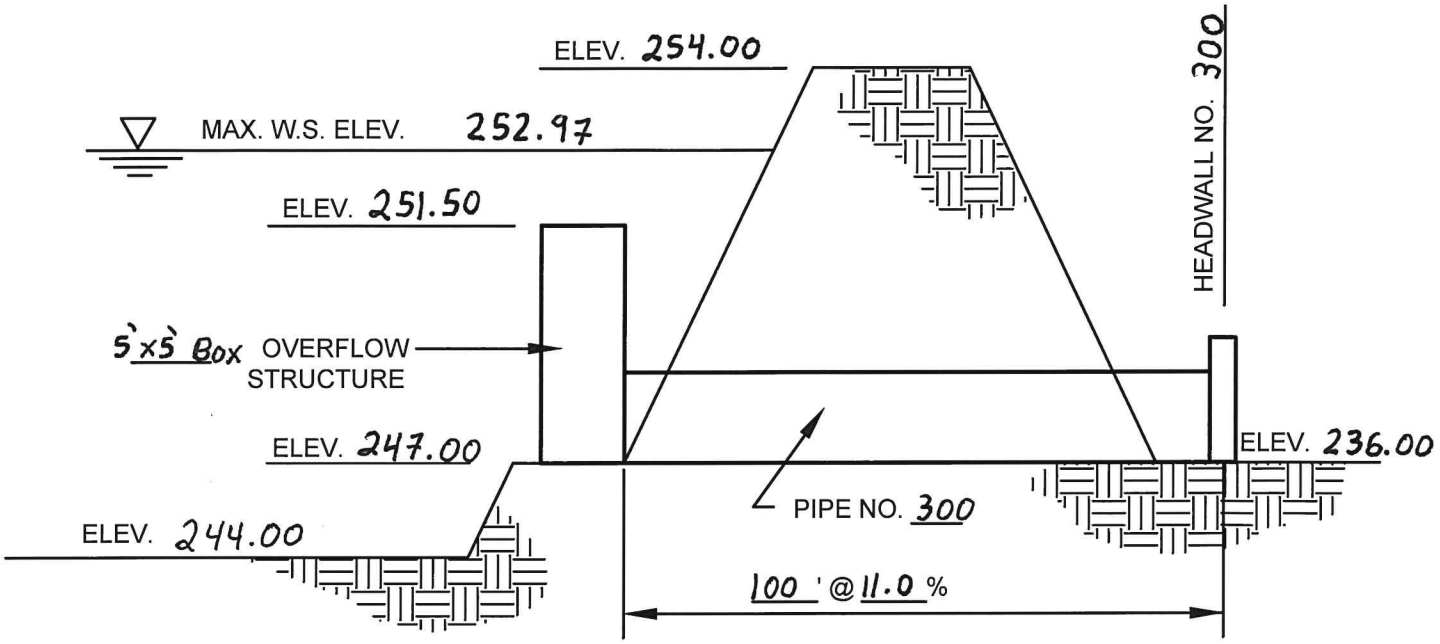
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022

| Hyd. No. | Hydrograph type (origin) | Peak flow (cfs) | Time interval (min) | Time to Peak (min) | Hyd. volume (cuft) | Inflow hyd(s) | Maximum elevation (ft) | Total strge used (cuft) | Hydrograph Description |
|---|---|---|---|---|---|---|---|---|---|
| 69 | SCS Runoff | 15.88 | 1 | 729 | 60,929 | ------ | ------ | ------ | DD No. 12 |
| 70 | SCS Runoff | 17.26 | 1 | 725 | 56,756 | ------ | ------ | ------ | Area to DD No.13 |
| 71 | Combine | 32.15 | 1 | 727 | 117,685 | 69, 70 | ------ | ------ | DD No. 13 |
| 72 | SCS Runoff | 15.33 | 1 | 724 | 48,379 | ------ | ------ | ------ | Area to DD No. 14 |
| 73 | Combine | 46.84 | 1 | 726 | 166,065 | 71, 72 | ------ | ------ | DD No. 14 |
| 74 | SCS Runoff | 15.25 | 1 | 724 | 48,126 | ------ | ------ | ------ | Area to DD No. 15 |
| 75 | Combine | 61.87 | 1 | 725 | 214,191 | 73, 74 | ------ | ------ | DD No. 15 |
| 76 | SCS Runoff | 15.25 | 1 | 724 | 48,126 | ------ | ------ | ------ | Area to DD No. 16 |
| 77 | Combine | 77.09 | 1 | 725 | 262,316 | 75, 76 | ------ | ------ | DD No. 16 |
| 78 | SCS Runoff | 11.80 | 1 | 728 | 43,751 | ------ | ------ | ------ | Ditch No.18 |
| 79 | SCS Runoff | 15.78 | 1 | 727 | 55,264 | ------ | ------ | ------ | Area to Ditch No. 17 |
| 80 | Combine | 103.35 | 1 | 725 | 361,332 | 77, 78, 79 | ------ | ------ | Ditch No. 17 |
| 81 | SCS Runoff | 3.891 | 1 | 722 | 10,823 | ------ | ------ | ------ | Area to Ditch No. 16 |
| 82 | Combine | 106.29 | 1 | 725 | 372,155 | 80, 81 | ------ | ------ | Ditch No. 16 |
| 83 | SCS Runoff | 12.52 | 1 | 724 | 39,514 | ------ | ------ | ------ | DD No. 17 |
| 84 | SCS Runoff | 13.16 | 1 | 724 | 41,540 | ------ | ------ | ------ | Area to DD No. 18 |
| 85 | Combine | 25.68 | 1 | 724 | 81,054 | 83, 84 | ------ | ------ | DD No. 18 |
| 86 | SCS Runoff | 14.76 | 1 | 724 | 46,606 | ------ | ------ | ------ | Area to DD No. 19 |
| 87 | Combine | 40.44 | 1 | 724 | 127,661 | 85, 86 | ------ | ------ | DD No. 19 |
| 88 | SCS Runoff | 9.396 | 1 | 727 | 32,913 | ------ | ------ | ------ | Area to DD No. 20 |
| 89 | Combine | 49.49 | 1 | 725 | 160,573 | 87, 88 | ------ | ------ | DD No. 20 |
| 90 | Combine | 155.78 | 1 | 725 | 532,728 | 82, 89 | ------ | ------ | Pipe No. 301 |
| 91 | SCS Runoff | 23.00 | 1 | 727 | 80,563 | ------ | ------ | ------ | Area to Pond No. 3 |
| 92 | Combine | 178.11 | 1 | 725 | 613,291 | 90, 91 | ------ | ------ | Total Pond No. 3 Inflow |
| 94 | Reservoir | 17.62 | 1 | 811 | 636,597 | 32 | 275.40 | 488,875 | Pond No. 1 - Perm Pool |
| 95 | Reservoir | 51.87 | 1 | 753 | 784,514 | 32 | 277.14 | 269,027 | Pond No. 1 - Riser |
| 96 | Reservoir | 10.59 | 1 | 935 | 796,183 | 68 | 264.62 | 643,075 | Pond No. 2 - perm pool |
| 97 | Reservoir | 105.39 | 1 | 743 | 920,117 | 68 | 266.33 | 236,670 | Pond No. 2 - riser |
| 98 | Reservoir | 6.626 | 1 | 944 | 501,109 | 92 | 251.60 | 439,224 | Pond No. 3 - perm pool |
| 99 | Reservoir | 69.77 | 1 | 742 | 613,284 | 92 | 252.97 | 160,388 | Pond No. 3 - riser |

**e. Overflow Structure and Carrier Pipe Design**

In order to confirm that the overflow structure, carrier pipe and emergency spillway pipe have been designed adequately to pass the maximum flow as modeled in the HydraFlow Hydrographs Extension for AutoCad Civil 3D 2022 Computer Program, the following design calculations have been included.

# OVERFLOW STRUCTURE NO. 3




# DESIGN OF OVERFLOW STRUCTURE AS EMERGENCY SPILLWAY

FLOW (Q) WORST CASE = 100 YEAR STORM EVENT OCCURS WHEN WATER SURFACE ELEVATION AT TOP OF OVERFLOW STRUCTURE AND ALL DEWATERING HOLES ARE PLUGGED

FLOW (Q) MAXIMUM = 68 CFS

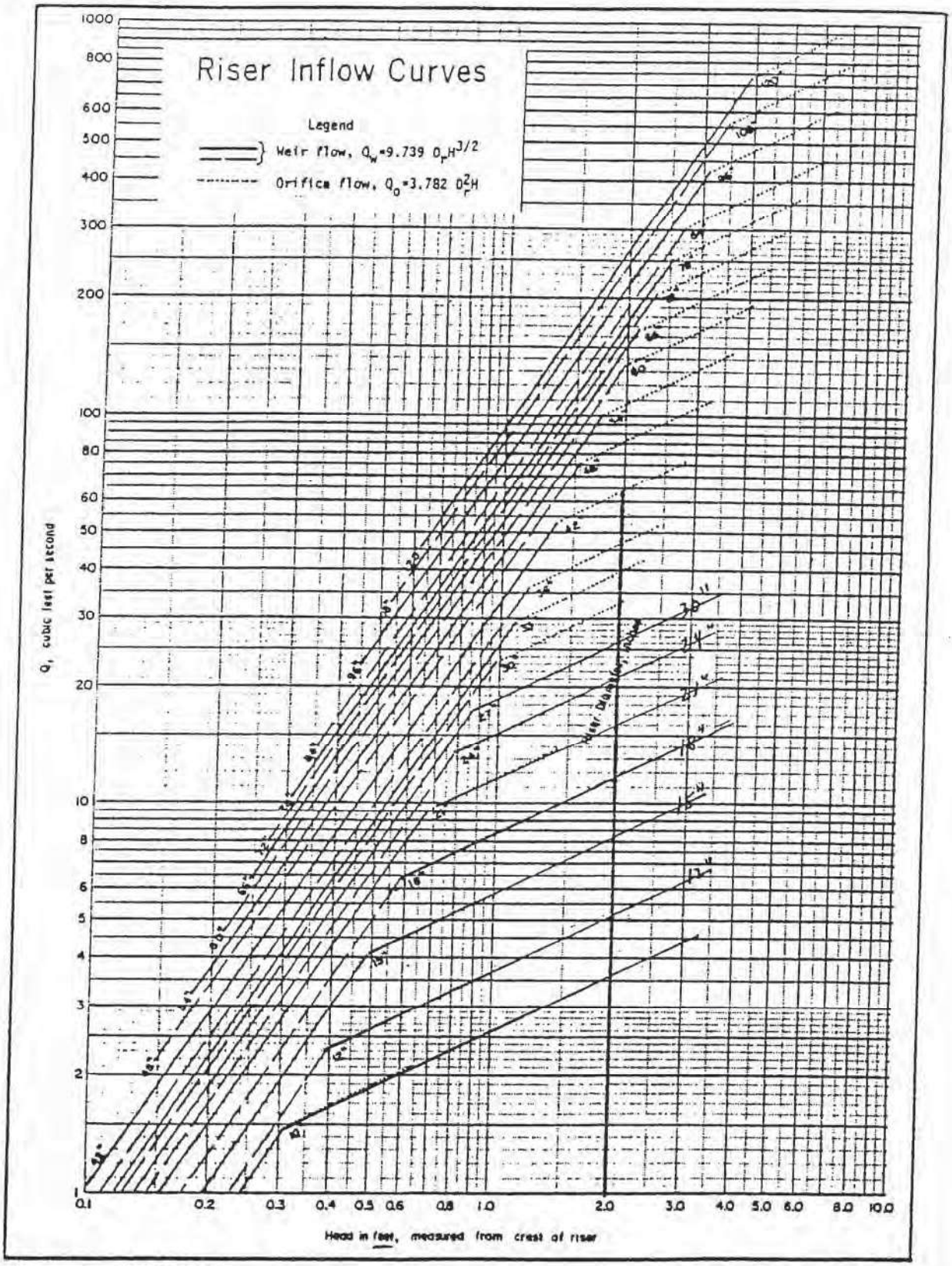
HEAD (H) MAXIMUM = MAXIMUM WATER SURFACE ELEVATION WITH 1' OF FREEBOARD MINUS THE ELEVATION AT THE CREST OF THE OVERFLOW STRUCTURE

=252.97 - 251.50 = 1.47 FEET

BASED ON ABOVE HEAD, USE 5'x5' BOX OVERFLOW STRUCTURE

(SEE CHART ON NEXT PAGE)

& standpipes




Source: USDA-SCS

Plate 1.26h

FIGURE A-10

# CARRIER PIPE NO. 300

Q = 68 CFS WORST CASE

MAXIMUM HEADWATER = TOP OF LEEVE ELEVATION MINUS 1' FREEBOARD
= 254.00 - 1.00 = 253.00

HEAD (H) = MAXIMUM WATER ELEVATION ALLOWED MINUS THE CENTERLINE ELEVATION AT THE DOWNSTREAM END OF THE CARRIER PIPE
= 253.00 - 237.50 = 15.5'

LENGTH (L) = 100'

LENGTH FACTOR = 0.95 FOR LENGTHS OTHER THAN 70'

Q (AVAILABLE) = Q FROM TABLE TIMES LENGTH FACTOR
= 153 X 0.95 = 145

Q (AVAILABLE) MUST BE GREATER THAN Q WORST CASE

**USE 36 " DIAMETER RCP CARRIER PIPE**

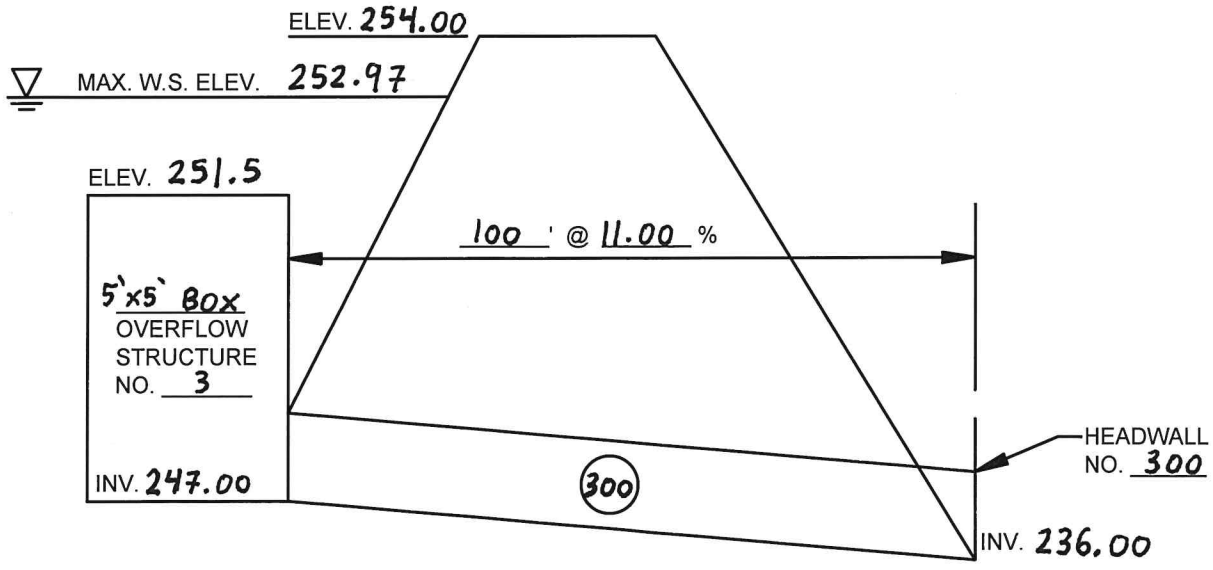


Table 6-25

PIPE FLOW CHART n = 0.025

FOR CORRUGATED METAL PIPE INLET $K_a = K_e + K_o = 1.0$ AND 70 FEET OF CORRUGATED METAL PIPE CONDUIT (full flow assumed)

Note correction factors for pipe lengths other than 70 feet

| H, in feet | diameter of pipe in inches | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 12" | 15" | 18" | 21" | 24" | 30" | 36" | 42" | 48" | 54" | 60" | 66" | 72" | 78" | 84" | 90" | 96" | 102" |
| 1 | 3.22 | 5.44 | 8.29 | 11.8 | 15.9 | 26.0 | 38.6 | 53.8 | 71.4 | 91.5 | 114 | 139 | 167 | 197 | 229 | 264 | 302 | 342 |
| 2 | 4.55 | 7.69 | 11.7 | 16.7 | 22.5 | 36.8 | 54.6 | 76.0 | 101 | 129 | 161 | 197 | 236 | 278 | 324 | 374 | 427 | 483 |
| 3 | 5.57 | 9.42 | 14.4 | 20.4 | 27.5 | 45.0 | 66.9 | 93.1 | 124 | 159 | 198 | 241 | 289 | 341 | 397 | 458 | 523 | 592 |
| 4 | 6.43 | 10.9 | 16.6 | 23.5 | 31.8 | 52.0 | 77.3 | 108 | 143 | 183 | 228 | 278 | 334 | 394 | 459 | 529 | 604 | 683 |
| 5 | 7.19 | 12.2 | 18.5 | 26.3 | 35.5 | 58.1 | 86.4 | 120 | 160 | 205 | 255 | 311 | 373 | 440 | 513 | 591 | 675 | 764 |
| 6 | 7.88 | 13.3 | 20.3 | 28.8 | 38.9 | 67.7 | 94.6 | 132 | 175 | 224 | 280 | 341 | 409 | 482 | 562 | 647 | 739 | 837 |
| 7 | 8.51 | 14.4 | 21.9 | 31.1 | 42.0 | 68.8 | 102 | 142 | 189 | 242 | 302 | 368 | 441 | 521 | 607 | 699 | 798 | 904 |
| 8 | 9.10 | 15.4 | 23.5 | 33.3 | 44.9 | 73.5 | 109 | 152 | 202 | 259 | 323 | 394 | 472 | 557 | 685 | 748 | 854 | 966 |
| 9 | 9.65 | 16.3 | 24.9 | 35.3 | 47.7 | 78.0 | 116 | 161 | 214 | 275 | 342 | 418 | 500 | 590 | 688 | 793 | 905 | 1025 |
| 10 | 10.2 | 17.2 | 26.2 | 37.2 | 50.2 | 82.2 | 122 | 170 | 226 | 289 | 361 | 440 | 527 | 622 | 725 | 836 | 954 | 1080 |
| 11 | 10.7 | 18.0 | 27.5 | 39.0 | 52.7 | 86.2 | 128 | 178 | 237 | 304 | 379 | 462 | 553 | 653 | 761 | 877 | 1001 | 1133 |
| 12 | 11.1 | 18.9 | 28.7 | 40.8 | 55.0 | 90.1 | 134 | 186 | 247 | 317 | 395 | 482 | 578 | 682 | 794 | 916 | 1045 | 1184 |
| 13 | 11.6 | 19.6 | 29.9 | 42.4 | 57.3 | 93.7 | 139 | 194 | 257 | 330 | 411 | 502 | 601 | 710 | 827 | 953 | 1088 | 1232 |
| 14 | 12.0 | 20.4 | 31.0 | 44.1 | 59.4 | 97.3 | 145 | 201 | 267 | 342 | 427 | 521 | 624 | 736 | 858 | 989 | 1129 | 1278 |
| 15 | 12.5 | 21.1 | 32.1 | 45.6 | 61.5 | 101 | 150 | 208 | 277 | 354 | 442 | 539 | 646 | 762 | 886 | 1024 | 1169 | 1323 |
| 16 | 12.9 | 21.8 | 33.2 | 47.1 | 63.5 | 104 | 155 | 215 | 288 | 366 | 457 | 557 | 667 | 787 | 917 | 1057 | 1207 | 1367 |
| 17 | 13.3 | 22.4 | 34.2 | 48.5 | 65.5 | 107 | 159 | 222 | 294 | 377 | 471 | 574 | 688 | 812 | 946 | 1090 | 1244 | 1409 |
| 18 | 13.7 | 23.1 | 35.2 | 49.9 | 67.4 | 110 | 164 | 228 | 303 | 388 | 484 | 591 | 708 | 835 | 973 | 1121 | 1280 | 1450 |
| 19 | 14.0 | 23.8 | 36.1 | 51.3 | 69.2 | 113 | 168 | 234 | 311 | 399 | 497 | 607 | 727 | 858 | 1000 | 1152 | 1315 | 1489 |
| 20 | 14.4 | 24.3 | 37.1 | 52.6 | 71.0 | 116 | 173 | 240 | 319 | 409 | 510 | 623 | 746 | 880 | 1028 | 1182 | 1350 | 1528 |
| 21 | 14.7 | 24.9 | 38.0 | 53.9 | 72.8 | 119 | 177 | 246 | 327 | 419 | 523 | 638 | 764 | 902 | 1051 | 1211 | 1383 | 1566 |
| 22 | 15.1 | 25.5 | 38.9 | 55.2 | 74.5 | 122 | 181 | 252 | 335 | 429 | 535 | 653 | 782 | 923 | 1076 | 1240 | 1415 | 1603 |
| 23 | 15.4 | 26.1 | 39.8 | 56.5 | 76.2 | 125 | 186 | 258 | 342 | 439 | 547 | 668 | 800 | 944 | 1100 | 1268 | 1447 | 1639 |
| 24 | 15.8 | 26.7 | 40.6 | 57.7 | 77.8 | 127 | 189 | 263 | 350 | 448 | 559 | 682 | 817 | 964 | 1123 | 1295 | 1478 | 1674 |
| 25 | 16.1 | 27.2 | 41.5 | 58.9 | 79.4 | 130 | 193 | 269 | 357 | 458 | 571 | 696 | 834 | 984 | 1147 | 1322 | 1509 | 1708 |
| 26 | 16.4 | 27.7 | 42.3 | 60.0 | 81.0 | 133 | 197 | 274 | 364 | 467 | 582 | 710 | 850 | 1004 | 1169 | 1348 | 1539 | 1742 |
| 27 | 16.7 | 28.3 | 43.1 | 61.2 | 82.5 | 135 | 201 | 279 | 371 | 476 | 593 | 723 | 867 | 1023 | 1192 | 1373 | 1568 | 1775 |
| 28 | 17.0 | 28.8 | 43.9 | 62.3 | 84.1 | 138 | 204 | 285 | 378 | 484 | 604 | 737 | 883 | 1041 | 1214 | 1399 | 1597 | 1808 |
| 29 | 17.3 | 29.3 | 44.7 | 63.4 | 85.5 | 140 | 208 | 290 | 384 | 493 | 615 | 750 | 898 | 1060 | 1235 | 1423 | 1625 | 1840 |
| 30 | 17.8 | 29.8 | 45.4 | 64.5 | 87.0 | 142 | 212 | 294 | 391 | 501 | 625 | 763 | 913 | 1078 | 1256 | 1448 | 1653 | 1871 |
| L, in feet | Correction Factors For Other Pipe Lengths | | | | | | | | | | | | | | | | | |
| 20 | 1.30 | 1.24 | 1.21 | 1.18 | 1.15 | 1.12 | 1.10 | 1.08 | 1.07 | 1.06 | 1.05 | 1.04 | 1.04 | 1.03 | 1.03 | 1.03 | 1.03 | 1.03 |
| 30 | 1.22 | 1.18 | 1.15 | 1.13 | 1.12 | 1.09 | 1.08 | 1.06 | 1.05 | 1.05 | 1.04 | 1.04 | 1.03 | 1.03 | 1.03 | 1.02 | 1.02 | 1.02 |
| 40 | 1.15 | 1.13 | 1.11 | 1.10 | 1.08 | 1.07 | 1.05 | 1.05 | 1.04 | 1.03 | 1.03 | 1.03 | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 |
| 50 | 1.09 | 1.08 | 1.07 | 1.06 | 1.05 | 1.04 | 1.04 | 1.03 | 1.03 | 1.02 | 1.02 | 1.02 | 1.02 | 1.01 | 1.01 | 1.01 | 1.01 | 1.01 |
| 60 | 1.04 | 1.04 | 1.03 | 1.03 | 1.03 | 1.02 | 1.02 | 1.02 | 1.01 | 1.01 | 1.01 | 1.01 | 1.01 | 1.01 | 1.01 | 1.01 | 1.01 | 1.01 |
| 70 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 80 | .96 | .97 | .97 | .97 | .98 | .98 | .98 | .99 | .99 | .99 | .99 | .99 | .99 | .99 | .99 | .99 | .99 | .99 |
| 90 | .93 | .94 | .94 | .95 | .95 | .96 | .97 | .97 | .98 | .98 | .98 | .98 | .98 | .99 | .99 | .99 | .99 | .99 |
| 100 | .90 | .91 | .92 | .93 | .93 | .95 | .95 | .96 | .97 | .97 | .97 | .98 | .98 | .98 | .98 | .98 | .98 | .99 |
| 120 | .84 | .86 | .87 | .89 | .90 | .91 | .93 | .94 | .94 | .95 | .96 | .96 | .96 | .97 | .97 | .97 | .97 | .98 |
| 140 | .80 | .82 | .83 | .85 | .86 | .88 | .90 | .91 | .92 | .93 | .94 | .94 | .95 | .95 | .96 | .96 | .96 | .97 |
| 160 | .76 | .78 | .80 | .82 | .83 | .86 | .88 | .89 | .90 | .91 | .92 | .93 | .94 | .94 | .95 | .95 | .95 | .96 |

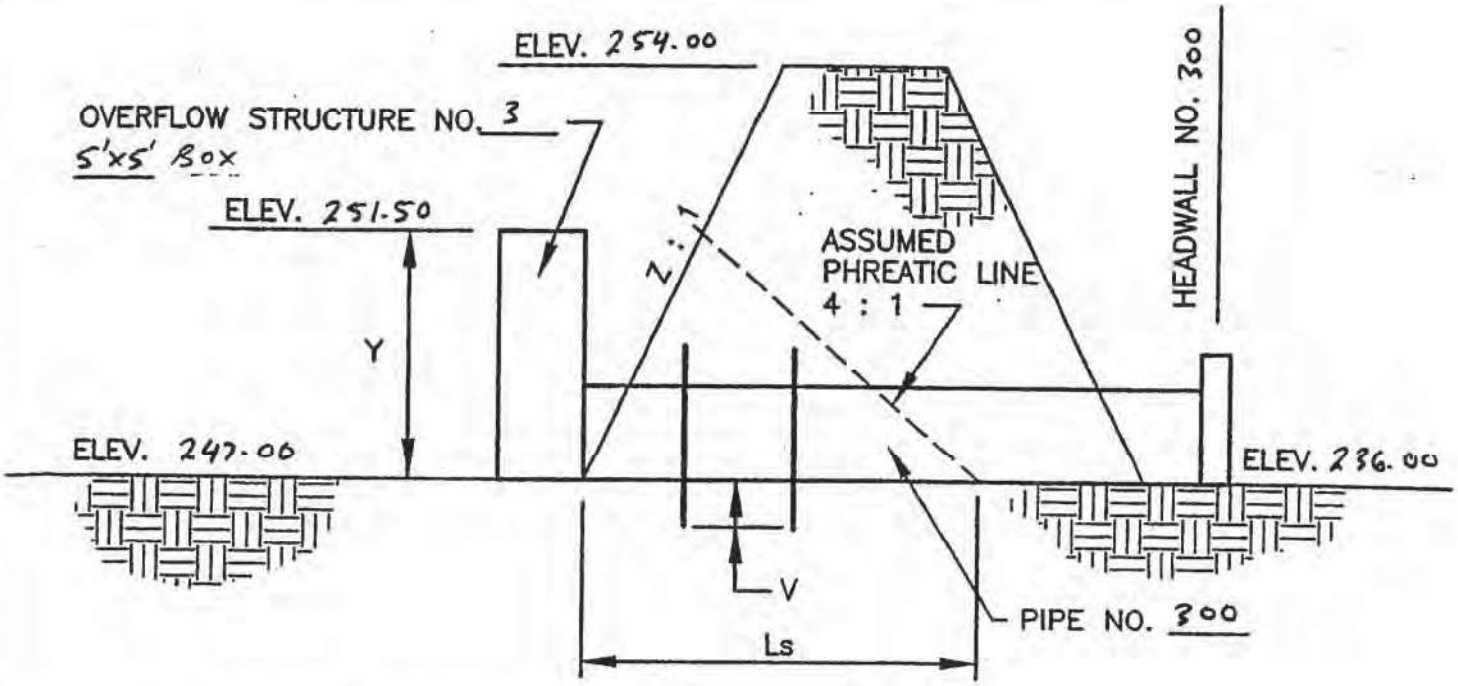
Source: USDA - SCS

**f. Anti-Seep Collar Design**

The seepage of water through the existing sediment pond dam along the carrier pipe could result in dam failure.

The proposed anti-seep collars have been designed to be located at intervals within the zone of saturation along the carrier pipe to increase the seepage length along the carrier pipe and thereby prevent piping or seepage along the carrier pipe.

# ANTI – SEEP COLLAR DESIGN




Ls = LENGTH IN SATURATION ZONE

Y = OVERFLOW STRUCTURE HEIGHT = 4.5 FEET

Z = INSIDE SLOPE OF LEVEE = 3

PIPE SLOPE = 11.00 % = 0.110 FEET/FEET

$$Ls = Y ( Z + 4 ) \left( 1 + \frac{\text{PIPE SLOPE}}{0.25 - \text{PIPE SLOPE}} \right)$$

Ls = 56 FEET

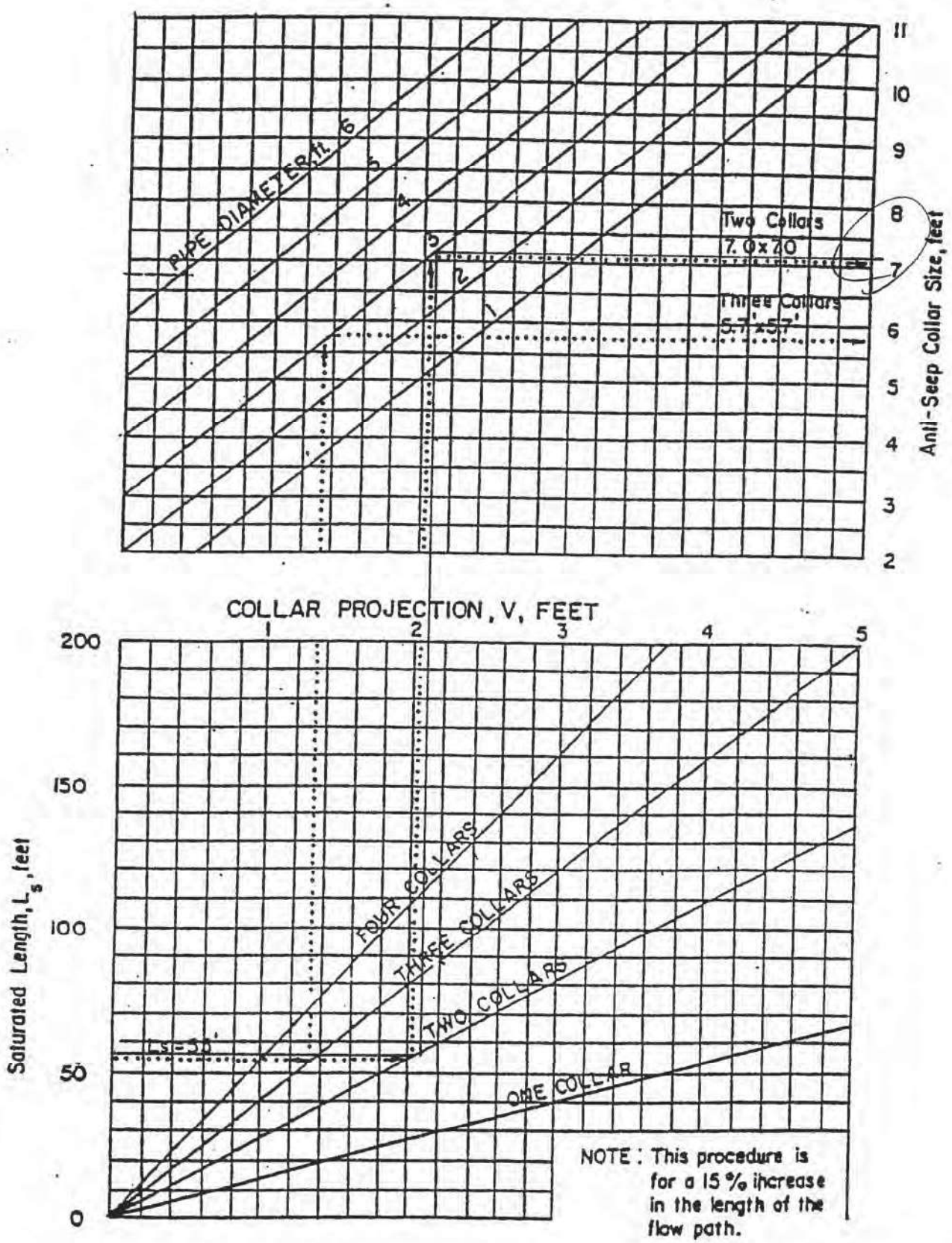
FROM ANTI – SEEP COLLAR DESIGN CHART ON THE NEXT PAGE :

V = COLLAR PROJECTION = 2-1 FEET

DIMENSIONS OF 12" THICK COLLAR = 9'×8'

NUMBER OF REQUIRED COLLARS = 2

# ANTI-SEEP COLLAR DESIGN



**g. Overflow Structure Base Foundation Design**

The overflow structure and carrier pipe will be subject to a certain amount of buoyant force when the sediment pond is filled with storm water. In order to overcome this buoyant force and prevent the flotation of the overflow structure and carrier pipe, a concrete overflow structure base foundation and concrete carrier pipe encasement have been designed. The design calculations for the concrete overflow structure base foundation and carrier pipe encasement are included in this section.

**OVERFLOW STRUCTURE BASE FOUNDATION DESIGN**

A certain volume of concrete will be used to overcome the buoyancy of an empty overflow structure and carrier pipe that are below the assumed phreatic water surface. This volume is equal to:

Overflow Structure

= (L)(w)(h)(62.4) L = w = 5.0' inside = 6.0' outside

= (6.0)(6.0)(4.5)(62.4) h = height = 4.5'

= 10,109 #

Carrier Pipe = 3.1416($R_2^2$)(Ls)(62.4) Ls = length in saturation zone = 56'

= 3.1416(1.83)(1.83)(56)(62.4) $R_2$ = outside radius = 22" = 1.83'

= 36,764 # $r_2$ = inside radius = 18" = 1.50'

TOTAL WEIGHT

= 46,873 # x 1.5 (SAFETY FACTOR)

= 70,309 #

TOTAL REVISED VOLUME OF CONCRETE =

TOTAL WEIGHT / WEIGHT OF CONC. IN WATER

= 70,309/87.6 pcf (87.6 pcf = Wt. of conc. in submerged water)

= 802 C.F.

This volume of concrete will be made up from five areas.

1. Overflow Structures
2. Anti-Seep Collars
3. Carrier Pipe
4. Overflow Structure Base
5. Carrier Pipe Encasement

1. Overflow Structure = $(L_2 - l_2)h$

   $(6.0^2 – 5.0^2)(4.5)$ = 49.5 C.F.

   L = outside dimension of box = 6.0’

   l = inside dimension of box = 5.0’

   h = height of overflow structures = 4.5’

2. Anti-seep collars = area of square collar around carrier pipe x 12" thick x # of collars

   = [( 8.0' x 8.0' ) - $(3.1416)(R_2^2)$]

   x 1' x 2

   = 107 C.F.

   $R_2$ = outside radius of carrier pipe = 22" = 1.83’

   $r_2$ = inside radius of carrier pipe = 18" = 1.5’

3. Carrier Pipe

   = $3.1416 (R_2^2 - r_2^2)$ L = 193 C.F.

   L = length in saturation = 56’

4. Overflow Structure Base = Volume to handle riser bouyance x 1.2

   = (L)(w)h(62.4)(1.2)/weight of conc. in water

   L = w = 6.0’ outside

   h = height = 4.5’

   = (6.0’)(6.0’)(4.5)(62.4)(1.2)/87.6

   = 138 C.F.

   Use 10.0’ x 10.0’ x 3.0’ = 300

5. Carrier Pipe Encasement

   Must extend 5’ into dam. Distance from overflow structure to dam is equal to 13.5’. Therefore, encasement length will be 18.5’.

   $[(4 \times 5) – (3.1416)R_2^2]$ 18.5’

   Carrier pipe encasement volume = 175 C.F.

**TOTAL REQUIRED VOLUME = 802 C.F.**

Actual Total Volume

| | | |
|---|---|---|
| Overflow Structure | = | 49 C.F. |
| Anti-Seep Collars | = | 107 C.F. |
| Carrier Pipe | = | 193 C.F. |
| Overflow Structure Base | = | 300 C.F. |
| Carrier Pipe Encasement | = | 175 C.F. |
| **TOTAL** | **=** | **84 C.F. ⇒ Okay** |

# 5. PROPOSED SEDIMENT POND NO. 4

## a. Sediment Storage and Settling Efficiency Calculations

As required in the "Alabama Handbook for Erosion Control, Sediment Control and Stormwater Management on Construction Sites and Urban Area", the sediment storage volume of the pond shall be at least 67 cubic yards per acre for the disturbed area draining into the pond (67 cubic yards is equivalent to ½ inch of sediment per acre of drainage area). The peak inflow rate for the 25 year storm event has also been used to calculate the minimum pond surface area needed for adequate settling efficiency. These calculations for the sediment pond are included below.

Sediment Storage Calculation

Assume maximum sediment from 50 disturbed acres.

50 Acres x 67 c.y./acre = 3,350 c.y. = 90,450 c.f.

This sediment volume corresponds to a depth of 0.68' or Elev. 224.68.

Dewatering opening is set at Elev. 227.00. Therefore, ample sediment storage volume is available.

Settling Efficiency Calculations

- Use 25 year storm event, Q25 Flow = 246 cfs
- Minimum Surface Area = .01 acre / cfs x Q25 Flow
  = .01 acre / cfs x 246 cfs
  = 2.46 acres = 107,158 s.f
- Top of Overflow Structure = Elev. 231.00
  Surface Area @ Elev. 231.00 = 163,687 s.f.
- Adequate surface area is available for settling

# Pond Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022 Monday, 11 / 4 / 2024

## Pond No. 1 - Pond No. 4

### Pond Data

**Contours -**User-defined contour areas. Average end area method used for volume calculation. Begining Elevation = 224.00 ft

### Stage / Storage Table

| Stage (ft) | Elevation (ft) | Contour area (sqft) | Incr. Storage (cuft) | Total storage (cuft) |
|---|---|---|---|---|
| 0.00 | 224.00 | 127,898 | 0 | 0 |
| 2.00 | 226.00 | 137,880 | 265,778 | 265,778 |
| 3.00 | 227.00 | 143,009 | 140,445 | 406,223 |
| 4.00 | 228.00 | 148,137 | 145,573 | 551,796 |
| 6.00 | 230.00 | 158,428 | 306,565 | 858,361 |
| 7.50 | 231.50 | 166,316 | 243,559 | 1,101,919 |
| 8.00 | 232.00 | 168,945 | 83,815 | 1,185,734 |
| 10.00 | 234.00 | 179,688 | 348,633 | 1,534,367 |

### Culvert / Orifice Structures

| | [A] | [B] | [C] | [PrfRsr] |
|---|---|---|---|---|
| **Rise (in)** | = 48.00 | 6.00 | Inactive | Inactive |
| **Span (in)** | = 48.00 | 12.00 | 0.00 | 0.00 |
| **No. Barrels** | = 1 | 2 | 0 | 0 |
| **Invert El. (ft)** | = 226.00 | 227.10 | 0.00 | 0.00 |
| **Length (ft)** | = 81.00 | 0.00 | 0.00 | 0.00 |
| **Slope (%)** | = 4.94 | 0.00 | 0.00 | n/a |
| **N-Value** | = .013 | .013 | .013 | n/a |
| **Orifice Coeff.** | = 0.60 | 0.60 | 0.60 | 0.60 |
| **Multi-Stage** | = n/a | Yes | No | No |

### Weir Structures

| | [A] | [B] | [C] | [D] |
|---|---|---|---|---|
| **Crest Len (ft)** | = 24.00 | Inactive | Inactive | Inactive |
| **Crest El. (ft)** | = 231.00 | 0.00 | 0.00 | 0.00 |
| **Weir Coeff.** | = 3.33 | 3.33 | 3.33 | 3.33 |
| **Weir Type** | = 1 | --- | --- | --- |
| **Multi-Stage** | = Yes | No | No | No |

**Exfil.(in/hr)** = 0.000 (by Wet area)

**TW Elev. (ft)** = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).

### Stage / Storage / Discharge Table

| Stage ft | Storage cuft | Elevation ft | Clv A cfs | Clv B cfs | Clv C cfs | PrfRsr cfs | Wr A cfs | Wr B cfs | Wr C cfs | Wr D cfs | Exfil cfs | User cfs | Total cfs |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.00 | 0 | 224.00 | 0.00 | 0.00 | --- | --- | 0.00 | --- | --- | --- | --- | --- | 0.000 |
| 2.00 | 265,778 | 226.00 | 0.00 | 0.00 | --- | --- | 0.00 | --- | --- | --- | --- | --- | 0.000 |
| 3.00 | 406,223 | 227.00 | 0.00 | 0.00 | --- | --- | 0.00 | --- | --- | --- | --- | --- | 0.000 |
| 4.00 | 551,796 | 228.00 | 3.88 ic | 3.88 ic | --- | --- | 0.00 | --- | --- | --- | --- | --- | 3.882 |
| 6.00 | 858,361 | 230.00 | 7.97 ic | 7.84 ic | --- | --- | 0.00 | --- | --- | --- | --- | --- | 7.838 |
| 7.50 | 1,101,919 | 231.50 | 36.97 ic | 8.72 ic | --- | --- | 28.26 | --- | --- | --- | --- | --- | 36.97 |
| 8.00 | 1,185,734 | 232.00 | 86.64 ic | 6.72 ic | --- | --- | 79.92 | --- | --- | --- | --- | --- | 86.64 |
| 10.00 | 1,534,367 | 234.00 | 146.56 ic | 1.74 ic | --- | --- | 144.82 s | --- | --- | --- | --- | --- | 146.56 |

**b. Total Pond Dewatering at Top of Riser (Elev. 231.00)**

Retention time within the basin is an important factor in effective sediment retention. The overflow structure has been designed as specified below.

The 6' x 6' square overflow structure has two 6" (h) x 12" (w) dewatering weirs at elevation 227.00.

The calculation below has been performed to confirm that the dewatering (retention) time within the pond is between 24 and 72 hours. This dewatering time will ensure the storm water is retained for an adequate length of time to allow the sediment to settle (minimum 24 hours) and is also discharged gradually in an acceptable length of time to allow storage for future storm events (maximum 72 hours).

The dewatering time is calculated as follows:

$$T = \frac{A_s \times (2h)^{1/2}}{A_O \times C_d \times (20{,}428)}$$

$A_O$ = Surface Area of Dewatering Holes (ft2)

$A_s$ = Surface Area Corresponding to top of riser elevation (ft2)

h = Head of water above dewatering hole (ft)

$C_d$ = Coefficient of contraction for an orifice (use 0.6)

T = Time to dewater

T = 24 to 72 hours

$A_O$ = 1.0 s.f. = 2 – 6" x 12" rectangular openings at elev. 227.00

$A_s$ = 163,687 s.f. @ Elev. 231.00

h = 231.00 – 227.00 = 4.0'

$$T = \frac{163{,}687\ (2 \times 4.0)^{1/2}}{(1.0)\ (0.6)\ (20{,}428)} = 37.8 \text{ hours}$$

**(Okay between 24 – 72 hours)**

**c. Reservoir Routing**

Reservoir routing is determined by using the HydraFlow Hydrographs Extension for AutoCad Civil 3D 2022 Computer Program.

Peak inflow rates (Q) are determined using the SCS Method and HydraFlow Hydrographs Extension for AutoCad Civil 3D 2022 Computer Program. Peak inflow rates are calculated for the 10 year, 25 year and 100 year storm events and are summarized below.

Q25 = 246 cfs

Q100 = 349 cfs

The bottom of the pond has been set at 224.00. Dewatering of the pond is accomplished by two 6" x 12" rectangular openings beginning at an invert elevation of 227.00.

For routing calculations, a 6'x 6' rectangular riser with two 6" x 12" rectangular openings at an invert elevation of 227.00 were used. The top of the riser is at an elevation of 231.00. The bottom of the pond is elev. 224.00. The invert of the carrier pipe is elev. 226.00. The top of the levee around the sediment pond is at an elevation of 234.00.

The maximum height of sediment is elevation 224.68 which is below the elevation of the first dewatering opening (Elev. 227.00). For routing calculations, the starting water surface elevation was set at 227.00, assuming the remainder of the pond bottom is filled below the dewatering orifice invert elevation.

Based on the above information the reservoir routing calculations are performed and summarized below.

| STORM YEAR | PEAK INFLOW CFS | PEAK OUTFLOW CFS | PEAK ELEV. FEET |
|---|---|---|---|
| 25 | 246 | 8.9 | 230.75 |
| 100 | 349 | 38.4 | 231.52 |

Based on these routing calculations, the riser is large enough and the pond has sufficient storage volume to retain the sediment from 50 disturbed acres plus the 25 year storm event from the entire drainage area below the crest of the riser (elev. 231.00).

# Pond Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022 Monday, 11 / 4 / 2024

## Pond No. 2 - Pond No. 4-perm pool

### Pond Data

**Contours -**User-defined contour areas. Average end area method used for volume calculation. Begining Elevation = 227.00 ft

### Stage / Storage Table

| Stage (ft) | Elevation (ft) | Contour area (sqft) | Incr. Storage (cuft) | Total storage (cuft) |
|---|---|---|---|---|
| 0.00 | 227.00 | 143,009 | 0 | 0 |
| 1.00 | 228.00 | 148,137 | 145,573 | 145,573 |
| 3.00 | 230.00 | 158,428 | 306,565 | 452,138 |
| 4.50 | 231.50 | 166,316 | 243,558 | 695,696 |
| 5.00 | 232.00 | 168,945 | 83,815 | 779,511 |
| 7.00 | 234.00 | 179,688 | 348,633 | 1,128,144 |

### Culvert / Orifice Structures

| | [A] | [B] | [C] | [PrfRsr] |
|---|---|---|---|---|
| **Rise (in)** | = 48.00 | 6.00 | Inactive | Inactive |
| **Span (in)** | = 48.00 | 12.00 | 0.00 | 0.00 |
| **No. Barrels** | = 1 | 2 | 0 | 0 |
| **Invert El. (ft)** | = 226.00 | 227.10 | 0.00 | 0.00 |
| **Length (ft)** | = 81.00 | 0.00 | 0.00 | 0.00 |
| **Slope (%)** | = 4.94 | 0.00 | 0.00 | n/a |
| **N-Value** | = .013 | .013 | .013 | n/a |
| **Orifice Coeff.** | = 0.60 | 0.60 | 0.60 | 0.60 |
| **Multi-Stage** | = n/a | Yes | No | No |

### Weir Structures

| | [A] | [B] | [C] | [D] |
|---|---|---|---|---|
| **Crest Len (ft)** | = 24.00 | Inactive | Inactive | Inactive |
| **Crest El. (ft)** | = 231.00 | 0.00 | 0.00 | 0.00 |
| **Weir Coeff.** | = 3.33 | 3.33 | 3.33 | 3.33 |
| **Weir Type** | = 1 | --- | --- | --- |
| **Multi-Stage** | = Yes | No | No | No |

**Exfil.(in/hr)** = 0.000 (by Wet area)

**TW Elev. (ft)** = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).

### Stage / Storage / Discharge Table

| Stage ft | Storage cuft | Elevation ft | Clv A cfs | Clv B cfs | Clv C cfs | PrfRsr cfs | Wr A cfs | Wr B cfs | Wr C cfs | Wr D cfs | Exfil cfs | User cfs | Total cfs |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.00 | 0 | 227.00 | 0.00 | 0.00 | --- | --- | 0.00 | --- | --- | --- | --- | --- | 0.000 |
| 1.00 | 145,573 | 228.00 | 8.47 ic | 3.88 ic | --- | --- | 0.00 | --- | --- | --- | --- | --- | 3.882 |
| 3.00 | 452,138 | 230.00 | 8.47 ic | 7.84 ic | --- | --- | 0.00 | --- | --- | --- | --- | --- | 7.838 |
| 4.50 | 695,696 | 231.50 | 36.97 ic | 8.72 ic | --- | --- | 28.26 | --- | --- | --- | --- | --- | 36.97 |
| 5.00 | 779,511 | 232.00 | 86.64 ic | 6.72 ic | --- | --- | 79.92 | --- | --- | --- | --- | --- | 86.64 |
| 7.00 | 1,128,144 | 234.00 | 146.57 ic | 1.74 ic | --- | --- | 144.78 s | --- | --- | --- | --- | --- | 146.52 |

# Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022

| Hyd. No. | Hydrograph type (origin) | Peak flow (cfs) | Time interval (min) | Time to Peak (min) | Hyd. volume (cuft) | Inflow hyd(s) | Maximum elevation (ft) | Total strge used (cuft) | Hydrograph Description |
|---|---|---|---|---|---|---|---|---|---|
| 35 | Combine | 43.00 | 1 | 726 | 142,305 | 33, 34 | ------ | ------ | DD No. 31 |
| 36 | SCS Runoff | 3.169 | 1 | 727 | 10,948 | ------ | ------ | ------ | Area to Ditch No. 11 |
| 37 | Combine | 129.84 | 1 | 726 | 437,976 | 28, 35, 36 | ------ | ------ | Ditch No. 11 |
| 38 | SCS Runoff | 4.711 | 1 | 728 | 17,238 | ------ | ------ | ------ | Area to Ditch No. 12 |
| 39 | Combine | 134.40 | 1 | 726 | 455,215 | 37, 38 | ------ | ------ | Ditch No. 12 |
| 40 | SCS Runoff | 8.322 | 1 | 725 | 25,933 | ------ | ------ | ------ | DD No. 27 |
| 41 | Combine | 142.42 | 1 | 726 | 481,148 | 39, 40 | ------ | ------ | Pipe 402 |
| 43 | SCS Runoff | 34.97 | 1 | 723 | 101,958 | ------ | ------ | ------ | Area to Pond No. 4 |
| 44 | Combine | 245.69 | 1 | 725 | 843,929 | 16, 41, 43 | ------ | ------ | Total Pond No. 4 Inflow |
| 46 | Reservoir | 8.882 | 1 | 957 | 781,304 | 44 | 230.75 | 574,397 | Pond No. 4 - perm pool |
| 47 | Reservoir | 112.06 | 1 | 739 | 843,921 | 44 | 232.34 | 225,133 | Pond No. 4 - riser |

# Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022

| Hyd. No. | Hydrograph type (origin) | Peak flow (cfs) | Time interval (min) | Time to Peak (min) | Hyd. volume (cuft) | Inflow hyd(s) | Maximum elevation (ft) | Total strge used (cuft) | Hydrograph Description |
|---|---|---|---|---|---|---|---|---|---|
| 35 | Combine | 60.89 | 1 | 726 | 204,318 | 33, 34 | ------ | ------ | DD No. 31 |
| 36 | SCS Runoff | 4.488 | 1 | 727 | 15,720 | ------ | ------ | ------ | Area to Ditch No. 11 |
| 37 | Combine | 183.97 | 1 | 726 | 628,838 | 28, 35, 36 | ------ | ------ | Ditch No. 11 |
| 38 | SCS Runoff | 6.677 | 1 | 728 | 24,751 | ------ | ------ | ------ | Area to Ditch No. 12 |
| 39 | Combine | 190.46 | 1 | 726 | 653,589 | 37, 38 | ------ | ------ | Ditch No. 12 |
| 40 | SCS Runoff | 11.80 | 1 | 724 | 37,234 | ------ | ------ | ------ | DD No. 27 |
| 41 | Combine | 201.77 | 1 | 726 | 690,823 | 39, 40 | ------ | ------ | Pipe 402 |
| 43 | SCS Runoff | 49.56 | 1 | 723 | 146,389 | ------ | ------ | ------ | Area to Pond No. 4 |
| 44 | Combine | 348.61 | 1 | 725 | 1,211,698 | 16, 41, 43 | ------ | ------ | Total Pond No. 4 Inflow |
| 46 | Reservoir | 38.38 | 1 | 775 | 1,134,598 | 44 | 231.52 | 698,508 | Pond No. 4 - perm pool |
| 47 | Reservoir | 129.99 | 1 | 743 | 1,211,694 | 44 | 232.97 | 335,116 | Pond No. 4 - riser |

**d. Emergency Spillway**

Worst Case

Assume the dewatering opening in the overflow structure is not operating and the starting water surface elevation is at the top of the riser (231.00) at the start of a 100 year storm event.

| | | |
|---|---|---|
| Top of Pond | = | 234.00 |
| Less Required Freeboard | = | 1.00 |
| Maximum Allowable Water Surface Elevation in Emergency Spillway | = | 233.00 |

Re-route the 100 year storm event through the 6'x 6' square overflow structure and 48" diameter carrier pipe.

From Hydrograph Summary Report, Line 47, the maximum flow out of the pond will be 130 cfs. The maximum water surface elevation is 232.97 which is less than to the maximum allowable water surface elevation of 233.00.

Therefore, the overflow structure and carrier pipe will safely pass the 100 year storm event with a starting water surface elevation at 231.00.

# Pond Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022 Monday, 11 / 4 / 2024

## Pond No. 3 - Pond No. 4-riser

### Pond Data

**Contours -**User-defined contour areas. Average end area method used for volume calculation. Begining Elevation = 231.00 ft

### Stage / Storage Table

| Stage (ft) | Elevation (ft) | Contour area (sqft) | Incr. Storage (cuft) | Total storage (cuft) |
|---|---|---|---|---|
| 0.00 | 231.00 | 163,687 | 0 | 0 |
| 1.00 | 232.00 | 168,945 | 166,316 | 166,316 |
| 3.00 | 234.00 | 179,688 | 348,633 | 514,949 |

### Culvert / Orifice Structures

| | [A] | [B] | [C] | [PrfRsr] |
|---|---|---|---|---|
| **Rise (in)** | = 48.00 | Inactive | Inactive | Inactive |
| **Span (in)** | = 48.00 | 0.00 | 0.00 | 0.00 |
| **No. Barrels** | = 1 | 1 | 0 | 0 |
| **Invert El. (ft)** | = 226.00 | 0.00 | 0.00 | 0.00 |
| **Length (ft)** | = 81.00 | 0.00 | 0.00 | 0.00 |
| **Slope (%)** | = 4.94 | 0.00 | 0.00 | n/a |
| **N-Value** | = .013 | .013 | .013 | n/a |
| **Orifice Coeff.** | = 0.60 | 0.60 | 0.60 | 0.60 |
| **Multi-Stage** | = n/a | Yes | No | No |

### Weir Structures

| | [A] | [B] | [C] | [D] |
|---|---|---|---|---|
| **Crest Len (ft)** | = 24.00 | Inactive | Inactive | Inactive |
| **Crest El. (ft)** | = 231.00 | 0.00 | 0.00 | 0.00 |
| **Weir Coeff.** | = 3.33 | 3.33 | 3.33 | 3.33 |
| **Weir Type** | = 1 | --- | --- | --- |
| **Multi-Stage** | = Yes | No | No | No |

**Exfil.(in/hr)** = 0.000 (by Wet area)

**TW Elev. (ft)** = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).

### Stage / Storage / Discharge Table

| Stage ft | Storage cuft | Elevation ft | Clv A cfs | Clv B cfs | Clv C cfs | PrfRsr cfs | Wr A cfs | Wr B cfs | Wr C cfs | Wr D cfs | Exfil cfs | User cfs | Total cfs |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.00 | 0 | 231.00 | 0.00 | --- | --- | --- | 0.00 | --- | --- | --- | --- | --- | 0.000 |
| 1.00 | 166,316 | 232.00 | 104.79 ic | --- | --- | --- | 79.92 | --- | --- | --- | --- | --- | 79.92 |
| 3.00 | 514,949 | 234.00 | 146.51 ic | --- | --- | --- | 146.51 s | --- | --- | --- | --- | --- | 146.51 |

# Hydrograph Summary Report

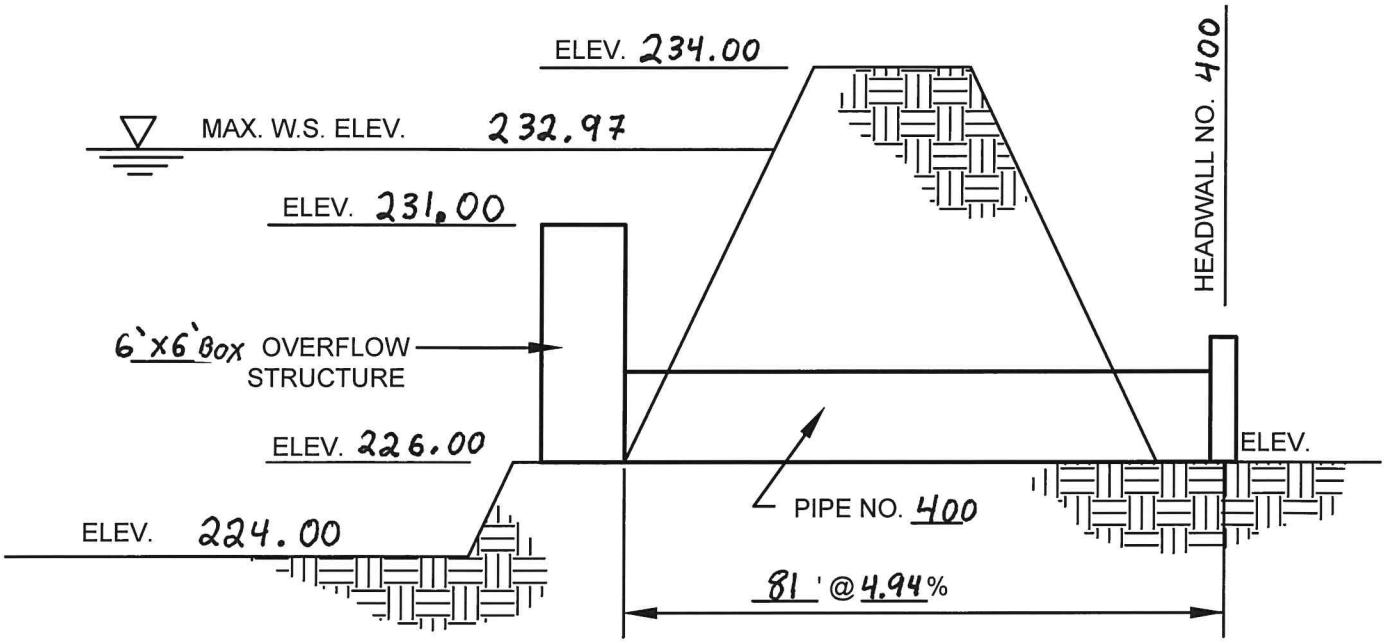
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022

| Hyd. No. | Hydrograph type (origin) | Peak flow (cfs) | Time interval (min) | Time to Peak (min) | Hyd. volume (cuft) | Inflow hyd(s) | Maximum elevation (ft) | Total strge used (cuft) | Hydrograph Description |
|---|---|---|---|---|---|---|---|---|---|
| 35 | Combine | 60.89 | 1 | 726 | 204,318 | 33, 34 | ------ | ------ | DD No. 31 |
| 36 | SCS Runoff | 4.488 | 1 | 727 | 15,720 | ------ | ------ | ------ | Area to Ditch No. 11 |
| 37 | Combine | 183.97 | 1 | 726 | 628,838 | 28, 35, 36 | ------ | ------ | Ditch No. 11 |
| 38 | SCS Runoff | 6.677 | 1 | 728 | 24,751 | ------ | ------ | ------ | Area to Ditch No. 12 |
| 39 | Combine | 190.46 | 1 | 726 | 653,589 | 37, 38 | ------ | ------ | Ditch No. 12 |
| 40 | SCS Runoff | 11.80 | 1 | 724 | 37,234 | ------ | ------ | ------ | DD No. 27 |
| 41 | Combine | 201.77 | 1 | 726 | 690,823 | 39, 40 | ------ | ------ | Pipe 402 |
| 43 | SCS Runoff | 49.56 | 1 | 723 | 146,389 | ------ | ------ | ------ | Area to Pond No. 4 |
| 44 | Combine | 348.61 | 1 | 725 | 1,211,698 | 16, 41, 43 | ------ | ------ | Total Pond No. 4 Inflow |
| 46 | Reservoir | 38.38 | 1 | 775 | 1,134,598 | 44 | 231.52 | 698,508 | Pond No. 4 - perm pool |
| 47 | Reservoir | 129.99 | 1 | 743 | 1,211,694 | 44 | 232.97 | 335,116 | Pond No. 4 - riser |

**e. Overflow Structure and Carrier Pipe Design**

In order to confirm that the overflow structure, carrier pipe and emergency spillway pipe have been designed adequately to pass the maximum flow as modeled in the HydraFlow Hydrographs Extension for AutoCad Civil 3D 2022 Computer Program, the following design calculations have been included.

# OVERFLOW STRUCTURE NO. 4




# DESIGN OF OVERFLOW STRUCTURE AS EMERGENCY SPILLWAY

FLOW (Q) WORST CASE = 100 YEAR STORM EVENT OCCURS WHEN WATER SURFACE ELEVATION AT TOP OF OVERFLOW STRUCTURE AND ALL DEWATERING HOLES ARE PLUGGED

FLOW (Q) MAXIMUM = 130 CFS

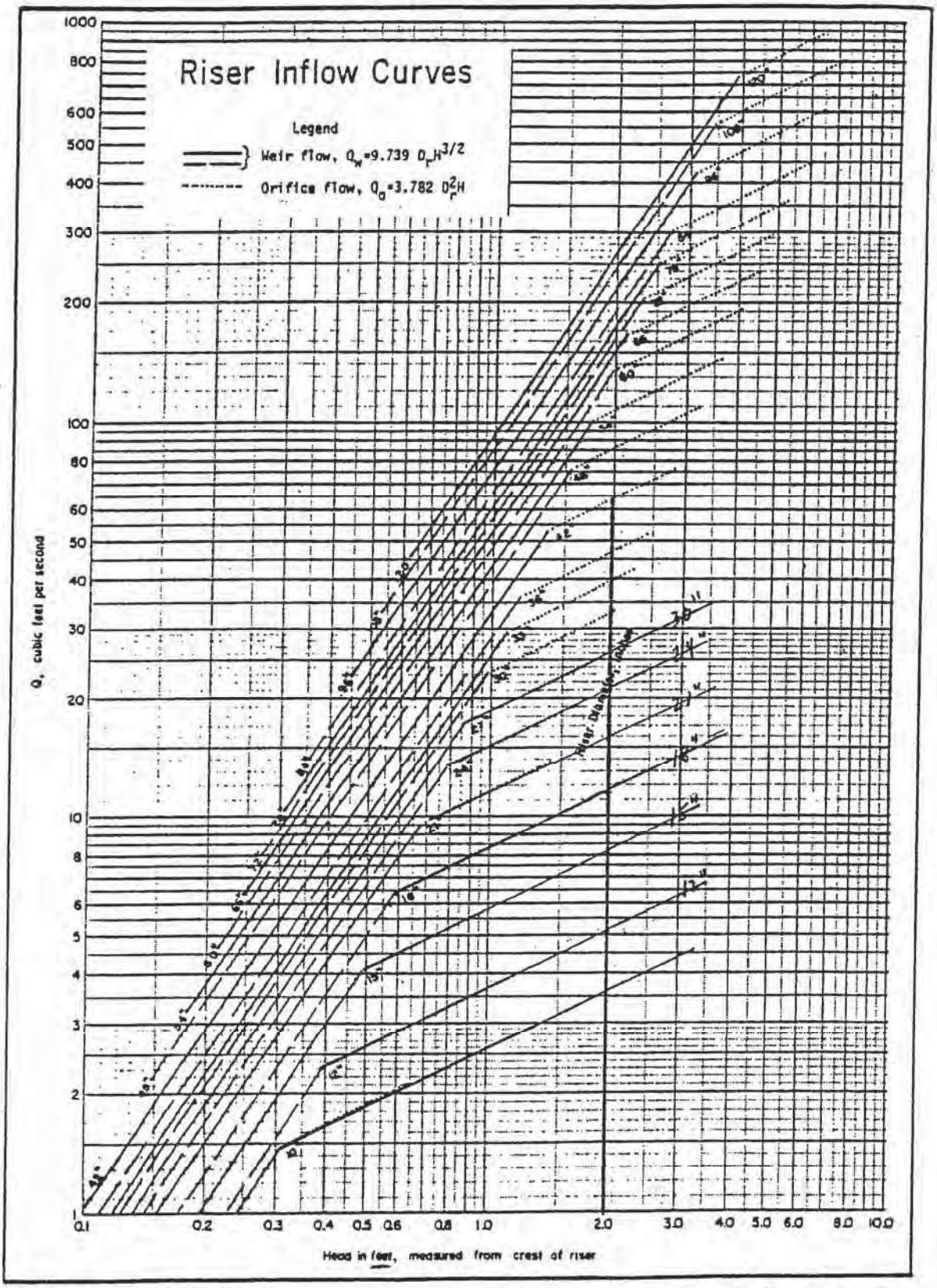
HEAD (H) MAXIMUM = MAXIMUM WATER SURFACE ELEVATION WITH 1' OF FREEBOARD MINUS THE ELEVATION AT THE CREST OF THE OVERFLOW STRUCTURE

= 232.97 - 231.00 = 1.97 FEET

BASED ON ABOVE HEAD, USE 6'x6' Box OVERFLOW STRUCTURE

(SEE CHART ON NEXT PAGE)

& stand pipes




Source: USDA-SCS

Plate 1.26h

FIGURE A-10

Table 6-23

# CARRIER PIPE NO. 400

Q = 130 CFS WORST CASE

MAXIMUM HEADWATER = TOP OF LEEVE ELEVATION MINUS 1' FREEBOARD
= 234.00 - 1.00 = 233.00

HEAD (H) = MAXIMUM WATER ELEVATION ALLOWED MINUS THE CENTERLINE ELEVATION AT THE DOWNSTREAM END OF THE CARRIER PIPE
= 233.00 - 224.00 = 9.00

LENGTH (L) = 81

LENGTH FACTOR = 0.99 FOR LENGTHS OTHER THAN 70'

Q (AVAILABLE) = Q FROM TABLE TIMES LENGTH FACTOR
= 214 X 0.99 = 212

Q (AVAILABLE) MUST BE GREATER THAN Q WORST CASE

**USE 48" DIAMETER RCP CARRIER PIPE**

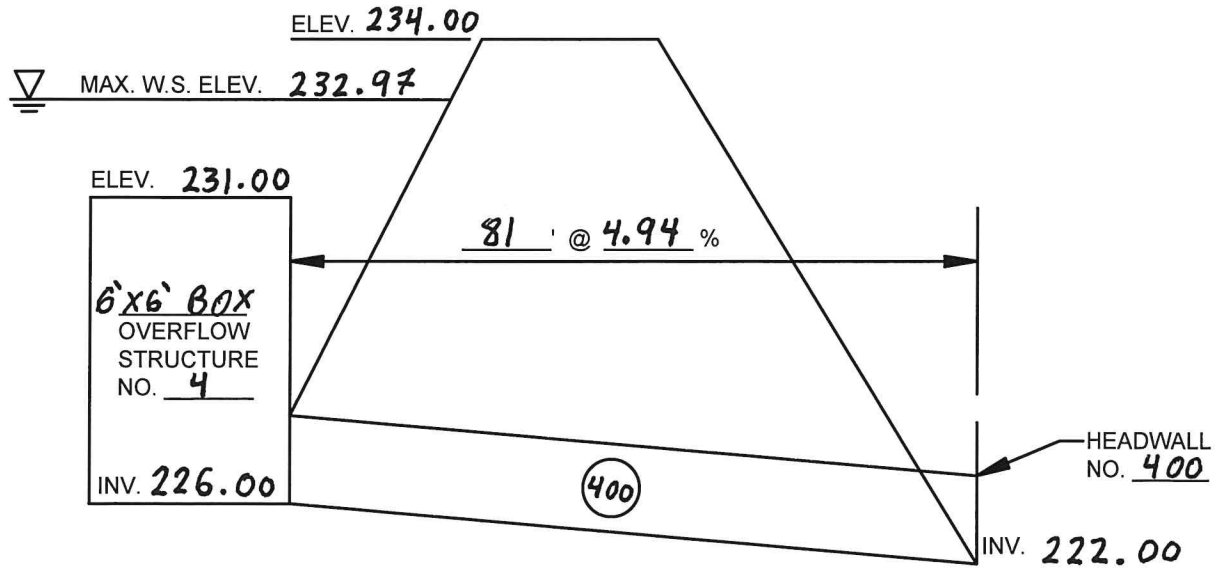


Table 6-25

PIPE FLOW CHART n = 0.025

FOR CORRUGATED METAL PIPE INLET $K_e = K_o + K_b = 1.0$ AND 70 FEET OF CORRUGATED METAL PIPE CONDUIT (full flow assumed)

Note correction factors for pipe lengths other than 70 feet

| H, in feet | diameter of pipe in inches | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 12" | 15" | 18" | 21" | 24" | 30" | 36" | 42" | 48" | 54" | 60" | 66" | 72" | 78" | 84" | 90" | 96" | 102" |
| 1 | 3.22 | 5.44 | 8.29 | 11.8 | 15.9 | 26.0 | 38.6 | 53.8 | 71.4 | 91.5 | 114 | 139 | 167 | 197 | 229 | 264 | 302 | 342 |
| 2 | 4.55 | 7.69 | 11.7 | 16.7 | 22.5 | 36.8 | 54.6 | 76.0 | 101 | 129 | 161 | 197 | 236 | 278 | 324 | 374 | 427 | 483 |
| 3 | 5.57 | 9.42 | 14.4 | 20.4 | 27.5 | 45.0 | 66.9 | 93.1 | 124 | 159 | 198 | 241 | 289 | 341 | 397 | 458 | 523 | 592 |
| 4 | 6.43 | 10.9 | 16.6 | 23.5 | 31.8 | 52.0 | 77.3 | 108 | 143 | 183 | 228 | 278 | 334 | 394 | 459 | 529 | 604 | 683 |
| 5 | 7.19 | 12.2 | 18.5 | 26.3 | 35.5 | 58.1 | 86.4 | 120 | 160 | 205 | 255 | 311 | 373 | 440 | 513 | 591 | 675 | 764 |
| 6 | 7.88 | 13.3 | 20.3 | 28.8 | 38.9 | 67.7 | 94.6 | 132 | 175 | 224 | 280 | 341 | 409 | 482 | 562 | 647 | 739 | 837 |
| 7 | 8.51 | 14.4 | 21.9 | 31.1 | 42.0 | 68.8 | 102 | 142 | 189 | 242 | 302 | 368 | 441 | 521 | 607 | 699 | 798 | 904 |
| 8 | 9.10 | 15.4 | 23.5 | 33.3 | 44.9 | 73.5 | 109 | 152 | 202 | 259 | 323 | 394 | 472 | 557 | 685 | 748 | 854 | 966 |
| 9 | 9.65 | 16.3 | 24.9 | 35.3 | 47.7 | 78.0 | 116 | 161 | 214 | 275 | 342 | 418 | 500 | 590 | 688 | 793 | 905 | 1025 |
| 10 | 10.2 | 17.2 | 26.2 | 37.2 | 50.2 | 82.2 | 122 | 170 | 226 | 289 | 361 | 440 | 527 | 622 | 725 | 836 | 954 | 1080 |
| 11 | 10.7 | 18.0 | 27.5 | 39.0 | 52.7 | 86.2 | 128 | 178 | 237 | 304 | 379 | 462 | 553 | 653 | 761 | 877 | 1001 | 1133 |
| 12 | 11.1 | 18.9 | 28.7 | 40.8 | 55.0 | 90.1 | 134 | 186 | 247 | 317 | 395 | 482 | 578 | 682 | 794 | 916 | 1045 | 1184 |
| 13 | 11.8 | 19.6 | 29.9 | 42.4 | 57.3 | 93.7 | 139 | 194 | 257 | 330 | 411 | 502 | 601 | 710 | 827 | 953 | 1088 | 1232 |
| 14 | 12.0 | 20.4 | 31.0 | 44.1 | 59.4 | 97.3 | 145 | 201 | 267 | 342 | 427 | 521 | 624 | 736 | 858 | 989 | 1129 | 1278 |
| 15 | 12.5 | 21.1 | 32.1 | 45.6 | 61.5 | 101 | 150 | 208 | 277 | 354 | 442 | 539 | 646 | 762 | 888 | 1024 | 1169 | 1323 |
| 16 | 12.9 | 21.8 | 33.2 | 47.1 | 63.5 | 104 | 155 | 215 | 288 | 366 | 457 | 557 | 667 | 787 | 917 | 1057 | 1207 | 1367 |
| 17 | 13.3 | 22.4 | 34.2 | 48.5 | 65.5 | 107 | 159 | 222 | 294 | 377 | 471 | 574 | 688 | 812 | 946 | 1090 | 1244 | 1409 |
| 18 | 13.7 | 23.1 | 35.2 | 49.9 | 67.4 | 110 | 164 | 228 | 303 | 388 | 484 | 591 | 708 | 835 | 973 | 1121 | 1280 | 1450 |
| 19 | 14.0 | 23.8 | 36.1 | 51.3 | 69.2 | 113 | 168 | 234 | 311 | 399 | 497 | 607 | 727 | 858 | 1000 | 1152 | 1315 | 1489 |
| 20 | 14.4 | 24.3 | 37.1 | 52.6 | 71.0 | 116 | 173 | 240 | 319 | 409 | 510 | 623 | 746 | 880 | 1026 | 1182 | 1350 | 1528 |
| 21 | 14.7 | 24.9 | 38.0 | 53.9 | 72.8 | 119 | 177 | 246 | 327 | 419 | 523 | 638 | 764 | 902 | 1051 | 1211 | 1383 | 1566 |
| 22 | 15.1 | 25.5 | 38.9 | 55.2 | 74.5 | 122 | 181 | 252 | 335 | 429 | 535 | 653 | 782 | 923 | 1078 | 1240 | 1415 | 1603 |
| 23 | 15.4 | 26.1 | 39.8 | 56.5 | 76.2 | 125 | 186 | 258 | 342 | 439 | 547 | 668 | 800 | 944 | 1100 | 1268 | 1447 | 1639 |
| 24 | 15.8 | 26.7 | 40.6 | 57.7 | 77.8 | 127 | 189 | 263 | 350 | 448 | 559 | 682 | 817 | 964 | 1123 | 1295 | 1478 | 1674 |
| 25 | 16.1 | 27.2 | 41.5 | 58.9 | 79.4 | 130 | 193 | 269 | 357 | 458 | 571 | 696 | 834 | 984 | 1147 | 1322 | 1509 | 1708 |
| 26 | 16.4 | 27.7 | 42.3 | 60.0 | 81.0 | 133 | 197 | 274 | 364 | 467 | 582 | 710 | 850 | 1004 | 1169 | 1348 | 1539 | 1742 |
| 27 | 16.7 | 28.3 | 43.1 | 61.2 | 82.5 | 135 | 201 | 279 | 371 | 476 | 593 | 723 | 867 | 1023 | 1192 | 1373 | 1568 | 1775 |
| 28 | 17.0 | 28.8 | 43.9 | 62.3 | 84.1 | 138 | 204 | 285 | 378 | 484 | 604 | 737 | 883 | 1041 | 1214 | 1399 | 1597 | 1808 |
| 29 | 17.3 | 29.3 | 44.7 | 63.4 | 85.5 | 140 | 208 | 290 | 384 | 493 | 615 | 750 | 898 | 1060 | 1235 | 1423 | 1625 | 1840 |
| 30 | 17.8 | 29.8 | 45.4 | 64.5 | 87.0 | 142 | 212 | 294 | 391 | 501 | 625 | 763 | 913 | 1078 | 1256 | 1448 | 1653 | 1871 |
| L, in feet | Correction Factors For Other Pipe Lengths | | | | | | | | | | | | | | | | | |
| 20 | 1.30 | 1.24 | 1.21 | 1.18 | 1.15 | 1.12 | 1.10 | 1.08 | 1.07 | 1.06 | 1.05 | 1.05 | 1.04 | 1.04 | 1.03 | 1.03 | 1.03 | 1.03 |
| 30 | 1.22 | 1.18 | 1.15 | 1.13 | 1.12 | 1.09 | 1.08 | 1.06 | 1.05 | 1.05 | 1.04 | 1.04 | 1.03 | 1.03 | 1.03 | 1.02 | 1.02 | 1.02 |
| 40 | 1.15 | 1.13 | 1.11 | 1.10 | 1.08 | 1.07 | 1.05 | 1.05 | 1.04 | 1.03 | 1.03 | 1.03 | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 |
| 50 | 1.09 | 1.08 | 1.07 | 1.06 | 1.05 | 1.04 | 1.04 | 1.03 | 1.03 | 1.02 | 1.02 | 1.02 | 1.02 | 1.01 | 1.01 | 1.01 | 1.01 | 1.01 |
| 60 | 1.04 | 1.04 | 1.03 | 1.03 | 1.03 | 1.02 | 1.02 | 1.02 | 1.01 | 1.01 | 1.01 | 1.01 | 1.01 | 1.01 | 1.01 | 1.01 | 1.01 | 1.01 |
| 70 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 80 | .96 | .97 | .97 | .97 | .98 | .98 | .98 | .99 | .99 | .99 | .99 | .99 | .99 | .99 | .99 | .99 | .99 | .99 |
| 90 | .93 | .94 | .94 | .95 | .95 | .96 | .97 | .97 | .98 | .98 | .98 | .98 | .98 | .99 | .99 | .99 | .99 | .99 |
| 100 | .90 | .91 | .92 | .93 | .93 | .95 | .95 | .96 | .97 | .97 | .97 | .98 | .98 | .98 | .98 | .98 | .98 | .99 |
| 120 | .84 | .86 | .87 | .89 | .90 | .91 | .93 | .94 | .94 | .95 | .96 | .96 | .96 | .97 | .97 | .97 | .97 | .98 |
| 140 | .80 | .82 | .83 | .85 | .86 | .88 | .90 | .91 | .92 | .93 | .94 | .94 | .95 | .95 | .96 | .96 | .96 | .97 |
| 160 | .76 | .78 | .80 | .82 | .83 | .86 | .88 | .89 | .90 | .91 | .92 | .93 | .94 | .94 | .95 | .95 | .95 | .96 |

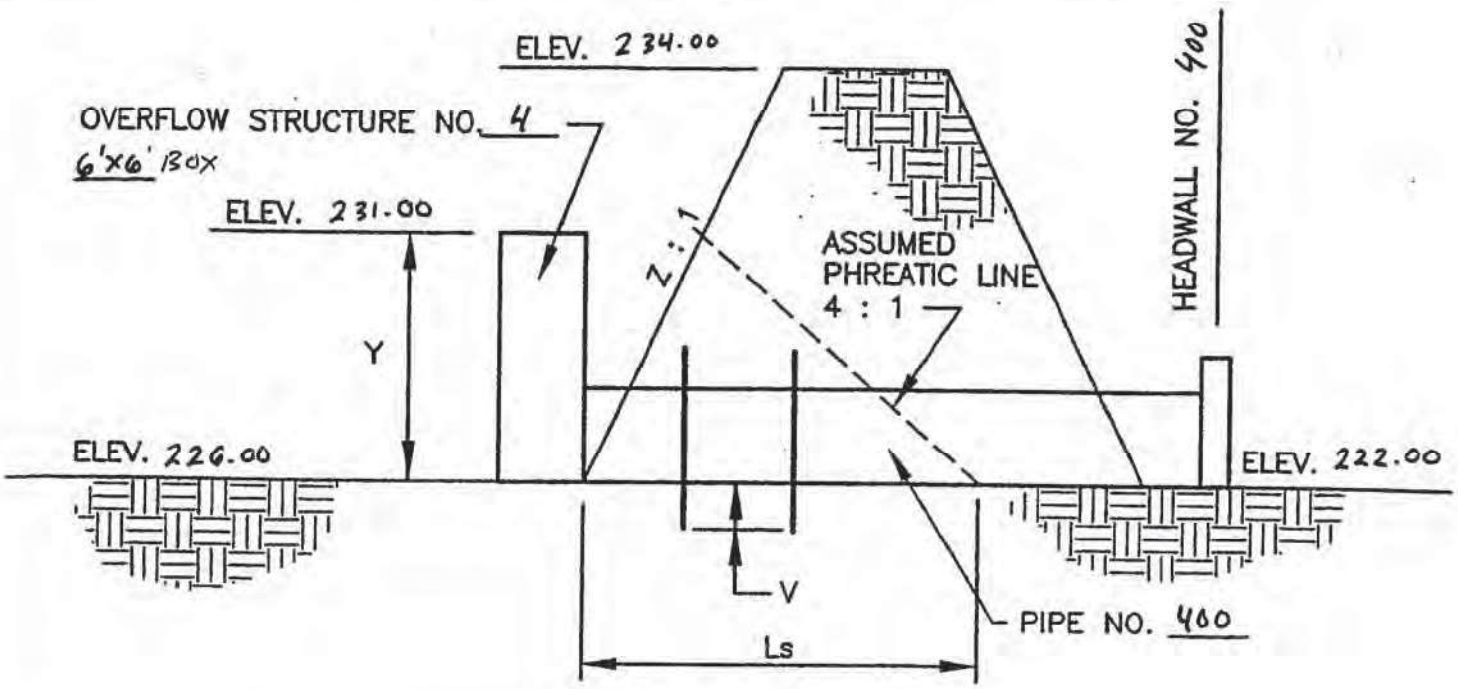
Source: USDA - SCS

**f. Anti-Seep Collar Design**

The seepage of water through the existing sediment pond dam along the carrier pipe could result in dam failure.

The proposed anti-seep collars have been designed to be located at intervals within the zone of saturation along the carrier pipe to increase the seepage length along the carrier pipe and thereby prevent piping or seepage along the carrier pipe.

# ANTI – SEEP COLLAR DESIGN




Ls = LENGTH IN SATURATION ZONE

Y = OVERFLOW STRUCTURE HEIGHT = 5.0 FEET

Z = INSIDE SLOPE OF LEVEE = 3

PIPE SLOPE = 4.94 % = 0.0494 FEET/FEET

$$Ls = Y ( Z + 4 ) \left( 1 + \frac{\text{PIPE SLOPE}}{0.25 - \text{PIPE SLOPE}} \right)$$

Ls = 44 FEET

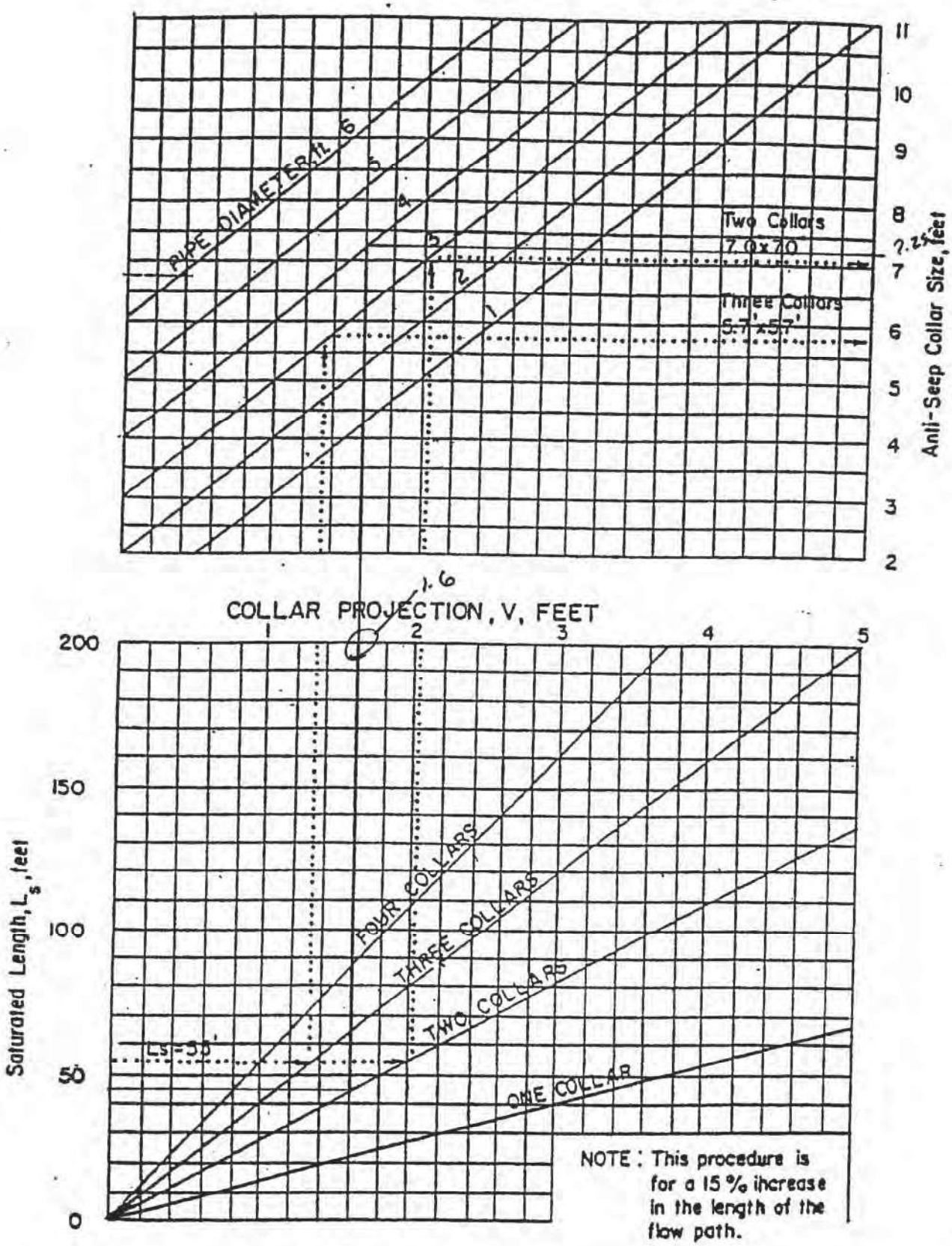
FROM ANTI – SEEP COLLAR DESIGN CHART ON THE NEXT PAGE :

V = COLLAR PROJECTION = 1.6 FEET

DIMENSIONS OF 12" THICK COLLAR = 8'X8'

NUMBER OF REQUIRED COLLARS = 2

# ANTI-SEEP COLLAR DESIGN



**g. Overflow Structure Base Foundation Design**

The overflow structure and carrier pipe will be subject to a certain amount of buoyant force when the sediment pond is filled with storm water. In order to overcome this buoyant force and prevent the flotation of the overflow structure and carrier pipe, a concrete overflow structure base foundation and concrete carrier pipe encasement have been designed. The design calculations for the concrete overflow structure base foundation and carrier pipe encasement are included in this section.

**OVERFLOW STRUCTURE BASE FOUNDATION DESIGN**

A certain volume of concrete will be used to overcome the buoyancy of an empty overflow structure and carrier pipe that are below the assumed phreatic water surface. This volume is equal to:

Overflow Structure

= (L)(w)(h)(62.4) L = w = 6.0' inside = 7.0' outside

= (7.0)(7.0)(5.0)(62.4) h = height = 5.0'

= 15,288 #

Carrier Pipe = 3.1416($R_2^2$)(Ls)(62.4) Ls = length in saturation zone = 44'

= 3.1416(2.42)(2.42)(44)(62.4) $R_2$ = outside radius = 29" = 2.42

= 50,515 # $r_2$ = inside radius = 24" = 2.0'

TOTAL WEIGHT

= 65,803 # x 1.5 (SAFETY FACTOR)

= 98,705 #

TOTAL REVISED VOLUME OF CONCRETE =

TOTAL WEIGHT / WEIGHT OF CONC. IN WATER

= 98,705/87.6 pcf (87.6 pcf = Wt. of conc. in submerged water)

= 1,127 C.F.

This volume of concrete will be made up from five areas.

1. Overflow Structures
2. Anti-Seep Collars
3. Carrier Pipe
4. Overflow Structure Base
5. Carrier Pipe Encasement

1. Overflow Structure = $(L_2 – l_2)h$

   $(7.0^2 – 6.0^2)(5.0)$ = 65 C.F.

   L = outside dimension of box = 7.0’

   l = inside dimension of box = 6.0’

   h = height of overflow structures = 5.0’

2. Anti-seep collars = area of square collar around carrier pipe x 12" thick x # of collars

   = [( 8.0' x 8.0') - $(3.1416)(R_2^2)$]

   x 1' x 2

   = 91 C.F.

   $R_2$ = outside radius of carrier pipe = 29" = 2.42’

   $r_2$ = inside radius of carrier pipe = 24" = 2.0’

3. Carrier Pipe

   = $3.1416 (R_2^2 - r_2^2)$ L = 257 C.F. L = length in saturation = 44’

4. Overflow Structure Base = Volume to handle riser bouyance x 1.2

   = (L)(w)h(62.4)(1.2)/weight of conc. in water

   L = w = 7.0’ outside

   h = height = 5.0’

   = (7.0’)(7.0’)(5.0)(62.4)(1.2)/87.6

   = 209 C.F.

   Use 11.0’ x 11.0’ x 3.5’ = 424

5. Carrier Pipe Encasement

   Must extend 5’ into dam. Distance from overflow structure to dam is equal to 15.0’. Therefore, encasement length will be 20.0’.

   $[(5.0 \times 7.0) – (3.1416)R_2^2]$ 20.0’

   Carrier pipe encasement volume = 332 C.F.

**TOTAL REQUIRED VOLUME = 1,127 C.F.**

Actual Total Volume

| | | |
|---|---|---|
| Overflow Structure | = | 65 C.F. |
| Anti-Seep Collars | = | 91 C.F. |
| Carrier Pipe | = | 257 C.F. |
| Overflow Structure Base | = | 424 C.F. |
| Carrier Pipe Encasement | = | 332 C.F. |
| **TOTAL** | **=** | **1,169 C.F. ⇒ Okay** |

# 6. PROPOSED SEDIMENT POND NO. 5

## a. Sediment Storage and Settling Efficiency Calculations

As required in the "Alabama Handbook for Erosion Control, Sediment Control and Stormwater Management on Construction Sites and Urban Area", the sediment storage volume of the pond shall be at least 67 cubic yards per acre for the disturbed area draining into the pond (67 cubic yards is equivalent to ½ inch of sediment per acre of drainage area). The peak inflow rate for the 25 year storm event has also been used to calculate the minimum pond surface area needed for adequate settling efficiency. These calculations for the sediment pond are included below.

Sediment Storage Calculation

Assume maximum sediment from 51 disturbed acres.

51 Acres x 67 c.y./acre = 3,417 c.y. = 92,259 c.f.

This sediment volume corresponds to a depth of 0.85' or Elev. 264.85.

Dewatering opening is set at Elev. 267.00. Therefore, ample sediment storage volume is available.

Settling Efficiency Calculations

- Use 25 year storm event, Q25 Flow = 235 cfs
- Minimum Surface Area = .01 acre / cfs x Q25 Flow
  = .01 acre / cfs x 235 cfs
  = 2.35 acres = 102,366 s.f
- Top of Overflow Structure = Elev. 271.00
  Surface Area @ Elev. 271.00 = 149,349 s.f.
- Adequate surface area is available for settling

# Pond Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022 Thursday, 01 / 30 / 2025

## Pond No. 1 - Pond No. 5

### Pond Data

**Contours -**User-defined contour areas. Average end area method used for volume calculation. Begining Elevation = 264.00 ft

### Stage / Storage Table

| Stage (ft) | Elevation (ft) | Contour area (sqft) | Incr. Storage (cuft) | Total storage (cuft) |
|---|---|---|---|---|
| 0.00 | 264.00 | 101,346 | 0 | 0 |
| 2.00 | 266.00 | 114,770 | 216,116 | 216,116 |
| 3.00 | 267.00 | 121,595 | 118,183 | 334,299 |
| 4.00 | 268.00 | 128,420 | 125,008 | 459,306 |
| 6.00 | 270.00 | 142,297 | 270,717 | 730,023 |
| 7.50 | 271.50 | 152,874 | 221,378 | 951,401 |
| 8.00 | 272.00 | 156,400 | 77,319 | 1,028,720 |
| 10.00 | 274.00 | 170,730 | 327,130 | 1,355,850 |

### Culvert / Orifice Structures

| | [A] | [B] | [C] | [PrfRsr] |
|---|---|---|---|---|
| **Rise (in)** | = 48.00 | 6.00 | 6.00 | Inactive |
| **Span (in)** | = 48.00 | 16.00 | 24.00 | 0.00 |
| **No. Barrels** | = 1 | 2 | 1 | 0 |
| **Invert El. (ft)** | = 266.00 | 267.00 | 269.50 | 0.00 |
| **Length (ft)** | = 92.00 | 0.00 | 0.00 | 0.00 |
| **Slope (%)** | = 8.70 | 0.00 | 0.00 | n/a |
| **N-Value** | = .013 | .013 | .013 | n/a |
| **Orifice Coeff.** | = 0.60 | 0.60 | 0.60 | 0.60 |
| **Multi-Stage** | = n/a | Yes | Yes | No |

### Weir Structures

| | [A] | [B] | [C] | [D] |
|---|---|---|---|---|
| **Crest Len (ft)** | = 24.00 | 0.00 | 0.00 | 0.00 |
| **Crest El. (ft)** | = 271.00 | 0.00 | 0.00 | 0.00 |
| **Weir Coeff.** | = 3.33 | 3.33 | 3.33 | 3.33 |
| **Weir Type** | = 1 | --- | --- | --- |
| **Multi-Stage** | = Yes | No | No | No |

**Exfil.(in/hr)** = 0.000 (by Wet area)

**TW Elev. (ft)** = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).

### Stage / Storage / Discharge Table

| Stage ft | Storage cuft | Elevation ft | Clv A cfs | Clv B cfs | Clv C cfs | PrfRsr cfs | Wr A cfs | Wr B cfs | Wr C cfs | Wr D cfs | Exfil cfs | User cfs | Total cfs |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.00 | 0 | 264.00 | 0.00 | 0.00 | 0.00 | --- | 0.00 | --- | --- | --- | --- | --- | 0.000 |
| 2.00 | 216,116 | 266.00 | 0.00 | 0.00 | 0.00 | --- | 0.00 | --- | --- | --- | --- | --- | 0.000 |
| 3.00 | 334,299 | 267.00 | 0.00 | 0.00 | 0.00 | --- | 0.00 | --- | --- | --- | --- | --- | 0.000 |
| 4.00 | 459,306 | 268.00 | 5.69 ic | 5.56 ic | 0.00 | --- | 0.00 | --- | --- | --- | --- | --- | 5.560 |
| 6.00 | 730,023 | 270.00 | 13.03 ic | 10.62 ic | 2.41 ic | --- | 0.00 | --- | --- | --- | --- | --- | 13.03 |
| 7.50 | 951,401 | 271.50 | 45.94 ic | 11.07 ic | 6.37 ic | --- | 28.26 | --- | --- | --- | --- | --- | 45.69 |
| 8.00 | 1,028,720 | 272.00 | 94.06 ic | 8.08 ic | 6.06 ic | --- | 79.92 | --- | --- | --- | --- | --- | 94.06 |
| 10.00 | 1,355,850 | 274.00 | 146.63 ic | 2.28 ic | 1.71 ic | --- | 142.61 s | --- | --- | --- | --- | --- | 146.60 |

**b. Total Pond Dewatering at Top of Riser (Elev. 271.00)**

Retention time within the basin is an important factor in effective sediment retention. The overflow structure has been designed as specified below

Since the overflow structure will have two stages, the dewatering time has been calculated for each stage. Stage 1 calculates the drawdown time of the maximum water surface elevation from the top of the riser to the orifice at elevation 269.50. Stage 2 calculates the drawdown time from the orifice at elevation 269.50 to the orifice at elevation 267.00.

The calculation below has been performed to confirm that the dewatering (retention) time within the pond is between 24 and 72 hours. This dewatering time will ensure the storm water is retained for an adequate length of time to allow the sediment to settle (minimum 24 hours) and is also discharged gradually in an acceptable length of time to allow storage for future storm events (maximum 72 hours).

The dewatering time is calculated as follows:

$$T = \frac{A_s \times (2h)^{1/2}}{A_O \times C_d \times (20{,}428)}$$

$A_O$ = Surface Area of Dewatering Holes ($ft_2$)

$A_s$ = Surface Area Corresponding to top of riser elevation ($ft_2$)

h = Head of water above dewatering hole (ft)

$C_d$ = Coefficient of contraction for an orifice (use 0.6)

T = Time to dewater

**Stage 1**

$T_1$

$A_O$ = 1.0 s.f. = 1 – 6” x 24” rectangular opening at elev. 269.50

$A_s$ = 149,349 s.f. @ Elev. 271.00

h = 271.00 – 269.50 = 1.5’

$$T = \frac{149{,}349\ (2 \times 1.5)^{1/2}}{(1.0)\ (0.6)\ (20{,}428)} = 21 \text{ hours}$$

**(Okay between 24 – 72 hours)**

**Stage 2**

$T_2$

Ao = 1.33 s.f. @ Elev. 267.00 (2 – 6" x 16" rectangular opening)

As = 138,828 s.f. @ Elev. 269.5 (invert of orifice #2)

h = 269.50 – 267.00 = 2.5'

$$T = \frac{138{,}828\ (2 \times 2.5)^{1/2}}{(1.33)\ (0.6)\ (20{,}428)} = 19.0 \text{ hours}$$

$T_1 + T_2$ = 21.0 + 19.0 = 40 hours

**(Okay between 24 - 72 hours)**

**c. Reservoir Routing**

Reservoir routing is determined by using the HydraFlow Hydrographs Extension for AutoCad Civil 3D 2022 Computer Program.

Peak inflow rates (Q) are determined using the SCS Method and HydraFlow Hydrographs Extension for AutoCad Civil 3D 2022 Computer Program. Peak inflow rates are calculated for the 25 year and 100 year storm events and are summarized below.

Q25 = 235 cfs

Q100 = 333 cfs

The bottom of the pond has been set at 264.00. Dewatering of the pond is accomplished by two 6" x 16" rectangular openings beginning at an invert elevation of 267.00 and one 6" x 24" rectangular openings at elevation 269.50.

For routing calculations, a 6' x 6' rectangular riser with two 6" x 16" rectangular openings at an invert elevation of 267.00 and one 6" x 24" rectangular openings at elevation 269.50 were used. The top of the riser is at an elevation of 271.00. The bottom of the pond is elev. 264.00. The invert of the carrier pipe is elev. 266.00. The top of the levee around the sediment pond is at an elevation of 274.00.

The maximum height of sediment is elevation 264.85 which is below the elevation of the first dewatering opening (Elev. 267.00). For routing calculations, the starting water surface elevation was set at 267.00, assuming the remainder of the pond bottom is filled below the dewatering orifice invert elevation.

Based on the above information the reservoir routing calculations are performed and summarized below.

| STORM YEAR | PEAK INFLOW CFS | PEAK OUTFLOW CFS | PEAK ELEV. FEET |
|---|---|---|---|
| 25 | 235 | 16.8 | 270.75 |
| 100 | 334 | 64.5 | 271.70 |

Based on these routing calculations, the riser is large enough and the pond has sufficient storage volume to retain the sediment from 51 disturbed acres plus the 25 year storm event from the entire drainage area below the crest of the riser (elev. 271.00).

# Pond Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022 Thursday, 01 / 30 / 2025

## Pond No. 2 - Pond No. 5 - perm pool

### Pond Data

**Contours -**User-defined contour areas. Average end area method used for volume calculation. Begining Elevation = 267.00 ft

### Stage / Storage Table

| Stage (ft) | Elevation (ft) | Contour area (sqft) | Incr. Storage (cuft) | Total storage (cuft) |
|---|---|---|---|---|
| 0.00 | 267.00 | 121,595 | 0 | 0 |
| 1.00 | 268.00 | 128,420 | 125,008 | 125,008 |
| 3.00 | 270.00 | 142,297 | 270,717 | 395,725 |
| 4.50 | 271.50 | 152,874 | 221,378 | 617,103 |
| 5.00 | 272.00 | 156,400 | 77,319 | 694,421 |
| 7.00 | 274.00 | 170,730 | 327,130 | 1,021,551 |

### Culvert / Orifice Structures

| | [A] | [B] | [C] | [PrfRsr] |
|---|---|---|---|---|
| **Rise (in)** | = 48.00 | 6.00 | 6.00 | Inactive |
| **Span (in)** | = 48.00 | 16.00 | 24.00 | 0.00 |
| **No. Barrels** | = 1 | 2 | 1 | 0 |
| **Invert El. (ft)** | = 266.00 | 267.00 | 269.50 | 0.00 |
| **Length (ft)** | = 92.00 | 0.00 | 0.00 | 0.00 |
| **Slope (%)** | = 8.70 | 0.00 | 0.00 | n/a |
| **N-Value** | = .013 | .013 | .013 | n/a |
| **Orifice Coeff.** | = 0.60 | 0.60 | 0.60 | 0.60 |
| **Multi-Stage** | = n/a | Yes | No | No |

### Weir Structures

| | [A] | [B] | [C] | [D] |
|---|---|---|---|---|
| **Crest Len (ft)** | = 24.00 | Inactive | Inactive | Inactive |
| **Crest El. (ft)** | = 271.00 | 0.00 | 0.00 | 0.00 |
| **Weir Coeff.** | = 3.33 | 3.33 | 3.33 | 3.33 |
| **Weir Type** | = 1 | --- | --- | --- |
| **Multi-Stage** | = Yes | No | No | No |

**Exfil.(in/hr)** = 0.000 (by Wet area)

**TW Elev. (ft)** = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).

### Stage / Storage / Discharge Table

| Stage ft | Storage cuft | Elevation ft | Clv A cfs | Clv B cfs | Clv C cfs | PrfRsr cfs | Wr A cfs | Wr B cfs | Wr C cfs | Wr D cfs | Exfil cfs | User cfs | Total cfs |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.00 | 0 | 267.00 | 0.00 | 0.00 | 0.00 | --- | 0.00 | --- | --- | --- | --- | --- | 0.000 |
| 1.00 | 125,008 | 268.00 | 8.47 ic | 5.56 ic | 0.00 | --- | 0.00 | --- | --- | --- | --- | --- | 5.560 |
| 3.00 | 395,725 | 270.00 | 10.75 ic | 10.65 ic | 2.41 ic | --- | 0.00 | --- | --- | --- | --- | --- | 13.05 |
| 4.50 | 617,103 | 271.50 | 39.70 ic | 11.44 ic | 6.37 ic | --- | 28.26 | --- | --- | --- | --- | --- | 46.07 |
| 5.00 | 694,421 | 272.00 | 88.66 ic | 8.74 ic | 7.22 ic | --- | 79.92 | --- | --- | --- | --- | --- | 95.88 |
| 7.00 | 1,021,551 | 274.00 | 146.58 ic | 2.31 ic | 9.93 ic | --- | 144.24 s | --- | --- | --- | --- | --- | 156.48 |

# Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022

| Hyd. No. | Hydrograph type (origin) | Peak flow (cfs) | Time interval (min) | Time to Peak (min) | Hyd. volume (cuft) | Inflow hyd(s) | Maximum elevation (ft) | Total strge used (cuft) | Hydrograph Description |
|---|---|---|---|---|---|---|---|---|---|
| 35 | SCS Runoff | 12.58 | 1 | 727 | 43,452 | ------ | ------ | ------ | DD24 |
| 36 | SCS Runoff | 12.92 | 1 | 727 | 44,649 | ------ | ------ | ------ | Area to DD25 |
| 37 | Combine | 25.50 | 1 | 727 | 88,101 | 35, 36 | ------ | ------ | DD25 |
| 38 | Combine | 70.71 | 1 | 727 | 251,895 | 34, 37 | ------ | ------ | DD23 & DD25 |
| 39 | Combine | 76.05 | 1 | 727 | 270,371 | 27, 38 | ------ | ------ | Ditch No. 8, DD23, & DD25 |
| 40 | SCS Runoff | 7.286 | 1 | 733 | 32,332 | ------ | ------ | ------ | Area to Ditch No. 7 |
| 41 | Combine | 82.08 | 1 | 727 | 302,703 | 39, 40 | ------ | ------ | Ditch No. 7 |
| 42 | Combine | 87.53 | 1 | 727 | 325,797 | 26, 41 | ------ | ------ | DI. 502 |
| 43 | SCS Runoff | 31.40 | 1 | 722 | 86,123 | ------ | ------ | ------ | Area to Pond No. 5 |
| 44 | Combine | 235.44 | 1 | 726 | 875,050 | 25, 42, 43 | ------ | ------ | Pond No. 5 Total Inflow |
| 46 | Reservoir | 16.83 | 1 | 841 | 863,476 | 44 | 270.75 | 506,617 | Pond No. 5 - perm pool |
| 47 | Reservoir | 115.56 | 1 | 741 | 875,043 | 44 | 272.41 | 219,791 | Pond No. 5 - riser |
| 50 | SCS Runoff | 3.170 | 1 | 725 | 9,879 | ------ | ------ | ------ | Ditch No. 3 |
| 51 | SCS Runoff | 8.096 | 1 | 725 | 25,227 | ------ | ------ | ------ | DD7 |
| 52 | SCS Runoff | 10.07 | 1 | 725 | 32,691 | ------ | ------ | ------ | Area to DD8 |
| 53 | Combine | 18.16 | 1 | 725 | 57,919 | 51, 52 | ------ | ------ | DD8 |
| 54 | Combine | 21.33 | 1 | 725 | 67,798 | 50, 53 | ------ | ------ | Ditch No. 3 & DD8 |
| 55 | SCS Runoff | 5.216 | 1 | 734 | 24,007 | ------ | ------ | ------ | Area to Ditch No. 2 |
| 56 | Combine | 24.97 | 1 | 725 | 91,806 | 54, 55 | ------ | ------ | Ditch No. 2 |
| 57 | SCS Runoff | 6.794 | 1 | 725 | 21,170 | ------ | ------ | ------ | DD1 |
| 58 | SCS Runoff | 9.058 | 1 | 725 | 28,227 | ------ | ------ | ------ | Area to DD2 |
| 59 | Combine | 15.85 | 1 | 725 | 49,396 | 57, 58 | ------ | ------ | DD2 |
| 60 | SCS Runoff | 12.48 | 1 | 725 | 40,531 | ------ | ------ | ------ | Area to DD3 |
| 61 | Combine | 28.33 | 1 | 725 | 89,927 | 59, 60 | ------ | ------ | DD3 |
| 62 | SCS Runoff | 13.59 | 1 | 725 | 42,340 | ------ | ------ | ------ | DD4 |
| 63 | SCS Runoff | 11.15 | 1 | 725 | 34,754 | ------ | ------ | ------ | Area to DD5 |
| 64 | Combine | 24.74 | 1 | 725 | 77,094 | 62, 63 | ------ | ------ | DD5 |
| 65 | SCS Runoff | 11.38 | 1 | 725 | 35,460 | ------ | ------ | ------ | Area to DD6 |
| 66 | Combine | 36.12 | 1 | 725 | 112,553 | 64, 65 | ------ | ------ | DD6 |
| 67 | Combine | 64.45 | 1 | 725 | 202,480 | 61, 66 | ------ | ------ | DD3 & DD6 |
| 68 | Combine | 89.42 | 1 | 725 | 294,286 | 56, 67 | ------ | ------ | Ditch No. 2, DD3, & DD6 |
| 69 | SCS Runoff | 8.273 | 1 | 723 | 24,121 | ------ | ------ | ------ | DD67 |
| 70 | SCS Runoff | 9.398 | 1 | 725 | 29,285 | ------ | ------ | ------ | Area to DD68 |

# Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022

| Hyd. No. | Hydrograph type (origin) | Peak flow (cfs) | Time interval (min) | Time to Peak (min) | Hyd. volume (cuft) | Inflow hyd(s) | Maximum elevation (ft) | Total strge used (cuft) | Hydrograph Description |
|---|---|---|---|---|---|---|---|---|---|
| 35 | SCS Runoff | 17.81 | 1 | 727 | 62,387 | ------ | ------ | ------ | DD24 |
| 36 | SCS Runoff | 18.30 | 1 | 727 | 64,107 | ------ | ------ | ------ | Area to DD25 |
| 37 | Combine | 36.11 | 1 | 727 | 126,494 | 35, 36 | ------ | ------ | DD25 |
| 38 | Combine | 100.19 | 1 | 727 | 361,666 | 34, 37 | ------ | ------ | DD23 & DD25 |
| 39 | Combine | 107.76 | 1 | 727 | 388,193 | 27, 38 | ------ | ------ | Ditch No. 8, DD23, & DD25 |
| 40 | SCS Runoff | 10.34 | 1 | 733 | 46,422 | ------ | ------ | ------ | Area to Ditch No. 7 |
| 41 | Combine | 116.42 | 1 | 727 | 434,616 | 39, 40 | ------ | ------ | Ditch No. 7 |
| 42 | Combine | 124.19 | 1 | 727 | 467,774 | 26, 41 | ------ | ------ | DI. 502 |
| 43 | SCS Runoff | 44.46 | 1 | 722 | 123,654 | ------ | ------ | ------ | Area to Pond No. 5 |
| 44 | Combine | 333.93 | 1 | 726 | 1,256,381 | 25, 42, 43 | ------ | ------ | Pond No. 5 Total Inflow |
| 46 | Reservoir | 64.50 | 1 | 757 | 1,243,246 | 44 | 271.70 | 648,445 | Pond No. 5 - perm pool |
| 47 | Reservoir | 132.53 | 1 | 745 | 1,256,375 | 44 | 273.10 | 333,182 | Pond No. 5 - riser |
| 50 | SCS Runoff | 4.494 | 1 | 724 | 14,185 | ------ | ------ | ------ | Ditch No. 3 |
| 51 | SCS Runoff | 11.47 | 1 | 724 | 36,221 | ------ | ------ | ------ | DD7 |
| 52 | SCS Runoff | 14.28 | 1 | 725 | 46,938 | ------ | ------ | ------ | Area to DD8 |
| 53 | Combine | 25.73 | 1 | 725 | 83,159 | 51, 52 | ------ | ------ | DD8 |
| 54 | Combine | 30.22 | 1 | 725 | 97,343 | 50, 53 | ------ | ------ | Ditch No. 3 & DD8 |
| 55 | SCS Runoff | 7.410 | 1 | 734 | 34,469 | ------ | ------ | ------ | Area to Ditch No. 2 |
| 56 | Combine | 35.48 | 1 | 725 | 131,813 | 54, 55 | ------ | ------ | Ditch No. 2 |
| 57 | SCS Runoff | 9.629 | 1 | 724 | 30,395 | ------ | ------ | ------ | DD1 |
| 58 | SCS Runoff | 12.84 | 1 | 724 | 40,527 | ------ | ------ | ------ | Area to DD2 |
| 59 | Combine | 22.47 | 1 | 724 | 70,923 | 57, 58 | ------ | ------ | DD2 |
| 60 | SCS Runoff | 17.70 | 1 | 725 | 58,193 | ------ | ------ | ------ | Area to DD3 |
| 61 | Combine | 40.13 | 1 | 725 | 129,116 | 59, 60 | ------ | ------ | DD3 |
| 62 | SCS Runoff | 19.26 | 1 | 724 | 60,791 | ------ | ------ | ------ | DD4 |
| 63 | SCS Runoff | 15.81 | 1 | 724 | 49,899 | ------ | ------ | ------ | Area to DD5 |
| 64 | Combine | 35.07 | 1 | 724 | 110,690 | 62, 63 | ------ | ------ | DD5 |
| 65 | SCS Runoff | 16.13 | 1 | 724 | 50,912 | ------ | ------ | ------ | Area to DD6 |
| 66 | Combine | 51.20 | 1 | 724 | 161,602 | 64, 65 | ------ | ------ | DD6 |
| 67 | Combine | 91.23 | 1 | 725 | 290,718 | 61, 66 | ------ | ------ | DD3 & DD6 |
| 68 | Combine | 126.71 | 1 | 725 | 422,531 | 56, 67 | ------ | ------ | Ditch No. 2, DD3, & DD6 |
| 69 | SCS Runoff | 11.73 | 1 | 723 | 34,632 | ------ | ------ | ------ | DD67 |
| 70 | SCS Runoff | 13.32 | 1 | 724 | 42,047 | ------ | ------ | ------ | Area to DD68 |

**d. Emergency Spillway**

Worst Case

Assume the dewatering opening in the overflow structure is not operating and the starting water surface elevation is at the top of the riser (271.00) at the start of a 100 year storm event.

| | | |
|---|---|---|
| Top of Pond | = | 274.00 |
| Less Required Freeboard | = | 1.00 |
| Maximum Allowable Water Surface Elevation in Emergency Spillway | = | 273.00 |

Re-route the 100 year storm event through the 6' x 6' square overflow structure and 54" diameter carrier pipe.

From Hydrograph Summary Report, Line 47, the maximum flow out of the pond will be 133 cfs. The maximum water surface elevation is 273.10 which is approximately equal to the maximum allowable water surface elevation of 273.00.

Therefore, the overflow structure and carrier pipe will safely pass the 100 year storm event with a starting water surface elevation at 271.00.

# Pond Report



## Pond No. 3 - Pond No. 5 - riser

### Pond Data

**Contours -**User-defined contour areas. Average end area method used for volume calculation. Begining Elevation = 271.00 ft

### Stage / Storage Table

| Stage (ft) | Elevation (ft) | Contour area (sqft) | Incr. Storage (cuft) | Total storage (cuft) |
|---|---|---|---|---|
| 0.00 | 271.00 | 149,349 | 0 | 0 |
| 1.00 | 272.00 | 156,400 | 152,875 | 152,875 |
| 3.00 | 274.00 | 170,730 | 327,130 | 480,005 |

### Culvert / Orifice Structures

| | [A] | [B] | [C] | [PrfRsr] |
|---|---|---|---|---|
| **Rise (in)** | = 48.00 | Inactive | Inactive | Inactive |
| **Span (in)** | = 48.00 | 0.00 | 0.00 | 0.00 |
| **No. Barrels** | = 1 | 1 | 0 | 0 |
| **Invert El. (ft)** | = 266.00 | 0.00 | 0.00 | 0.00 |
| **Length (ft)** | = 92.00 | 0.00 | 0.00 | 0.00 |
| **Slope (%)** | = 8.70 | 0.00 | 0.00 | n/a |
| **N-Value** | = .013 | .013 | .013 | n/a |
| **Orifice Coeff.** | = 0.60 | 0.60 | 0.60 | 0.60 |
| **Multi-Stage** | = n/a | Yes | No | No |

### Weir Structures

| | [A] | [B] | [C] | [D] |
|---|---|---|---|---|
| **Crest Len (ft)** | = 24.00 | Inactive | Inactive | Inactive |
| **Crest El. (ft)** | = 271.00 | 0.00 | 0.00 | 0.00 |
| **Weir Coeff.** | = 3.33 | 3.33 | 3.33 | 3.33 |
| **Weir Type** | = 1 | --- | --- | --- |
| **Multi-Stage** | = Yes | No | No | No |
| **Exfil.(in/hr)** | = 0.000 (by Wet area) | | | |
| **TW Elev. (ft)** | = 0.00 | | | |

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).

### Stage / Storage / Discharge Table

| Stage ft | Storage cuft | Elevation ft | Clv A cfs | Clv B cfs | Clv C cfs | PrfRsr cfs | Wr A cfs | Wr B cfs | Wr C cfs | Wr D cfs | Exfil cfs | User cfs | Total cfs |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.00 | 0 | 271.00 | 0.00 | --- | --- | --- | 0.00 | --- | --- | --- | --- | --- | 0.000 |
| 1.00 | 152,875 | 272.00 | 104.79 ic | --- | --- | --- | 79.92 | --- | --- | --- | --- | --- | 79.92 |
| 3.00 | 480,005 | 274.00 | 146.51 ic | --- | --- | --- | 146.48 s | --- | --- | --- | --- | --- | 146.48 |

# Hydrograph Summary Report

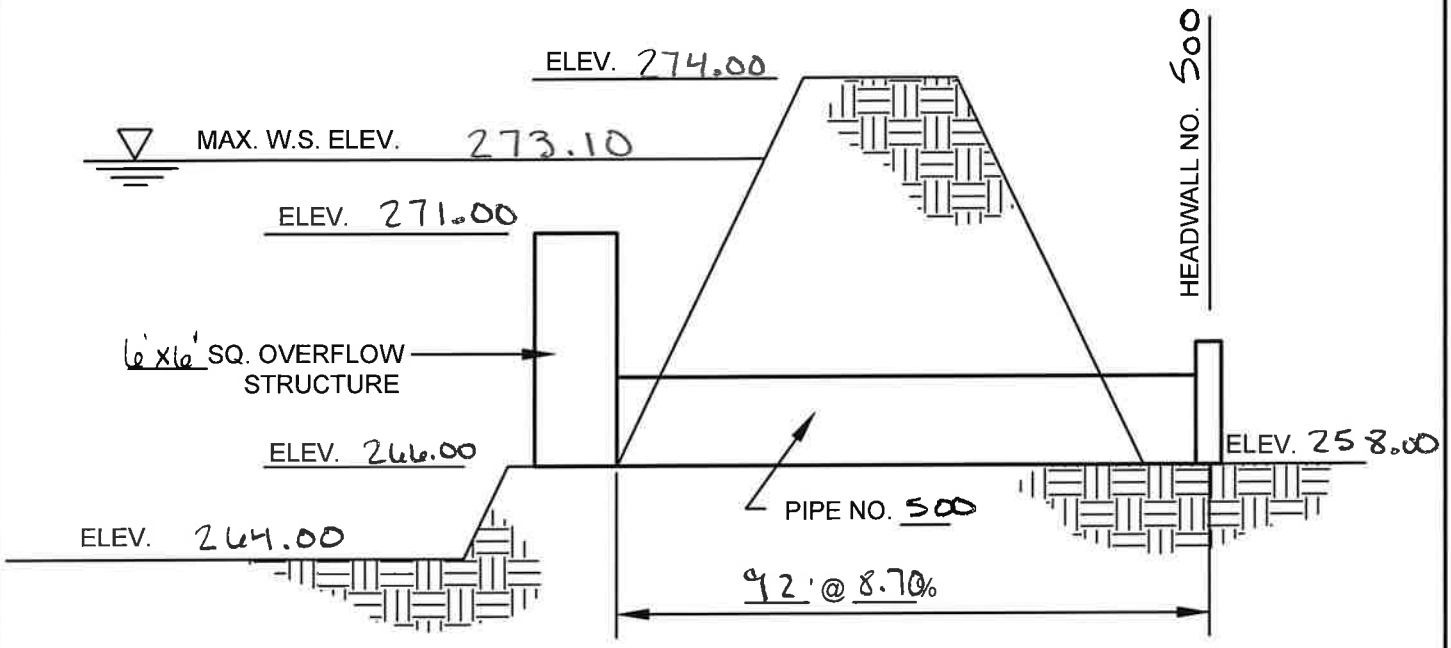
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022

| Hyd. No. | Hydrograph type (origin) | Peak flow (cfs) | Time interval (min) | Time to Peak (min) | Hyd. volume (cuft) | Inflow hyd(s) | Maximum elevation (ft) | Total strge used (cuft) | Hydrograph Description |
|---|---|---|---|---|---|---|---|---|---|
| 35 | SCS Runoff | 17.81 | 1 | 727 | 62,387 | ------ | ------ | ------ | DD24 |
| 36 | SCS Runoff | 18.30 | 1 | 727 | 64,107 | ------ | ------ | ------ | Area to DD25 |
| 37 | Combine | 36.11 | 1 | 727 | 126,494 | 35, 36 | ------ | ------ | DD25 |
| 38 | Combine | 100.19 | 1 | 727 | 361,666 | 34, 37 | ------ | ------ | DD23 & DD25 |
| 39 | Combine | 107.76 | 1 | 727 | 388,193 | 27, 38 | ------ | ------ | Ditch No. 8, DD23, & DD25 |
| 40 | SCS Runoff | 10.34 | 1 | 733 | 46,422 | ------ | ------ | ------ | Area to Ditch No. 7 |
| 41 | Combine | 116.42 | 1 | 727 | 434,616 | 39, 40 | ------ | ------ | Ditch No. 7 |
| 42 | Combine | 124.19 | 1 | 727 | 467,774 | 26, 41 | ------ | ------ | DI. 502 |
| 43 | SCS Runoff | 44.46 | 1 | 722 | 123,654 | ------ | ------ | ------ | Area to Pond No. 5 |
| 44 | Combine | 333.93 | 1 | 726 | 1,256,381 | 25, 42, 43 | ------ | ------ | Pond No. 5 Total Inflow |
| 46 | Reservoir | 64.50 | 1 | 757 | 1,243,246 | 44 | 271.70 | 648,445 | Pond No. 5 - perm pool |
| 47 | Reservoir | 132.53 | 1 | 745 | 1,256,375 | 44 | 273.10 | 333,182 | Pond No. 5 - riser |
| 50 | SCS Runoff | 4.494 | 1 | 724 | 14,185 | ------ | ------ | ------ | Ditch No. 3 |
| 51 | SCS Runoff | 11.47 | 1 | 724 | 36,221 | ------ | ------ | ------ | DD7 |
| 52 | SCS Runoff | 14.28 | 1 | 725 | 46,938 | ------ | ------ | ------ | Area to DD8 |
| 53 | Combine | 25.73 | 1 | 725 | 83,159 | 51, 52 | ------ | ------ | DD8 |
| 54 | Combine | 30.22 | 1 | 725 | 97,343 | 50, 53 | ------ | ------ | Ditch No. 3 & DD8 |
| 55 | SCS Runoff | 7.410 | 1 | 734 | 34,469 | ------ | ------ | ------ | Area to Ditch No. 2 |
| 56 | Combine | 35.48 | 1 | 725 | 131,813 | 54, 55 | ------ | ------ | Ditch No. 2 |
| 57 | SCS Runoff | 9.629 | 1 | 724 | 30,395 | ------ | ------ | ------ | DD1 |
| 58 | SCS Runoff | 12.84 | 1 | 724 | 40,527 | ------ | ------ | ------ | Area to DD2 |
| 59 | Combine | 22.47 | 1 | 724 | 70,923 | 57, 58 | ------ | ------ | DD2 |
| 60 | SCS Runoff | 17.70 | 1 | 725 | 58,193 | ------ | ------ | ------ | Area to DD3 |
| 61 | Combine | 40.13 | 1 | 725 | 129,116 | 59, 60 | ------ | ------ | DD3 |
| 62 | SCS Runoff | 19.26 | 1 | 724 | 60,791 | ------ | ------ | ------ | DD4 |
| 63 | SCS Runoff | 15.81 | 1 | 724 | 49,899 | ------ | ------ | ------ | Area to DD5 |
| 64 | Combine | 35.07 | 1 | 724 | 110,690 | 62, 63 | ------ | ------ | DD5 |
| 65 | SCS Runoff | 16.13 | 1 | 724 | 50,912 | ------ | ------ | ------ | Area to DD6 |
| 66 | Combine | 51.20 | 1 | 724 | 161,602 | 64, 65 | ------ | ------ | DD6 |
| 67 | Combine | 91.23 | 1 | 725 | 290,718 | 61, 66 | ------ | ------ | DD3 & DD6 |
| 68 | Combine | 126.71 | 1 | 725 | 422,531 | 56, 67 | ------ | ------ | Ditch No. 2, DD3, & DD6 |
| 69 | SCS Runoff | 11.73 | 1 | 723 | 34,632 | ------ | ------ | ------ | DD67 |
| 70 | SCS Runoff | 13.32 | 1 | 724 | 42,047 | ------ | ------ | ------ | Area to DD68 |

**e. Overflow Structure and Carrier Pipe Design**

In order to confirm that the overflow structure, carrier pipe and emergency spillway pipe have been designed adequately to pass the maximum flow as modeled in the HydraFlow Hydrographs Extension for AutoCad Civil 3D 2022 Computer Program, the following design calculations have been included.

# OVERFLOW STRUCTURE NO. 5




# DESIGN OF OVERFLOW STRUCTURE AS EMERGENCY SPILLWAY

FLOW (Q) WORST CASE = 100 YEAR STORM EVENT OCCURS WHEN WATER SURFACE ELEVATION AT TOP OF OVERFLOW STRUCTURE AND ALL DEWATERING HOLES ARE PLUGGED

FLOW (Q) MAXIMUM = 133 CFS

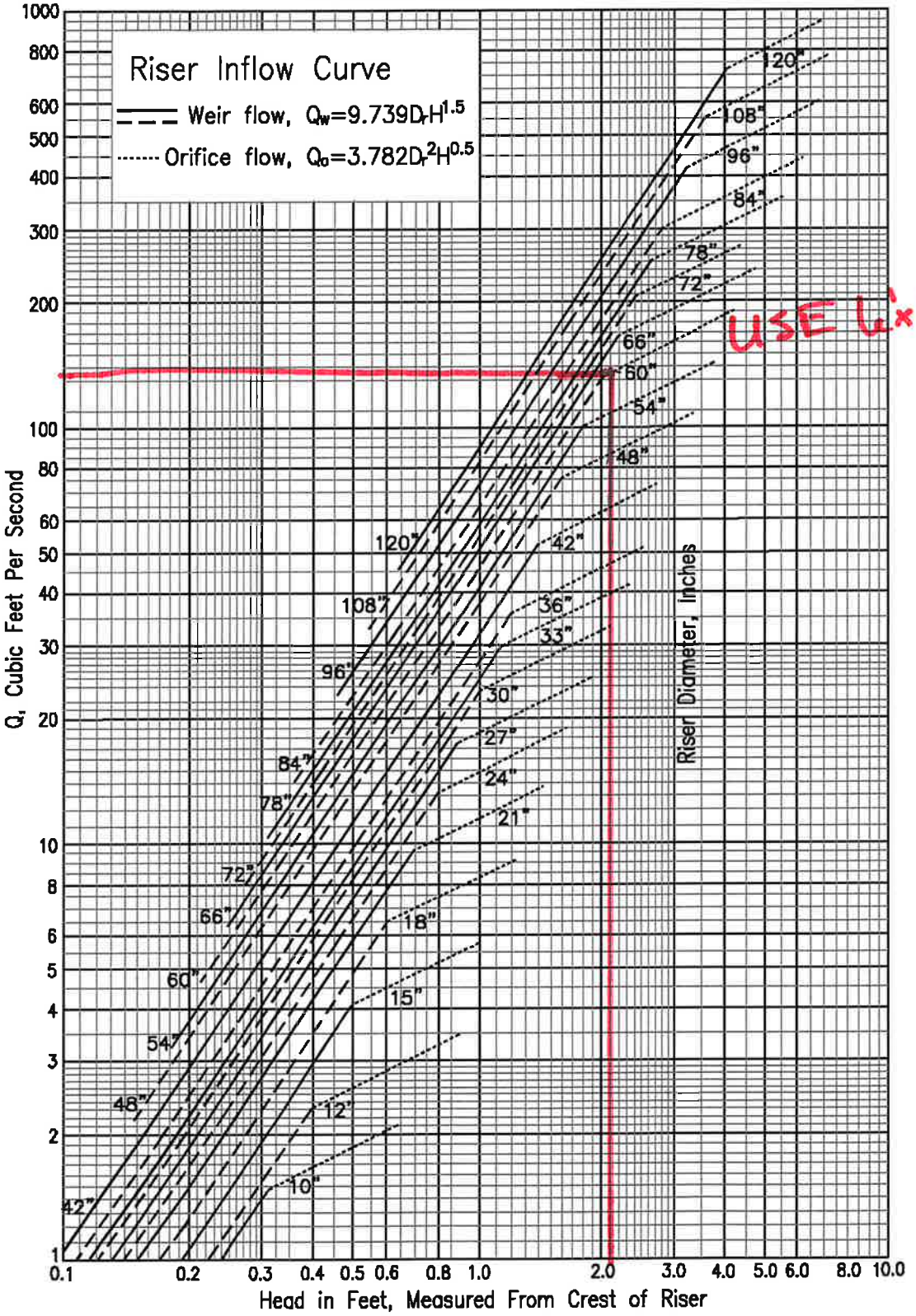
HEAD (H) MAXIMUM = MAXIMUM WATER SURFACE ELEVATION WITH 1' OF FREEBOARD MINUS THE ELEVATION AT THE CREST OF THE OVERFLOW STRUCTURE

= 273.10 - 271.00 = 2.10 FEET

BASED ON ABOVE HEAD, USE 6' x 6' SQ. OVERFLOW STRUCTURE

(SEE CHART ON NEXT PAGE)

**Figure G.2: Riser Inflow Curves**



# CARRIER PIPE NO. 500

Q = 133 CFS WORST CASE

MAXIMUM HEADWATER = TOP OF LEEVE ELEVATION MINUS 1' FREEBOARD
= 274.00 - 1.00 = 273.00

HEAD (H) = MAXIMUM WATER ELEVATION ALLOWED MINUS THE CENTERLINE ELEVATION AT THE DOWNSTREAM END OF THE CARRIER PIPE
= 273.00 - 260.00 = 13.0

LENGTH (L) = 92'

LENGTH FACTOR = 0.98 FOR LENGTHS OTHER THAN 70'

Q (AVAILABLE) = Q FROM TABLE TIMES LENGTH FACTOR
= 257 X 0.98 = 252

Q (AVAILABLE) MUST BE GREATER THAN Q WORST CASE

**USE 48 " DIAMETER RCP CARRIER PIPE**

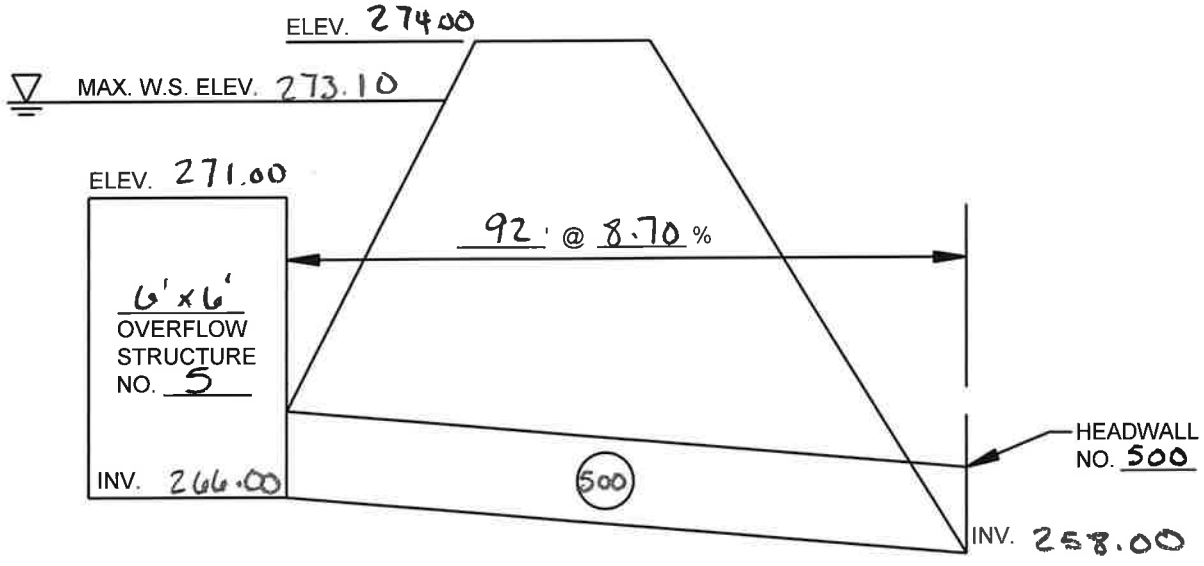


Table 6-25

PIPE FLOW CHART n = 0.025

FOR CORRUGATED METAL PIPE INLET $K_a = K_e + K_b = 1.0$ AND 70 FEET OF CORRUGATED METAL PIPE CONDUIT (full flow assumed)

Note correction factors for pipe lengths other than 70 feet

diameter of pipe in inches

| H, in feet | 12" | 15" | 18" | 21" | 24" | 30" | 36" | 42" | 48" | 54" | 60" | 66" | 72" | 78" | 84" | 90" | 96" | 102" |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3.22 | 5.44 | 8.29 | 11.8 | 15.9 | 26.0 | 38.6 | 53.8 | 71.4 | 91.5 | 114 | 139 | 167 | 197 | 229 | 264 | 302 | 342 |
| 2 | 4.55 | 7.69 | 11.7 | 16.7 | 22.5 | 36.8 | 54.6 | 76.0 | 101 | 129 | 161 | 197 | 236 | 278 | 324 | 374 | 427 | 483 |
| 3 | 5.57 | 9.42 | 14.4 | 20.4 | 27.5 | 45.0 | 66.9 | 93.1 | 124 | 159 | 198 | 241 | 289 | 341 | 397 | 458 | 523 | 592 |
| 4 | 6.43 | 10.9 | 16.6 | 23.5 | 31.8 | 52.0 | 77.3 | 108 | 143 | 183 | 228 | 278 | 334 | 394 | 459 | 529 | 604 | 683 |
| 5 | 7.19 | 12.2 | 18.5 | 26.3 | 35.5 | 58.1 | 86.4 | 120 | 160 | 205 | 255 | 311 | 373 | 440 | 513 | 591 | 675 | 764 |
| 6 | 7.88 | 13.3 | 20.3 | 28.8 | 38.9 | 67.7 | 94.8 | 132 | 175 | 224 | 280 | 341 | 409 | 482 | 562 | 647 | 739 | 837 |
| 7 | 8.51 | 14.4 | 21.9 | 31.1 | 42.0 | 68.8 | 102 | 142 | 189 | 242 | 302 | 368 | 441 | 521 | 607 | 699 | 798 | 904 |
| 8 | 9.10 | 15.4 | 23.5 | 33.3 | 44.9 | 73.5 | 109 | 152 | 202 | 259 | 323 | 394 | 472 | 557 | 685 | 746 | 854 | 966 |
| 9 | 9.65 | 16.3 | 24.9 | 35.3 | 47.7 | 78.0 | 116 | 161 | 214 | 275 | 342 | 418 | 500 | 590 | 688 | 793 | 905 | 1025 |
| 10 | 10.2 | 17.2 | 26.2 | 37.2 | 50.2 | 82.2 | 122 | 170 | 226 | 289 | 361 | 440 | 527 | 622 | 725 | 836 | 954 | 1080 |
| 11 | 10.7 | 18.0 | 27.5 | 39.0 | 52.7 | 86.2 | 128 | 178 | 237 | 304 | 379 | 462 | 553 | 653 | 761 | 877 | 1001 | 1133 |
| 12 | 11.1 | 18.9 | 28.7 | 40.8 | 55.0 | 90.1 | 134 | 186 | 247 | 317 | 395 | 482 | 578 | 682 | 794 | 916 | 1046 | 1184 |
| 13 | 11.6 | 19.6 | 29.9 | 42.4 | 57.3 | 93.7 | 139 | 194 | 257 | 330 | 411 | 502 | 601 | 710 | 827 | 953 | 1088 | 1232 |
| 14 | 12.0 | 20.4 | 31.0 | 44.1 | 59.4 | 97.3 | 145 | 201 | 267 | 342 | 427 | 521 | 624 | 738 | 858 | 989 | 1129 | 1278 |
| 15 | 12.6 | 21.1 | 32.1 | 45.6 | 61.5 | 101 | 150 | 208 | 277 | 354 | 442 | 539 | 646 | 762 | 888 | 1024 | 1169 | 1323 |
| 16 | 12.9 | 21.8 | 33.2 | 47.1 | 63.5 | 104 | 155 | 215 | 286 | 366 | 457 | 557 | 667 | 787 | 917 | 1057 | 1207 | 1367 |
| 17 | 13.3 | 22.4 | 34.2 | 48.5 | 65.5 | 107 | 159 | 222 | 294 | 377 | 471 | 574 | 688 | 812 | 946 | 1090 | 1244 | 1409 |
| 18 | 13.7 | 23.1 | 35.2 | 49.9 | 67.4 | 110 | 164 | 228 | 303 | 388 | 484 | 591 | 708 | 835 | 973 | 1121 | 1280 | 1450 |
| 19 | 14.0 | 23.8 | 36.1 | 51.3 | 69.2 | 113 | 168 | 234 | 311 | 399 | 497 | 607 | 727 | 858 | 1000 | 1152 | 1315 | 1489 |
| 20 | 14.4 | 24.3 | 37.1 | 52.6 | 71.0 | 116 | 173 | 240 | 319 | 409 | 510 | 623 | 746 | 880 | 1026 | 1182 | 1350 | 1528 |
| 21 | 14.7 | 24.9 | 38.0 | 53.9 | 72.8 | 119 | 177 | 246 | 327 | 419 | 523 | 638 | 764 | 902 | 1051 | 1211 | 1383 | 1566 |
| 22 | 15.1 | 25.5 | 38.9 | 55.2 | 74.5 | 122 | 181 | 252 | 335 | 429 | 535 | 653 | 782 | 923 | 1078 | 1240 | 1416 | 1603 |
| 23 | 15.4 | 26.1 | 39.8 | 56.5 | 76.2 | 125 | 188 | 258 | 342 | 439 | 547 | 668 | 800 | 944 | 1100 | 1268 | 1447 | 1639 |
| 24 | 15.8 | 26.7 | 40.6 | 57.7 | 77.8 | 127 | 189 | 263 | 350 | 448 | 559 | 682 | 817 | 964 | 1123 | 1295 | 1478 | 1674 |
| 25 | 16.1 | 27.2 | 41.5 | 58.9 | 79.4 | 130 | 193 | 269 | 357 | 458 | 571 | 696 | 834 | 984 | 1147 | 1322 | 1509 | 1708 |
| 26 | 16.4 | 27.7 | 42.3 | 60.0 | 81.0 | 133 | 197 | 274 | 364 | 467 | 582 | 710 | 850 | 1004 | 1169 | 1348 | 1539 | 1742 |
| 27 | 16.7 | 28.3 | 43.1 | 61.2 | 82.5 | 135 | 201 | 279 | 371 | 476 | 593 | 723 | 867 | 1023 | 1192 | 1373 | 1568 | 1775 |
| 28 | 17.0 | 28.8 | 43.9 | 62.3 | 84.1 | 138 | 204 | 285 | 378 | 484 | 604 | 737 | 883 | 1041 | 1214 | 1399 | 1597 | 1808 |
| 29 | 17.3 | 29.3 | 44.7 | 63.4 | 85.5 | 140 | 208 | 290 | 384 | 493 | 615 | 750 | 898 | 1060 | 1235 | 1423 | 1625 | 1840 |
| 30 | 17.6 | 29.8 | 45.4 | 64.5 | 87.0 | 142 | 212 | 294 | 391 | 501 | 625 | 763 | 913 | 1078 | 1256 | 1448 | 1653 | 1871 |
| L, in feet | Correction Factors For Other Pipe Lengths | | | | | | | | | | | | | | | | | |
| 20 | 1.30 | 1.24 | 1.21 | 1.18 | 1.15 | 1.12 | 1.10 | 1.08 | 1.07 | 1.06 | 1.05 | 1.05 | 1.04 | 1.04 | 1.03 | 1.03 | 1.03 | 1.03 |
| 30 | 1.22 | 1.18 | 1.15 | 1.13 | 1.12 | 1.09 | 1.08 | 1.06 | 1.05 | 1.05 | 1.04 | 1.04 | 1.03 | 1.03 | 1.03 | 1.02 | 1.02 | 1.02 |
| 40 | 1.15 | 1.13 | 1.11 | 1.10 | 1.08 | 1.07 | 1.05 | 1.05 | 1.04 | 1.03 | 1.03 | 1.03 | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 |
| 50 | 1.09 | 1.08 | 1.07 | 1.06 | 1.05 | 1.04 | 1.04 | 1.03 | 1.03 | 1.02 | 1.02 | 1.02 | 1.02 | 1.01 | 1.01 | 1.01 | 1.01 | 1.01 |
| 60 | 1.04 | 1.04 | 1.03 | 1.03 | 1.03 | 1.02 | 1.02 | 1.02 | 1.01 | 1.01 | 1.01 | 1.01 | 1.01 | 1.01 | 1.01 | 1.01 | 1.01 | 1.01 |
| 70 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 80 | .96 | .97 | .97 | .97 | .98 | .98 | .98 | .99 | .99 | .99 | .99 | .99 | .99 | .99 | .99 | .99 | .99 | .99 |
| 90 | .93 | .94 | .94 | .95 | .96 | .96 | .97 | .97 | .98 | .98 | .98 | .98 | .98 | .99 | .99 | .99 | .99 | .99 |
| 100 | .90 | .91 | .92 | .93 | .93 | .95 | .95 | .96 | .97 | .97 | .97 | .98 | .98 | .98 | .98 | .98 | .98 | .99 |
| 120 | .84 | .86 | .87 | .89 | .90 | .91 | .93 | .94 | .94 | .95 | .96 | .96 | .96 | .97 | .97 | .97 | .97 | .98 |
| 140 | .80 | .82 | .83 | .85 | .86 | .88 | .90 | .91 | .92 | .93 | .94 | .94 | .95 | .95 | .96 | .96 | .96 | .97 |
| 160 | .76 | .78 | .80 | .82 | .83 | .86 | .88 | .89 | .90 | .91 | .92 | .93 | .94 | .94 | .95 | .95 | .95 | .96 |

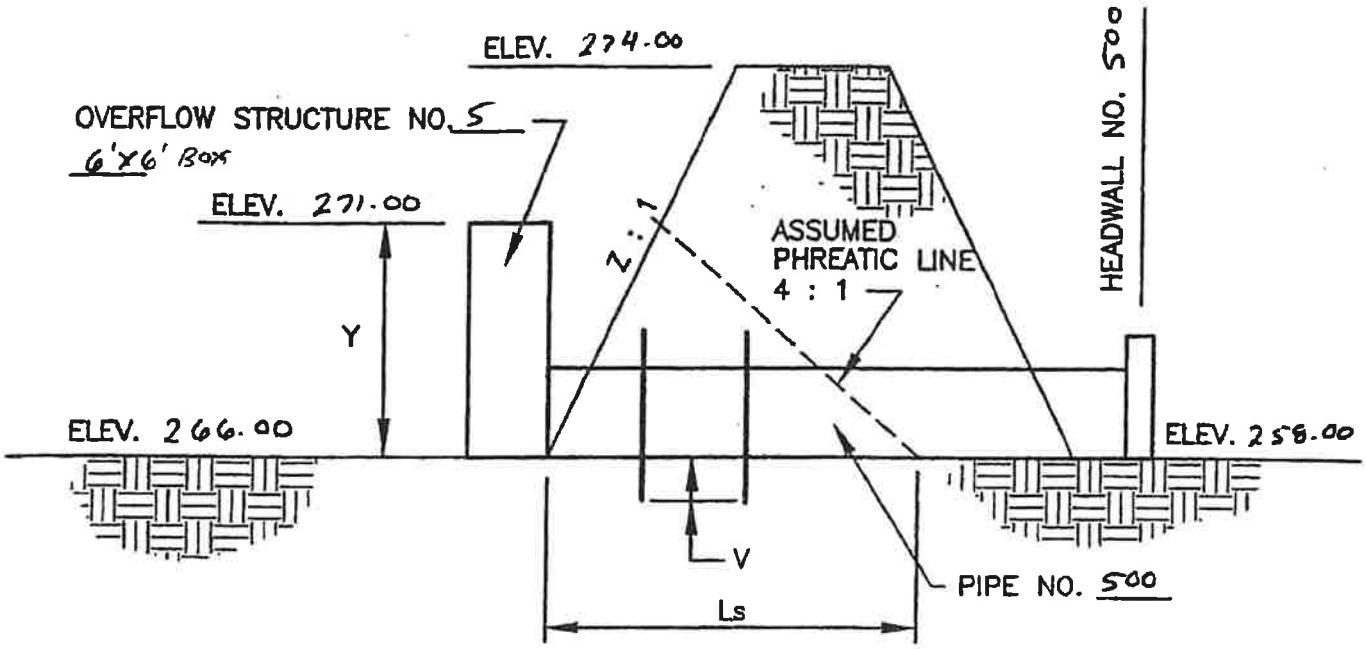
Source: USDA - SCS

**f. Anti-Seep Collar Design**

The seepage of water through the existing sediment pond dam along the carrier pipe could result in dam failure.

The proposed anti-seep collars have been designed to be located at intervals within the zone of saturation along the carrier pipe to increase the seepage length along the carrier pipe and thereby prevent piping or seepage along the carrier pipe.

# ANTI – SEEP COLLAR DESIGN




Ls = LENGTH IN SATURATION ZONE

Y = OVERFLOW STRUCTURE HEIGHT = 5.0 FEET

Z = INSIDE SLOPE OF LEVEE = 3

PIPE SLOPE = 8.70 % = 0.087 FEET/FEET

$$Ls = Y ( Z + 4 ) \left( 1 + \frac{\text{PIPE SLOPE}}{0.25 - \text{PIPE SLOPE}} \right)$$

Ls = 54 FEET

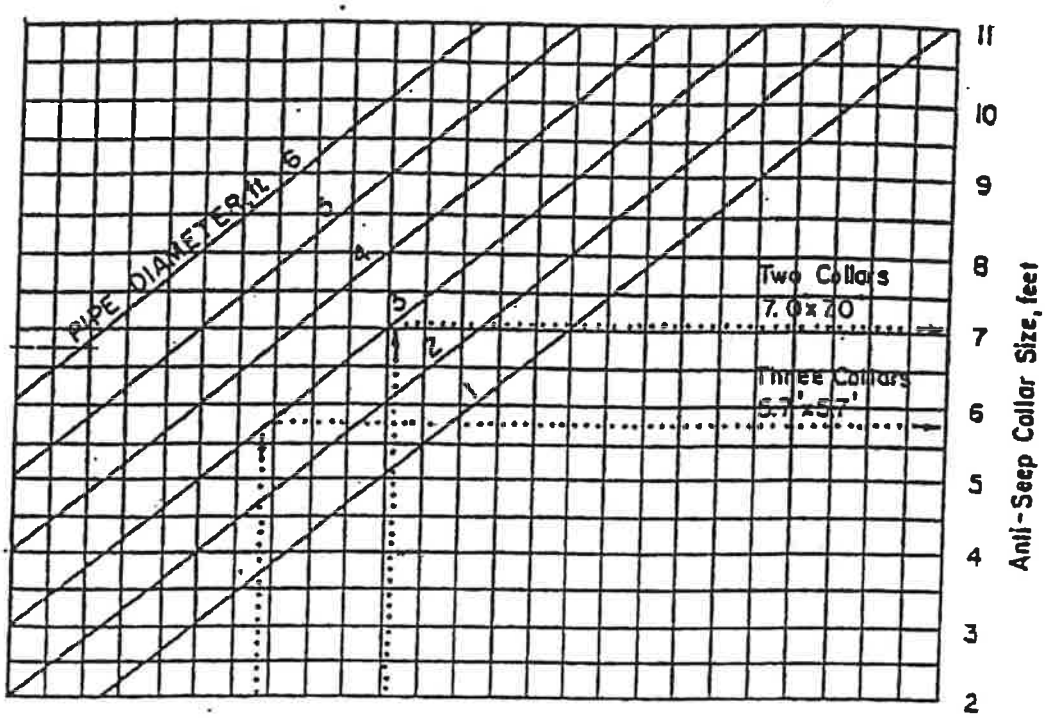
FROM ANTI – SEEP COLLAR DESIGN CHART ON THE NEXT PAGE :

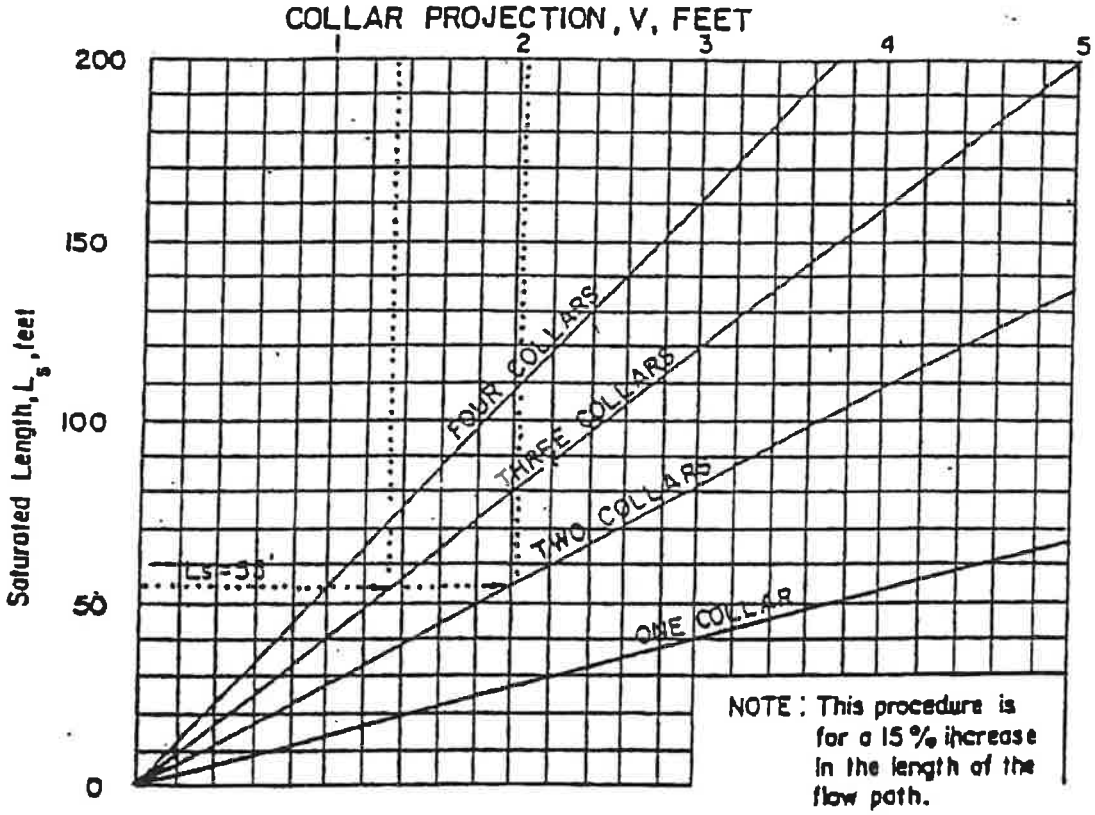
V = COLLAR PROJECTION = 2.0 FEET

DIMENSIONS OF 12" THICK COLLAR = 9.0'X 9.0'

NUMBER OF REQUIRED COLLARS = 2

# ANTI-SEEP COLLAR DESIGN



**g. Overflow Structure Base Foundation Design**

The overflow structure and carrier pipe will be subject to a certain amount of buoyant force when the sediment pond is filled with storm water. In order to overcome this buoyant force and prevent the flotation of the overflow structure and carrier pipe, a concrete overflow structure base foundation and concrete carrier pipe encasement have been designed. The design calculations for the concrete overflow structure base foundation and carrier pipe encasement are included in this section.

**OVERFLOW STRUCTURE BASE FOUNDATION DESIGN**

A certain volume of concrete will be used to overcome the buoyancy of an empty overflow structure and carrier pipe that are below the assumed phreatic water surface. This volume is equal to:

Overflow Structure

= (L)(w)(h)(62.4) L = w = 6.0' inside = 7.0' outside

= (7.0)(7.0)(5.0)(62.4) h = height = 5.0'

= 15,288 #

Carrier Pipe = 3.1416($R_2^2$)(Ls)(62.4) Ls = length in saturation zone = 54'

= 3.1416(2.42)(2.42)(54)(62.4) $R_2$ = outside radius = 29" = 2.42

= 61,995 # $r_2$ = inside radius = 24" = 2.0'

TOTAL WEIGHT

= 77,283 # x 1.5 (SAFETY FACTOR)

= 115,925 #

TOTAL REVISED VOLUME OF CONCRETE =

TOTAL WEIGHT / WEIGHT OF CONC. IN WATER

= 115,925/87.6 pcf (87.6 pcf = Wt. of conc. in submerged water)

= 1323 C.F.

This volume of concrete will be made up from five areas.

1. Overflow Structures
2. Anti-Seep Collars
3. Carrier Pipe
4. Overflow Structure Base
5. Carrier Pipe Encasement

1. Overflow Structure = $(L_2 - l_2)h$

   $(7.0^2 – 6.0^2)(5.0) = 65$ C.F.

   L = outside dimension of box = 7.0’

   l = inside dimension of box = 6.0’

   h = height of overflow structures = 5.0’

2. Anti-seep collars = area of square collar around carrier pipe x 12" thick x # of collars

   = [( 9.0' x 9.0' ) - (3.1416)( $R_2^2$)]

   x 1' x 2

   = 125 C.F.

   $R_2$ = outside radius of carrier pipe = 29" = 2.42’

   $r_2$ = inside radius of carrier pipe = 24" = 2.0’

3. Carrier Pipe

   = 3.1416 ($R_2^2 – r_2^2$) L = 315 C.F.

   L = length in saturation = 54’

4. Overflow Structure Base = Volume to handle riser bouyance x 1.2

   = (L)(w)h(62.4)(1.2)/weight of conc. in water

   = (7.0’)(7.0’)(5.0)(62.4)(1.2)/87.6

   = 209 C.F.

   Use 11.0’ x 11.0’ x 3.0’ = 363

   L = w = 7.0’ outside

   h = height = 5.0’

5. Carrier Pipe Encasement

   Must extend 5’ into dam. Distance from overflow structure to dam is equal to 15.0’. Therefore, encasement length will be 20.0’, will use 40’ length for additional ballast.

   [(5 x 6) – (3.1416)$R_2^2$] 40

   Carrier pipe encasement volume = 464 C.F.

**TOTAL REQUIRED VOLUME = 1,323 C.F.**

Actual Total Volume

| | | |
|---|---|---|
| Overflow Structure | = | 65 C.F. |
| Anti-Seep Collars | = | 125 C.F. |
| Carrier Pipe | = | 315 C.F. |
| Overflow Structure Base | = | 363 C.F. |
| Carrier Pipe Encasement | = | 464 C.F. |
| **TOTAL** | **=** | **1,332 C.F. ⇒ Okay** |

# 7. PROPOSED SEDIMENT POND NO. 6

## a. Sediment Storage and Settling Efficiency Calculations

As required in the "Alabama Handbook for Erosion Control, Sediment Control and Stormwater Management on Construction Sites and Urban Area", the sediment storage volume of the pond shall be at least 67 cubic yards per acre for the disturbed area draining into the pond (67 cubic yards is equivalent to ½ inch of sediment per acre of drainage area). The peak inflow rate for the 25 year storm event has also been used to calculate the minimum pond surface area needed for adequate settling efficiency. These calculations for the sediment pond are included below.

Sediment Storage Calculation

Assume maximum sediment from 46 disturbed acres.

46 Acres x 67 c.y./acre = 3,082 c.y. = 83,214 c.f.

This sediment volume corresponds to a depth of 0.95' or Elev. 256.95.

Dewatering opening is set at Elev. 259.00. Therefore, ample sediment storage volume is available.

<u>Settling Efficiency Calculations</u>

- Use 25 year storm event, Q25 Flow = 218 cfs
- Minimum Surface Area = .01 acre / cfs x Q25 Flow
  = .01 acre / cfs x 218 cfs
  = 2.18 acres = 94,961 s.f.
- Top of Overflow Structure = Elev. 263.00

  Surface Area @ Elev. 263.00 = 114,838 s.f.

- Adequate surface area is available for settling

# Pond Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022 Thursday, 01 / 30 / 2025

## Pond No. 5 - Pond No. 6

### Pond Data

**Contours -**User-defined contour areas. Average end area method used for volume calculation. Begining Elevation = 256.00 ft

### Stage / Storage Table

| Stage (ft) | Elevation (ft) | Contour area (sqft) | Incr. Storage (cuft) | Total storage (cuft) |
|---|---|---|---|---|
| 0.00 | 256.00 | 83,709 | 0 | 0 |
| 2.00 | 258.00 | 92,360 | 176,069 | 176,069 |
| 3.00 | 259.00 | 96,823 | 94,592 | 270,661 |
| 4.00 | 260.00 | 101,286 | 99,055 | 369,715 |
| 6.00 | 262.00 | 110,245 | 211,531 | 581,246 |
| 7.50 | 263.50 | 117,135 | 170,535 | 751,781 |
| 8.00 | 264.00 | 119,431 | 59,142 | 810,923 |
| 10.00 | 266.00 | 129,108 | 248,540 | 1,059,462 |

### Culvert / Orifice Structures

| | [A] | [B] | [C] | [PrfRsr] |
|---|---|---|---|---|
| **Rise (in)** | = 54.00 | 6.00 | 6.00 | Inactive |
| **Span (in)** | = 54.00 | 24.00 | 12.00 | 0.00 |
| **No. Barrels** | = 1 | 2 | 2 | 0 |
| **Invert El. (ft)** | = 258.00 | 259.00 | 261.00 | 0.00 |
| **Length (ft)** | = 87.00 | 0.00 | 0.00 | 0.00 |
| **Slope (%)** | = 6.90 | 0.00 | 0.00 | n/a |
| **N-Value** | = .013 | .013 | .013 | n/a |
| **Orifice Coeff.** | = 0.60 | 0.60 | 0.60 | 0.60 |
| **Multi-Stage** | = n/a | Yes | Yes | No |

### Weir Structures

| | [A] | [B] | [C] | [D] |
|---|---|---|---|---|
| **Crest Len (ft)** | = 24.00 | Inactive | Inactive | Inactive |
| **Crest El. (ft)** | = 263.00 | 0.00 | 0.00 | 0.00 |
| **Weir Coeff.** | = 3.33 | 3.33 | 3.33 | 3.33 |
| **Weir Type** | = 1 | --- | --- | --- |
| **Multi-Stage** | = Yes | No | No | No |

**Exfil.(in/hr)** = 0.000 (by Wet area)

**TW Elev. (ft)** = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).

### Stage / Storage / Discharge Table

| Stage ft | Storage cuft | Elevation ft | Clv A cfs | Clv B cfs | Clv C cfs | PrfRsr cfs | Wr A cfs | Wr B cfs | Wr C cfs | Wr D cfs | Exfil cfs | User cfs | Total cfs |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.00 | 0 | 256.00 | 0.00 | 0.00 | 0.00 | --- | 0.00 | --- | --- | --- | --- | --- | 0.000 |
| 2.00 | 176,069 | 258.00 | 0.00 | 0.00 | 0.00 | --- | 0.00 | --- | --- | --- | --- | --- | 0.000 |
| 3.00 | 270,661 | 259.00 | 0.00 | 0.00 | 0.00 | --- | 0.00 | --- | --- | --- | --- | --- | 0.000 |
| 4.00 | 369,715 | 260.00 | 8.58 ic | 8.34 ic | 0.00 | --- | 0.00 | --- | --- | --- | --- | --- | 8.340 |
| 6.00 | 581,246 | 262.00 | 19.65 ic | 15.26 ic | 4.17 ic | --- | 0.00 | --- | --- | --- | --- | --- | 19.43 |
| 7.50 | 751,781 | 263.50 | 51.98 ic | 16.49 ic | 7.22 ic | --- | 28.26 | --- | --- | --- | --- | --- | 51.97 |
| 8.00 | 810,923 | 264.00 | 100.91 ic | 13.75 ic | 6.88 ic | --- | 79.92 | --- | --- | --- | --- | --- | 100.55 |
| 10.00 | 1,059,462 | 266.00 | 180.20 ic | 4.43 ic | 2.21 ic | --- | 173.54 s | --- | --- | --- | --- | --- | 180.18 |

**b. Total Pond Dewatering at Top of Riser (Elev. 263.00)**

Retention time within the basin is an important factor in effective sediment retention. The overflow structure has been designed as specified below.

Since the overflow structure will have two stages, the dewatering time has been calculated for each stage. Stage 1 calculates the drawdown time of the maximum water surface elevation from the top of the riser to the orifice at elevation 261.00. Stage 2 calculates the drawdown time from the orifice at elevation 261.00 to the orifice at elevation 259.00.

The calculation below has been performed to confirm that the dewatering (retention) time within the pond is between 24 and 72 hours. This dewatering time will ensure the storm water is retained for an adequate length of time to allow the sediment to settle (minimum 24 hours) and is also discharged gradually in an acceptable length of time to allow storage for future storm events (maximum 72 hours).

The dewatering time is calculated as follows:

$$T = \frac{A_s \times (2h)^{1/2}}{A_O \times C_d \times (20{,}428)}$$

$A_O$ = Surface Area of Dewatering Holes ($ft_2$)

$A_s$ = Surface Area Corresponding to top of riser elevation ($ft_2$)

h = Head of water above dewatering hole (ft)

$C_d$ = Coefficient of contraction for an orifice (use 0.6)

T = Time to dewater

**Stage 1**

$T_1$

$A_O$ = 1.0 s.f. @ Elev. 261.00 (2 - 6" x 12" rectangular openings)

$A_s$ = 114,838 s.f. @ Elev. 263.00

h = 263.00 – 261.00 = 2.0'

$$T = \frac{114{,}838\ (2 \times 2.0)^{1/2}}{(1.0)\ (0.6)\ (20{,}428)} = 18.74 \text{ hours}$$

**Stage 2**

$T_2$

$A_O$ = 2.0 s.f. @ Elev. 259.00 (2 – 6" x 24" rectangular opening)

$A_s$ = 105,765 s.f. @ Elev. 261.00 (invert of orifice #2)

h = 261.00 – 259.00 = 2.00'

$$T = \frac{105{,}766\,(2 \times 2.00)^{1/2}}{(2.0)\,(0.6)\,(20{,}428)} = 8.6 \text{ hours}$$

$T_1 + T_2$ = 18.7 + 8.6 = 27.3 hours

**(okay between 24 - 72 hours)**

**c. Reservoir Routing**

Reservoir routing is determined by using the HydraFlow Hydrographs Extension for AutoCad Civil 3D 2022 Computer Program.

Peak inflow rates (Q) are determined using the SCS Method and HydraFlow Hydrographs Extension for AutoCad Civil 3D 2022 Computer Program. Peak inflow rates are calculated for the 25 year and 100 year storm events and are summarized below.

Q25 = 278 cfs

Q100 = 309 cfs

The bottom of the pond has been set at 256.00. Dewatering of the pond is accomplished by two 6" x 24" rectangular openings beginning at an invert elevation of 259.00 and two 6" x 12" rectangular openings at elevation 261.00.

For routing calculations, a 6' x 6' rectangular riser with two 6" x 24" rectangular opening at an invert elevation of 259.00 and two 6" x 12" rectangular openings at elevation 261.00 were used. The top of the riser is at an elevation of 263.00. The bottom of the pond is elev. 256.00. The invert of the carrier pipe is elev. 258.00. The top of the levee around the sediment pond is at an elevation of 266.00.

The maximum height of sediment is elevation 256.95 which is below the elevation of the first dewatering opening (Elev. 259.00). For routing calculations, the starting water surface elevation was set at 259.00, assuming the remainder of the pond bottom is filled below the dewatering orifice invert elevation.

Based on the above information the reservoir routing calculations are performed and summarized below.

| STORM YEAR | PEAK INFLOW CFS | PEAK OUTFLOW CFS | PEAK ELEV. FEET |
|---|---|---|---|
| 25 | 218 | 22.5 | 262.66 |
| 100 | 309 | 74.3 | 263.75 |

Based on these routing calculations, the riser is large enough and the pond has sufficient storage volume to retain the sediment from 46 disturbed acres plus the 25 year storm event from the entire drainage area below the crest of the riser (elev. 263.00).

# Pond Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022 Thursday, 01 / 30 / 2025

## Pond No. 6 - Pond No. 6 - perm pool

### Pond Data

**Contours -**User-defined contour areas. Average end area method used for volume calculation. Begining Elevation = 259.00 ft

### Stage / Storage Table

| Stage (ft) | Elevation (ft) | Contour area (sqft) | Incr. Storage (cuft) | Total storage (cuft) |
|---|---|---|---|---|
| 0.00 | 259.00 | 96,823 | 0 | 0 |
| 1.00 | 260.00 | 101,286 | 99,055 | 99,055 |
| 3.00 | 262.00 | 110,245 | 211,531 | 310,586 |
| 4.50 | 263.50 | 117,135 | 170,535 | 481,121 |
| 5.00 | 264.00 | 119,431 | 59,142 | 540,262 |
| 7.00 | 266.00 | 129,108 | 248,539 | 788,801 |

### Culvert / Orifice Structures

| | [A] | [B] | [C] | [PrfRsr] |
|---|---|---|---|---|
| **Rise (in)** | = 54.00 | 6.00 | 6.00 | Inactive |
| **Span (in)** | = 54.00 | 24.00 | 12.00 | 0.00 |
| **No. Barrels** | = 1 | 2 | 2 | 0 |
| **Invert El. (ft)** | = 258.00 | 259.00 | 261.00 | 0.00 |
| **Length (ft)** | = 87.00 | 0.00 | 0.00 | 0.00 |
| **Slope (%)** | = 6.90 | 0.00 | 0.00 | n/a |
| **N-Value** | = .013 | .013 | .013 | n/a |
| **Orifice Coeff.** | = 0.60 | 0.60 | 0.60 | 0.60 |
| **Multi-Stage** | = n/a | Yes | Yes | No |

### Weir Structures

| | [A] | [B] | [C] | [D] |
|---|---|---|---|---|
| **Crest Len (ft)** | = 24.00 | Inactive | Inactive | Inactive |
| **Crest El. (ft)** | = 263.00 | 0.00 | 0.00 | 0.00 |
| **Weir Coeff.** | = 3.33 | 3.33 | 3.33 | 3.33 |
| **Weir Type** | = 1 | --- | --- | --- |
| **Multi-Stage** | = Yes | No | No | No |

**Exfil.(in/hr)** = 0.000 (by Wet area)

**TW Elev. (ft)** = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).

### Stage / Storage / Discharge Table

| Stage ft | Storage cuft | Elevation ft | Clv A cfs | Clv B cfs | Clv C cfs | PrfRsr cfs | Wr A cfs | Wr B cfs | Wr C cfs | Wr D cfs | Exfil cfs | User cfs | Total cfs |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.00 | 0 | 259.00 | 0.00 | 0.00 | 0.00 | --- | 0.00 | --- | --- | --- | --- | --- | 0.000 |
| 1.00 | 99,055 | 260.00 | 9.15 ic | 8.34 ic | 0.00 | --- | 0.00 | --- | --- | --- | --- | --- | 8.340 |
| 3.00 | 310,586 | 262.00 | 19.65 ic | 15.26 ic | 4.17 ic | --- | 0.00 | --- | --- | --- | --- | --- | 19.43 |
| 4.50 | 481,121 | 263.50 | 51.98 ic | 16.49 ic | 7.22 ic | --- | 28.26 | --- | --- | --- | --- | --- | 51.97 |
| 5.00 | 540,262 | 264.00 | 100.91 ic | 13.75 ic | 6.88 ic | --- | 79.92 | --- | --- | --- | --- | --- | 100.55 |
| 7.00 | 788,801 | 266.00 | 180.20 ic | 4.43 ic | 2.21 ic | --- | 173.56 s | --- | --- | --- | --- | --- | 180.20 |

# Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022

| Hyd. No. | Hydrograph type (origin) | Peak flow (cfs) | Time interval (min) | Time to Peak (min) | Hyd. volume (cuft) | Inflow hyd(s) | Maximum elevation (ft) | Total strge used (cuft) | Hydrograph Description |
|---|---|---|---|---|---|---|---|---|---|
| 71 | Combine | 17.55 | 1 | 724 | 53,406 | 69, 70 | ------ | ------ | DD68 |
| 72 | SCS Runoff | 11.55 | 1 | 725 | 35,989 | ------ | ------ | ------ | Area to DD69 |
| 73 | Combine | 29.09 | 1 | 724 | 89,395 | 71, 72 | ------ | ------ | DD69 |
| 74 | SCS Runoff | 8.556 | 1 | 734 | 39,379 | ------ | ------ | ------ | Area to Ditch No. 1 |
| 75 | Combine | 95.40 | 1 | 725 | 333,665 | 68, 74 | ------ | ------ | Ditch No. 1 |
| 76 | Combine | 124.03 | 1 | 725 | 423,059 | 73, 75 | ------ | ------ | Ditch No. 1 & DD69 |
| 77 | SCS Runoff | 9.984 | 1 | 733 | 44,307 | ------ | ------ | ------ | Area to Ditch No. 17 |
| 78 | Combine | 131.30 | 1 | 725 | 467,367 | 76, 77 | ------ | ------ | Ditch No. 17 |
| 79 | SCS Runoff | 14.18 | 1 | 729 | 53,719 | ------ | ------ | ------ | DD61 |
| 80 | SCS Runoff | 11.81 | 1 | 725 | 38,362 | ------ | ------ | ------ | Area to DD62 |
| 81 | Combine | 25.24 | 1 | 727 | 92,081 | 79, 80 | ------ | ------ | DD62 |
| 82 | SCS Runoff | 12.48 | 1 | 727 | 43,110 | ------ | ------ | ------ | Area to DD63 |
| 83 | Combine | 37.72 | 1 | 727 | 135,191 | 81, 82 | ------ | ------ | DD63 |
| 84 | SCS Runoff | 11.04 | 1 | 725 | 34,401 | ------ | ------ | ------ | DD64 |
| 85 | SCS Runoff | 11.55 | 1 | 725 | 35,989 | ------ | ------ | ------ | Area to DD65 |
| 86 | Combine | 22.59 | 1 | 725 | 70,390 | 84, 85 | ------ | ------ | DD65 |
| 87 | SCS Runoff | 12.00 | 1 | 725 | 37,400 | ------ | ------ | ------ | Area to DD66 |
| 88 | Combine | 34.59 | 1 | 725 | 107,790 | 86, 87 | ------ | ------ | DD66 |
| 89 | Combine | 202.24 | 1 | 725 | 710,348 | 78, 83, 88 | ------ | ------ | DI. 601 |
| 90 | SCS Runoff | 20.23 | 1 | 722 | 55,491 | ------ | ------ | ------ | Area to Pond No. 6 |
| 91 | Combine | 217.69 | 1 | 725 | 765,838 | 89, 90 | ------ | ------ | Pond No. 6 Total Inflow |
| 93 | Reservoir | 22.54 | 1 | 782 | 764,979 | 91 | 262.66 | 385,806 | Pond No. 6 - perm pool |
| 94 | Reservoir | 124.75 | 1 | 735 | 765,834 | 91 | 264.35 | 161,227 | Pond No. 6 - riser |

# Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022

| Hyd. No. | Hydrograph type (origin) | Peak flow (cfs) | Time interval (min) | Time to Peak (min) | Hyd. volume (cuft) | Inflow hyd(s) | Maximum elevation (ft) | Total strge used (cuft) | Hydrograph Description |
|---|---|---|---|---|---|---|---|---|---|
| 71 | Combine | 24.85 | 1 | 724 | 76,679 | 69, 70 | ------ | ------ | DD68 |
| 72 | SCS Runoff | 16.37 | 1 | 724 | 51,672 | ------ | ------ | ------ | Area to DD69 |
| 73 | Combine | 41.22 | 1 | 724 | 128,352 | 71, 72 | ------ | ------ | DD69 |
| 74 | SCS Runoff | 12.16 | 1 | 734 | 56,540 | ------ | ------ | ------ | Area to Ditch No. 1 |
| 75 | Combine | 135.34 | 1 | 725 | 479,071 | 68, 74 | ------ | ------ | Ditch No. 1 |
| 76 | Combine | 175.81 | 1 | 725 | 607,421 | 73, 75 | ------ | ------ | Ditch No. 1 & DD69 |
| 77 | SCS Runoff | 14.18 | 1 | 733 | 63,615 | ------ | ------ | ------ | Area to Ditch No. 17 |
| 78 | Combine | 186.30 | 1 | 725 | 671,038 | 76, 77 | ------ | ------ | Ditch No. 17 |
| 79 | SCS Runoff | 20.10 | 1 | 729 | 77,128 | ------ | ------ | ------ | DD61 |
| 80 | SCS Runoff | 16.75 | 1 | 725 | 55,080 | ------ | ------ | ------ | Area to DD62 |
| 81 | Combine | 35.78 | 1 | 727 | 132,208 | 79, 80 | ------ | ------ | DD62 |
| 82 | SCS Runoff | 17.67 | 1 | 727 | 61,896 | ------ | ------ | ------ | Area to DD63 |
| 83 | Combine | 53.45 | 1 | 727 | 194,104 | 81, 82 | ------ | ------ | DD63 |
| 84 | SCS Runoff | 15.65 | 1 | 724 | 49,392 | ------ | ------ | ------ | DD64 |
| 85 | SCS Runoff | 16.37 | 1 | 724 | 51,672 | ------ | ------ | ------ | Area to DD65 |
| 86 | Combine | 32.02 | 1 | 724 | 101,065 | 84, 85 | ------ | ------ | DD65 |
| 87 | SCS Runoff | 17.01 | 1 | 724 | 53,699 | ------ | ------ | ------ | Area to DD66 |
| 88 | Combine | 49.03 | 1 | 724 | 154,763 | 86, 87 | ------ | ------ | DD66 |
| 89 | Combine | 286.98 | 1 | 725 | 1,019,905 | 78, 83, 88 | ------ | ------ | DI. 601 |
| 90 | SCS Runoff | 28.65 | 1 | 722 | 79,673 | ------ | ------ | ------ | Area to Pond No. 6 |
| 91 | Combine | 308.65 | 1 | 725 | 1,099,577 | 89, 90 | ------ | ------ | Pond No. 6 Total Inflow |
| 93 | Reservoir | 74.39 | 1 | 751 | 1,098,530 | 91 | 263.75 | 510,146 | Pond No. 6 - perm pool |
| 94 | Reservoir | 154.21 | 1 | 738 | 1,099,573 | 91 | 264.92 | 231,603 | Pond No. 6 - riser |

**d. Emergency Spillway**

Worst Case

Assume the dewatering opening in the overflow structure is not operating and the starting water surface elevation is at the top of the riser (263.00) at the start of a 100 year storm event.

| | | |
|---|---|---|
| Top of Pond | = | 266.00 |
| Less Required Freeboard | = | 1.00 |
| Maximum Allowable Water Surface Elevation in Emergency Spillway | = | 265.00 |

Re-route the 100 year storm event through the 6' x 6' square overflow structure and 54" diameter carrier pipe.

From Hydrograph Summary Report, Line 94, the maximum flow out of the pond will be 154 cfs. The maximum water surface elevation is 264.92 which is less than the maximum allowable water surface elevation of 265.00.

Therefore, the overflow structure and carrier pipe will safely pass the 100 year storm event with a starting water surface elevation at 263.00.

# Pond Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022 Thursday, 01 / 30 / 2025

## Pond No. 7 - Pond No. 6 - riser

### Pond Data

**Contours -**User-defined contour areas. Average end area method used for volume calculation. Begining Elevation = 263.00 ft

### Stage / Storage Table

| Stage (ft) | Elevation (ft) | Contour area (sqft) | Incr. Storage (cuft) | Total storage (cuft) |
|---|---|---|---|---|
| 0.00 | 263.00 | 114,838 | 0 | 0 |
| 1.00 | 264.00 | 119,431 | 117,135 | 117,135 |
| 3.00 | 266.00 | 129,108 | 248,539 | 365,674 |

### Culvert / Orifice Structures

| | [A] | [B] | [C] | [PrfRsr] |
|---|---|---|---|---|
| **Rise (in)** | = 54.00 | Inactive | Inactive | Inactive |
| **Span (in)** | = 54.00 | 0.00 | 0.00 | 0.00 |
| **No. Barrels** | = 1 | 1 | 0 | 0 |
| **Invert El. (ft)** | = 258.00 | 0.00 | 0.00 | 0.00 |
| **Length (ft)** | = 87.00 | 0.00 | 0.00 | 0.00 |
| **Slope (%)** | = 6.90 | 0.00 | 0.00 | n/a |
| **N-Value** | = .013 | .013 | .013 | n/a |
| **Orifice Coeff.** | = 0.60 | 0.60 | 0.60 | 0.60 |
| **Multi-Stage** | = n/a | No | No | No |

### Weir Structures

| | [A] | [B] | [C] | [D] |
|---|---|---|---|---|
| **Crest Len (ft)** | = 24.00 | Inactive | Inactive | Inactive |
| **Crest El. (ft)** | = 263.00 | 0.00 | 0.00 | 0.00 |
| **Weir Coeff.** | = 3.33 | 3.33 | 3.33 | 3.33 |
| **Weir Type** | = 1 | --- | --- | --- |
| **Multi-Stage** | = Yes | No | No | No |

**Exfil.(in/hr)** = 0.000 (by Wet area)

**TW Elev. (ft)** = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).

### Stage / Storage / Discharge Table

| Stage ft | Storage cuft | Elevation ft | Clv A cfs | Clv B cfs | Clv C cfs | PrfRsr cfs | Wr A cfs | Wr B cfs | Wr C cfs | Wr D cfs | Exfil cfs | User cfs | Total cfs |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.00 | 0 | 263.00 | 0.00 | --- | --- | --- | 0.00 | --- | --- | --- | --- | --- | 0.000 |
| 1.00 | 117,135 | 264.00 | 126.98 ic | --- | --- | --- | 79.92 | --- | --- | --- | --- | --- | 79.92 |
| 3.00 | 365,674 | 266.00 | 179.86 ic | --- | --- | --- | 179.86 s | --- | --- | --- | --- | --- | 179.86 |

# Hydrograph Summary Report

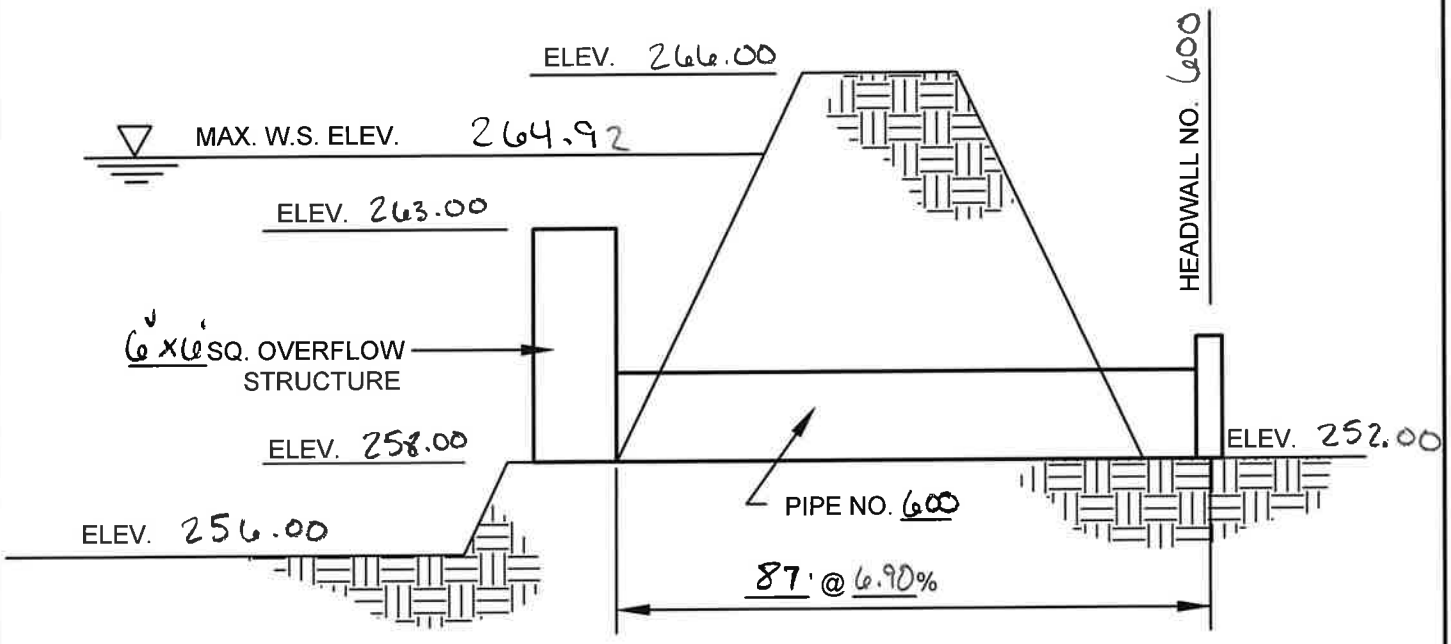
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022

| Hyd. No. | Hydrograph type (origin) | Peak flow (cfs) | Time interval (min) | Time to Peak (min) | Hyd. volume (cuft) | Inflow hyd(s) | Maximum elevation (ft) | Total strge used (cuft) | Hydrograph Description |
|---|---|---|---|---|---|---|---|---|---|
| 71 | Combine | 24.85 | 1 | 724 | 76,679 | 69, 70 | ------ | ------ | DD68 |
| 72 | SCS Runoff | 16.37 | 1 | 724 | 51,672 | ------ | ------ | ------ | Area to DD69 |
| 73 | Combine | 41.22 | 1 | 724 | 128,352 | 71, 72 | ------ | ------ | DD69 |
| 74 | SCS Runoff | 12.16 | 1 | 734 | 56,540 | ------ | ------ | ------ | Area to Ditch No. 1 |
| 75 | Combine | 135.34 | 1 | 725 | 479,071 | 68, 74 | ------ | ------ | Ditch No. 1 |
| 76 | Combine | 175.81 | 1 | 725 | 607,421 | 73, 75 | ------ | ------ | Ditch No. 1 & DD69 |
| 77 | SCS Runoff | 14.18 | 1 | 733 | 63,615 | ------ | ------ | ------ | Area to Ditch No. 17 |
| 78 | Combine | 186.30 | 1 | 725 | 671,038 | 76, 77 | ------ | ------ | Ditch No. 17 |
| 79 | SCS Runoff | 20.10 | 1 | 729 | 77,128 | ------ | ------ | ------ | DD61 |
| 80 | SCS Runoff | 16.75 | 1 | 725 | 55,080 | ------ | ------ | ------ | Area to DD62 |
| 81 | Combine | 35.78 | 1 | 727 | 132,208 | 79, 80 | ------ | ------ | DD62 |
| 82 | SCS Runoff | 17.67 | 1 | 727 | 61,896 | ------ | ------ | ------ | Area to DD63 |
| 83 | Combine | 53.45 | 1 | 727 | 194,104 | 81, 82 | ------ | ------ | DD63 |
| 84 | SCS Runoff | 15.65 | 1 | 724 | 49,392 | ------ | ------ | ------ | DD64 |
| 85 | SCS Runoff | 16.37 | 1 | 724 | 51,672 | ------ | ------ | ------ | Area to DD65 |
| 86 | Combine | 32.02 | 1 | 724 | 101,065 | 84, 85 | ------ | ------ | DD65 |
| 87 | SCS Runoff | 17.01 | 1 | 724 | 53,699 | ------ | ------ | ------ | Area to DD66 |
| 88 | Combine | 49.03 | 1 | 724 | 154,763 | 86, 87 | ------ | ------ | DD66 |
| 89 | Combine | 286.98 | 1 | 725 | 1,019,905 | 78, 83, 88 | ------ | ------ | DI. 601 |
| 90 | SCS Runoff | 28.65 | 1 | 722 | 79,673 | ------ | ------ | ------ | Area to Pond No. 6 |
| 91 | Combine | 308.65 | 1 | 725 | 1,099,577 | 89, 90 | ------ | ------ | Pond No. 6 Total Inflow |
| 93 | Reservoir | 74.39 | 1 | 751 | 1,098,530 | 91 | 263.75 | 510,146 | Pond No. 6 - perm pool |
| 94 | Reservoir | 154.21 | 1 | 738 | 1,099,573 | 91 | 264.92 | 231,603 | Pond No. 6 - riser |

**e. Overflow Structure and Carrier Pipe Design**

In order to confirm that the overflow structure, carrier pipe and emergency spillway pipe have been designed adequately to pass the maximum flow as modeled in the HydraFlow Hydrographs Extension for AutoCad Civil 3D 2022 Computer Program, the following design calculations have been included.

# OVERFLOW STRUCTURE NO. 6




## DESIGN OF OVERFLOW STRUCTURE AS EMERGENCY SPILLWAY

FLOW (Q) WORST CASE = 100 YEAR STORM EVENT OCCURS WHEN WATER SURFACE ELEVATION AT TOP OF OVERFLOW STRUCTURE AND ALL DEWATERING HOLES ARE PLUGGED

FLOW (Q) MAXIMUM = 154 CFS

HEAD (H) MAXIMUM = MAXIMUM WATER SURFACE ELEVATION WITH 1' OF FREEBOARD MINUS THE ELEVATION AT THE CREST OF THE OVERFLOW STRUCTURE

= 264.92 - 263.00 = 1.92 FEET

BASED ON ABOVE HEAD, USE 6' x 6' SQ. OVERFLOW STRUCTURE

(SEE CHART ON NEXT PAGE)

## WEIR FLOW (Q) OVER RISER CREST FOR CIRCULAR RISERS WITH TRASH RACK

$Q = CLh^{3/2}$

$Q = 3.1 \times (\pi) \times (D/12) \times h^{3/2}$

Table 6-22.2

| HEAD-h In feet | Riser Diameter ($D_r$) In Inches | | | | | | | | HEAD-h In feet |
|---|---|---|---|---|---|---|---|---|---|
| | 12 | 18 | 24 | 30 | 36 | 48 | 54 | 60 | |
| | Flow In Cubic Feet Per Second | | | | | | | | |
| 0.1 | 0.3 | 0.5 | 0.6 | 0.8 | 0.9 | 1.2 | 1.4 | 1.5 | 0.1 |
| 0.2 | 0.9 | 1.3 | 1.7 | 2.2 | 2.6 | 3.5 | 3.9 | 4.4 | 0.2 |
| 0.3 | 1.6 | 2.4 | 3.2 | 4.0 | 4.8 | 6.4 | 7.2 | 8.0 | 0.3 |
| 0.4 | 2.5 | 3.7 | 4.9 | 6.2 | 7.4 | 9.9 | 11.1 | 12.3 | 0.4 |
| 0.6 | 4.5 | 6.8 | 9.1 | 11.3 | 13.6 | 18.1 | 20.4 | 22.6 | 0.6 |
| 0.8 | | 10.5 | 13.9 | 17.4 | 20.9 | 27.9 | 31.4 | 34.8 | 0.8 |
| 1.0 | | | 19.5 | 24.3 | 29.2 | 39.0 | 43.8 | 48.7 | 1.0 |
| 1.2 | | | 25.6 | 32.0 | 38.4 | 51.2 | 57.6 | 64.0 | 1.2 |
| 1.4 | | | | 40.3 | 48.4 | 64.5 | 72.6 | 80.7 | 1.4 |
| 1.6 | | | | 49.3 | 59.1 | 78.8 | 88.7 | 98.6 | 1.6 |
| 1.8 | | | | | 70.6 | 94.1 | 105.8 | 117.6 | 1.8 |
| 2.0 | | | | | 82.6 | 110.2 | 124.0 | 137.7 | 2.0 |
| 2.2 | | | | | | 127.1 | 143.0 | 158.9 | 2.2 |
| 2.4 | | | | | | | 162.9 | 181.0 | 2.4 |
| 2.6 | | | | | | | 183.7 | 204.1 | 2.6 |
| 2.8 | | | | | | | | 228.1 | 2.8 |
| 3.0 | | | | | | | | 253.0 | 3.0 |

### Pipe, Riser, and Trash Rack Proportions

Eq. 6-10 $D_r \geq (1.50)\ (D_{ps})$

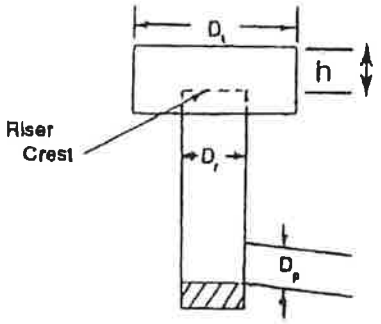
where $D_r$ = diameter of riser

$D_{ps}$ = diameter of principal spillway

Eq. 6-11 $D_t \geq (1.4)\ (D_r)$

where $D_t$ = diameter of trash rack

$D_r$ = diameter of riser




EXAMPLE: The peak runoff for a 2-year, 24-hour rain is 32 cfs. Select a pipe size for a head of 12 feet and length of 100 feet. From Table 6-15.1, 38.2 x 0.89 = 34 cfs discharge for a 24-inch diameter pipe.

Using Equation 6-10 $D_t \geq (1.5)\ (D_p)$

$D_t \geq (1.5)\ (24) \geq$ 36 inch diameter riser

Using Equation 6-11 $D_t \geq (1.4)\ (D_r)$

$D_t \geq (1.4)\ (36) \geq$ 50 inch diameter (Use 54 inch)

Determine h - From Table 6-15.2

$Q$ = 34 cfs $D_r$ = 36" h = 1.2'

NOTE: h = minimum distance between the crest of the riser and the crest of the emergency spillway.

# CARRIER PIPE NO. 600

Q = 154 CFS WORST CASE

MAXIMUM HEADWATER = TOP OF LEEVE ELEVATION MINUS 1' FREEBOARD
= 266.00 - 1.00 = 265.00

HEAD (H) = MAXIMUM WATER ELEVATION ALLOWED MINUS THE CENTERLINE ELEVATION AT THE DOWNSTREAM END OF THE CARRIER PIPE
= 265.00 - 254.25 = 10.75'

LENGTH (L) = 87'

LENGTH FACTOR = 0.98 FOR LENGTHS OTHER THAN 70'

Q (AVAILABLE) = Q FROM TABLE TIMES LENGTH FACTOR
= 300 X 0.98 = 294

Q (AVAILABLE) MUST BE GREATER THAN Q WORST CASE

**USE 54 " DIAMETER RCP CARRIER PIPE**

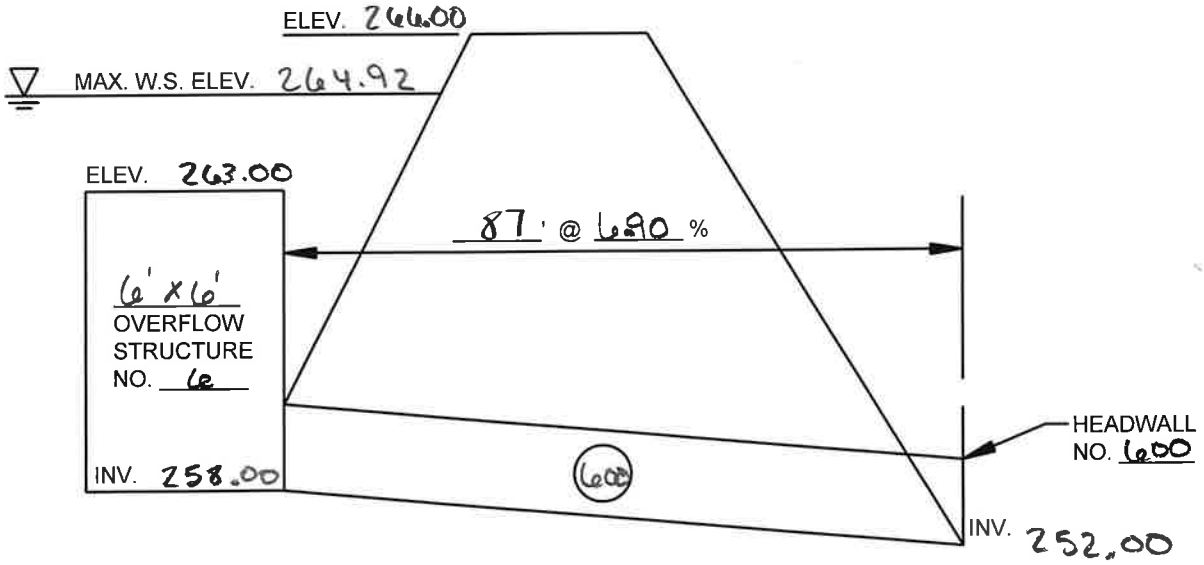


Table 6-25

## PIPE FLOW CHART n = 0.025

FOR CORRUGATED METAL PIPE INLET $K_e = K_o + K_c = 1.0$ AND 70 FEET OF CORRUGATED METAL PIPE CONDUIT (full flow assumed)

Note correction factors for pipe lengths other than 70 feet

diameter of pipe in inches

| H, in feet | 12" | 15" | 18" | 21" | 24" | 30" | 36" | 42" | 48" | 54" | 60" | 66" | 72" | 78" | 84" | 90" | 96" | 102" |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3.22 | 5.44 | 8.29 | 11.8 | 15.9 | 26.0 | 38.6 | 53.8 | 71.4 | 91.5 | 114 | 139 | 167 | 197 | 229 | 264 | 302 | 342 |
| 2 | 4.55 | 7.69 | 11.7 | 16.7 | 22.5 | 36.8 | 54.6 | 76.0 | 101 | 129 | 161 | 197 | 236 | 278 | 324 | 374 | 427 | 483 |
| 3 | 5.57 | 9.42 | 14.4 | 20.4 | 27.5 | 45.0 | 66.9 | 93.1 | 124 | 159 | 198 | 241 | 289 | 341 | 397 | 458 | 523 | 592 |
| 4 | 6.43 | 10.9 | 16.6 | 23.5 | 31.8 | 52.0 | 77.3 | 108 | 143 | 183 | 228 | 278 | 334 | 394 | 459 | 529 | 604 | 683 |
| 5 | 7.19 | 12.2 | 18.5 | 26.3 | 35.5 | 58.1 | 86.4 | 120 | 160 | 205 | 255 | 311 | 373 | 440 | 513 | 591 | 675 | 764 |
| 6 | 7.88 | 13.3 | 20.3 | 28.8 | 38.9 | 67.7 | 94.6 | 132 | 175 | 224 | 280 | 341 | 409 | 482 | 562 | 647 | 739 | 837 |
| 7 | 8.51 | 14.4 | 21.9 | 31.1 | 42.0 | 68.8 | 102 | 142 | 189 | 242 | 302 | 368 | 441 | 521 | 607 | 699 | 798 | 904 |
| 8 | 9.10 | 15.4 | 23.5 | 33.3 | 44.9 | 73.5 | 109 | 152 | 202 | 259 | 323 | 394 | 472 | 557 | 685 | 748 | 854 | 966 |
| 9 | 9.65 | 16.3 | 24.9 | 35.3 | 47.7 | 78.0 | 116 | 161 | 214 | 275 | 342 | 418 | 500 | 590 | 688 | 793 | 905 | 1025 |
| 10 | 10.2 | 17.2 | 26.2 | 37.2 | 50.2 | 82.2 | 122 | 170 | 226 | 289 | 361 | 440 | 527 | 622 | 725 | 836 | 954 | 1080 |
| 11 | 10.7 | 18.0 | 27.5 | 39.0 | 52.7 | 86.2 | 128 | 178 | 237 | 304 | 379 | 462 | 553 | 653 | 761 | 877 | 1001 | 1133 |
| 12 | 11.1 | 18.9 | 28.7 | 40.8 | 55.0 | 90.1 | 134 | 186 | 247 | 317 | 395 | 482 | 578 | 682 | 794 | 916 | 1046 | 1184 |
| 13 | 11.6 | 19.6 | 29.9 | 42.4 | 57.3 | 93.7 | 139 | 194 | 257 | 330 | 411 | 502 | 601 | 710 | 827 | 953 | 1088 | 1232 |
| 14 | 12.0 | 20.4 | 31.0 | 44.1 | 59.4 | 97.3 | 145 | 201 | 267 | 342 | 427 | 521 | 624 | 738 | 858 | 989 | 1129 | 1278 |
| 15 | 12.5 | 21.1 | 32.1 | 45.6 | 61.5 | 101 | 150 | 208 | 277 | 354 | 442 | 539 | 646 | 762 | 888 | 1024 | 1169 | 1323 |
| 16 | 12.9 | 21.8 | 33.2 | 47.1 | 63.5 | 104 | 155 | 215 | 286 | 366 | 457 | 557 | 667 | 787 | 917 | 1057 | 1207 | 1367 |
| 17 | 13.3 | 22.4 | 34.2 | 48.5 | 65.5 | 107 | 159 | 222 | 294 | 377 | 471 | 574 | 688 | 812 | 946 | 1090 | 1244 | 1409 |
| 18 | 13.7 | 23.1 | 35.2 | 49.9 | 67.4 | 110 | 164 | 228 | 303 | 388 | 484 | 591 | 708 | 835 | 973 | 1121 | 1280 | 1450 |
| 19 | 14.0 | 23.8 | 36.1 | 51.3 | 69.2 | 113 | 168 | 234 | 311 | 399 | 497 | 607 | 727 | 858 | 1000 | 1152 | 1315 | 1489 |
| 20 | 14.4 | 24.3 | 37.1 | 52.6 | 71.0 | 116 | 173 | 240 | 319 | 409 | 510 | 623 | 746 | 880 | 1026 | 1182 | 1350 | 1528 |
| 21 | 14.7 | 24.9 | 38.0 | 53.9 | 72.8 | 119 | 177 | 246 | 327 | 419 | 523 | 638 | 764 | 902 | 1051 | 1211 | 1383 | 1566 |
| 22 | 15.1 | 25.5 | 38.9 | 55.2 | 74.5 | 122 | 181 | 252 | 335 | 429 | 535 | 653 | 782 | 923 | 1076 | 1240 | 1415 | 1603 |
| 23 | 15.4 | 26.1 | 39.8 | 56.5 | 76.2 | 125 | 186 | 258 | 342 | 439 | 547 | 668 | 800 | 944 | 1100 | 1268 | 1447 | 1639 |
| 24 | 15.8 | 26.7 | 40.6 | 57.7 | 77.8 | 127 | 189 | 263 | 350 | 448 | 559 | 682 | 817 | 964 | 1123 | 1295 | 1478 | 1674 |
| 25 | 16.1 | 27.2 | 41.5 | 58.9 | 79.4 | 130 | 193 | 269 | 357 | 458 | 571 | 696 | 834 | 984 | 1147 | 1322 | 1509 | 1708 |
| 26 | 16.4 | 27.7 | 42.3 | 60.0 | 81.0 | 133 | 197 | 274 | 364 | 467 | 582 | 710 | 850 | 1004 | 1169 | 1348 | 1539 | 1742 |
| 27 | 16.7 | 28.3 | 43.1 | 61.2 | 82.5 | 135 | 201 | 279 | 371 | 476 | 593 | 723 | 867 | 1023 | 1192 | 1373 | 1568 | 1775 |
| 28 | 17.0 | 28.8 | 43.9 | 62.3 | 84.1 | 138 | 204 | 285 | 378 | 484 | 604 | 737 | 883 | 1041 | 1214 | 1399 | 1597 | 1808 |
| 29 | 17.3 | 29.3 | 44.7 | 63.4 | 85.5 | 140 | 208 | 290 | 384 | 493 | 615 | 750 | 898 | 1060 | 1235 | 1423 | 1625 | 1840 |
| 30 | 17.6 | 29.8 | 45.4 | 64.5 | 87.0 | 142 | 212 | 294 | 391 | 501 | 625 | 763 | 913 | 1078 | 1256 | 1448 | 1653 | 1871 |
| L, in feet | Correction Factors For Other Pipe Lengths | | | | | | | | | | | | | | | | | |
| 20 | 1.30 | 1.24 | 1.21 | 1.18 | 1.15 | 1.12 | 1.10 | 1.08 | 1.07 | 1.06 | 1.05 | 1.05 | 1.04 | 1.04 | 1.03 | 1.03 | 1.03 | 1.03 |
| 30 | 1.22 | 1.18 | 1.15 | 1.13 | 1.12 | 1.09 | 1.08 | 1.06 | 1.05 | 1.05 | 1.04 | 1.04 | 1.03 | 1.03 | 1.03 | 1.02 | 1.02 | 1.02 |
| 40 | 1.15 | 1.13 | 1.11 | 1.10 | 1.08 | 1.07 | 1.05 | 1.05 | 1.04 | 1.03 | 1.03 | 1.03 | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 |
| 50 | 1.09 | 1.08 | 1.07 | 1.06 | 1.05 | 1.04 | 1.04 | 1.03 | 1.03 | 1.02 | 1.02 | 1.02 | 1.02 | 1.01 | 1.01 | 1.01 | 1.01 | 1.01 |
| 60 | 1.04 | 1.04 | 1.03 | 1.03 | 1.03 | 1.02 | 1.02 | 1.02 | 1.01 | 1.01 | 1.01 | 1.01 | 1.01 | 1.01 | 1.01 | 1.01 | 1.01 | 1.01 |
| 70 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 80 | .96 | .97 | .97 | .97 | .98 | .98 | .98 | .99 | .99 | .99 | .99 | .99 | .99 | .99 | .99 | .99 | .99 | .99 |
| 90 | .93 | .94 | .94 | .95 | .95 | .96 | .97 | .97 | .98 | .98 | .98 | .98 | .98 | .99 | .99 | .99 | .99 | .99 |
| 100 | .90 | .91 | .92 | .93 | .93 | .95 | .95 | .96 | .97 | .97 | .97 | .98 | .98 | .98 | .98 | .98 | .98 | .99 |
| 120 | .84 | .86 | .87 | .89 | .90 | .91 | .93 | .94 | .94 | .95 | .96 | .96 | .96 | .97 | .97 | .97 | .97 | .98 |
| 140 | .80 | .82 | .83 | .85 | .86 | .88 | .90 | .91 | .92 | .93 | .94 | .94 | .95 | .95 | .96 | .96 | .96 | .97 |
| 160 | .76 | .78 | .80 | .82 | .83 | .86 | .88 | .89 | .90 | .91 | .92 | .93 | .94 | .94 | .95 | .95 | .95 | .98 |

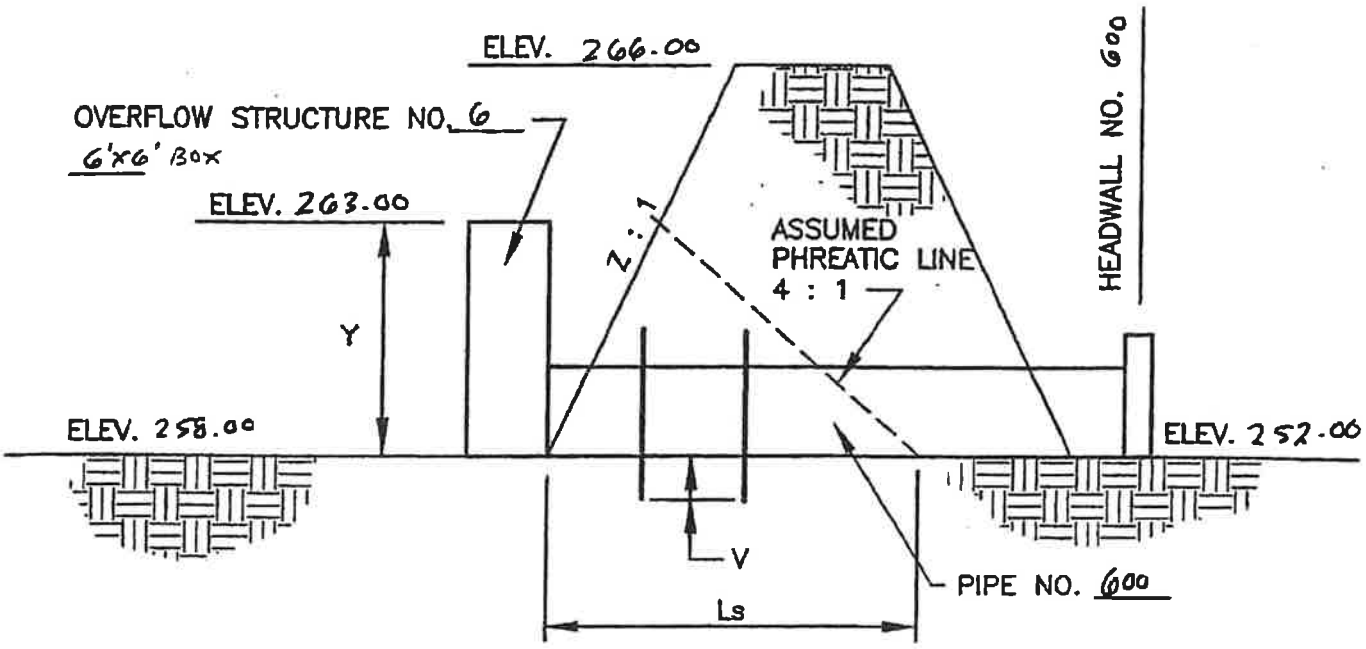
Source: USDA - SCS

**f. Anti-Seep Collar Design**

The seepage of water through the existing sediment pond dam along the carrier pipe could result in dam failure.

The proposed anti-seep collars have been designed to be located at intervals within the zone of saturation along the carrier pipe to increase the seepage length along the carrier pipe and thereby prevent piping or seepage along the carrier pipe.

# ANTI – SEEP COLLAR DESIGN




Ls = LENGTH IN SATURATION ZONE

Y = OVERFLOW STRUCTURE HEIGHT = 5.0 FEET

Z = INSIDE SLOPE OF LEVEE = 3

PIPE SLOPE = 6.90 % = 0.069 FEET/FEET

$$Ls = Y ( Z + 4 ) \left( 1 + \frac{\text{PIPE SLOPE}}{0.25 - \text{PIPE SLOPE}} \right)$$

Ls = 418 FEET

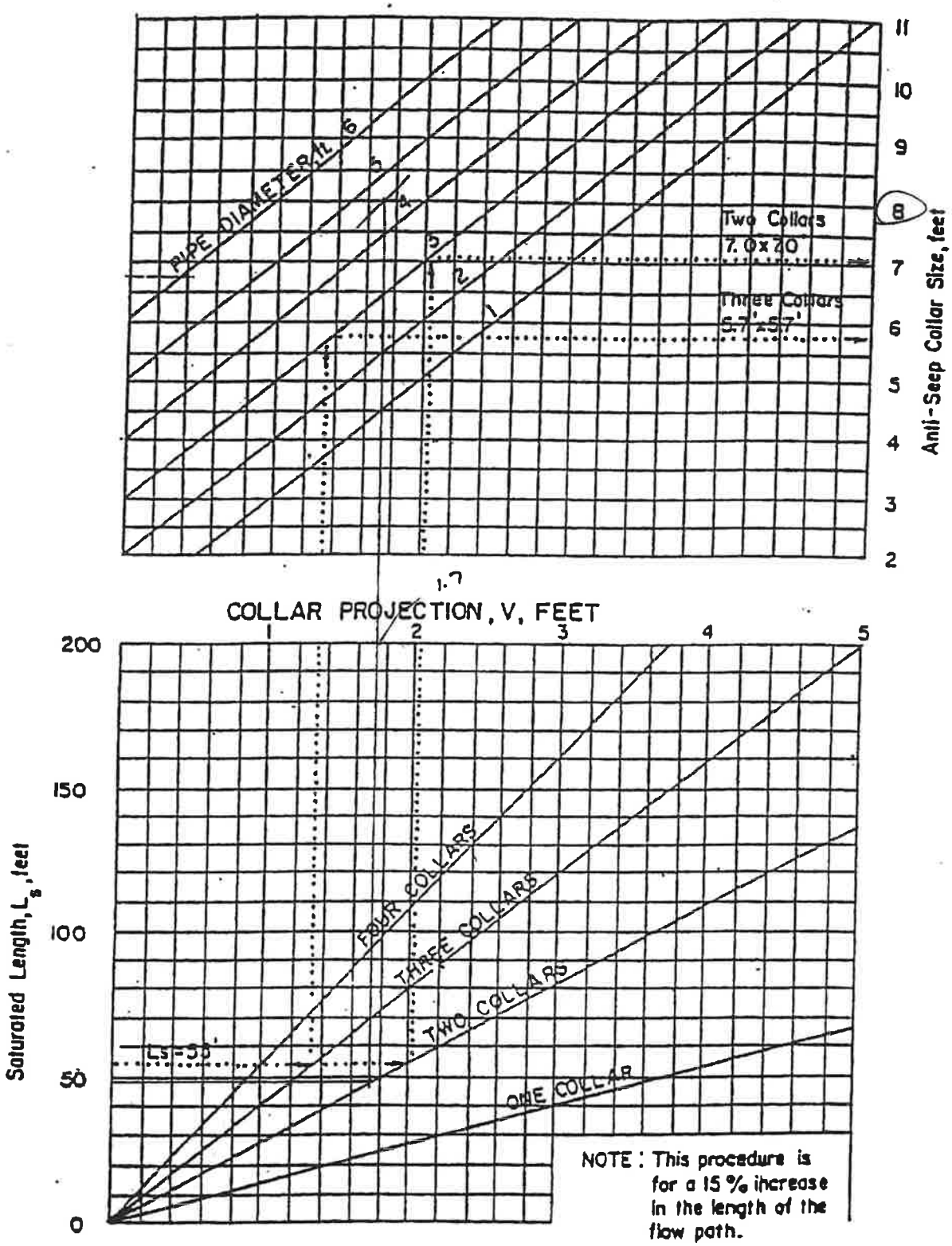
FROM ANTI – SEEP COLLAR DESIGN CHART ON THE NEXT PAGE :

V = COLLAR PROJECTION = 1.7 FEET

DIMENSIONS OF 12" THICK COLLAR = 9.0'X9.0'

NUMBER OF REQUIRED COLLARS = 2

# ANTI-SEEP COLLAR DESIGN



**g. Overflow Structure Base Foundation Design**

The overflow structure and carrier pipe will be subject to a certain amount of buoyant force when the sediment pond is filled with storm water. In order to overcome this buoyant force and prevent the flotation of the overflow structure and carrier pipe, a concrete overflow structure base foundation and concrete carrier pipe encasement have been designed. The design calculations for the concrete overflow structure base foundation and carrier pipe encasement are included in this section.

**OVERFLOW STRUCTURE BASE FOUNDATION DESIGN**

A certain volume of concrete will be used to overcome the buoyancy of an empty overflow structure and carrier pipe that are below the assumed phreatic water surface. This volume is equal to:

Overflow Structure

= (L)(w)(h)(62.4) L = w = 6.0' inside = 7.0' outside

= (7.0)(7.0)(5.0)(62.4) h = height = 5.0'

= 15,288 #

Carrier Pipe = $3.1416(R_2^2)(Ls)(62.4)$ Ls = length in saturation zone = 48'

= 3.1416(2.71)(2.71)(48)(62.4) $R_2$ = outside radius = 32.5" = 2.71'

= 69,106 # $r_2$ = inside radius = 27" = 2.25'

TOTAL WEIGHT

= 84,394 # x 1.5 (SAFETY FACTOR)

= 126,591 #

TOTAL REVISED VOLUME OF CONCRETE =

TOTAL WEIGHT / WEIGHT OF CONC. IN WATER

= 126,591/87.6 pcf (87.6 pcf = Wt. of conc. in submerged water)

= 1,445 C.F.

This volume of concrete will be made up from five areas.

1. Overflow Structures
2. Anti-Seep Collars
3. Carrier Pipe
4. Overflow Structure Base
5. Carrier Pipe Encasement

1. Overflow Structure = $(L_2 - l_2)h$

   $(7.0^2 – 6.0^2)(5.0)$ = 65 C.F.

   L = outside dimension of box = 7.0’

   l = inside dimension of box = 6.0’

   h = height of overflow structures = 5.0’

2. Anti-seep collars = area of square collar around carrier pipe x 12" thick x # of collars

   = [( 9.0' x 9.0' ) - $(3.1416)(R_2^2)$]

   x 1' x 2

   = 116 C.F.

   $R_2$ = outside radius of carrier pipe = 32.5" = 2.71’

   $r_2$ = inside radius of carrier pipe = 27" = 2.25’

3. Carrier Pipe

   = $3.1416 (R_2^2 - r_2^2)$ L = 344 C.F. L = length in saturation = 48’

4. Overflow Structure Base = Volume to handle riser bouyance x 1.2

   = (L)(w)h(62.4)(1.2)/weight of conc. in water

   L = w = 7.0’ outside

   h = height = 5.0’

   = (7.0’)(7.0’)(5.0)(62.4)(1.2)/87.6

   = 209 C.F.

   Use 12.0’ x 12.0’ x 3.0’ = 432’

5. Carrier Pipe Encasement

   Must extend 5’ into dam minimum. Distance from overflow structure to dam is equal to 15’. Therefore, minimum encasement length will be 20’. Will use a length of 30 to meet buoyancy requirements.

   $[(6’ \times 7’) – (3.1416)R_2^2]$ 30.0

   Carrier pipe encasement volume = 568 C.F.

**TOTAL REQUIRED VOLUME = 1445 C.F.**

Actual Total Volume

| | | | |
|---|---|---|---|
| Overflow Structure | = | 65 C.F. | |
| Anti-Seep Collars | = | 116 C.F. | |
| Carrier Pipe | = | 344 C.F. | |
| Overflow Structure Base | = | 432 C.F. | |
| Carrier Pipe Encasement | = | 568 C.F. | |
| **TOTAL** | **=** | **1,525 C.F.** | **⇒ Okay** |

# 8. PROPOSED SEDIMENT POND NO. 7

## a. Sediment Storage and Settling Efficiency Calculations

As required in the "Alabama Handbook for Erosion Control, Sediment Control and Stormwater Management on Construction Sites and Urban Area", the sediment storage volume of the pond shall be at least 67 cubic yards per acre for the disturbed area draining into the pond (67 cubic yards is equivalent to ½ inch of sediment per acre of drainage area). The peak inflow rate for the 25 year storm event has also been used to calculate the minimum pond surface area needed for adequate settling efficiency. These calculations for the sediment pond are included below.

Sediment Storage Calculation

Assume maximum sediment from 95 disturbed acres.

95 Acres x 67 c.y./acre = 6,365 c.y. = 171,855 c.f.

This sediment volume corresponds to a depth of 0.80' or Elev. 212.80.

Dewatering opening is set at Elev. 215.00. Therefore, ample sediment storage volume is available.

Settling Efficiency Calculations

- Use 25 year storm event, Q25 Flow = 453 cfs
- Minimum Surface Area = .01 acre / cfs x Q25 Flow
  = .01 acre / cfs x 453 cfs
  = 4.53 acres = 197,327 s.f.
- Top of Overflow Structure = Elev. 220.00
  Surface Area @ Elev. 220.00 = 279,286 s.f.
- Adequate surface area is available for settling

# Pond Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022 Thursday, 01 / 30 / 2025

## Pond No. 5 - Pond No. 7

### Pond Data

**Contours -**User-defined contour areas. Average end area method used for volume calculation. Begining Elevation = 212.00 ft

### Stage / Storage Table

| Stage (ft) | Elevation (ft) | Contour area (sqft) | Incr. Storage (cuft) | Total storage (cuft) |
|---|---|---|---|---|
| 0.00 | 212.00 | 204,034 | 0 | 0 |
| 2.00 | 214.00 | 222,853 | 426,887 | 426,887 |
| 3.00 | 215.00 | 232,146 | 227,500 | 654,387 |
| 4.00 | 216.00 | 241,438 | 236,792 | 891,179 |
| 6.00 | 218.00 | 260,249 | 501,688 | 1,392,866 |
| 8.00 | 220.00 | 279,286 | 539,535 | 1,932,401 |
| 10.00 | 222.00 | 298,705 | 577,991 | 2,510,392 |
| 12.00 | 224.00 | 318,231 | 616,936 | 3,127,328 |
| 14.00 | 226.00 | 337,946 | 656,177 | 3,783,505 |

### Culvert / Orifice Structures

| | [A] | [B] | [C] | [PrfRsr] |
|---|---|---|---|---|
| **Rise (in)** | = 48.00 | 6.00 | Inactive | Inactive |
| **Span (in)** | = 48.00 | 16.00 | 0.00 | 0.00 |
| **No. Barrels** | = 1 | 2 | 0 | 0 |
| **Invert El. (ft)** | = 215.00 | 215.10 | 0.00 | 0.00 |
| **Length (ft)** | = 109.00 | 0.00 | 0.00 | 0.00 |
| **Slope (%)** | = 2.75 | 0.00 | 0.00 | n/a |
| **N-Value** | = .013 | .013 | .013 | n/a |
| **Orifice Coeff.** | = 0.60 | 0.60 | 0.60 | 0.60 |
| **Multi-Stage** | = n/a | Yes | No | No |

### Weir Structures

| | [A] | [B] | [C] | [D] |
|---|---|---|---|---|
| **Crest Len (ft)** | = 24.00 | Inactive | Inactive | Inactive |
| **Crest El. (ft)** | = 220.00 | 0.00 | 0.00 | 0.00 |
| **Weir Coeff.** | = 3.33 | 3.33 | 3.33 | 3.33 |
| **Weir Type** | = 1 | --- | --- | --- |
| **Multi-Stage** | = Yes | No | No | No |

**Exfil.(in/hr)** = 0.000 (by Wet area)

**TW Elev. (ft)** = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).

### Stage / Storage / Discharge Table

| Stage ft | Storage cuft | Elevation ft | Clv A cfs | Clv B cfs | Clv C cfs | PrfRsr cfs | Wr A cfs | Wr B cfs | Wr C cfs | Wr D cfs | Exfil cfs | User cfs | Total cfs |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.00 | 0 | 212.00 | 0.00 | 0.00 | --- | --- | 0.00 | --- | --- | --- | --- | --- | 0.000 |
| 2.00 | 426,887 | 214.00 | 0.00 | 0.00 | --- | --- | 0.00 | --- | --- | --- | --- | --- | 0.000 |
| 3.00 | 654,387 | 215.00 | 0.00 | 0.00 | --- | --- | 0.00 | --- | --- | --- | --- | --- | 0.000 |
| 4.00 | 891,179 | 216.00 | 3.88 ic | 3.78 ic | --- | --- | 0.00 | --- | --- | --- | --- | --- | 3.776 |
| 6.00 | 1,392,866 | 218.00 | 9.29 ic | 9.00 ic | --- | --- | 0.00 | --- | --- | --- | --- | --- | 8.996 |
| 8.00 | 1,932,401 | 220.00 | 12.46 ic | 12.46 ic | --- | --- | 0.00 | --- | --- | --- | --- | --- | 12.46 |
| 10.00 | 2,510,392 | 222.00 | 130.98 ic | 3.59 ic | --- | --- | 127.38 s | --- | --- | --- | --- | --- | 130.97 |
| 12.00 | 3,127,328 | 224.00 | 159.26 ic | 1.70 ic | --- | --- | 157.52 s | --- | --- | --- | --- | --- | 159.23 |
| 14.00 | 3,783,505 | 226.00 | 181.19 ic | 1.12 ic | --- | --- | 179.87 s | --- | --- | --- | --- | --- | 180.99 |

**b. Total Pond Dewatering at Top of Riser (Elev. 220.00)**

Retention time within the basin is an important factor in effective sediment retention. The overflow structure has been designed as specified below.

The 6' x 6' square concrete overflow structure has two 6"(h)x6"(w) dewatering openings at elevation 215.00.

The calculation below has been performed to confirm that the dewatering (retention) time within the pond is between 24 and 72 hours. This dewatering time will ensure the storm water is retained for an adequate length of time to allow the sediment to settle (minimum 24 hours) and is also discharged gradually in an acceptable length of time to allow storage for future storm events (maximum 72 hours).

The dewatering time is calculated as follows:

$$T = \frac{A_s \times (2h)^{1/2}}{A_O \times C_d \times (20{,}428)}$$

$A_O$ = Surface Area of Dewatering Holes ($ft^2$)

$A_s$ = Surface Area Corresponding to top of riser elevation ($ft^2$)

h = Head of water above dewatering hole (ft)

$C_d$ = Coefficient of contraction for an orifice (use 0.6)

T = Time to dewater

T = 24 to 72 hours

$A_O$ = 1.33 s.f. @ Elev. 215.00 (2 - 6" x 16" rectangular openings)

$A_s$ = 279,286 s.f. @ Elev. 220.00

h = 220.00 – 215.00 = 5.0'

$$T = \frac{279{,}286\ (2 \times 5.0)^{½}}{(1.33)\ (0.6)\ (20{,}428)} = 54.2 \text{ hours}$$

**(Okay between 24 – 72 hours)**

**c. Reservoir Routing**

Reservoir routing is determined by using the HydraFlow Hydrographs Extension for AutoCad Civil 3D 2022 Computer Program.

Peak inflow rates (Q) are determined using the SCS Method and HydraFlow Hydrographs Extension for AutoCad Civil 3D 2022 Computer Program. Peak inflow rates are calculated for the 25 year and 100 year storm events and are summarized below.

Q25 = 453 cfs

Q100 = 642 cfs

The bottom of the pond has been set at 212.00. Dewatering of the pond is accomplished by two 6" x 16" rectangular opening beginning at an invert elevation of 215.00.

For routing calculations, a 6'x 6' rectangular riser with two 6" x 16" rectangular openings at an invert elevation of 215.00 was used. The top of the riser is at an elevation of 220.00. The bottom of the pond is elev. 212.00. The invert of the carrier pipe is elev. 215.00. The top of the levee around the sediment pond is at an elevation of 224.00

The maximum height of sediment is elevation 212.80 which is below the elevation of the first dewatering opening (Elev. 215.00). For routing calculations, the starting water surface elevation was set at 215.00, assuming the remainder of the pond bottom is filled below the dewatering orifice invert elevation.

Based on the above information the reservoir routing calculations are performed and summarized below.

| STORM YEAR | PEAK INFLOW CFS | PEAK OUTFLOW CFS | PEAK ELEV. FEET |
|---|---|---|---|
| 25 | 453 | 12 | 219.67 |
| 100 | 642 | 49 | 220.90 |

Based on these routing calculations, the riser is large enough and the pond has sufficient storage volume to retain the sediment from 95 disturbed acres plus the 25 year storm event from the entire drainage area below the crest of the riser (elev. 220.00).

# Pond Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022 Thursday, 01 / 30 / 2025

## Pond No. 6 - Pond No. 7 - PermPool

### Pond Data

**Contours -**User-defined contour areas. Average end area method used for volume calculation. Begining Elevation = 215.00 ft

### Stage / Storage Table

| Stage (ft) | Elevation (ft) | Contour area (sqft) | Incr. Storage (cuft) | Total storage (cuft) |
|---|---|---|---|---|
| 0.00 | 215.00 | 232,146 | 0 | 0 |
| 1.00 | 216.00 | 241,438 | 236,792 | 236,792 |
| 3.00 | 218.00 | 260,249 | 501,687 | 738,479 |
| 5.00 | 220.00 | 279,286 | 539,535 | 1,278,014 |
| 7.00 | 222.00 | 298,705 | 577,991 | 1,856,005 |
| 9.00 | 224.00 | 318,231 | 616,936 | 2,472,941 |
| 11.00 | 226.00 | 337,946 | 656,177 | 3,129,118 |

### Culvert / Orifice Structures

| | [A] | [B] | [C] | [PrfRsr] |
|---|---|---|---|---|
| **Rise (in)** | = 48.00 | 6.00 | Inactive | Inactive |
| **Span (in)** | = 48.00 | 16.00 | 0.00 | 0.00 |
| **No. Barrels** | = 1 | 2 | 0 | 0 |
| **Invert El. (ft)** | = 215.00 | 215.10 | 0.00 | 0.00 |
| **Length (ft)** | = 109.00 | 0.00 | 0.00 | 0.00 |
| **Slope (%)** | = 2.75 | 0.00 | 0.00 | n/a |
| **N-Value** | = .013 | .013 | .013 | n/a |
| **Orifice Coeff.** | = 0.60 | 0.60 | 0.60 | 0.60 |
| **Multi-Stage** | = n/a | Yes | No | No |

### Weir Structures

| | [A] | [B] | [C] | [D] |
|---|---|---|---|---|
| **Crest Len (ft)** | = 24.00 | Inactive | Inactive | Inactive |
| **Crest El. (ft)** | = 220.00 | 0.00 | 0.00 | 0.00 |
| **Weir Coeff.** | = 3.33 | 3.33 | 3.33 | 3.33 |
| **Weir Type** | = 1 | --- | --- | --- |
| **Multi-Stage** | = Yes | No | No | No |
| **Exfil.(in/hr)** | = 0.000 (by Wet area) | | | |
| **TW Elev. (ft)** | = 0.00 | | | |

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).

### Stage / Storage / Discharge Table

| Stage ft | Storage cuft | Elevation ft | Clv A cfs | Clv B cfs | Clv C cfs | PrfRsr cfs | Wr A cfs | Wr B cfs | Wr C cfs | Wr D cfs | Exfil cfs | User cfs | Total cfs |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.00 | 0 | 215.00 | 0.00 | 0.00 | --- | --- | 0.00 | --- | --- | --- | --- | --- | 0.000 |
| 1.00 | 236,792 | 216.00 | 3.88 ic | 3.78 ic | --- | --- | 0.00 | --- | --- | --- | --- | --- | 3.776 |
| 3.00 | 738,479 | 218.00 | 9.29 ic | 9.00 ic | --- | --- | 0.00 | --- | --- | --- | --- | --- | 8.996 |
| 5.00 | 1,278,014 | 220.00 | 12.46 ic | 12.46 ic | --- | --- | 0.00 | --- | --- | --- | --- | --- | 12.46 |
| 7.00 | 1,856,005 | 222.00 | 130.98 ic | 3.59 ic | --- | --- | 127.38 s | --- | --- | --- | --- | --- | 130.97 |
| 9.00 | 2,472,941 | 224.00 | 159.26 ic | 1.70 ic | --- | --- | 157.52 s | --- | --- | --- | --- | --- | 159.23 |
| 11.00 | 3,129,118 | 226.00 | 181.19 ic | 1.12 ic | --- | --- | 179.87 s | --- | --- | --- | --- | --- | 180.99 |

# Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022

| Hyd. No. | Hydrograph type (origin) | Peak flow (cfs) | Time interval (min) | Time to Peak (min) | Hyd. volume (cuft) | Inflow hyd(s) | Maximum elevation (ft) | Total strge used (cuft) | Hydrograph Description |
|---|---|---|---|---|---|---|---|---|---|
| 69 | Combine | 14.38 | 1 | 725 | 45,676 | 67, 68 | ------ | ------ | DD45 |
| 70 | SCS Runoff | 9.398 | 1 | 725 | 29,285 | ------ | ------ | ------ | Area to DD46 |
| 71 | Combine | 23.77 | 1 | 725 | 74,961 | 69, 70 | ------ | ------ | DD46 |
| 72 | SCS Runoff | 11.55 | 1 | 725 | 35,989 | ------ | ------ | ------ | Area to DD47 |
| 73 | Combine | 35.32 | 1 | 725 | 110,949 | 71, 72 | ------ | ------ | DD47 |
| 74 | SCS Runoff | 12.07 | 1 | 725 | 39,196 | ------ | ------ | ------ | Area to DD48 |
| 75 | Combine | 47.39 | 1 | 725 | 150,146 | 73, 74 | ------ | ------ | DD48 |
| 76 | SCS Runoff | 13.71 | 1 | 725 | 44,534 | ------ | ------ | ------ | DD49 |
| 77 | Combine | 61.10 | 1 | 725 | 194,680 | 75, 76 | ------ | ------ | DD48 & DD49 |
| 78 | Combine | 142.10 | 1 | 725 | 495,141 | 65, 66, | ------ | ------ | Ditch No. 14 |
| 79 | Combine | 203.20 | 1 | 725 | 689,821 | 77, 78 | ------ | ------ | Ditch No. 14, DD48, & DD49 |
| 80 | SCS Runoff | 12.69 | 1 | 736 | 59,679 | ------ | ------ | ------ | Area to Ditch No. 13 |
| 81 | Combine | 211.73 | 1 | 725 | 749,500 | 79, 80 | ------ | ------ | Ditch No. 13 |
| 82 | Combine | 36.25 | 1 | 726 | 142,539 | 30, 31, | ------ | ------ | Ditch No. 12 |
| 83 | Combine | 288.40 | 1 | 725 | 1,021,726 | 40, 81, 82 | ------ | ------ | DI. 701 |
| 84 | SCS Runoff | 53.80 | 1 | 722 | 147,548 | ------ | ------ | ------ | Area to Pond No. 7 |
| 85 | Combine | 452.76 | 1 | 725 | 1,611,812 | 25, 83, 84 | ------ | ------ | Pond No. 7 Total Inflow |
| 87 | Reservoir | 11.97 | 1 | 1045 | 1,242,327 | 85 | 219.67 | 1,189,562 | Pond No. 7 perm pool |
| 88 | Reservoir | 129.60 | 1 | 750 | 1,611,809 | 85 | 221.95 | 563,289 | Pond No. 7 Riser |

# Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022

| Hyd. No. | Hydrograph type (origin) | Peak flow (cfs) | Time interval (min) | Time to Peak (min) | Hyd. volume (cuft) | Inflow hyd(s) | Maximum elevation (ft) | Total strge used (cuft) | Hydrograph Description |
|---|---|---|---|---|---|---|---|---|---|
| 69 | Combine | 20.36 | 1 | 725 | 65,580 | 67, 68 | ------ | ------ | DD45 |
| 70 | SCS Runoff | 13.32 | 1 | 724 | 42,047 | ------ | ------ | ------ | Area to DD46 |
| 71 | Combine | 33.66 | 1 | 725 | 107,627 | 69, 70 | ------ | ------ | DD46 |
| 72 | SCS Runoff | 16.37 | 1 | 724 | 51,672 | ------ | ------ | ------ | Area to DD47 |
| 73 | Combine | 50.00 | 1 | 725 | 159,299 | 71, 72 | ------ | ------ | DD47 |
| 74 | SCS Runoff | 17.12 | 1 | 725 | 56,277 | ------ | ------ | ------ | Area to DD48 |
| 75 | Combine | 67.12 | 1 | 725 | 215,577 | 73, 74 | ------ | ------ | DD48 |
| 76 | SCS Runoff | 19.45 | 1 | 725 | 63,941 | ------ | ------ | ------ | DD49 |
| 77 | Combine | 86.56 | 1 | 725 | 279,518 | 75, 76 | ------ | ------ | DD48 & DD49 |
| 78 | Combine | 201.64 | 1 | 725 | 710,915 | 65, 66, | ------ | ------ | Ditch No. 14 |
| 79 | Combine | 288.20 | 1 | 725 | 990,433 | 77, 78 | ------ | ------ | Ditch No. 14, DD48, & DD49 |
| 80 | SCS Runoff | 18.03 | 1 | 735 | 85,686 | ------ | ------ | ------ | Area to Ditch No. 13 |
| 81 | Combine | 300.55 | 1 | 725 | 1,076,118 | 79, 80 | ------ | ------ | Ditch No. 13 |
| 82 | Combine | 51.50 | 1 | 726 | 204,654 | 30, 31, | ------ | ------ | Ditch No. 12 |
| 83 | Combine | 409.39 | 1 | 725 | 1,466,977 | 40, 81, 82 | ------ | ------ | DI. 701 |
| 84 | SCS Runoff | 76.17 | 1 | 722 | 211,847 | ------ | ------ | ------ | Area to Pond No. 7 |
| 85 | Combine | 642.29 | 1 | 725 | 2,314,212 | 25, 83, 84 | ------ | ------ | Pond No. 7 Total Inflow |
| 87 | Reservoir | 49.13 | 1 | 819 | 1,870,172 | 85 | 220.61 | 1,454,125 | Pond No. 7 perm pool |
| 88 | Reservoir | 145.05 | 1 | 753 | 2,314,197 | 85 | 222.90 | 854,550 | Pond No. 7 Riser |

**d. Emergency Spillway**

Worst Case
Assume the dewatering openings in the overflow structure are not operating and the starting water surface elevation is at the top of the riser (220.00) at the start of a 100 year storm event.

| | | |
|---|---|---|
| Top of Pond | = | 224.00 |
| Less Required Freeboard | = | 1.00 |
| Maximum Allowable Water Surface Elevation in Emergency Spillway | = | 223.00 |

Re-route the 100 year storm event through the 6'x 6' square overflow structure and 48" diameter carrier pipe.

From Hydrograph Summary Report Line 88, the maximum flow out of the pond will be 145 cfs. The maximum water surface elevation is 222.90 which is less than the maximum allowable water surface elevation of 223.00.

Therefore, the overflow structure and carrier pipe will safely pass the 100 year storm event with a starting water surface elevation at 220.00.

# Pond Report



## Pond No. 7 - Pond No. 7 - Riser

### Pond Data

**Contours -**User-defined contour areas. Average end area method used for volume calculation. Begining Elevation = 220.00 ft

### Stage / Storage Table

| Stage (ft) | Elevation (ft) | Contour area (sqft) | Incr. Storage (cuft) | Total storage (cuft) |
|---|---|---|---|---|
| 0.00 | 220.00 | 279,286 | 0 | 0 |
| 2.00 | 222.00 | 298,705 | 577,991 | 577,991 |
| 4.00 | 224.00 | 318,231 | 616,936 | 1,194,927 |
| 6.00 | 226.00 | 337,946 | 656,177 | 1,851,104 |

### Culvert / Orifice Structures

| | [A] | [B] | [C] | [PrfRsr] |
|---|---|---|---|---|
| **Rise (in)** | = 48.00 | Inactive | Inactive | Inactive |
| **Span (in)** | = 48.00 | 0.00 | 0.00 | 0.00 |
| **No. Barrels** | = 1 | 1 | 0 | 0 |
| **Invert El. (ft)** | = 215.00 | 0.00 | 0.00 | 0.00 |
| **Length (ft)** | = 109.00 | 0.00 | 0.00 | 0.00 |
| **Slope (%)** | = 2.75 | 0.00 | 0.00 | n/a |
| **N-Value** | = .013 | .013 | .013 | n/a |
| **Orifice Coeff.** | = 0.60 | 0.60 | 0.60 | 0.60 |
| **Multi-Stage** | = n/a | Yes | No | No |

### Weir Structures

| | [A] | [B] | [C] | [D] |
|---|---|---|---|---|
| **Crest Len (ft)** | = 24.00 | Inactive | Inactive | Inactive |
| **Crest El. (ft)** | = 220.00 | 0.00 | 0.00 | 0.00 |
| **Weir Coeff.** | = 3.33 | 3.33 | 3.33 | 3.33 |
| **Weir Type** | = 1 | --- | --- | --- |
| **Multi-Stage** | = Yes | No | No | No |

**Exfil.(in/hr)** = 0.000 (by Wet area)

**TW Elev. (ft)** = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).

### Stage / Storage / Discharge Table

| Stage ft | Storage cuft | Elevation ft | Clv A cfs | Clv B cfs | Clv C cfs | PrfRsr cfs | Wr A cfs | Wr B cfs | Wr C cfs | Wr D cfs | Exfil cfs | User cfs | Total cfs |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.00 | 0 | 220.00 | 0.00 | --- | --- | --- | 0.00 | --- | --- | --- | --- | --- | 0.000 |
| 2.00 | 577,991 | 222.00 | 130.66 ic | --- | --- | --- | 130.65 s | --- | --- | --- | --- | --- | 130.65 |
| 4.00 | 1,194,927 | 224.00 | 159.24 ic | --- | --- | --- | 159.21 s | --- | --- | --- | --- | --- | 159.21 |
| 6.00 | 1,851,104 | 226.00 | 181.18 ic | --- | --- | --- | 181.02 s | --- | --- | --- | --- | --- | 181.02 |

# Hydrograph Summary Report

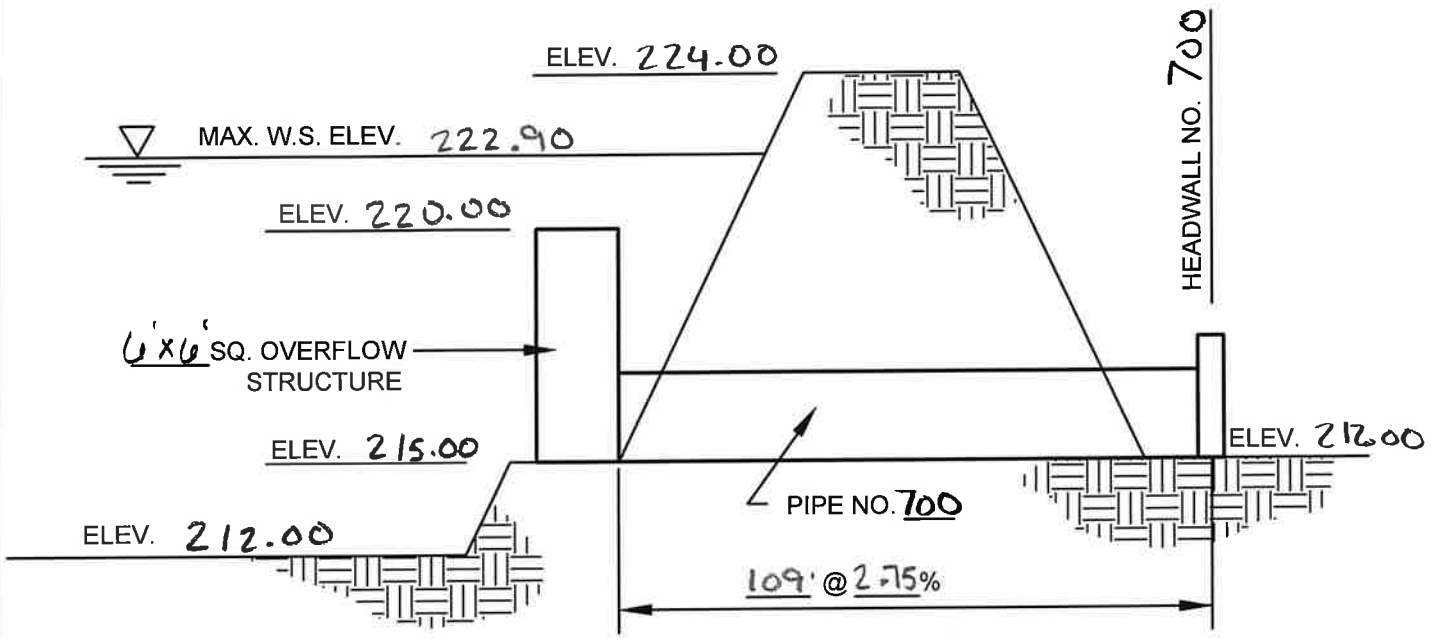
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022

| Hyd. No. | Hydrograph type (origin) | Peak flow (cfs) | Time interval (min) | Time to Peak (min) | Hyd. volume (cuft) | Inflow hyd(s) | Maximum elevation (ft) | Total strge used (cuft) | Hydrograph Description |
|---|---|---|---|---|---|---|---|---|---|
| 69 | Combine | 20.36 | 1 | 725 | 65,580 | 67, 68 | ------ | ------ | DD45 |
| 70 | SCS Runoff | 13.32 | 1 | 724 | 42,047 | ------ | ------ | ------ | Area to DD46 |
| 71 | Combine | 33.66 | 1 | 725 | 107,627 | 69, 70 | ------ | ------ | DD46 |
| 72 | SCS Runoff | 16.37 | 1 | 724 | 51,672 | ------ | ------ | ------ | Area to DD47 |
| 73 | Combine | 50.00 | 1 | 725 | 159,299 | 71, 72 | ------ | ------ | DD47 |
| 74 | SCS Runoff | 17.12 | 1 | 725 | 56,277 | ------ | ------ | ------ | Area to DD48 |
| 75 | Combine | 67.12 | 1 | 725 | 215,577 | 73, 74 | ------ | ------ | DD48 |
| 76 | SCS Runoff | 19.45 | 1 | 725 | 63,941 | ------ | ------ | ------ | DD49 |
| 77 | Combine | 86.56 | 1 | 725 | 279,518 | 75, 76 | ------ | ------ | DD48 & DD49 |
| 78 | Combine | 201.64 | 1 | 725 | 710,915 | 65, 66, | ------ | ------ | Ditch No. 14 |
| 79 | Combine | 288.20 | 1 | 725 | 990,433 | 77, 78 | ------ | ------ | Ditch No. 14, DD48, & DD49 |
| 80 | SCS Runoff | 18.03 | 1 | 735 | 85,686 | ------ | ------ | ------ | Area to Ditch No. 13 |
| 81 | Combine | 300.55 | 1 | 725 | 1,076,118 | 79, 80 | ------ | ------ | Ditch No. 13 |
| 82 | Combine | 51.50 | 1 | 726 | 204,654 | 30, 31, | ------ | ------ | Ditch No. 12 |
| 83 | Combine | 409.39 | 1 | 725 | 1,466,977 | 40, 81, 82 | ------ | ------ | DI. 701 |
| 84 | SCS Runoff | 76.17 | 1 | 722 | 211,847 | ------ | ------ | ------ | Area to Pond No. 7 |
| 85 | Combine | 642.29 | 1 | 725 | 2,314,212 | 25, 83, 84 | ------ | ------ | Pond No. 7 Total Inflow |
| 87 | Reservoir | 49.13 | 1 | 819 | 1,870,172 | 85 | 220.61 | 1,454,125 | Pond No. 7 perm pool |
| 88 | Reservoir | 145.05 | 1 | 753 | 2,314,197 | 85 | 222.90 | 854,550 | Pond No. 7 Riser |

**e. Overflow Structure and Carrier Pipe Design**

In order to confirm that the overflow structure, carrier pipe and emergency spillway pipe have been designed adequately to pass the maximum flow as modeled in the HydraFlow Hydrographs Extension for AutoCad Civil 3D 2022 Computer Program, the following design calculations have been included.

# OVERFLOW STRUCTURE NO. 7




# DESIGN OF OVERFLOW STRUCTURE AS EMERGENCY SPILLWAY

FLOW (Q) WORST CASE = 100 YEAR STORM EVENT OCCURS WHEN WATER SURFACE ELEVATION AT TOP OF OVERFLOW STRUCTURE AND ALL DEWATERING HOLES ARE PLUGGED

FLOW (Q) MAXIMUM = 145 CFS

HEAD (H) MAXIMUM = MAXIMUM WATER SURFACE ELEVATION WITH 1' OF FREEBOARD MINUS THE ELEVATION AT THE CREST OF THE OVERFLOW STRUCTURE

= 222.90 - 220.00 = 2.86 FEET

BASED ON ABOVE HEAD, USE 6' x 6' SQ. OVERFLOW STRUCTURE

(SEE CHART ON NEXT PAGE)

## WEIR FLOW (Q) OVER RISER CREST FOR CIRCULAR RISERS WITH TRASH RACK

$Q = CLh^{3/2}$

$Q = 3.1 \times (\pi) \times (D/12) \times h^{3/2}$

Riser Diameter ($D_r$) In Inches

| HEAD-h In feet | 12 | 18 | 24 | 30 | 36 | 48 | 54 | 60 | HEAD-h In feet |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Flow In Cubic Feet Per Second | | | | | |
| 0.1 | 0.3 | 0.5 | 0.6 | 0.8 | 0.9 | 1.2 | 1.4 | 1.5 | 0.1 |
| 0.2 | 0.9 | 1.3 | 1.7 | 2.2 | 2.6 | 3.5 | 3.9 | 4.4 | 0.2 |
| 0.3 | 1.6 | 2.4 | 3.2 | 4.0 | 4.8 | 6.4 | 7.2 | 8.0 | 0.3 |
| 0.4 | 2.5 | 3.7 | 4.9 | 6.2 | 7.4 | 9.9 | 11.1 | 12.3 | 0.4 |
| 0.6 | 4.5 | 6.8 | 9.1 | 11.3 | 13.6 | 18.1 | 20.4 | 22.6 | 0.6 |
| 0.8 | | 10.5 | 13.9 | 17.4 | 20.9 | 27.9 | 31.4 | 34.8 | 0.8 |
| 1.0 | | | 19.5 | 24.3 | 29.2 | 39.0 | 43.8 | 48.7 | 1.0 |
| 1.2 | | | 25.6 | 32.0 | 38.4 | 51.2 | 57.6 | 64.0 | 1.2 |
| 1.4 | | | | 40.3 | 48.4 | 64.5 | 72.6 | 80.7 | 1.4 |
| 1.6 | | | | 49.3 | 59.1 | 78.8 | 88.7 | 98.6 | 1.6 |
| 1.8 | | | | | 70.6 | 94.1 | 105.8 | 117.6 | 1.8 |
| 2.0 | | | | | 82.6 | 110.2 | 124.0 | 137.7 | 2.0 |
| 2.2 | | | | | | 127.1 | 143.0 | 158.9 | 2.2 |
| 2.4 | | | | | | | 162.9 | 181.0 | 2.4 |
| 2.6 | | | | | | | 183.7 | 204.1 | 2.6 |
| 2.8 | | | | | | | | 228.1 | 2.8 |
| 3.0 | | | | | | | | 253.0 | 3.0 |

Table 6-22.2

### Pipe, Riser, and Trash Rack Proportions

Eq. 6-10 $D_r \geq (1.50)\ (D_{ps})$

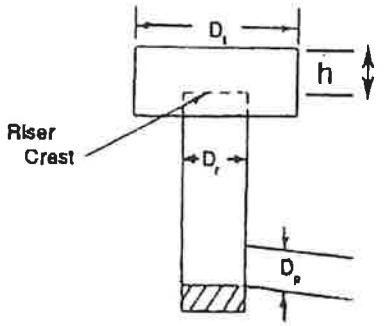
where $D_r$ = diameter of riser

$D_{ps}$ = diameter of principal spillway

Eq. 6-11 $D_t \geq (1.4)\ (D_r)$

where $D_t$ = diameter of trash rack

$D_r$ = diameter of riser




EXAMPLE: The peak runoff for a 2-year, 24-hour rain is 32 cfs. Select a pipe size for a head of 12 feet and length of 100 feet. From Table 6-15.1, 38.2 x 0.89 = 34 cfs discharge for a 24-inch diameter pipe.

Using Equation 6-10 $D_r \geq (1.5)\ (D_p)$

$D_r \geq (1.5)\ (24) \geq$ 36 inch diameter riser

Using Equation 6-11 $D_t \geq (1.4)\ (D_r)$

$D_t \geq (1.4)\ (36) \geq$ 50 inch diameter (Use 54 inch)

Determine h - From Table 6-15.2

$Q$ = 34 cfs $D_r$ = 36" h = 1.2'

NOTE: h = minimum distance between the crest of the riser and the crest of the emergency spillway.

# CARRIER PIPE NO. 700

Q = 144 CFS WORST CASE

MAXIMUM HEADWATER = TOP OF LEEVE ELEVATION MINUS 1' FREEBOARD
= 224.00 - 1.00 = 223.00

HEAD (H) = MAXIMUM WATER ELEVATION ALLOWED MINUS THE CENTERLINE ELEVATION AT THE DOWNSTREAM END OF THE CARRIER PIPE
= 223.00 - 214.00 = 9.0

LENGTH (L) = 109'

LENGTH FACTOR = 0.96 FOR LENGTHS OTHER THAN 70'

Q (AVAILABLE) = Q FROM TABLE TIMES LENGTH FACTOR
= 214 X 0.96 = 205

Q (AVAILABLE) MUST BE GREATER THAN Q WORST CASE

**USE 48 " DIAMETER RCP CARRIER PIPE**

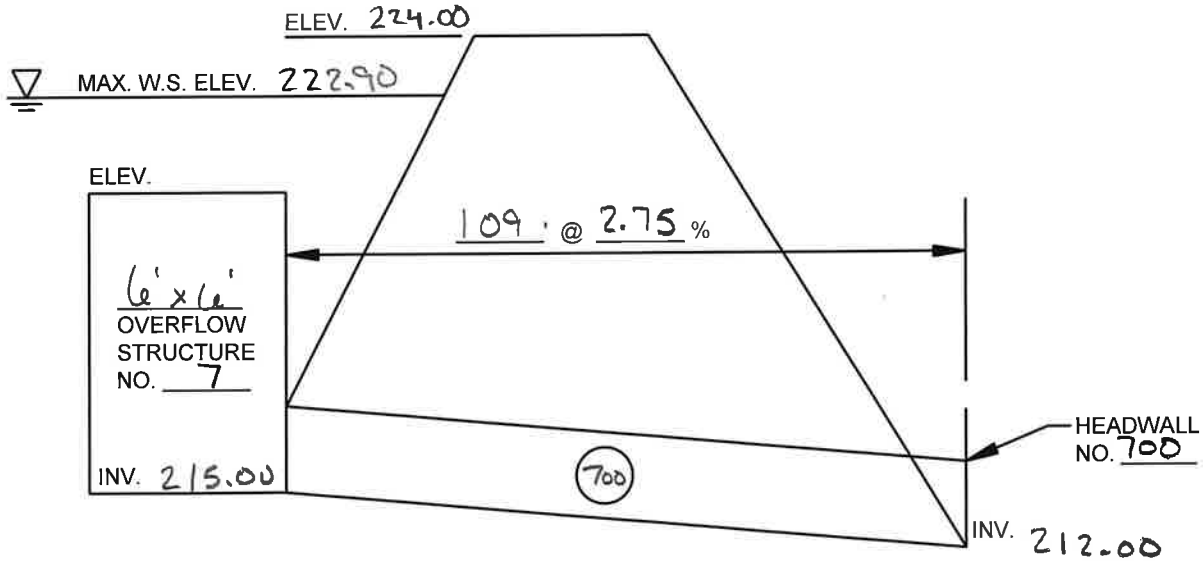


Table 6-25

## PIPE FLOW CHART n = 0.025

FOR CORRUGATED METAL PIPE INLET $K_a = K_e + K_b = 1.0$ AND 70 FEET OF CORRUGATED METAL PIPE CONDUIT (full flow assumed)

Note correction factors for pipe lengths other than 70 feet

diameter of pipe in inches

| H, in feet | 12" | 15" | 18" | 21" | 24" | 30" | 36" | 42" | 48" | 54" | 60" | 66" | 72" | 78" | 84" | 90" | 96" | 102" |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3.22 | 5.44 | 8.29 | 11.8 | 15.9 | 26.0 | 38.6 | 53.8 | 71.4 | 91.5 | 114 | 139 | 167 | 197 | 229 | 264 | 302 | 342 |
| 2 | 4.55 | 7.69 | 11.7 | 16.7 | 22.5 | 36.8 | 54.6 | 76.0 | 101 | 129 | 161 | 197 | 236 | 278 | 324 | 374 | 427 | 483 |
| 3 | 5.57 | 9.42 | 14.4 | 20.4 | 27.5 | 45.0 | 66.9 | 93.1 | 124 | 159 | 198 | 241 | 289 | 341 | 397 | 458 | 523 | 592 |
| 4 | 6.43 | 10.9 | 16.6 | 23.5 | 31.8 | 52.0 | 77.3 | 108 | 143 | 183 | 228 | 278 | 334 | 394 | 459 | 529 | 604 | 683 |
| 5 | 7.19 | 12.2 | 18.5 | 26.3 | 35.5 | 58.1 | 86.4 | 120 | 160 | 205 | 255 | 311 | 373 | 440 | 513 | 591 | 675 | 764 |
| 6 | 7.88 | 13.3 | 20.3 | 28.8 | 38.9 | 67.7 | 94.6 | 132 | 175 | 224 | 280 | 341 | 409 | 482 | 562 | 647 | 739 | 837 |
| 7 | 8.51 | 14.4 | 21.9 | 31.1 | 42.0 | 68.8 | 102 | 142 | 189 | 242 | 302 | 368 | 441 | 521 | 607 | 699 | 798 | 904 |
| 8 | 9.10 | 15.4 | 23.5 | 33.3 | 44.9 | 73.5 | 109 | 152 | 202 | 259 | 323 | 394 | 472 | 557 | 685 | 748 | 854 | 966 |
| 9 | 9.65 | 16.3 | 24.9 | 35.3 | 47.7 | 78.0 | 116 | 161 | 214 | 275 | 342 | 418 | 500 | 590 | 688 | 793 | 905 | 1025 |
| 10 | 10.2 | 17.2 | 26.2 | 37.2 | 50.2 | 82.2 | 122 | 170 | 226 | 289 | 361 | 440 | 527 | 622 | 725 | 836 | 954 | 1080 |
| 11 | 10.7 | 18.0 | 27.5 | 39.0 | 52.7 | 86.2 | 128 | 178 | 237 | 304 | 379 | 462 | 553 | 653 | 761 | 877 | 1001 | 1133 |
| 12 | 11.1 | 18.9 | 28.7 | 40.8 | 55.0 | 90.1 | 134 | 186 | 247 | 317 | 395 | 482 | 578 | 682 | 794 | 916 | 1046 | 1184 |
| 13 | 11.6 | 19.6 | 29.9 | 42.4 | 57.3 | 93.7 | 139 | 194 | 257 | 330 | 411 | 502 | 601 | 710 | 827 | 953 | 1088 | 1232 |
| 14 | 12.0 | 20.4 | 31.0 | 44.1 | 59.4 | 97.3 | 145 | 201 | 267 | 342 | 427 | 521 | 624 | 738 | 858 | 989 | 1129 | 1278 |
| 15 | 12.5 | 21.1 | 32.1 | 45.6 | 61.5 | 101 | 150 | 208 | 277 | 354 | 442 | 539 | 646 | 762 | 888 | 1024 | 1169 | 1323 |
| 16 | 12.9 | 21.8 | 33.2 | 47.1 | 63.5 | 104 | 155 | 215 | 286 | 366 | 457 | 557 | 667 | 787 | 917 | 1057 | 1207 | 1367 |
| 17 | 13.3 | 22.4 | 34.2 | 48.5 | 65.5 | 107 | 159 | 222 | 294 | 377 | 471 | 574 | 688 | 812 | 946 | 1090 | 1244 | 1409 |
| 18 | 13.7 | 23.1 | 35.2 | 49.9 | 67.4 | 110 | 164 | 228 | 303 | 388 | 484 | 591 | 708 | 835 | 973 | 1121 | 1280 | 1450 |
| 19 | 14.0 | 23.8 | 36.1 | 51.3 | 69.2 | 113 | 168 | 234 | 311 | 399 | 497 | 607 | 727 | 858 | 1000 | 1152 | 1315 | 1489 |
| 20 | 14.4 | 24.3 | 37.1 | 52.6 | 71.0 | 116 | 173 | 240 | 319 | 409 | 510 | 623 | 746 | 880 | 1026 | 1182 | 1350 | 1528 |
| 21 | 14.7 | 24.9 | 38.0 | 53.9 | 72.8 | 119 | 177 | 246 | 327 | 419 | 523 | 638 | 764 | 902 | 1051 | 1211 | 1383 | 1566 |
| 22 | 15.1 | 25.5 | 38.9 | 55.2 | 74.5 | 122 | 181 | 252 | 335 | 429 | 535 | 653 | 782 | 923 | 1076 | 1240 | 1415 | 1603 |
| 23 | 15.4 | 26.1 | 39.8 | 56.5 | 76.2 | 125 | 186 | 258 | 342 | 439 | 547 | 668 | 800 | 944 | 1100 | 1268 | 1447 | 1639 |
| 24 | 15.8 | 26.7 | 40.6 | 57.7 | 77.8 | 127 | 189 | 263 | 350 | 448 | 559 | 682 | 817 | 964 | 1123 | 1295 | 1478 | 1674 |
| 25 | 16.1 | 27.2 | 41.5 | 58.9 | 79.4 | 130 | 193 | 269 | 357 | 458 | 571 | 696 | 834 | 984 | 1147 | 1322 | 1509 | 1708 |
| 26 | 16.4 | 27.7 | 42.3 | 60.0 | 81.0 | 133 | 197 | 274 | 364 | 467 | 582 | 710 | 850 | 1004 | 1169 | 1348 | 1539 | 1742 |
| 27 | 16.7 | 28.3 | 43.1 | 61.2 | 82.5 | 135 | 201 | 279 | 371 | 476 | 593 | 723 | 867 | 1023 | 1192 | 1373 | 1568 | 1775 |
| 28 | 17.0 | 28.8 | 43.9 | 62.3 | 84.1 | 138 | 204 | 285 | 378 | 484 | 604 | 737 | 883 | 1041 | 1214 | 1399 | 1597 | 1808 |
| 29 | 17.3 | 29.3 | 44.7 | 63.4 | 85.5 | 140 | 208 | 290 | 384 | 493 | 615 | 750 | 898 | 1060 | 1235 | 1423 | 1625 | 1840 |
| 30 | 17.6 | 29.8 | 45.4 | 64.5 | 87.0 | 142 | 212 | 294 | 391 | 501 | 625 | 763 | 913 | 1078 | 1256 | 1448 | 1653 | 1871 |
| L, in feet | Correction Factors For Other Pipe Lengths | | | | | | | | | | | | | | | | | |
| 20 | 1.30 | 1.24 | 1.21 | 1.18 | 1.15 | 1.12 | 1.10 | 1.08 | 1.07 | 1.06 | 1.05 | 1.05 | 1.04 | 1.04 | 1.03 | 1.03 | 1.03 | 1.03 |
| 30 | 1.22 | 1.18 | 1.15 | 1.13 | 1.12 | 1.09 | 1.08 | 1.06 | 1.05 | 1.05 | 1.04 | 1.04 | 1.03 | 1.03 | 1.03 | 1.02 | 1.02 | 1.02 |
| 40 | 1.15 | 1.13 | 1.11 | 1.10 | 1.08 | 1.07 | 1.05 | 1.05 | 1.04 | 1.03 | 1.03 | 1.03 | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 |
| 50 | 1.09 | 1.08 | 1.07 | 1.06 | 1.05 | 1.04 | 1.04 | 1.03 | 1.03 | 1.02 | 1.02 | 1.02 | 1.02 | 1.01 | 1.01 | 1.01 | 1.01 | 1.01 |
| 60 | 1.04 | 1.04 | 1.03 | 1.03 | 1.03 | 1.02 | 1.02 | 1.02 | 1.01 | 1.01 | 1.01 | 1.01 | 1.01 | 1.01 | 1.01 | 1.01 | 1.01 | 1.01 |
| 70 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 80 | .96 | .97 | .97 | .97 | .98 | .98 | .98 | .99 | .99 | .99 | .99 | .99 | .99 | .99 | .99 | .99 | .99 | .99 |
| 90 | .93 | .94 | .94 | .95 | .95 | .96 | .97 | .97 | .98 | .98 | .98 | .98 | .98 | .99 | .99 | .99 | .99 | .99 |
| 100 | .90 | .91 | .92 | .93 | .93 | .95 | .95 | .96 | .97 | .97 | .97 | .98 | .98 | .98 | .98 | .98 | .98 | .99 |
| 120 | .84 | .86 | .87 | .89 | .90 | .91 | .93 | .94 | .94 | .95 | .96 | .96 | .96 | .97 | .97 | .97 | .97 | .98 |
| 140 | .80 | .82 | .83 | .85 | .86 | .88 | .90 | .91 | .92 | .93 | .94 | .94 | .95 | .95 | .96 | .96 | .96 | .97 |
| 160 | .78 | .78 | .80 | .82 | .83 | .86 | .88 | .89 | .90 | .91 | .92 | .93 | .94 | .94 | .95 | .95 | .95 | .96 |

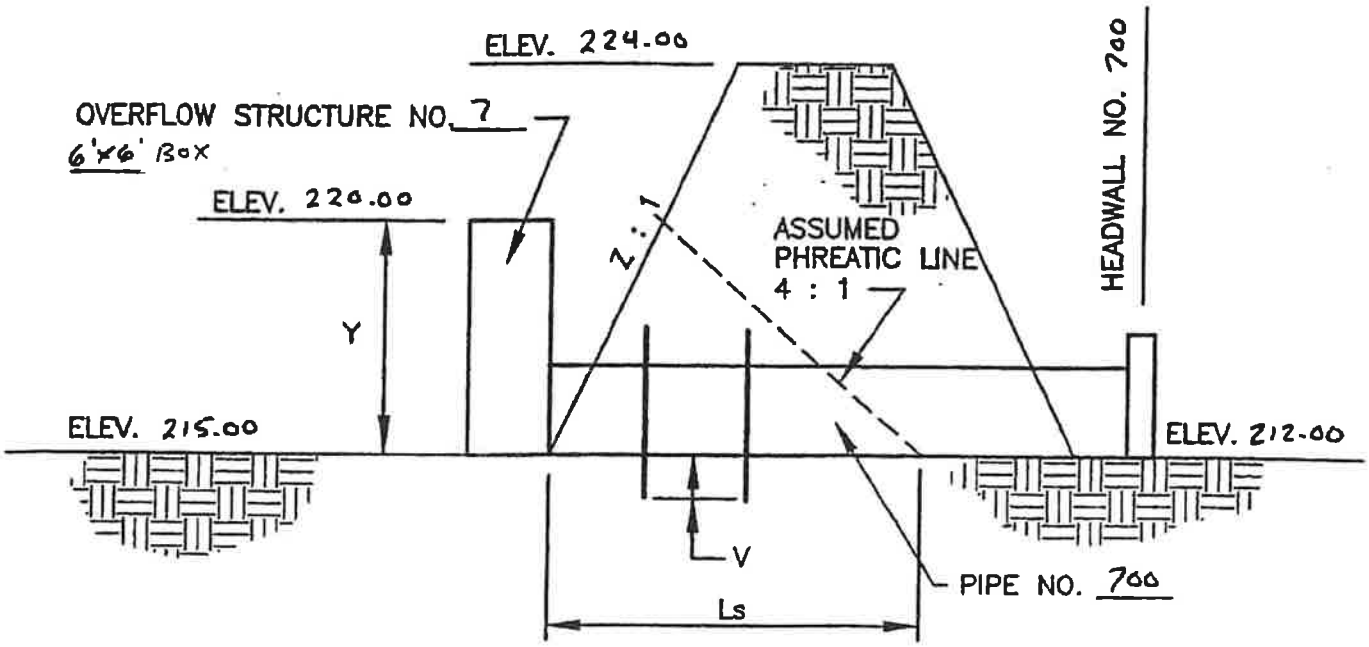
Source: USDA - SCS

**f. Anti-Seep Collar Design**

The seepage of water through the existing sediment pond dam along the carrier pipe could result in dam failure.

The proposed anti-seep collars have been designed to be located at intervals within the zone of saturation along the carrier pipe to increase the seepage length along the carrier pipe and thereby prevent piping or seepage along the carrier pipe.

# ANTI – SEEP COLLAR DESIGN




Ls = LENGTH IN SATURATION ZONE

Y = OVERFLOW STRUCTURE HEIGHT = 5.0 FEET

Z = INSIDE SLOPE OF LEVEE = 3

PIPE SLOPE = 2.75 % = 0.0275 FEET/FEET

$$Ls = Y ( Z + 4 ) \left( 1 + \frac{\text{PIPE SLOPE}}{0.25 - \text{PIPE SLOPE}} \right)$$

Ls = 39 FEET

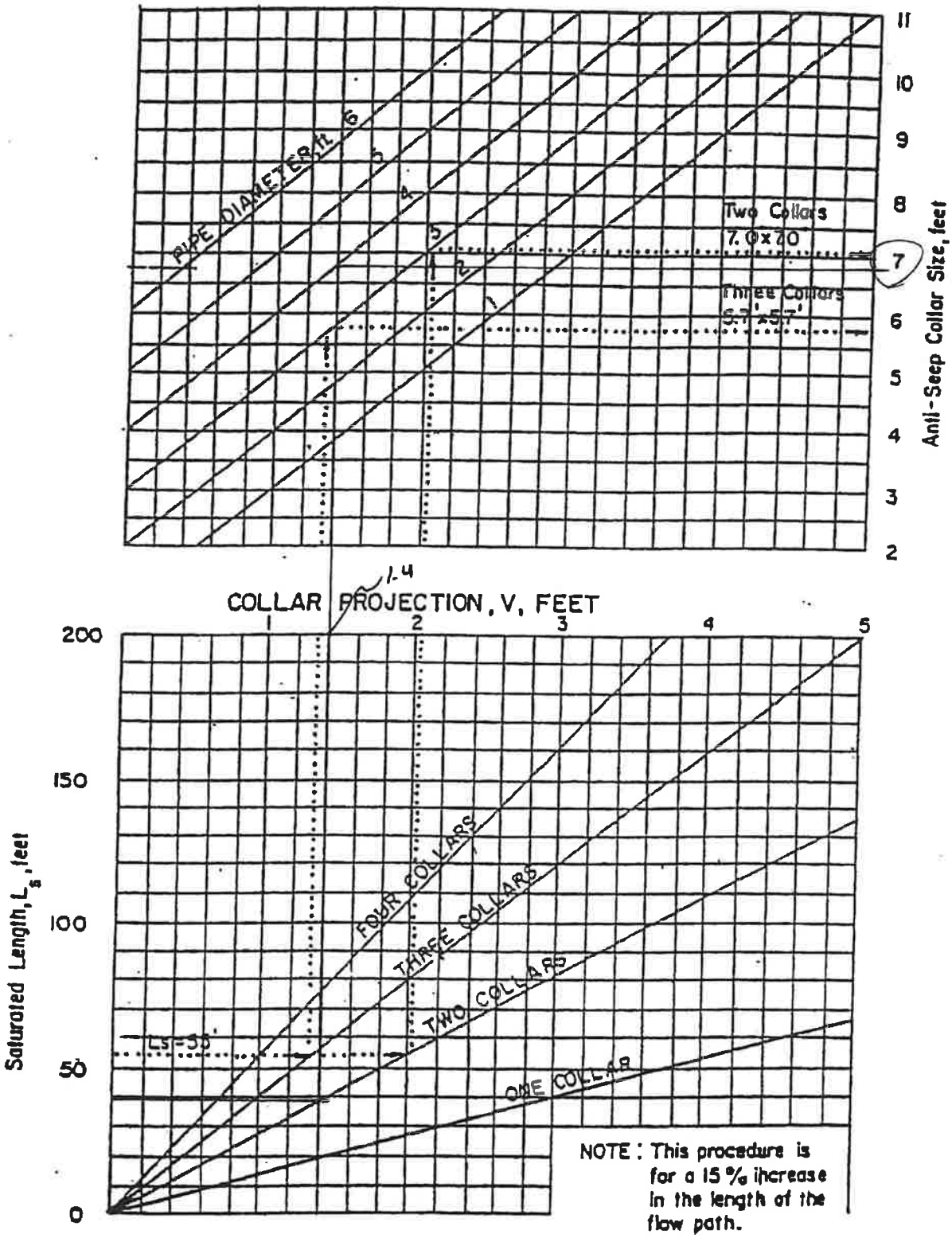
FROM ANTI – SEEP COLLAR DESIGN CHART ON THE NEXT PAGE :

V = COLLAR PROJECTION = 1.4 FEET

DIMENSIONS OF 12" THICK COLLAR = 8.0' X 8.0'

NUMBER OF REQUIRED COLLARS = 2

# ANTI-SEEP COLLAR DESIGN



**g. Overflow Structure Base Foundation Design**

The overflow structure and carrier pipe will be subject to a certain amount of buoyant force when the sediment pond is filled with storm water. In order to overcome this buoyant force and prevent the flotation of the overflow structure and carrier pipe, a concrete overflow structure base foundation and concrete carrier pipe encasement have been designed. The design calculations for the concrete overflow structure base foundation and carrier pipe encasement are included in this section.

**OVERFLOW STRUCTURE BASE FOUNDATION DESIGN**

A certain volume of concrete will be used to overcome the buoyancy of an empty overflow structure and carrier pipe that are below the assumed phreatic water surface. This volume is equal to:

Overflow Structure

= (L)(w)(h)(62.4) L = w = 6.0' inside = 7.0' outside

= (7.0)(7.0)(5.0)(62.4) h = height = 5.0'

= 15,228 #

Carrier Pipe = 3.1416($R_2^2$)(Ls)(62.4) Ls = length in saturation zone = 39'

= 3.1416(2.42)(2.42)(39)(62.4) $R_2$ = outside radius = 29" = 2.42'

= 44,775 # $r_2$ = inside radius = 24" = 2.0'

TOTAL WEIGHT

= 60,063 # x 1.5 (SAFETY FACTOR)

= 90,095 #

TOTAL REVISED VOLUME OF CONCRETE =

TOTAL WEIGHT / WEIGHT OF CONC. IN WATER

= 90,095/87.6 pcf (87.6 pcf = Wt. of conc. in submerged water)

=1,028 C.F.

This volume of concrete will be made up from five areas.

1. Overflow Structures
2. Anti-Seep Collars
3. Carrier Pipe
4. Overflow Structure Base
5. Carrier Pipe Encasement

1. Overflow Structure = $(L_2 - l_2)h$

   $(7.0^2 – 6.0^2)(5.0)$ = 65 C.F.

   L = outside dimension of box = 7<u>6.0’</u>

   l = inside dimension of box = <u>6.0’</u>

   h = height of overflow structures = <u>5.0’</u>

2. Anti-seep collars = area of square collar around carrier pipe x 12" thick x # of collars

   = [( 8.0' x 8.0' ) - $(3.1416)(R_2^2)$]

   x 1' x 2

   = 91 C.F.

   $R_2$ = outside radius of carrier pipe = <u>29" = 2.42’</u>

   $r_2$ = inside radius of carrier pipe = <u>24" = 2.0’</u>

3. Carrier Pipe

   = $3.1416 (R_2^2 - r_2^2)$ L = 227 C.F.

   L = length in saturation = <u>39’</u>

4. Overflow Structure Base = Volume to handle riser bouyance x 1.2

   = (L)(w)h(62.4)(1.2)/weight of conc. in water

   L = w = <u>7.0’</u> outside

   h = height = <u>5.0’</u>

   = (7.0’)(7.0’)(5.0)(62.4)(1.2)/87.6

   = 209 C.F.

   Use 11.0’ x 11.0’ x 3.0’ = 363

5. Carrier Pipe Encasement

   Must extend 5’ into dam. Distance from overflow structure to dam is equal to 15.0’. Therefore, minimum encasement length will be <u>20.0’</u>.

   $[(5 \times 7.0) – (3.1416)R_2^2]$ 20

   Carrier pipe encasement volume = 332 C.F.

**TOTAL REQUIRED VOLUME = 1,028 C.F.**

Actual Total Volume

| | | |
|---|---|---|
| Overflow Structure | = | 65 C.F. |
| Anti-Seep Collars | = | 91 C.F. |
| Carrier Pipe | = | 227 C.F. |
| Overflow Structure Base | = | 363 C.F. |
| Carrier Pipe Encasement | = | 332 C.F. |

**TOTAL = 1,078 C.F. ⇒ Okay**

# 9. EXISTING SEDIMENT POND NO. 8

## a. Sediment Storage and Settling Efficiency Calculations

As required in the "Alabama Handbook for Erosion Control, Sediment Control and Stormwater Management on Construction Sites and Urban Area", the sediment storage volume of the pond shall be at least 67 cubic yards per acre for the disturbed area draining into the pond (67 cubic yards is equivalent to ½ inch of sediment per acre of drainage area). The peak inflow rate for the 25 year storm event has also been used to calculate the minimum pond surface area needed for adequate settling efficiency. These calculations for the sediment pond are included below.

Sediment Storage Calculation

Assume maximum sediment from 34 disturbed acres.

34 Acres x 67 c.y./acre = 2,278 c.y. = 61,506 c.f.

This sediment volume corresponds to a depth of 1.60' or Elev. 219.60.

Dewatering opening is set at Elev. 221.00. Therefore, ample sediment storage volume is available.

Settling Efficiency Calculations

- Use 25-year storm event, Q25 Flow = 152 cfs
- Minimum Surface Area = .01 acre / cfs x Q25 Flow
  = .01 acre / cfs x 152 cfs
  = 1.52 acres = 66,211 s.f.

- Top of Overflow Structure = Elev. 226.25
  Surface Area @ Elev. 226.25 = 68,166 s.f.

- Adequate surface area is available for settling

# Pond Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022 Thursday, 01 / 30 / 2025

## Pond No. 1 - Ex. Pond No. 8

### Pond Data

**Contours -**User-defined contour areas. Average end area method used for volume calculation. Begining Elevation = 218.00 ft

### Stage / Storage Table

| Stage (ft) | Elevation (ft) | Contour area (sqft) | Incr. Storage (cuft) | Total storage (cuft) |
|---|---|---|---|---|
| 0.00 | 218.00 | 34,514 | 0 | 0 |
| 2.00 | 220.00 | 42,682 | 77,196 | 77,196 |
| 4.00 | 222.00 | 50,654 | 93,336 | 170,532 |
| 6.00 | 224.00 | 58,750 | 109,404 | 279,936 |
| 8.00 | 226.00 | 67,129 | 125,879 | 405,815 |
| 10.00 | 228.00 | 75,793 | 142,922 | 548,737 |
| 12.00 | 230.00 | 84,740 | 160,533 | 709,270 |

### Culvert / Orifice Structures

| | [A] | [B] | [C] | [PrfRsr] |
|---|---|---|---|---|
| **Rise (in)** | = 42.00 | 4.00 | 6.00 | Inactive |
| **Span (in)** | = 42.00 | 9.00 | 18.00 | 0.00 |
| **No. Barrels** | = 1 | 1 | 3 | 0 |
| **Invert El. (ft)** | = 221.00 | 221.10 | 223.00 | 0.00 |
| **Length (ft)** | = 72.00 | 0.00 | 0.00 | 0.00 |
| **Slope (%)** | = 1.39 | 0.00 | 0.00 | n/a |
| **N-Value** | = .013 | .013 | .013 | n/a |
| **Orifice Coeff.** | = 0.60 | 0.60 | 0.60 | 0.60 |
| **Multi-Stage** | = n/a | Yes | Yes | No |

### Weir Structures

| | [A] | [B] | [C] | [D] |
|---|---|---|---|---|
| **Crest Len (ft)** | = 20.00 | Inactive | Inactive | Inactive |
| **Crest El. (ft)** | = 226.25 | 0.00 | 0.00 | 0.00 |
| **Weir Coeff.** | = 3.33 | 3.33 | 3.33 | 3.33 |
| **Weir Type** | = 1 | --- | --- | --- |
| **Multi-Stage** | = Yes | No | No | No |

**Exfil.(in/hr)** = 0.000 (by Wet area)

**TW Elev. (ft)** = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).

### Stage / Storage / Discharge Table

| Stage ft | Storage cuft | Elevation ft | Clv A cfs | Clv B cfs | Clv C cfs | PrfRsr cfs | Wr A cfs | Wr B cfs | Wr C cfs | Wr D cfs | Exfil cfs | User cfs | Total cfs |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.00 | 0 | 218.00 | 0.00 | 0.00 | 0.00 | --- | 0.00 | --- | --- | --- | --- | --- | 0.000 |
| 2.00 | 77,196 | 220.00 | 0.00 | 0.00 | 0.00 | --- | 0.00 | --- | --- | --- | --- | --- | 0.000 |
| 4.00 | 170,532 | 222.00 | 0.99 ic | 0.98 ic | 0.00 | --- | 0.00 | --- | --- | --- | --- | --- | 0.982 |
| 6.00 | 279,936 | 224.00 | 11.00 ic | 1.61 ic | 9.38 ic | --- | 0.00 | --- | --- | --- | --- | --- | 11.00 |
| 8.00 | 405,815 | 226.00 | 20.31 ic | 2.20 ic | 17.97 ic | --- | 0.00 | --- | --- | --- | --- | --- | 20.16 |
| 10.00 | 548,737 | 228.00 | 102.50 ic | 0.72 ic | 6.44 ic | --- | 95.34 s | --- | --- | --- | --- | --- | 102.49 |
| 12.00 | 709,270 | 230.00 | 124.13 ic | 0.32 ic | 2.84 ic | --- | 120.97 s | --- | --- | --- | --- | --- | 124.13 |

**b. Total Pond Dewatering at Top of Riser (Elev. 226.25)**

Retention time within the basin is an important factor in effective sediment retention. The overflow structure has been designed as specified below.

Since the overflow structure will have two stages, the dewatering time has been calculated for each stage. Stage 1 calculates the drawdown time of the maximum water surface elevation from the top of the riser to the orifice at elevation 223.00. Stage 2 calculates the drawdown time from the orifice at elevation 223.00 to the orifice at elevation 221.00.

The calculation below has been performed to confirm that the dewatering (retention) time within the pond is between 24 and 72 hours. This dewatering time will ensure the storm water is retained for an adequate length of time to allow the sediment to settle (minimum 24 hours) and is also discharged gradually in an acceptable length of time to allow storage for future storm events (maximum 72 hours).

The dewatering time is calculated as follows:

$$T = \frac{A_s \times (2h)^{1/2}}{A_O \times C_d \times (20{,}428)}$$

$A_O$ = Surface Area of Dewatering Holes ($ft^2$)

$A_s$ = Surface Area Corresponding to top of riser elevation ($ft^2$)

h = Head of water above dewatering hole (ft)

$C_d$ = Coefficient of contraction for an orifice (use 0.6)

T = Time to dewater

**Stage 1**

$T_1$

$A_O$ = 2.25 s.f. @ Elev. 223.00 (3 - 6" x 18" rectangular openings)

$A_s$ = 68,166 s.f. @ Elev. 226.25

h = 226.25 – 223.00 = 3.25'

$$T = \frac{68{,}166\ (2 \times 3.25)^{1/2}}{(2.25)\ (0.6)\ (20{,}428)} = 6.3 \text{ hours}$$

**Stage 2**

$T_2$

$A_O$ = 0.25 s.f. @ Elev. 221.00 (1 – 4" x 9" rectangular opening)

$A_s$ = 54,702 s.f. @ Elev. 223.00 (invert of orifice #2)

h = 223.00 – 221.00 = 2.00'

$$T = \frac{54{,}702\ (2 \times 2.00)^{1/2}}{(0.25)\ (0.6)\ (20{,}428)} = 35.7 \text{ hours}$$

$T_1 + T_2 = 6.3 + 35.7 = 42.0$ hours

**(okay between 24 - 72 hours)**

**c. Reservoir Routing**

Reservoir routing is determined by using the HydraFlow Hydrographs Extension for AutoCad Civil 3D 2022 Computer Program.

Peak inflow rates (Q) are determined using the SCS Method and HydraFlow Hydrographs Extension for AutoCad Civil 3D 2022 Computer Program. Peak inflow rates are calculated for the 25 year and 100 year storm events and are summarized below.

Q25 = 152 cfs

Q100 = 215 cfs

The bottom of the pond has been set at 218.00. Dewatering of the pond is accomplished by one 4" x 9" rectangular opening beginning at an invert elevation of 221.00 and three 6" x 18" rectangular openings at elevation 223.00.

For routing calculations, a 5'x 5' rectangular riser with one 4" x 9" rectangular opening at an invert elevation of 221.00 and three 6" x 18" rectangular openings at elevation 223.00 were used. The top of the riser is at an elevation of 226.25. The bottom of the pond is elev. 218.00. The invert of the carrier pipe is elev. 221.00. The top of the levee around the sediment pond is at an elevation of 230.00.

The maximum height of sediment is elevation 219.60 which is below the elevation of the first dewatering opening (Elev. 221.00). For routing calculations, the starting water surface elevation was set at 221.00, assuming the remainder of the pond bottom is filled below the dewatering orifice invert elevation.

Based on the above information the reservoir routing calculations are performed and summarized below.

| STORM YEAR | PEAK INFLOW CFS | PEAK OUTFLOW CFS | PEAK ELEV. FEET |
|---|---|---|---|
| 25 | 152 | 21 | 226.09 |
| 100 | 215 | 76 | 227.18 |

Based on these routing calculations, the riser is large enough and the pond has sufficient storage volume to retain the sediment from 34 disturbed acres plus the 10 year storm event from the entire drainage area below the crest of the riser (elev. 226.25).

# Pond Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022 Thursday, 01 / 30 / 2025

## Pond No. 2 - Ex. Pond No. 8 perm pool

### Pond Data

**Contours -**User-defined contour areas. Average end area method used for volume calculation. Begining Elevation = 221.00 ft

### Stage / Storage Table

| Stage (ft) | Elevation (ft) | Contour area (sqft) | Incr. Storage (cuft) | Total storage (cuft) |
|---|---|---|---|---|
| 0.00 | 221.00 | 46,826 | 0 | 0 |
| 1.00 | 222.00 | 50,654 | 48,740 | 48,740 |
| 3.00 | 224.00 | 58,750 | 109,404 | 158,144 |
| 5.00 | 226.00 | 67,129 | 125,879 | 284,023 |
| 7.00 | 228.00 | 75,793 | 142,922 | 426,945 |
| 9.00 | 230.00 | 84,740 | 160,533 | 587,478 |

### Culvert / Orifice Structures

| | [A] | [B] | [C] | [PrfRsr] |
|---|---|---|---|---|
| **Rise (in)** | = 42.00 | 4.00 | 6.00 | Inactive |
| **Span (in)** | = 42.00 | 9.00 | 18.00 | 0.00 |
| **No. Barrels** | = 1 | 1 | 3 | 0 |
| **Invert El. (ft)** | = 221.00 | 221.10 | 223.00 | 0.00 |
| **Length (ft)** | = 72.00 | 0.00 | 0.00 | 0.00 |
| **Slope (%)** | = 1.39 | 0.00 | 0.00 | n/a |
| **N-Value** | = .013 | .013 | .013 | n/a |
| **Orifice Coeff.** | = 0.60 | 0.60 | 0.60 | 0.60 |
| **Multi-Stage** | = n/a | Yes | Yes | No |

### Weir Structures

| | [A] | [B] | [C] | [D] |
|---|---|---|---|---|
| **Crest Len (ft)** | = 20.00 | Inactive | Inactive | Inactive |
| **Crest El. (ft)** | = 226.25 | 0.00 | 0.00 | 0.00 |
| **Weir Coeff.** | = 3.33 | 3.33 | 3.33 | 3.33 |
| **Weir Type** | = 1 | --- | --- | --- |
| **Multi-Stage** | = Yes | No | No | No |

**Exfil.(in/hr)** = 0.000 (by Wet area)

**TW Elev. (ft)** = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).

### Stage / Storage / Discharge Table

| Stage ft | Storage cuft | Elevation ft | Clv A cfs | Clv B cfs | Clv C cfs | PrfRsr cfs | Wr A cfs | Wr B cfs | Wr C cfs | Wr D cfs | Exfil cfs | User cfs | Total cfs |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.00 | 0 | 221.00 | 0.00 | 0.00 | 0.00 | --- | 0.00 | --- | --- | --- | --- | --- | 0.000 |
| 1.00 | 48,740 | 222.00 | 0.99 ic | 0.98 ic | 0.00 | --- | 0.00 | --- | --- | --- | --- | --- | 0.982 |
| 3.00 | 158,144 | 224.00 | 11.00 ic | 1.61 ic | 9.38 ic | --- | 0.00 | --- | --- | --- | --- | --- | 11.00 |
| 5.00 | 284,023 | 226.00 | 20.30 ic | 2.20 ic | 17.97 ic | --- | 0.00 | --- | --- | --- | --- | --- | 20.16 |
| 7.00 | 426,945 | 228.00 | 102.50 ic | 0.72 ic | 6.44 ic | --- | 95.34 s | --- | --- | --- | --- | --- | 102.49 |
| 9.00 | 587,478 | 230.00 | 124.13 ic | 0.32 ic | 2.84 ic | --- | 120.95 s | --- | --- | --- | --- | --- | 124.10 |

# Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022

| Hyd. No. | Hydrograph type (origin) | Peak flow (cfs) | Time interval (min) | Time to Peak (min) | Hyd. volume (cuft) | Inflow hyd(s) | Maximum elevation (ft) | Total strge used (cuft) | Hydrograph Description |
|---|---|---|---|---|---|---|---|---|---|
| 1 | SCS Runoff | 12.08 | 1 | 732 | 51,583 | ------ | ------ | ------ | Ditch No. 14 |
| 2 | SCS Runoff | 9.090 | 1 | 725 | 29,522 | ------ | ------ | ------ | DD64 |
| 3 | SCS Runoff | 7.926 | 1 | 725 | 24,698 | ------ | ------ | ------ | Area to DD65 |
| 4 | Combine | 17.02 | 1 | 725 | 54,221 | 2, 3 | ------ | ------ | DD65 |
| 5 | SCS Runoff | 10.87 | 1 | 725 | 33,872 | ------ | ------ | ------ | Area to DD66 |
| 6 | Combine | 27.89 | 1 | 725 | 88,092 | 4, 5 | ------ | ------ | DD66 |
| 7 | SCS Runoff | 11.43 | 1 | 729 | 43,278 | ------ | ------ | ------ | Area to DD67 |
| 8 | Combine | 37.94 | 1 | 725 | 131,371 | 6, 7 | ------ | ------ | DD67 |
| 9 | Combine | 47.71 | 1 | 726 | 182,954 | 1, 8 | ------ | ------ | Ditch No. 14 & DD67 |
| 10 | SCS Runoff | 8.536 | 1 | 729 | 32,332 | ------ | ------ | ------ | Area to Ditch No. 13 |
| 11 | Combine | 55.68 | 1 | 726 | 215,286 | 9, 10 | ------ | ------ | Ditch No. 13 |
| 12 | SCS Runoff | 15.05 | 1 | 725 | 48,870 | ------ | ------ | ------ | DD56 |
| 13 | SCS Runoff | 10.47 | 1 | 725 | 32,637 | ------ | ------ | ------ | Area to DD57 |
| 14 | Combine | 25.52 | 1 | 725 | 81,507 | 12, 13 | ------ | ------ | DD57 |
| 15 | SCS Runoff | 9.055 | 1 | 737 | 43,965 | ------ | ------ | ------ | Area to DD58 |
| 16 | Combine | 31.37 | 1 | 726 | 125,472 | 14, 15 | ------ | ------ | DD58 |
| 17 | SCS Runoff | 11.78 | 1 | 725 | 36,695 | ------ | ------ | ------ | Area to DD59 |
| 18 | Combine | 43.14 | 1 | 725 | 162,167 | 16, 17 | ------ | ------ | DD59 |
| 19 | SCS Runoff | 9.507 | 1 | 730 | 37,806 | ------ | ------ | ------ | Area to DD60 |
| 20 | Combine | 51.19 | 1 | 726 | 199,973 | 18, 19 | ------ | ------ | DD60 |
| 21 | SCS Runoff | 12.57 | 1 | 725 | 39,164 | ------ | ------ | ------ | DD61 |
| 22 | SCS Runoff | 12.74 | 1 | 725 | 39,694 | ------ | ------ | ------ | Area to DD62 |
| 23 | Combine | 25.31 | 1 | 725 | 78,858 | 21, 22 | ------ | ------ | DD62 |
| 24 | SCS Runoff | 14.38 | 1 | 725 | 44,810 | ------ | ------ | ------ | Area to DD63 |
| 25 | Combine | 39.69 | 1 | 725 | 123,667 | 23, 24 | ------ | ------ | DD63 |
| 26 | SCS Runoff | 3.345 | 1 | 723 | 9,751 | ------ | ------ | ------ | Ditch No. 12 |
| 27 | Combine | 148.53 | 1 | 725 | 548,678 | 11, 20, 25, 26 | ------ | ------ | DI. No. 801 |
| 28 | SCS Runoff | 15.20 | 1 | 722 | 41,698 | ------ | ------ | ------ | Area to Pond No. 8 |
| 29 | Combine | 160.13 | 1 | 725 | 590,377 | 27, 28 | ------ | ------ | Pond No. 8 Total Inflow |
| 30 | Reservoir | 22.74 | 1 | 768 | 569,435 | 29 | 226.28 | 304,313 | Pond No. 8 perm pool |
| 31 | Reservoir | 95.94 | 1 | 736 | 590,373 | 29 | 227.71 | 105,076 | Pond No. 8 - riser |
| 33 | SCS Runoff | 5.139 | 1 | 728 | 18,805 | ------ | ------ | ------ | Ditch No. 11 |
| 34 | SCS Runoff | 13.25 | 1 | 730 | 52,690 | ------ | ------ | ------ | DD48 |

# Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022

| Hyd. No. | Hydrograph type (origin) | Peak flow (cfs) | Time interval (min) | Time to Peak (min) | Hyd. volume (cuft) | Inflow hyd(s) | Maximum elevation (ft) | Total strge used (cuft) | Hydrograph Description |
|---|---|---|---|---|---|---|---|---|---|
| 1 | SCS Runoff | 17.15 | 1 | 732 | 74,063 | ------ | ------ | ------ | Ditch No. 14 |
| 2 | SCS Runoff | 12.89 | 1 | 725 | 42,388 | ------ | ------ | ------ | DD64 |
| 3 | SCS Runoff | 11.23 | 1 | 724 | 35,461 | ------ | ------ | ------ | Area to DD65 |
| 4 | Combine | 24.11 | 1 | 725 | 77,849 | 2, 3 | ------ | ------ | DD65 |
| 5 | SCS Runoff | 15.41 | 1 | 724 | 48,633 | ------ | ------ | ------ | Area to DD66 |
| 6 | Combine | 39.49 | 1 | 725 | 126,482 | 4, 5 | ------ | ------ | DD66 |
| 7 | SCS Runoff | 16.19 | 1 | 729 | 62,138 | ------ | ------ | ------ | Area to DD67 |
| 8 | Combine | 53.86 | 1 | 725 | 188,619 | 6, 7 | ------ | ------ | DD67 |
| 9 | Combine | 67.77 | 1 | 726 | 262,682 | 1, 8 | ------ | ------ | Ditch No. 14 & DD67 |
| 10 | SCS Runoff | 12.10 | 1 | 729 | 46,422 | ------ | ------ | ------ | Area to Ditch No. 13 |
| 11 | Combine | 79.13 | 1 | 726 | 309,104 | 9, 10 | ------ | ------ | Ditch No. 13 |
| 12 | SCS Runoff | 21.34 | 1 | 725 | 70,167 | ------ | ------ | ------ | DD56 |
| 13 | SCS Runoff | 14.85 | 1 | 724 | 46,860 | ------ | ------ | ------ | Area to DD57 |
| 14 | Combine | 36.16 | 1 | 725 | 117,027 | 12, 13 | ------ | ------ | DD57 |
| 15 | SCS Runoff | 12.85 | 1 | 736 | 63,124 | ------ | ------ | ------ | Area to DD58 |
| 16 | Combine | 44.63 | 1 | 725 | 180,151 | 14, 15 | ------ | ------ | DD58 |
| 17 | SCS Runoff | 16.69 | 1 | 724 | 52,685 | ------ | ------ | ------ | Area to DD59 |
| 18 | Combine | 61.29 | 1 | 725 | 232,836 | 16, 17 | ------ | ------ | DD59 |
| 19 | SCS Runoff | 13.48 | 1 | 730 | 54,282 | ------ | ------ | ------ | Area to DD60 |
| 20 | Combine | 72.68 | 1 | 726 | 287,118 | 18, 19 | ------ | ------ | DD60 |
| 21 | SCS Runoff | 17.81 | 1 | 724 | 56,231 | ------ | ------ | ------ | DD61 |
| 22 | SCS Runoff | 18.05 | 1 | 724 | 56,991 | ------ | ------ | ------ | Area to DD62 |
| 23 | Combine | 35.87 | 1 | 724 | 113,223 | 21, 22 | ------ | ------ | DD62 |
| 24 | SCS Runoff | 20.38 | 1 | 724 | 64,337 | ------ | ------ | ------ | Area to DD63 |
| 25 | Combine | 56.25 | 1 | 724 | 177,560 | 23, 24 | ------ | ------ | DD63 |
| 26 | SCS Runoff | 4.740 | 1 | 723 | 14,000 | ------ | ------ | ------ | Ditch No. 12 |
| 27 | Combine | 211.03 | 1 | 725 | 787,782 | 11, 20, 25, 26 | ------ | ------ | DI. No. 801 |
| 28 | SCS Runoff | 21.53 | 1 | 722 | 59,870 | ------ | ------ | ------ | Area to Pond No. 8 |
| 29 | Combine | 227.32 | 1 | 725 | 847,651 | 27, 28 | ------ | ------ | Pond No. 8 Total Inflow |
| 30 | Reservoir | 84.04 | 1 | 746 | 825,955 | 29 | 227.31 | 377,481 | Pond No. 8 perm pool |
| 31 | Reservoir | 108.87 | 1 | 741 | 847,648 | 29 | 228.51 | 166,849 | Pond No. 8 - riser |
| 33 | SCS Runoff | 7.284 | 1 | 728 | 27,001 | ------ | ------ | ------ | Ditch No. 11 |
| 34 | SCS Runoff | 18.79 | 1 | 730 | 75,651 | ------ | ------ | ------ | DD48 |

**d. Emergency Spillway**

Worst Case

Assume the dewatering opening in the overflow structure is not operating and the starting water surface elevation is at the top of the riser (226.25) at the start of a 100 year storm event.

| | | |
|---|---|---|
| Top of Pond | = | 230.00 |
| Less Required Freeboard | = | 1.00 |
| Maximum Allowable Water Surface Elevation in Emergency Spillway | = | 229.00 |

Re-route the 100 year storm event through the 5'x 5' square overflow structure and 42" diameter carrier pipe.

From Hydrograph Summary Report, Line 31, the maximum flow out of the pond will be 107 cfs. The maximum water surface elevation is 228.37 which is less than the maximum allowable water surface elevation of 229.00.

Therefore, the overflow structure and carrier pipe will safely pass the 100 year storm event with a starting water surface elevation at 226.25.

# Pond Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022 Thursday, 01 / 30 / 2025

## Pond No. 3 - Ex. Pond No. 8 riser

### Pond Data

**Contours -**User-defined contour areas. Average end area method used for volume calculation. Begining Elevation = 226.25 ft

### Stage / Storage Table

| Stage (ft) | Elevation (ft) | Contour area (sqft) | Incr. Storage (cuft) | Total storage (cuft) |
|---|---|---|---|---|
| 0.00 | 226.25 | 68,166 | 0 | 0 |
| 1.75 | 228.00 | 75,793 | 125,964 | 125,964 |
| 3.75 | 230.00 | 84,740 | 160,533 | 286,497 |

### Culvert / Orifice Structures

| | [A] | [B] | [C] | [PrfRsr] |
|---|---|---|---|---|
| **Rise (in)** | = 42.00 | Inactive | Inactive | Inactive |
| **Span (in)** | = 42.00 | 0.00 | 0.00 | 0.00 |
| **No. Barrels** | = 1 | 1 | 1 | 0 |
| **Invert El. (ft)** | = 221.00 | 0.00 | 0.00 | 0.00 |
| **Length (ft)** | = 72.00 | 0.00 | 0.00 | 0.00 |
| **Slope (%)** | = 1.39 | 0.00 | 0.00 | n/a |
| **N-Value** | = .013 | .013 | .013 | n/a |
| **Orifice Coeff.** | = 0.60 | 0.60 | 0.60 | 0.60 |
| **Multi-Stage** | = n/a | No | No | No |

### Weir Structures

| | [A] | [B] | [C] | [D] |
|---|---|---|---|---|
| **Crest Len (ft)** | = 20.00 | Inactive | Inactive | Inactive |
| **Crest El. (ft)** | = 226.25 | 0.00 | 0.00 | 0.00 |
| **Weir Coeff.** | = 3.33 | 3.33 | 3.33 | 3.33 |
| **Weir Type** | = 1 | --- | --- | --- |
| **Multi-Stage** | = Yes | No | No | No |

**Exfil.(in/hr)** = 0.000 (by Wet area)

**TW Elev. (ft)** = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).

### Stage / Storage / Discharge Table

| Stage ft | Storage cuft | Elevation ft | Clv A cfs | Clv B cfs | Clv C cfs | PrfRsr cfs | Wr A cfs | Wr B cfs | Wr C cfs | Wr D cfs | Exfil cfs | User cfs | Total cfs |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.00 | 0 | 226.25 | 0.00 | --- | --- | --- | 0.00 | --- | --- | --- | --- | --- | 0.000 |
| 1.75 | 125,964 | 228.00 | 101.76 ic | --- | --- | --- | 101.76 s | --- | --- | --- | --- | --- | 101.76 |
| 3.75 | 286,497 | 230.00 | 124.09 ic | --- | --- | --- | 124.03 s | --- | --- | --- | --- | --- | 124.03 |

# Hydrograph Summary Report

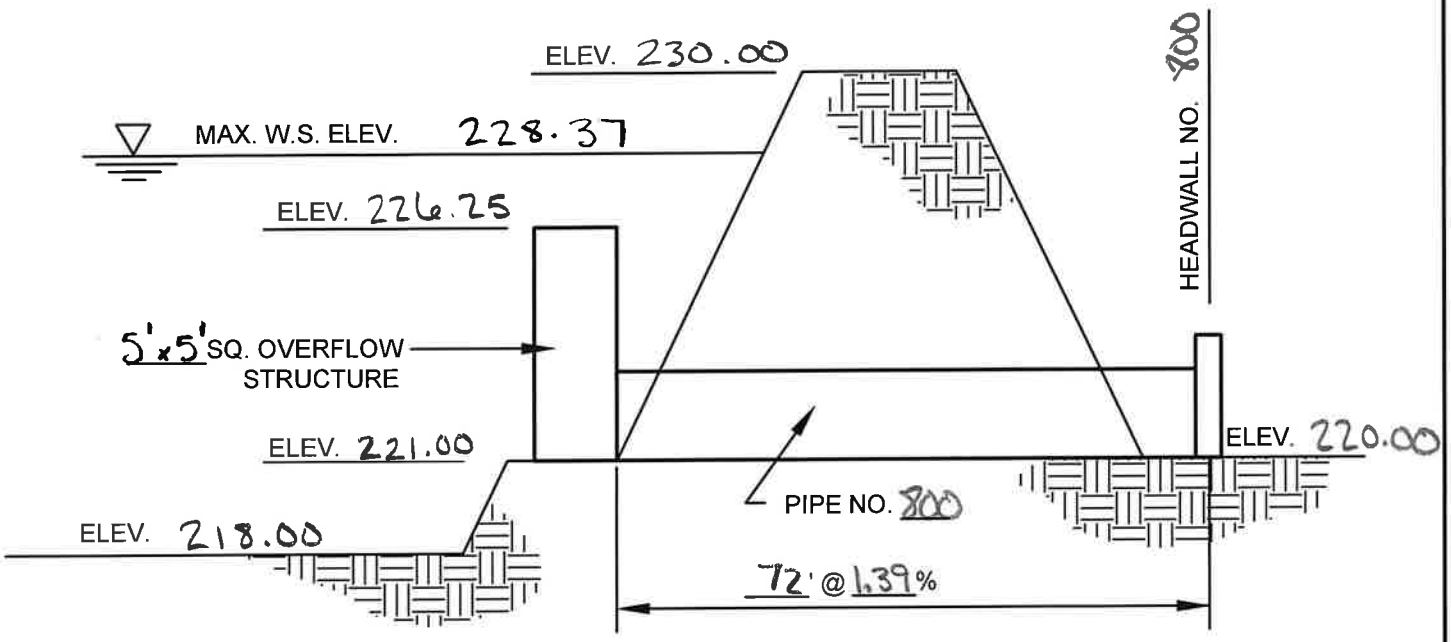
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022

| Hyd. No. | Hydrograph type (origin) | Peak flow (cfs) | Time interval (min) | Time to Peak (min) | Hyd. volume (cuft) | Inflow hyd(s) | Maximum elevation (ft) | Total strge used (cuft) | Hydrograph Description |
|---|---|---|---|---|---|---|---|---|---|
| 1 | SCS Runoff | 12.08 | 1 | 732 | 51,583 | ------ | ------ | ------ | Ditch No. 14 |
| 2 | SCS Runoff | 9.090 | 1 | 725 | 29,522 | ------ | ------ | ------ | DD64 |
| 3 | SCS Runoff | 7.926 | 1 | 725 | 24,698 | ------ | ------ | ------ | Area to DD65 |
| 4 | Combine | 17.02 | 1 | 725 | 54,221 | 2, 3 | ------ | ------ | DD65 |
| 5 | SCS Runoff | 10.87 | 1 | 725 | 33,872 | ------ | ------ | ------ | Area to DD66 |
| 6 | Combine | 27.89 | 1 | 725 | 88,092 | 4, 5 | ------ | ------ | DD66 |
| 7 | SCS Runoff | 11.43 | 1 | 729 | 43,278 | ------ | ------ | ------ | Area to DD67 |
| 8 | Combine | 37.94 | 1 | 725 | 131,371 | 6, 7 | ------ | ------ | DD67 |
| 9 | Combine | 47.71 | 1 | 726 | 182,954 | 1, 8 | ------ | ------ | Ditch No. 14 & DD67 |
| 10 | SCS Runoff | 8.536 | 1 | 729 | 32,332 | ------ | ------ | ------ | Area to Ditch No. 13 |
| 11 | Combine | 55.68 | 1 | 726 | 215,286 | 9, 10 | ------ | ------ | Ditch No. 13 |
| 12 | SCS Runoff | 15.05 | 1 | 725 | 48,870 | ------ | ------ | ------ | DD56 |
| 13 | SCS Runoff | 10.47 | 1 | 725 | 32,637 | ------ | ------ | ------ | Area to DD57 |
| 14 | Combine | 25.52 | 1 | 725 | 81,507 | 12, 13 | ------ | ------ | DD57 |
| 15 | SCS Runoff | 9.055 | 1 | 737 | 43,965 | ------ | ------ | ------ | Area to DD58 |
| 16 | Combine | 31.37 | 1 | 726 | 125,472 | 14, 15 | ------ | ------ | DD58 |
| 17 | SCS Runoff | 11.78 | 1 | 725 | 36,695 | ------ | ------ | ------ | Area to DD59 |
| 18 | Combine | 43.14 | 1 | 725 | 162,167 | 16, 17 | ------ | ------ | DD59 |
| 19 | SCS Runoff | 9.507 | 1 | 730 | 37,806 | ------ | ------ | ------ | Area to DD60 |
| 20 | Combine | 51.19 | 1 | 726 | 199,973 | 18, 19 | ------ | ------ | DD60 |
| 21 | SCS Runoff | 12.57 | 1 | 725 | 39,164 | ------ | ------ | ------ | DD61 |
| 22 | SCS Runoff | 12.74 | 1 | 725 | 39,694 | ------ | ------ | ------ | Area to DD62 |
| 23 | Combine | 25.31 | 1 | 725 | 78,858 | 21, 22 | ------ | ------ | DD62 |
| 24 | SCS Runoff | 14.38 | 1 | 725 | 44,810 | ------ | ------ | ------ | Area to DD63 |
| 25 | Combine | 39.69 | 1 | 725 | 123,667 | 23, 24 | ------ | ------ | DD63 |
| 26 | SCS Runoff | 3.345 | 1 | 723 | 9,751 | ------ | ------ | ------ | Ditch No. 12 |
| 27 | Combine | 148.53 | 1 | 725 | 548,678 | 11, 20, 25, 26 | ------ | ------ | DI. No. 801 |
| 28 | SCS Runoff | 15.20 | 1 | 722 | 41,698 | ------ | ------ | ------ | Area to Pond No. 8 |
| 29 | Combine | 160.13 | 1 | 725 | 590,377 | 27, 28 | ------ | ------ | Pond No. 8 Total Inflow |
| 30 | Reservoir | 22.74 | 1 | 768 | 569,435 | 29 | 226.28 | 304,313 | Pond No. 8 perm pool |
| 31 | Reservoir | 95.94 | 1 | 736 | 590,373 | 29 | 227.71 | 105,076 | Pond No. 8 - riser |
| 33 | SCS Runoff | 5.139 | 1 | 728 | 18,805 | ------ | ------ | ------ | Ditch No. 11 |
| 34 | SCS Runoff | 13.25 | 1 | 730 | 52,690 | ------ | ------ | ------ | DD48 |

**e. Overflow Structure and Carrier Pipe Design**

In order to confirm that the overflow structure, carrier pipe and emergency spillway pipe have been designed adequately to pass the maximum flow as modeled in the HydraFlow Hydrographs Extension for AutoCad Civil 3D 2022 Computer Program, the following design calculations have been included.

# OVERFLOW STRUCTURE NO. 8




## DESIGN OF OVERFLOW STRUCTURE AS EMERGENCY SPILLWAY

FLOW (Q) WORST CASE = 100 YEAR STORM EVENT OCCURS WHEN WATER SURFACE ELEVATION AT TOP OF OVERFLOW STRUCTURE AND ALL DEWATERING HOLES ARE PLUGGED

FLOW (Q) MAXIMUM = 107 CFS

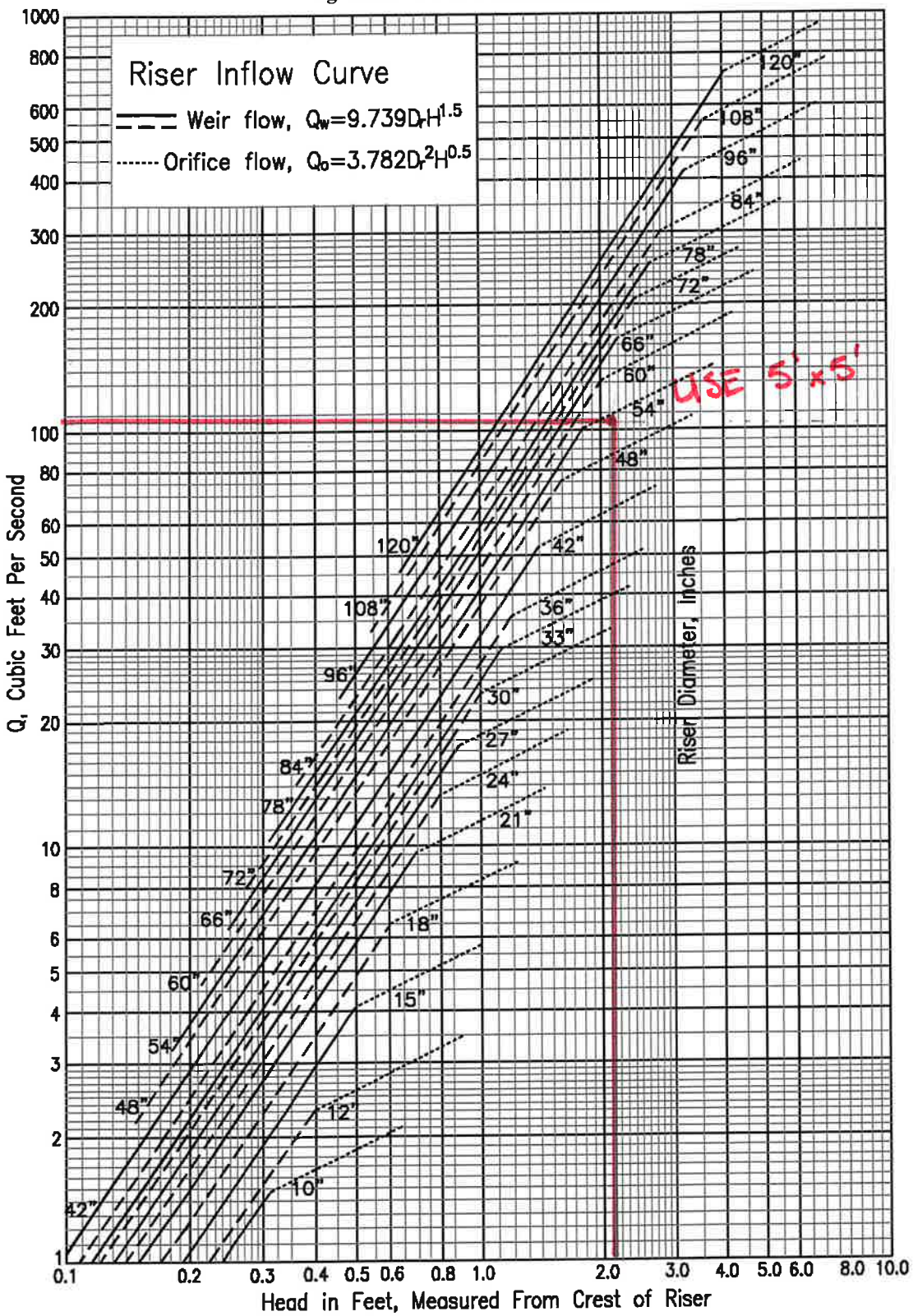
HEAD (H) MAXIMUM = MAXIMUM WATER SURFACE ELEVATION WITH 1' OF FREEBOARD MINUS THE ELEVATION AT THE CREST OF THE OVERFLOW STRUCTURE

= 228.37 - 226.25 = 2.12 FEET

BASED ON ABOVE HEAD, USE 5'x5' SQ. OVERFLOW STRUCTURE

(SEE CHART ON NEXT PAGE)

**Figure G.2: Riser Inflow Curves**



# CARRIER PIPE NO. 800

Q = 107 CFS WORST CASE

MAXIMUM HEADWATER = TOP OF LEEVE ELEVATION MINUS 1' FREEBOARD
= 230.00 - 1.00' = 229.00

HEAD (H) = MAXIMUM WATER ELEVATION ALLOWED MINUS THE CENTERLINE ELEVATION AT THE DOWNSTREAM END OF THE CARRIER PIPE
= 229.00 - 221.75 = 7.25

LENGTH (L) = 72

LENGTH FACTOR = 0.998 FOR LENGTHS OTHER THAN 70'

Q (AVAILABLE) = Q FROM TABLE TIMES LENGTH FACTOR
= 144.5 X 0.998 = 144.2

Q (AVAILABLE) MUST BE GREATER THAN Q WORST CASE

**USE Ex. 42 " DIAMETER RCP CARRIER PIPE**

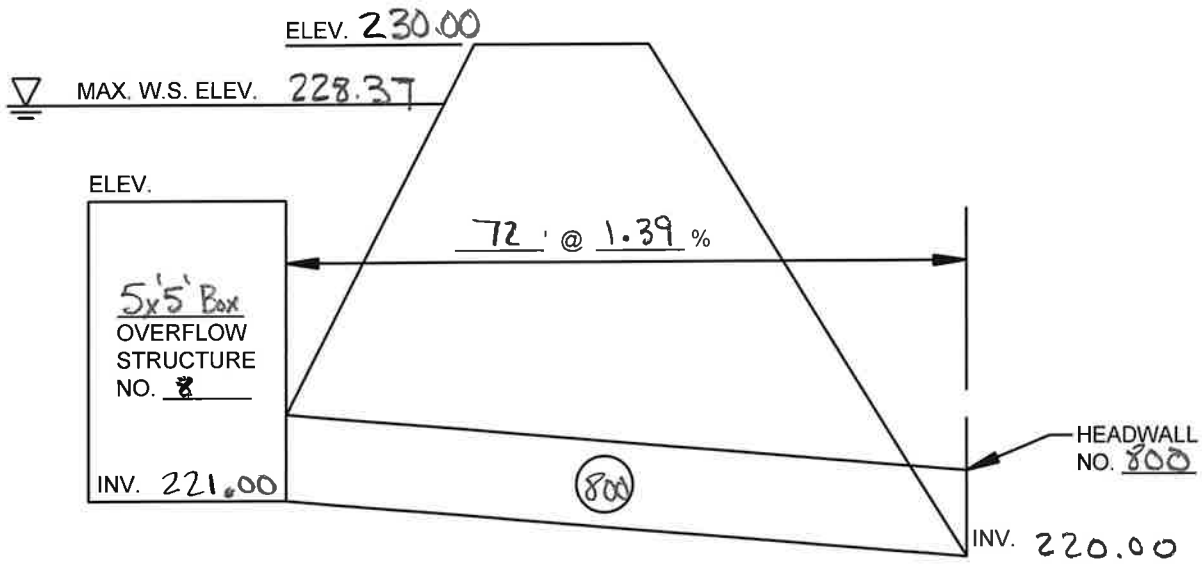


Table 6-25

PIPE FLOW CHART n = 0.025

FOR CORRUGATED METAL PIPE INLET $K_e = K_c + K_t = 1.0$ AND 70 FEET OF CORRUGATED METAL PIPE CONDUIT (full flow assumed)

Note correction factors for pipe lengths other than 70 feet

| | diameter of pipe in inches | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| H, in feet | 12" | 15" | 18" | 21" | 24" | 30" | 36" | 42" | 48" | 54" | 60" | 66" | 72" | 78" | 84" | 90" | 96" | 102" |
| 1 | 3.22 | 5.44 | 8.29 | 11.8 | 15.9 | 26.0 | 38.6 | 53.8 | 71.4 | 91.5 | 114 | 139 | 167 | 197 | 229 | 264 | 302 | 342 |
| 2 | 4.55 | 7.69 | 11.7 | 16.7 | 22.5 | 36.8 | 54.6 | 76.0 | 101 | 129 | 161 | 197 | 236 | 278 | 324 | 374 | 427 | 483 |
| 3 | 5.57 | 9.42 | 14.4 | 20.4 | 27.5 | 45.0 | 66.9 | 93.1 | 124 | 159 | 198 | 241 | 289 | 341 | 397 | 458 | 523 | 592 |
| 4 | 6.43 | 10.9 | 16.6 | 23.5 | 31.8 | 52.0 | 77.3 | 108 | 143 | 183 | 228 | 278 | 334 | 394 | 459 | 529 | 604 | 683 |
| 5 | 7.19 | 12.2 | 18.5 | 26.3 | 35.5 | 58.1 | 86.4 | 120 | 160 | 205 | 255 | 311 | 373 | 440 | 513 | 591 | 675 | 764 |
| 6 | 7.88 | 13.3 | 20.3 | 28.8 | 38.9 | 87.7 | 94.6 | 132 | 175 | 224 | 280 | 341 | 409 | 482 | 562 | 647 | 739 | 837 |
| 7 | 8.51 | 14.4 | 21.9 | 31.1 | 42.0 | 68.8 | 102 | 142 | 189 | 242 | 302 | 368 | 441 | 521 | 607 | 699 | 798 | 904 |
| 8 | 9.10 | 15.4 | 23.5 | 33.3 | 44.9 | 73.5 | 109 | 152 | 202 | 259 | 323 | 394 | 472 | 557 | 685 | 748 | 854 | 966 |
| 9 | 9.65 | 16.3 | 24.8 | 35.3 | 47.7 | 78 0 | 116 | 161 | 214 | 275 | 342 | 418 | 500 | 590 | 686 | 793 | 905 | 1025 |
| 10 | 10.2 | 17.2 | 26.2 | 37.2 | 50.2 | 82.2 | 122 | 170 | 226 | 289 | 361 | 440 | 527 | 622 | 725 | 836 | 954 | 1080 |
| 11 | 10.7 | 18.0 | 27.5 | 39.0 | 52.7 | 86.2 | 128 | 178 | 237 | 304 | 379 | 462 | 553 | 653 | 761 | 877 | 1001 | 1133 |
| 12 | 11.1 | 18.9 | 28.7 | 40.8 | 55.0 | 90.1 | 134 | 188 | 247 | 317 | 395 | 482 | 578 | 682 | 794 | 916 | 1045 | 1184 |
| 13 | 11.6 | 19.6 | 29.9 | 42.4 | 57.3 | 93.7 | 139 | 194 | 257 | 330 | 411 | 502 | 601 | 710 | 827 | 953 | 1088 | 1232 |
| 14 | 12.0 | 20.4 | 31.0 | 44.1 | 59.4 | 97.3 | 145 | 201 | 267 | 342 | 427 | 521 | 624 | 736 | 858 | 989 | 1129 | 1278 |
| 15 | 12.5 | 21.1 | 32.1 | 45.6 | 61.5 | 101 | 150 | 208 | 277 | 354 | 442 | 539 | 648 | 762 | 888 | 1024 | 1169 | 1323 |
| 16 | 12.9 | 21.8 | 33.2 | 47.1 | 63.5 | 104 | 155 | 215 | 286 | 366 | 457 | 557 | 667 | 787 | 917 | 1057 | 1207 | 1367 |
| 17 | 13.3 | 22.4 | 34.2 | 48.5 | 65.5 | 107 | 159 | 222 | 294 | 377 | 471 | 574 | 688 | 812 | 946 | 1090 | 1244 | 1409 |
| 18 | 13.7 | 23.1 | 35.2 | 49.9 | 67.4 | 110 | 164 | 228 | 303 | 388 | 484 | 591 | 708 | 835 | 973 | 1121 | 1280 | 1450 |
| 19 | 14.0 | 23.8 | 36.1 | 51.3 | 69.2 | 113 | 168 | 234 | 311 | 399 | 497 | 607 | 727 | 858 | 1000 | 1152 | 1315 | 1489 |
| 20 | 14.4 | 24.3 | 37.1 | 52.6 | 71.0 | 116 | 173 | 240 | 319 | 408 | 510 | 623 | 746 | 880 | 1026 | 1182 | 1350 | 1528 |
| 21 | 14.7 | 24.9 | 38.0 | 53.9 | 72.8 | 119 | 177 | 246 | 327 | 419 | 523 | 638 | 764 | 902 | 1051 | 1211 | 1383 | 1566 |
| 22 | 15.1 | 25.5 | 38.9 | 55.2 | 74.5 | 122 | 181 | 252 | 335 | 429 | 535 | 653 | 782 | 923 | 1078 | 1240 | 1415 | 1603 |
| 23 | 15.4 | 26.1 | 39.8 | 56.5 | 76.2 | 125 | 186 | 258 | 342 | 439 | 547 | 668 | 800 | 944 | 1100 | 1268 | 1447 | 1639 |
| 24 | 15.8 | 26.7 | 40.6 | 57.7 | 77.8 | 127 | 189 | 263 | 350 | 448 | 559 | 682 | 817 | 964 | 1123 | 1295 | 1478 | 1674 |
| 25 | 16.1 | 27.2 | 41.5 | 58.9 | 79.4 | 130 | 193 | 269 | 357 | 458 | 571 | 698 | 834 | 984 | 1147 | 1322 | 1509 | 1708 |
| 26 | 16.4 | 27.7 | 42.3 | 60.0 | 81.0 | 133 | 197 | 274 | 364 | 467 | 582 | 710 | 850 | 1004 | 1169 | 1348 | 1539 | 1742 |
| 27 | 16.7 | 28.3 | 43.1 | 61.2 | 82.5 | 135 | 201 | 279 | 371 | 476 | 593 | 723 | 867 | 1023 | 1192 | 1373 | 1568 | 1775 |
| 28 | 17.0 | 28.8 | 43.9 | 62.3 | 84.1 | 138 | 204 | 285 | 378 | 484 | 604 | 737 | 883 | 1041 | 1214 | 1399 | 1597 | 1808 |
| 29 | 17.3 | 29.3 | 44.7 | 63.4 | 85.5 | 140 | 208 | 290 | 384 | 493 | 615 | 750 | 898 | 1060 | 1235 | 1423 | 1625 | 1840 |
| 30 | 17.6 | 29.8 | 45.4 | 64.5 | 87.0 | 142 | 212 | 294 | 391 | 501 | 625 | 763 | 913 | 1078 | 1256 | 1448 | 1653 | 1871 |
| L,in feet | Correction Factors For Other Pipe Lengths | | | | | | | | | | | | | | | | | |
| 20 | 1.30 | 1.24 | 1.21 | 1.18 | 1.15 | 1.12 | 1.10 | 1.08 | 1.07 | 1.06 | 1.05 | 1.05 | 1.04 | 1.04 | 1.03 | 1.03 | 1.03 | 1.03 |
| 30 | 1.22 | 1.18 | 1.15 | 1.13 | 1.12 | 1.09 | 1.08 | 1.06 | 1.05 | 1.05 | 1.04 | 1.04 | 1.03 | 1.03 | 1.03 | 1.02 | 1.02 | 1.02 |
| 40 | 1.15 | 1.13 | 1.11 | 1.10 | 1.08 | 1.07 | 1.05 | 1.05 | 1.04 | 1.03 | 1.03 | 1.03 | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 |
| 50 | 1.09 | 1.08 | 1.07 | 1.06 | 1.05 | 1.04 | 1.04 | 1.03 | 1.03 | 1.02 | 1.02 | 1.02 | 1.02 | 1.01 | 1.01 | 1.01 | 1.01 | 1.01 |
| 60 | 1.04 | 1.04 | 1.03 | 1.03 | 1.03 | 1.02 | 1.02 | 1.02 | 1.01 | 1.01 | 1.01 | 1.01 | 1.01 | 1.01 | 1.01 | 1.01 | 1.01 | 1.01 |
| 70 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 80 | .96 | .97 | .97 | .97 | .98 | .98 | .98 | .98 | .99 | .99 | .99 | .99 | .99 | .99 | .99 | .99 | .99 | .99 |
| 90 | .93 | .94 | .94 | .95 | .95 | .96 | .97 | .97 | .98 | .98 | .98 | .98 | .98 | .98 | .99 | .99 | .99 | .99 |
| 100 | .90 | .91 | .92 | .93 | .93 | .95 | .95 | .96 | .97 | .97 | .97 | .98 | .98 | .98 | .98 | .98 | .98 | .99 |
| 120 | .84 | .86 | .87 | .89 | .90 | .91 | .93 | .94 | .94 | .95 | .96 | .96 | .96 | .97 | .97 | .97 | .97 | .98 |
| 140 | .80 | .82 | .83 | .85 | .86 | .88 | .90 | .91 | .92 | .93 | .94 | .94 | .95 | .95 | .96 | .96 | .96 | .97 |
| 160 | .76 | .78 | .80 | .82 | .83 | .86 | .88 | .89 | .90 | .91 | .92 | .93 | .94 | .94 | .95 | .95 | .95 | .96 |

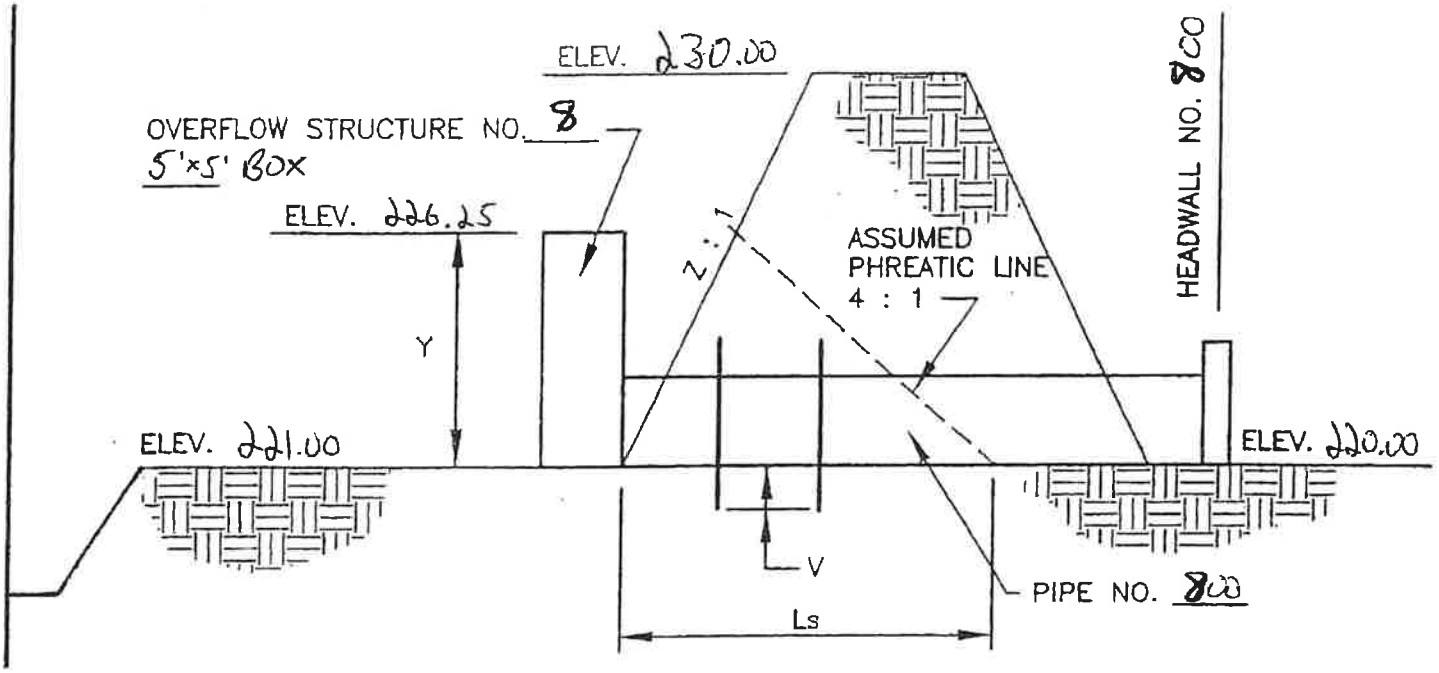
Source: USDA - SCS

**f. Anti-Seep Collar Design**

The seepage of water through the existing sediment pond dam along the carrier pipe could result in dam failure.

The proposed anti-seep collars have been designed to be located at intervals within the zone of saturation along the carrier pipe to increase the seepage length along the carrier pipe and thereby prevent piping or seepage along the carrier pipe.

# ANTI – SEEP COLLAR DESIGN




Ls = LENGTH IN SATURATION ZONE

Y = OVERFLOW STRUCTURE HEIGHT = 5.25 FEET

Z = INSIDE SLOPE OF LEVEE = 3

PIPE SLOPE = 1.39 % = 0.0139 FEET/FEET

$$Ls = Y ( Z + 4 ) \left( 1 + \frac{\text{PIPE SLOPE}}{0.25 - \text{PIPE SLOPE}} \right)$$

Ls = 38.91 FEET

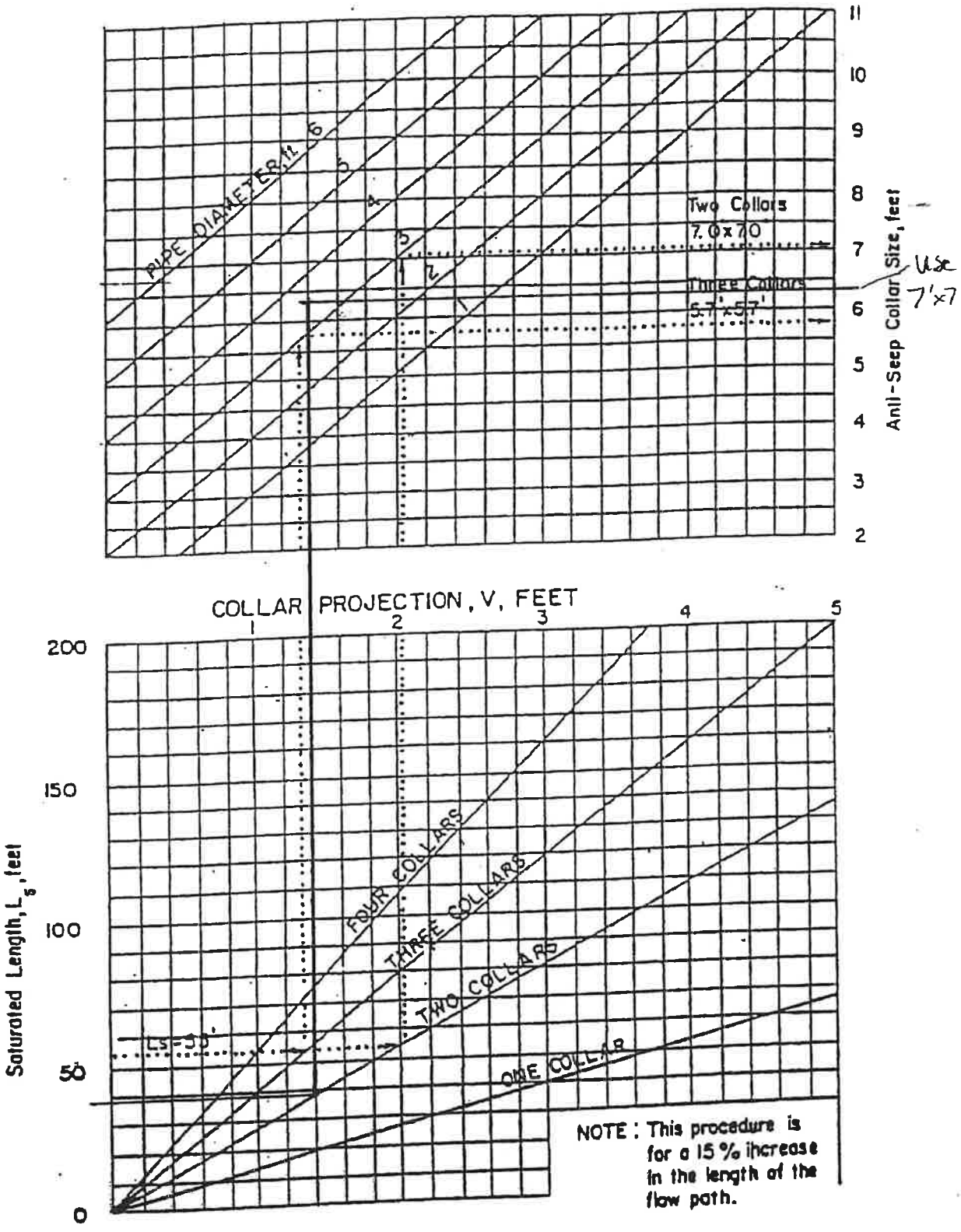
FROM ANTI – SEEP COLLAR DESIGN CHART ON THE NEXT PAGE :

V = COLLAR PROJECTION = 1.4 FEET

DIMENSIONS OF 12" THICK COLLAR = 2

NUMBER OF REQUIRED COLLARS = ex. 7'x7'

# ANTI-SEEP COLLAR DESIGN



**g. Overflow Structure Base Foundation Design**

The overflow structure and carrier pipe will be subject to a certain amount of buoyant force when the sediment pond is filled with storm water. In order to overcome this buoyant force and prevent the flotation of the overflow structure and carrier pipe, a concrete overflow structure base foundation and concrete carrier pipe encasement have been designed. The design calculations for the concrete overflow structure base foundation and carrier pipe encasement are included in this section.

**OVERFLOW STRUCTURE BASE FOUNDATION DESIGN**

A certain volume of concrete will be used to overcome the buoyancy of an empty overflow structure and carrier pipe that are below the assumed phreatic water surface. This volume is equal to:

Overflow Structure

= (L)(w)(h)(62.4) L = w = 5.0' inside = 6.00' outside

= (6.00)(6.00)(5.25)(62.4) h = height = 5.25'

= 11,794 #

Carrier Pipe = 3.1416($R_2^2$)(Ls)(62.4) Ls = length in saturation zone = 39'

= 3.1416(2.13)(2.13)(39)(62.4) $R_2$ = outside radius = 25.5" = 2.13'

= 34,686 # $r_2$ = inside radius = 21" = 1.75'

TOTAL WEIGHT

= 46,480 # x 1.5 (SAFETY FACTOR)

= 69,720 #

TOTAL REVISED VOLUME OF CONCRETE =
TOTAL WEIGHT / WEIGHT OF CONC. IN WATER

= 69,720/87.6 pcf (87.6 pcf = Wt. of conc. in submerged water)

= 796 C.F.

This volume of concrete will be made up from five areas.

1. Overflow Structures
2. Anti-Seep Collars
3. Carrier Pipe
4. Overflow Structure Base
5. Carrier Pipe Encasement

1. Overflow Structure = $(L_2 - l_2)h$

   $(6.0^2 – 5.0^2)(5.25)$ = 58 C.F.

   L = outside dimension of box = 6.00’

   l = inside dimension of box = 5.0’

   h = height of overflow structure = 5.25’

2. Anti-seep collars = area of square collar around carrier pipe x 12" thick x # of collars

   = [( 7.0' x 7.0' ) - $(3.1416)(R_2^2)$]

   x 1' x 2

   = 69 C.F.

   $R_2$ = outside radius of carrier pipe = 25.5" = 2.13’

   $r_2$ = inside radius of carrier pipe = 21" = 1.75’

3. Carrier Pipe

   = $3.1416 (R_2^2 - r_2^2)$ L = 181 C.F.

   L = length in saturation = 39’

4. Overflow Structure Base = Volume to handle riser bouyance x 1.2

   = (L)(w)h(62.4)(1.2)/weight of conc. in water

   L = w = 6.00’ outside

   h = height = 5.25’

   = (6.00’)(6.00’)(5.25)(62.4)(1.2)/87.6

   = 162 C.F.

   Use 9' x 9' x 2' = 162 C.F.

5. Carrier Pipe Encasement

   Must extend 5’ into dam. Distance from overflow structure to dam is equal to 13.0’. Therefore, encasement length will be 18.0’:

   $[(5.25 \times 6.25) – (3.1416)\ R_2^2] \times 18.0’$

   Carrier pipe encasement volume = 334 C.F.

**TOTAL REQUIRED VOLUME = 796C.F.**

Actual Total Volume

| | | |
|---|---|---|
| Overflow Structure | = | 58 C.F. |
| Anti-Seep Collars | = | 69 C.F. |
| Carrier Pipe | = | 181 C.F. |
| Overflow Structure Base | = | 162 C.F. |
| Carrier Pipe Encasement | = | 334 C.F. |
| **TOTAL** | **=** | **804 C.F. ⇒ Okay** |

# 10. PROPOSED SEDIMENT POND NO. 9

## a. Sediment Storage and Settling Efficiency Calculations

As required in the "Alabama Handbook for Erosion Control, Sediment Control and Stormwater Management on Construction Sites and Urban Area", the sediment storage volume of the pond shall be at least 67 cubic yards per acre for the disturbed area draining into the pond (67 cubic yards is equivalent to ½ inch of sediment per acre of drainage area). The peak inflow rate for the 25 year storm event has also been used to calculate the minimum pond surface area needed for adequate settling efficiency. These calculations for the sediment pond are included below.

Sediment Storage Calculation

Assume maximum sediment from 30 disturbed acres.

30 Acres x 67 c.y./acre = 2,010 c.y. = 54,270 c.f.

This sediment volume corresponds to a depth of 0.78' or Elev. 214.78.

Dewatering opening is set at Elev. 217.00. Therefore, ample sediment storage volume is available.

Settling Efficiency Calculations

- Use 25 year storm event, Q25 Flow = 160 cfs
- Minimum Surface Area = .01 acre / cfs x Q25 Flow
  = .01 acre / cfs x 160 cfs
  = 1.60 acres = 69,696 s.f.

- Top of Overflow Structure = Elev. 221.00
  Surface Area @ Elev. 221.00 = 101,117 s.f.

- Adequate surface area is available for settling

# Pond Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022 Thursday, 01 / 30 / 2025

## Pond No. 5 - Pond No. 9

### Pond Data

**Contours -**User-defined contour areas. Average end area method used for volume calculation. Begining Elevation = 214.00 ft

### Stage / Storage Table

| Stage (ft) | Elevation (ft) | Contour area (sqft) | Incr. Storage (cuft) | Total storage (cuft) |
|---|---|---|---|---|
| 0.00 | 214.00 | 64,457 | 0 | 0 |
| 2.00 | 216.00 | 74,712 | 139,169 | 139,169 |
| 3.00 | 217.00 | 79,961 | 77,337 | 216,506 |
| 4.00 | 218.00 | 85,209 | 82,585 | 299,091 |
| 6.00 | 220.00 | 95,742 | 180,951 | 480,042 |
| 8.00 | 222.00 | 106,491 | 202,233 | 682,275 |
| 10.00 | 224.00 | 117,479 | 223,970 | 906,245 |

### Culvert / Orifice Structures

| | [A] | [B] | [C] | [PrfRsr] |
|---|---|---|---|---|
| **Rise (in)** | = 42.00 | 6.00 | Inactive | Inactive |
| **Span (in)** | = 42.00 | 10.00 | 0.00 | 0.00 |
| **No. Barrels** | = 1 | 2 | 0 | 0 |
| **Invert El. (ft)** | = 217.00 | 217.10 | 0.00 | 0.00 |
| **Length (ft)** | = 93.00 | 0.00 | 0.00 | 0.00 |
| **Slope (%)** | = 9.68 | 0.00 | 0.00 | n/a |
| **N-Value** | = .013 | .013 | .013 | n/a |
| **Orifice Coeff.** | = 0.60 | 0.60 | 0.60 | 0.60 |
| **Multi-Stage** | = n/a | Yes | No | No |

### Weir Structures

| | [A] | [B] | [C] | [D] |
|---|---|---|---|---|
| **Crest Len (ft)** | = 20.00 | Inactive | Inactive | Inactive |
| **Crest El. (ft)** | = 221.00 | 0.00 | 0.00 | 0.00 |
| **Weir Coeff.** | = 3.33 | 3.33 | 3.33 | 3.33 |
| **Weir Type** | = 1 | --- | --- | --- |
| **Multi-Stage** | = Yes | No | No | No |
| **Exfil.(in/hr)** | = 0.000 (by Wet area) | | | |
| **TW Elev. (ft)** | = 0.00 | | | |

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).

### Stage / Storage / Discharge Table

| Stage ft | Storage cuft | Elevation ft | Clv A cfs | Clv B cfs | Clv C cfs | PrfRsr cfs | Wr A cfs | Wr B cfs | Wr C cfs | Wr D cfs | Exfil cfs | User cfs | Total cfs |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.00 | 0 | 214.00 | 0.00 | 0.00 | --- | --- | 0.00 | --- | --- | --- | --- | --- | 0.000 |
| 2.00 | 139,169 | 216.00 | 0.00 | 0.00 | --- | --- | 0.00 | --- | --- | --- | --- | --- | 0.000 |
| 3.00 | 216,506 | 217.00 | 0.00 | 0.00 | --- | --- | 0.00 | --- | --- | --- | --- | --- | 0.000 |
| 4.00 | 299,091 | 218.00 | 2.63 ic | 2.63 ic | --- | --- | 0.00 | --- | --- | --- | --- | --- | 2.633 |
| 6.00 | 480,042 | 220.00 | 6.01 ic | 5.87 ic | --- | --- | 0.00 | --- | --- | --- | --- | --- | 5.871 |
| 8.00 | 682,275 | 222.00 | 70.23 ic | 3.91 ic | --- | --- | 66.32 s | --- | --- | --- | --- | --- | 70.23 |
| 10.00 | 906,245 | 224.00 | 105.23 ic | 1.20 ic | --- | --- | 104.00 s | --- | --- | --- | --- | --- | 105.19 |

**b. Total Pond Dewatering at Top of Riser (Elev. 221.00)**

Retention time within the basin is an important factor in effective sediment retention. The overflow structure has been designed as specified below.

The 5' x 5' square concrete overflow structure has two 6"(h)x10"(w) dewatering openings at elevation 217.00.

The calculation below has been performed to confirm that the dewatering (retention) time within the pond is between 24 and 72 hours. This dewatering time will ensure the storm water is retained for an adequate length of time to allow the sediment to settle (minimum 24 hours) and is also discharged gradually in an acceptable length of time to allow storage for future storm events (maximum 72 hours).

The dewatering time is calculated as follows:

$$T = \frac{A_s \times (2h)^{1/2}}{A_O \times C_d \times (20{,}428)}$$

$A_O$ = Surface Area of Dewatering Holes ($ft^2$)

$A_s$ = Surface Area Corresponding to top of riser elevation ($ft^2$)

h = Head of water above dewatering hole (ft)

$C_d$ = Coefficient of contraction for an orifice (use 0.6)

T = Time to dewater

T = 24 to 72 hours

$A_O$ = 0.83 s.f. @ Elev. 217.00 (2 - 6" x 10" rectangular openings)

$A_s$ = 101,117 s.f. @ Elev. 221.00

h = 221.00 – 217.00 = 4.0'

$$T = \frac{101{,}117\ (2 \times 4.0)^{1/2}}{(0.83)\ (0.6)\ (20{,}428)} = 28.1 \text{ hours}$$

**(Okay between 24 - 72 hours)**

**c. Reservoir Routing**

Reservoir routing is determined by using the HydraFlow Hydrographs Extension for AutoCad Civil 3D 2022 Computer Program.

Peak inflow rates (Q) are determined using the SCS Method and HydraFlow Hydrographs Extension for AutoCad Civil 3D 2022 Computer Program. Peak inflow rates are calculated for the 25 year and 100 year storm events and are summarized below.

Q25 = 160 cfs

Q100 = 227 cfs

The bottom of the pond has been set at 214.00. Dewatering of the pond is accomplished by two 6" x 10" rectangular openings at elevation 217.00.

For routing calculations, a 5' x 5' rectangular riser with two 6" x 10" rectangular openings at elevation 217.00 was used. The top of the riser is at an elevation of 221.00. The bottom of the pond is elev. 214.00. The invert of the carrier pipe is elev. 217.00. The top of the levee around the sediment pond is at an elevation of 224.00.

The maximum height of sediment is elevation 214.78 which is below the elevation of the first dewatering opening (Elev. 217.00). For routing calculations, the starting water surface elevation was set at 217.00, assuming the remainder of the pond bottom is filled below the dewatering orifice invert elevation.

Based on the above information the reservoir routing calculations are performed and summarized below.

| STORM YEAR | PEAK INFLOW CFS | PEAK OUTFLOW CFS | PEAK ELEV. FEET |
|---|---|---|---|
| 25 | 160 | 7 | 220.81 |
| 100 | 227 | 33 | 221.54 |

Based on these routing calculations, the riser is large enough and the pond has sufficient storage volume to retain the sediment from 30 disturbed acres plus the 25 year storm event from the entire drainage area below the crest of the riser (elev. 221.00).

# Pond Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022 Thursday, 01 / 30 / 2025

## Pond No. 6 - Pond No. 9 perm pool

### Pond Data

**Contours -**User-defined contour areas. Average end area method used for volume calculation. Begining Elevation = 217.00 ft

### Stage / Storage Table

| Stage (ft) | Elevation (ft) | Contour area (sqft) | Incr. Storage (cuft) | Total storage (cuft) |
|---|---|---|---|---|
| 0.00 | 217.00 | 79,961 | 0 | 0 |
| 1.00 | 218.00 | 85,209 | 82,585 | 82,585 |
| 3.00 | 220.00 | 95,742 | 180,951 | 263,536 |
| 5.00 | 222.00 | 106,491 | 202,233 | 465,769 |
| 7.00 | 224.00 | 117,479 | 223,970 | 689,739 |

### Culvert / Orifice Structures

| | [A] | [B] | [C] | [PrfRsr] |
|---|---|---|---|---|
| **Rise (in)** | = 42.00 | 6.00 | Inactive | Inactive |
| **Span (in)** | = 42.00 | 10.00 | 0.00 | 0.00 |
| **No. Barrels** | = 1 | 2 | 0 | 0 |
| **Invert El. (ft)** | = 217.00 | 217.10 | 0.00 | 0.00 |
| **Length (ft)** | = 93.00 | 0.00 | 0.00 | 0.00 |
| **Slope (%)** | = 9.68 | 0.00 | 0.00 | n/a |
| **N-Value** | = .013 | .013 | .013 | n/a |
| **Orifice Coeff.** | = 0.60 | 0.60 | 0.60 | 0.60 |
| **Multi-Stage** | = n/a | Yes | No | No |

### Weir Structures

| | [A] | [B] | [C] | [D] |
|---|---|---|---|---|
| **Crest Len (ft)** | = 20.00 | Inactive | Inactive | Inactive |
| **Crest El. (ft)** | = 221.00 | 0.00 | 0.00 | 0.00 |
| **Weir Coeff.** | = 3.33 | 3.33 | 3.33 | 3.33 |
| **Weir Type** | = 1 | --- | --- | --- |
| **Multi-Stage** | = Yes | No | No | No |

**Exfil.(in/hr)** = 0.000 (by Wet area)

**TW Elev. (ft)** = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).

### Stage / Storage / Discharge Table

| Stage ft | Storage cuft | Elevation ft | Clv A cfs | Clv B cfs | Clv C cfs | PrfRsr cfs | Wr A cfs | Wr B cfs | Wr C cfs | Wr D cfs | Exfil cfs | User cfs | Total cfs |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.00 | 0 | 217.00 | 0.00 | 0.00 | --- | --- | 0.00 | --- | --- | --- | --- | --- | 0.000 |
| 1.00 | 82,585 | 218.00 | 2.63 ic | 2.63 ic | --- | --- | 0.00 | --- | --- | --- | --- | --- | 2.633 |
| 3.00 | 263,536 | 220.00 | 6.01 ic | 5.87 ic | --- | --- | 0.00 | --- | --- | --- | --- | --- | 5.871 |
| 5.00 | 465,769 | 222.00 | 70.23 ic | 3.91 ic | --- | --- | 66.32 s | --- | --- | --- | --- | --- | 70.23 |
| 7.00 | 689,739 | 224.00 | 105.23 ic | 1.20 ic | --- | --- | 104.00 s | --- | --- | --- | --- | --- | 105.19 |

# Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022

| Hyd. No. | Hydrograph type (origin) | Peak flow (cfs) | Time interval (min) | Time to Peak (min) | Hyd. volume (cuft) | Inflow hyd(s) | Maximum elevation (ft) | Total strge used (cuft) | Hydrograph Description |
|---|---|---|---|---|---|---|---|---|---|
| 35 | SCS Runoff | 10.19 | 1 | 725 | 31,755 | ------ | ------ | ------ | Area to DD49 |
| 36 | Combine | 21.63 | 1 | 726 | 84,444 | 34, 35 | ------ | ------ | DD49 |
| 37 | SCS Runoff | 11.83 | 1 | 725 | 36,871 | ------ | ------ | ------ | Area to DD50 |
| 38 | Combine | 33.09 | 1 | 725 | 121,315 | 36, 37 | ------ | ------ | DD50 |
| 39 | SCS Runoff | 10.81 | 1 | 725 | 33,695 | ------ | ------ | ------ | Area to DD51 |
| 40 | Combine | 43.91 | 1 | 725 | 155,011 | 38, 39 | ------ | ------ | DD51 |
| 41 | SCS Runoff | 10.76 | 1 | 725 | 33,519 | ------ | ------ | ------ | DD52 |
| 42 | SCS Runoff | 10.47 | 1 | 725 | 32,637 | ------ | ------ | ------ | Area to DD53 |
| 43 | Combine | 21.23 | 1 | 725 | 66,156 | 41, 42 | ------ | ------ | DD53 |
| 44 | SCS Runoff | 10.36 | 1 | 725 | 32,284 | ------ | ------ | ------ | Area to DD54 |
| 45 | Combine | 31.59 | 1 | 725 | 98,440 | 43, 44 | ------ | ------ | DD54 |
| 46 | SCS Runoff | 10.30 | 1 | 725 | 32,108 | ------ | ------ | ------ | Area to DD55 |
| 47 | Combine | 41.90 | 1 | 725 | 130,548 | 45, 46 | ------ | ------ | DD55 |
| 48 | Combine | 85.80 | 1 | 725 | 285,558 | 40, 47 | ------ | ------ | DD51 & DD55 |
| 49 | Combine | 90.54 | 1 | 725 | 304,364 | 33, 48 | ------ | ------ | Ditch No. 11, DD51, & DD55 |
| 50 | SCS Runoff | 5.068 | 1 | 729 | 19,197 | ------ | ------ | ------ | Area to Ditch No. 10 |
| 51 | Combine | 95.00 | 1 | 725 | 323,561 | 49, 50 | ------ | ------ | Ditch No. 10 |
| 52 | SCS Runoff | 7.159 | 1 | 723 | 20,871 | ------ | ------ | ------ | DD43 |
| 53 | SCS Runoff | 6.983 | 1 | 723 | 20,357 | ------ | ------ | ------ | Area to DD44 |
| 54 | Combine | 14.14 | 1 | 723 | 41,228 | 52, 53 | ------ | ------ | DD44 |
| 55 | SCS Runoff | 9.347 | 1 | 725 | 30,356 | ------ | ------ | ------ | Area to DD45 |
| 56 | Combine | 22.97 | 1 | 724 | 71,584 | 54, 55 | ------ | ------ | DD45 |
| 57 | SCS Runoff | 9.228 | 1 | 725 | 28,756 | ------ | ------ | ------ | Area to DD46 |
| 58 | Combine | 32.19 | 1 | 724 | 100,340 | 56, 57 | ------ | ------ | DD46 |
| 59 | SCS Runoff | 10.22 | 1 | 725 | 33,192 | ------ | ------ | ------ | Area to DD47 |
| 60 | Combine | 42.07 | 1 | 724 | 133,532 | 58, 59 | ------ | ------ | DD47 |
| 61 | SCS Runoff | 4.673 | 1 | 725 | 15,178 | ------ | ------ | ------ | Ditch No. 9 |
| 62 | SCS Runoff | 20.82 | 1 | 722 | 57,095 | ------ | ------ | ------ | Area to Pond No. 9 |
| 63 | Combine | 141.61 | 1 | 725 | 472,271 | 51, 60, 61, | ------ | ------ | Pipe No. 901 |
| 64 | Combine | 158.15 | 1 | 724 | 529,365 | 62, 63 | ------ | ------ | Pond No. 9 Total Inflow |
| 65 | Reservoir | 6.778 | 1 | 924 | 505,432 | 64 | 220.78 | 342,662 | Pond No. 9 perm pool |
| 66 | Reservoir | 77.09 | 1 | 736 | 529,361 | 64 | 222.20 | 126,418 | Pond No. 9 riser |

# Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022

| Hyd. No. | Hydrograph type (origin) | Peak flow (cfs) | Time interval (min) | Time to Peak (min) | Hyd. volume (cuft) | Inflow hyd(s) | Maximum elevation (ft) | Total strge used (cuft) | Hydrograph Description |
|---|---|---|---|---|---|---|---|---|---|
| 35 | SCS Runoff | 14.44 | 1 | 724 | 45,593 | ------ | ------ | ------ | Area to DD49 |
| 36 | Combine | 30.75 | 1 | 726 | 121,244 | 34, 35 | ------ | ------ | DD49 |
| 37 | SCS Runoff | 16.77 | 1 | 724 | 52,939 | ------ | ------ | ------ | Area to DD50 |
| 38 | Combine | 47.02 | 1 | 725 | 174,182 | 36, 37 | ------ | ------ | DD50 |
| 39 | SCS Runoff | 15.33 | 1 | 724 | 48,379 | ------ | ------ | ------ | Area to DD51 |
| 40 | Combine | 62.32 | 1 | 725 | 222,562 | 38, 39 | ------ | ------ | DD51 |
| 41 | SCS Runoff | 15.25 | 1 | 724 | 48,126 | ------ | ------ | ------ | DD52 |
| 42 | SCS Runoff | 14.85 | 1 | 724 | 46,860 | ------ | ------ | ------ | Area to DD53 |
| 43 | Combine | 30.09 | 1 | 724 | 94,986 | 41, 42 | ------ | ------ | DD53 |
| 44 | SCS Runoff | 14.68 | 1 | 724 | 46,353 | ------ | ------ | ------ | Area to DD54 |
| 45 | Combine | 44.78 | 1 | 724 | 141,339 | 43, 44 | ------ | ------ | DD54 |
| 46 | SCS Runoff | 14.60 | 1 | 724 | 46,100 | ------ | ------ | ------ | Area to DD55 |
| 47 | Combine | 59.38 | 1 | 724 | 187,438 | 45, 46 | ------ | ------ | DD55 |
| 48 | Combine | 121.59 | 1 | 725 | 410,000 | 40, 47 | ------ | ------ | DD51 & DD55 |
| 49 | Combine | 128.35 | 1 | 725 | 437,001 | 33, 48 | ------ | ------ | Ditch No. 11, DD51, & DD55 |
| 50 | SCS Runoff | 7.183 | 1 | 729 | 27,563 | ------ | ------ | ------ | Area to Ditch No. 10 |
| 51 | Combine | 134.72 | 1 | 725 | 464,563 | 49, 50 | ------ | ------ | Ditch No. 10 |
| 52 | SCS Runoff | 10.15 | 1 | 723 | 29,966 | ------ | ------ | ------ | DD43 |
| 53 | SCS Runoff | 9.896 | 1 | 723 | 29,229 | ------ | ------ | ------ | Area to DD44 |
| 54 | Combine | 20.04 | 1 | 723 | 59,194 | 52, 53 | ------ | ------ | DD44 |
| 55 | SCS Runoff | 13.26 | 1 | 725 | 43,585 | ------ | ------ | ------ | Area to DD45 |
| 56 | Combine | 32.54 | 1 | 724 | 102,779 | 54, 55 | ------ | ------ | DD45 |
| 57 | SCS Runoff | 13.08 | 1 | 724 | 41,287 | ------ | ------ | ------ | Area to DD46 |
| 58 | Combine | 45.62 | 1 | 724 | 144,066 | 56, 57 | ------ | ------ | DD46 |
| 59 | SCS Runoff | 14.49 | 1 | 725 | 47,656 | ------ | ------ | ------ | Area to DD47 |
| 60 | Combine | 59.66 | 1 | 724 | 191,723 | 58, 59 | ------ | ------ | DD47 |
| 61 | SCS Runoff | 6.628 | 1 | 725 | 21,793 | ------ | ------ | ------ | Ditch No. 9 |
| 62 | SCS Runoff | 29.47 | 1 | 722 | 81,975 | ------ | ------ | ------ | Area to Pond No. 9 |
| 63 | Combine | 200.69 | 1 | 725 | 678,078 | 51, 60, 61, | ------ | ------ | Pipe No. 901 |
| 64 | Combine | 224.42 | 1 | 724 | 760,054 | 62, 63 | ------ | ------ | Pond No. 9 Total Inflow |
| 65 | Reservoir | 31.91 | 1 | 758 | 732,590 | 64 | 221.53 | 417,874 | Pond No. 9 perm pool |
| 66 | Reservoir | 89.40 | 1 | 740 | 760,050 | 64 | 222.77 | 189,633 | Pond No. 9 riser |

**d. Emergency Spillway**

Worst Case

Assume the dewatering opening in the overflow structure is not operating and the starting water surface elevation is at the top of the riser (221.00) at the start of a 100 year storm event.

| | | |
|---|---|---|
| Top of Pond | = | 224.00 |
| Less Required Freeboard | = | 1.00 |
| Maximum Allowable Water Surface Elevation in Emergency Spillway | = | 223.00 |

Re-route the 100 year storm event through the 5’ x 5’ square overflow structure and 42” diameter carrier pipe.

From Hydrograph Summary Report, Line 60, the maximum flow out of the pond will be 90 cfs. The maximum water surface elevation is 222.78 which is less than the maximum allowable water surface elevation of 223.00.

Therefore, the overflow structure and carrier pipe will safely pass the 100 year storm event with a starting water surface elevation at 221.00.

# Pond Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022 Thursday, 01 / 30 / 2025

## Pond No. 7 - Pond No. 9 riser

### Pond Data

**Contours -**User-defined contour areas. Average end area method used for volume calculation. Begining Elevation = 221.00 ft

### Stage / Storage Table

| Stage (ft) | Elevation (ft) | Contour area (sqft) | Incr. Storage (cuft) | Total storage (cuft) |
|---|---|---|---|---|
| 0.00 | 221.00 | 101,117 | 0 | 0 |
| 1.00 | 222.00 | 106,491 | 103,804 | 103,804 |
| 3.00 | 224.00 | 117,479 | 223,970 | 327,774 |

### Culvert / Orifice Structures

| | [A] | [B] | [C] | [PrfRsr] |
|---|---|---|---|---|
| **Rise (in)** | = 42.00 | Inactive | Inactive | Inactive |
| **Span (in)** | = 42.00 | 0.00 | 0.00 | 0.00 |
| **No. Barrels** | = 1 | 1 | 0 | 0 |
| **Invert El. (ft)** | = 217.00 | 0.00 | 0.00 | 0.00 |
| **Length (ft)** | = 93.00 | 0.00 | 0.00 | 0.00 |
| **Slope (%)** | = 9.68 | 0.00 | 0.00 | n/a |
| **N-Value** | = .013 | .013 | .013 | n/a |
| **Orifice Coeff.** | = 0.60 | 0.60 | 0.60 | 0.60 |
| **Multi-Stage** | = n/a | No | No | No |

### Weir Structures

| | [A] | [B] | [C] | [D] |
|---|---|---|---|---|
| **Crest Len (ft)** | = 20.00 | Inactive | Inactive | Inactive |
| **Crest El. (ft)** | = 221.00 | 0.00 | 0.00 | 0.00 |
| **Weir Coeff.** | = 3.33 | 3.33 | 3.33 | 3.33 |
| **Weir Type** | = 1 | --- | --- | --- |
| **Multi-Stage** | = Yes | No | No | No |

**Exfil.(in/hr)** = 0.000 (by Wet area)

**TW Elev. (ft)** = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).

### Stage / Storage / Discharge Table

| Stage ft | Storage cuft | Elevation ft | Clv A cfs | Clv B cfs | Clv C cfs | PrfRsr cfs | Wr A cfs | Wr B cfs | Wr C cfs | Wr D cfs | Exfil cfs | User cfs | Total cfs |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.00 | 0 | 221.00 | 0.00 | --- | --- | --- | 0.00 | --- | --- | --- | --- | --- | 0.000 |
| 1.00 | 103,804 | 222.00 | 69.48 ic | --- | --- | --- | 66.60 | --- | --- | --- | --- | --- | 66.60 |
| 3.00 | 327,774 | 224.00 | 105.20 ic | --- | --- | --- | 105.17 s | --- | --- | --- | --- | --- | 105.17 |

# Hydrograph Summary Report

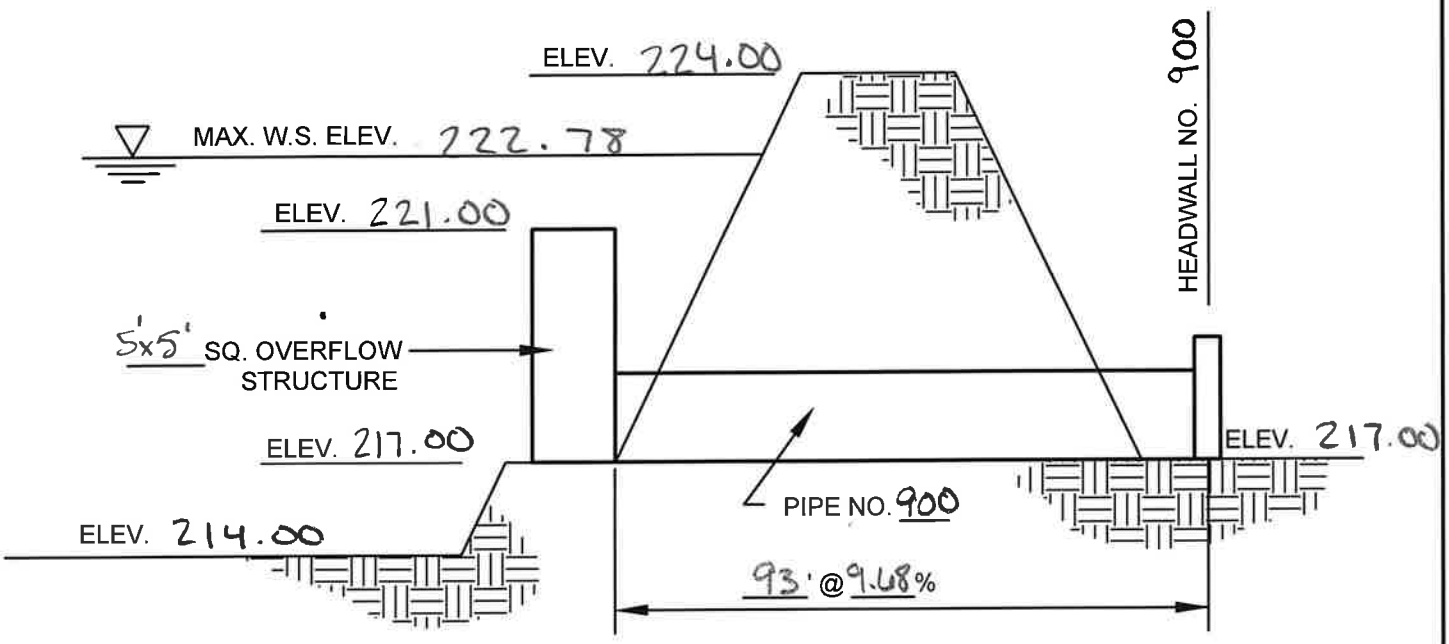
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022

| Hyd. No. | Hydrograph type (origin) | Peak flow (cfs) | Time interval (min) | Time to Peak (min) | Hyd. volume (cuft) | Inflow hyd(s) | Maximum elevation (ft) | Total strge used (cuft) | Hydrograph Description |
|---|---|---|---|---|---|---|---|---|---|
| 35 | SCS Runoff | 14.44 | 1 | 724 | 45,593 | ------ | ------ | ------ | Area to DD49 |
| 36 | Combine | 30.75 | 1 | 726 | 121,244 | 34, 35 | ------ | ------ | DD49 |
| 37 | SCS Runoff | 16.77 | 1 | 724 | 52,939 | ------ | ------ | ------ | Area to DD50 |
| 38 | Combine | 47.02 | 1 | 725 | 174,182 | 36, 37 | ------ | ------ | DD50 |
| 39 | SCS Runoff | 15.33 | 1 | 724 | 48,379 | ------ | ------ | ------ | Area to DD51 |
| 40 | Combine | 62.32 | 1 | 725 | 222,562 | 38, 39 | ------ | ------ | DD51 |
| 41 | SCS Runoff | 15.25 | 1 | 724 | 48,126 | ------ | ------ | ------ | DD52 |
| 42 | SCS Runoff | 14.85 | 1 | 724 | 46,860 | ------ | ------ | ------ | Area to DD53 |
| 43 | Combine | 30.09 | 1 | 724 | 94,986 | 41, 42 | ------ | ------ | DD53 |
| 44 | SCS Runoff | 14.68 | 1 | 724 | 46,353 | ------ | ------ | ------ | Area to DD54 |
| 45 | Combine | 44.78 | 1 | 724 | 141,339 | 43, 44 | ------ | ------ | DD54 |
| 46 | SCS Runoff | 14.60 | 1 | 724 | 46,100 | ------ | ------ | ------ | Area to DD55 |
| 47 | Combine | 59.38 | 1 | 724 | 187,438 | 45, 46 | ------ | ------ | DD55 |
| 48 | Combine | 121.59 | 1 | 725 | 410,000 | 40, 47 | ------ | ------ | DD51 & DD55 |
| 49 | Combine | 128.35 | 1 | 725 | 437,001 | 33, 48 | ------ | ------ | Ditch No. 11, DD51, & DD55 |
| 50 | SCS Runoff | 7.183 | 1 | 729 | 27,563 | ------ | ------ | ------ | Area to Ditch No. 10 |
| 51 | Combine | 134.72 | 1 | 725 | 464,563 | 49, 50 | ------ | ------ | Ditch No. 10 |
| 52 | SCS Runoff | 10.15 | 1 | 723 | 29,966 | ------ | ------ | ------ | DD43 |
| 53 | SCS Runoff | 9.896 | 1 | 723 | 29,229 | ------ | ------ | ------ | Area to DD44 |
| 54 | Combine | 20.04 | 1 | 723 | 59,194 | 52, 53 | ------ | ------ | DD44 |
| 55 | SCS Runoff | 13.26 | 1 | 725 | 43,585 | ------ | ------ | ------ | Area to DD45 |
| 56 | Combine | 32.54 | 1 | 724 | 102,779 | 54, 55 | ------ | ------ | DD45 |
| 57 | SCS Runoff | 13.08 | 1 | 724 | 41,287 | ------ | ------ | ------ | Area to DD46 |
| 58 | Combine | 45.62 | 1 | 724 | 144,066 | 56, 57 | ------ | ------ | DD46 |
| 59 | SCS Runoff | 14.49 | 1 | 725 | 47,656 | ------ | ------ | ------ | Area to DD47 |
| 60 | Combine | 59.66 | 1 | 724 | 191,723 | 58, 59 | ------ | ------ | DD47 |
| 61 | SCS Runoff | 6.628 | 1 | 725 | 21,793 | ------ | ------ | ------ | Ditch No. 9 |
| 62 | SCS Runoff | 29.47 | 1 | 722 | 81,975 | ------ | ------ | ------ | Area to Pond No. 9 |
| 63 | Combine | 200.69 | 1 | 725 | 678,078 | 51, 60, 61, | ------ | ------ | Pipe No. 901 |
| 64 | Combine | 224.42 | 1 | 724 | 760,054 | 62, 63 | ------ | ------ | Pond No. 9 Total Inflow |
| 65 | Reservoir | 31.91 | 1 | 758 | 732,590 | 64 | 221.53 | 417,874 | Pond No. 9 perm pool |
| 66 | Reservoir | 89.40 | 1 | 740 | 760,050 | 64 | 222.77 | 189,633 | Pond No. 9 riser |

**e. Overflow Structure and Carrier Pipe Design**

In order to confirm that the overflow structure, carrier pipe and emergency spillway pipe have been designed adequately to pass the maximum flow as modeled in the HydraFlow Hydrographs Extension for AutoCad Civil 3D 2022 Computer Program, the following design calculations have been included.

# OVERFLOW STRUCTURE NO. 9




## DESIGN OF OVERFLOW STRUCTURE AS EMERGENCY SPILLWAY

FLOW (Q) WORST CASE = 100 YEAR STORM EVENT OCCURS WHEN WATER SURFACE ELEVATION AT TOP OF OVERFLOW STRUCTURE AND ALL DEWATERING HOLES ARE PLUGGED

FLOW (Q) MAXIMUM = 90 CFS

HEAD (H) MAXIMUM = MAXIMUM WATER SURFACE ELEVATION WITH 1' OF FREEBOARD MINUS THE ELEVATION AT THE CREST OF THE OVERFLOW STRUCTURE

= 222.78 - 221.00 = 1.78 FEET

BASED ON ABOVE HEAD, USE 5'x5' SQ. OVERFLOW STRUCTURE

(SEE CHART ON NEXT PAGE)

## WEIR FLOW (Q) OVER RISER CREST FOR CIRCULAR RISERS WITH TRASH RACK

$$Q = CLh^{3/2}$$

$$Q = 3.1 \times (\pi) \times (D/12) \times h^{3/2}$$

Table 6-22.2

| HEAD-h In feet | Riser Diameter ($D_r$) In Inches | | | | | | | | HEAD-h In feet |
|---|---|---|---|---|---|---|---|---|---|
| | 12 | 18 | 24 | 30 | 36 | 48 | 54 | 60 | |
| | Flow In Cubic Feet Per Second | | | | | | | | |
| 0.1 | 0.3 | 0.5 | 0.6 | 0.8 | 0.9 | 1.2 | 1.4 | 1.5 | 0.1 |
| 0.2 | 0.9 | 1.3 | 1.7 | 2.2 | 2.6 | 3.5 | 3.9 | 4.4 | 0.2 |
| 0.3 | 1.6 | 2.4 | 3.2 | 4.0 | 4.8 | 6.4 | 7.2 | 8.0 | 0.3 |
| 0.4 | 2.5 | 3.7 | 4.9 | 6.2 | 7.4 | 9.9 | 11.1 | 12.3 | 0.4 |
| 0.6 | 4.5 | 6.8 | 9.1 | 11.3 | 13.6 | 18.1 | 20.4 | 22.6 | 0.6 |
| 0.8 | | 10.5 | 13.9 | 17.4 | 20.9 | 27.9 | 31.4 | 34.8 | 0.8 |
| 1.0 | | | 19.5 | 24.3 | 29.2 | 39.0 | 43.8 | 48.7 | 1.0 |
| 1.2 | | | 25.6 | 32.0 | 38.4 | 51.2 | 57.6 | 64.0 | 1.2 |
| 1.4 | | | | 40.3 | 48.4 | 64.5 | 72.6 | 80.7 | 1.4 |
| 1.6 | | | | 49.3 | 59.1 | 78.8 | 88.7 | 98.6 | 1.6 |
| 1.8 | | | | | 70.6 | 94.1 | 105.8 | 117.6 | 1.8 |
| 2.0 | | | | | 82.6 | 110.2 | 124.0 | 137.7 | 2.0 |
| 2.2 | | | | | | 127.1 | 143.0 | 158.9 | 2.2 |
| 2.4 | | | | | | | 162.9 | 181.0 | 2.4 |
| 2.6 | | | | | | | 183.7 | 204.1 | 2.6 |
| 2.8 | | | | | | | | 228.1 | 2.8 |
| 3.0 | | | | | | | | 253.0 | 3.0 |

### Pipe, Riser, and Trash Rack Proportions

Eq. 6-10 $D_r \geq (1.50)\ (D_{ps})$

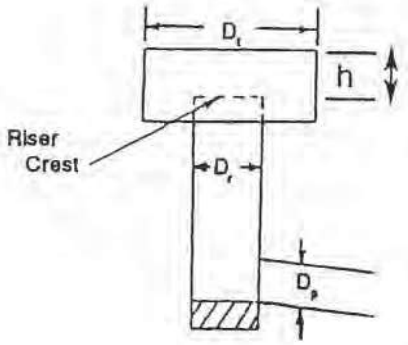
where $D_r$ = diameter of riser

$D_{ps}$ = diameter of principal spillway

Eq. 6-11 $D_t \geq (1.4)\ (D_r)$

where $D_t$ = diameter of trash rack

$D_r$ = diameter of riser




EXAMPLE: The peak runoff for a 2-year, 24-hour rain is 32 cfs. Select a pipe size for a head of 12 feet and length of 100 feet. From Table 6-15.1, 38.2 x 0.89 = 34 cfs discharge for a 24-inch diameter pipe.

Using Equation 6-10 $D_r \geq (1.5)\ (D_p)$

$D_r \geq (1.5)\ (24) \geq$ 36 inch diameter riser

Using Equation 6-11 $D_t \geq (1.4)\ (D_r)$

$D_t \geq (1.4)\ (36) \geq$ 50 inch diameter (Use 54 inch)

Determine h - From Table 6-15.2

$Q$ = 34 cfs $D_r$ = 36" h = 1.2'

NOTE: h = minimum distance between the crest of the riser and the crest of the emergency spillway.

# CARRIER PIPE NO. 900

Q = 90 CFS WORST CASE

MAXIMUM HEADWATER = TOP OF LEEVE ELEVATION MINUS 1' FREEBOARD
= 224.00 - 1.00 = 223.00

HEAD (H) = MAXIMUM WATER ELEVATION ALLOWED MINUS THE CENTERLINE ELEVATION AT THE DOWNSTREAM END OF THE CARRIER PIPE
= 223.00 - 209.75 = 13.25

LENGTH (L) = 93'

LENGTH FACTOR = 0.97 FOR LENGTHS OTHER THAN 70'

Q (AVAILABLE) = Q FROM TABLE TIMES LENGTH FACTOR
= 196 X 0.97 = 190

Q (AVAILABLE) MUST BE GREATER THAN Q WORST CASE

**USE 42 " DIAMETER RCP CARRIER PIPE**

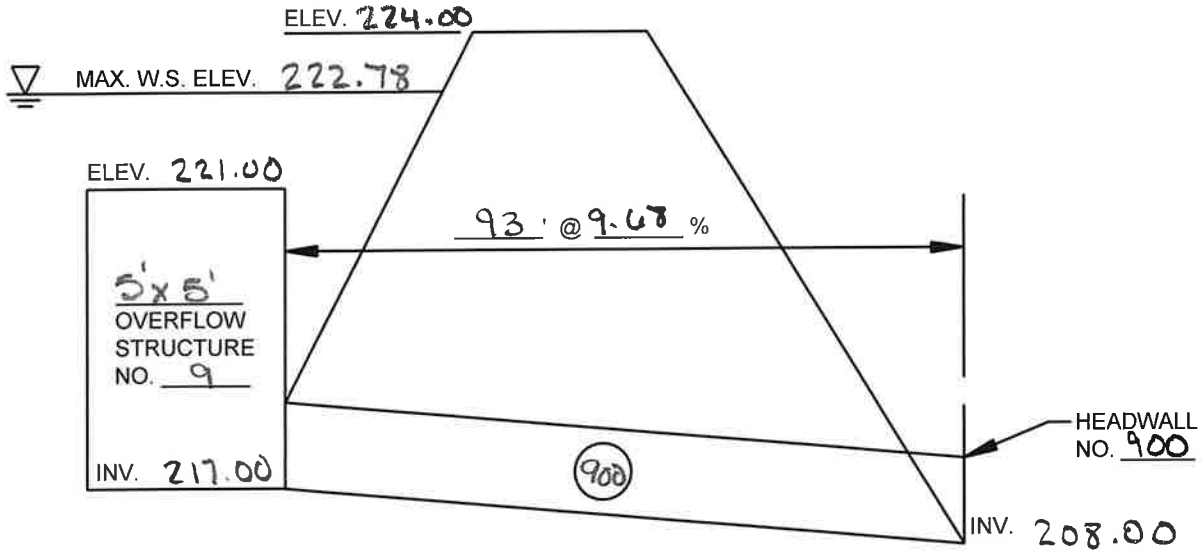


Table 6-25

PIPE FLOW CHART n = 0.025

FOR CORRUGATED METAL PIPE INLET $K_e = K_o + K_i = 1.0$ AND 70 FEET OF CORRUGATED METAL PIPE CONDUIT (full flow assumed)

Note correction factors for pipe lengths other than 70 feet

| H, in feet | diameter of pipe in inches | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 12" | 15" | 18" | 21" | 24" | 30" | 36" | 42" | 48" | 54" | 60" | 66" | 72" | 78" | 84" | 90" | 96" | 102" |
| 1 | 3.22 | 5.44 | 8.29 | 11.8 | 15.9 | 26.0 | 38.6 | 53.8 | 71.4 | 91.5 | 114 | 139 | 167 | 197 | 229 | 264 | 302 | 342 |
| 2 | 4.55 | 7.69 | 11.7 | 16.7 | 22.5 | 36.8 | 54.6 | 76.0 | 101 | 129 | 161 | 197 | 236 | 278 | 324 | 374 | 427 | 483 |
| 3 | 5.57 | 9.42 | 14.4 | 20.4 | 27.5 | 45.0 | 66.9 | 93.1 | 124 | 159 | 198 | 241 | 289 | 341 | 397 | 458 | 523 | 592 |
| 4 | 6.43 | 10.9 | 16.6 | 23.5 | 31.8 | 52.0 | 77.3 | 108 | 143 | 183 | 228 | 278 | 334 | 394 | 459 | 529 | 604 | 683 |
| 5 | 7.19 | 12.2 | 18.5 | 26.3 | 35.5 | 58.1 | 86.4 | 120 | 160 | 205 | 255 | 311 | 373 | 440 | 513 | 591 | 675 | 764 |
| 6 | 7.88 | 13.3 | 20.3 | 28.8 | 38.9 | 67.7 | 94.6 | 132 | 175 | 224 | 280 | 341 | 409 | 482 | 562 | 647 | 739 | 837 |
| 7 | 8.51 | 14.4 | 21.9 | 31.1 | 42.0 | 68.8 | 102 | 142 | 189 | 242 | 302 | 368 | 441 | 521 | 607 | 699 | 798 | 904 |
| 8 | 9.10 | 15.4 | 23.5 | 33.3 | 44.9 | 73.5 | 109 | 152 | 202 | 258 | 323 | 394 | 472 | 557 | 685 | 748 | 854 | 966 |
| 9 | 9.65 | 16.3 | 24.9 | 35.3 | 47.7 | 78.0 | 116 | 161 | 214 | 275 | 342 | 418 | 500 | 590 | 688 | 793 | 905 | 1025 |
| 10 | 10.2 | 17.2 | 26.2 | 37.2 | 50.2 | 82.2 | 122 | 170 | 226 | 289 | 361 | 440 | 527 | 622 | 725 | 836 | 954 | 1080 |
| 11 | 10.7 | 18.0 | 27.5 | 39.0 | 52.7 | 86.2 | 128 | 178 | 237 | 304 | 379 | 462 | 553 | 653 | 761 | 877 | 1001 | 1133 |
| 12 | 11.1 | 18.9 | 28.7 | 40.8 | 55.0 | 90.1 | 134 | 186 | 247 | 317 | 395 | 482 | 578 | 682 | 794 | 916 | 1045 | 1184 |
| 13 | 11.6 | 19.6 | 29.9 | 42.4 | 57.3 | 93.7 | 139 | 194 | 257 | 330 | 411 | 502 | 601 | 710 | 827 | 953 | 1088 | 1232 |
| 14 | 12.0 | 20.4 | 31.0 | 44.1 | 59.4 | 97.3 | 145 | 201 | 267 | 342 | 427 | 521 | 624 | 736 | 858 | 989 | 1129 | 1278 |
| 15 | 12.6 | 21.1 | 32.1 | 45.8 | 61.5 | 101 | 150 | 208 | 277 | 354 | 442 | 539 | 646 | 762 | 888 | 1024 | 1169 | 1323 |
| 16 | 12.9 | 21.8 | 33.2 | 47.1 | 63.5 | 104 | 155 | 215 | 286 | 366 | 457 | 557 | 667 | 787 | 917 | 1057 | 1207 | 1367 |
| 17 | 13.3 | 22.4 | 34.2 | 48.5 | 65.5 | 107 | 159 | 222 | 294 | 377 | 471 | 574 | 688 | 812 | 946 | 1090 | 1244 | 1409 |
| 18 | 13.7 | 23.1 | 35.2 | 49.9 | 67.4 | 110 | 164 | 228 | 303 | 388 | 484 | 591 | 708 | 835 | 973 | 1121 | 1280 | 1450 |
| 19 | 14.0 | 23.8 | 36.1 | 51.3 | 69.2 | 113 | 168 | 234 | 311 | 399 | 497 | 607 | 727 | 858 | 1000 | 1152 | 1315 | 1489 |
| 20 | 14.4 | 24.3 | 37.1 | 52.6 | 71.0 | 116 | 173 | 240 | 319 | 409 | 510 | 623 | 746 | 880 | 1026 | 1182 | 1350 | 1528 |
| 21 | 14.7 | 24.9 | 38.0 | 53.9 | 72.8 | 119 | 177 | 246 | 327 | 419 | 523 | 638 | 764 | 902 | 1051 | 1211 | 1383 | 1566 |
| 22 | 15.1 | 25.5 | 38.9 | 55.2 | 74.5 | 122 | 181 | 252 | 335 | 429 | 535 | 653 | 782 | 923 | 1078 | 1240 | 1415 | 1603 |
| 23 | 15.4 | 26.1 | 39.8 | 56.5 | 76.2 | 125 | 186 | 258 | 342 | 439 | 547 | 668 | 800 | 944 | 1100 | 1268 | 1447 | 1639 |
| 24 | 15.8 | 26.7 | 40.6 | 57.7 | 77.8 | 127 | 189 | 263 | 350 | 448 | 559 | 682 | 817 | 964 | 1123 | 1295 | 1478 | 1674 |
| 25 | 16.1 | 27.2 | 41.5 | 58.9 | 79.4 | 130 | 193 | 269 | 357 | 458 | 571 | 696 | 834 | 984 | 1147 | 1322 | 1509 | 1708 |
| 26 | 16.4 | 27.7 | 42.3 | 60.0 | 81.0 | 133 | 197 | 274 | 364 | 467 | 582 | 710 | 850 | 1004 | 1169 | 1348 | 1539 | 1742 |
| 27 | 16.7 | 28.3 | 43.1 | 61.2 | 82.5 | 135 | 201 | 279 | 371 | 476 | 593 | 723 | 867 | 1023 | 1192 | 1373 | 1568 | 1775 |
| 28 | 17.0 | 28.8 | 43.9 | 62.3 | 84.1 | 138 | 204 | 285 | 378 | 484 | 604 | 737 | 883 | 1041 | 1214 | 1399 | 1597 | 1808 |
| 29 | 17.3 | 29.3 | 44.7 | 63.4 | 85.5 | 140 | 208 | 290 | 384 | 493 | 615 | 750 | 898 | 1060 | 1235 | 1423 | 1625 | 1840 |
| 30 | 17.8 | 29.8 | 45.4 | 64.5 | 87.0 | 142 | 212 | 294 | 391 | 501 | 625 | 763 | 913 | 1078 | 1256 | 1448 | 1653 | 1871 |
| L, in feet | Correction Factors For Other Pipe Lengths | | | | | | | | | | | | | | | | | |
| 20 | 1.30 | 1.24 | 1.21 | 1.18 | 1.15 | 1.12 | 1.10 | 1.08 | 1.07 | 1.06 | 1.05 | 1.05 | 1.04 | 1.04 | 1.03 | 1.03 | 1.03 | 1.03 |
| 30 | 1.22 | 1.18 | 1.15 | 1.13 | 1.12 | 1.09 | 1.08 | 1.06 | 1.06 | 1.05 | 1.04 | 1.04 | 1.03 | 1.03 | 1.03 | 1.02 | 1.02 | 1.02 |
| 40 | 1.15 | 1.13 | 1.11 | 1.10 | 1.08 | 1.07 | 1.05 | 1.05 | 1.04 | 1.03 | 1.03 | 1.03 | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 |
| 50 | 1.09 | 1.08 | 1.07 | 1.06 | 1.05 | 1.04 | 1.04 | 1.03 | 1.03 | 1.02 | 1.02 | 1.02 | 1.02 | 1.01 | 1.01 | 1.01 | 1.01 | 1.01 |
| 60 | 1.04 | 1.04 | 1.03 | 1.03 | 1.03 | 1.02 | 1.02 | 1.02 | 1.01 | 1.01 | 1.01 | 1.01 | 1.01 | 1.01 | 1.01 | 1.01 | 1.01 | 1.01 |
| 70 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 80 | .98 | .97 | .97 | .97 | .98 | .98 | .98 | .99 | .99 | .99 | .99 | .99 | .99 | .99 | .99 | .99 | .99 | .99 |
| 90 | .93 | .94 | .94 | .95 | .95 | .96 | .97 | .97 | .98 | .98 | .98 | .98 | .98 | .99 | .99 | .99 | .99 | .99 |
| 100 | .90 | .91 | .92 | .93 | .93 | .95 | .95 | .96 | .97 | .97 | .97 | .98 | .98 | .98 | .98 | .98 | .98 | .99 |
| 120 | .84 | .86 | .87 | .89 | .90 | .91 | .93 | .94 | .94 | .95 | .96 | .96 | .96 | .97 | .97 | .97 | .97 | .98 |
| 140 | .80 | .82 | .83 | .85 | .86 | .88 | .90 | .91 | .92 | .93 | .94 | .94 | .95 | .95 | .96 | .96 | .96 | .97 |
| 160 | .76 | .78 | .80 | .82 | .83 | .86 | .88 | .89 | .90 | .91 | .92 | .93 | .94 | .94 | .95 | .95 | .95 | .96 |

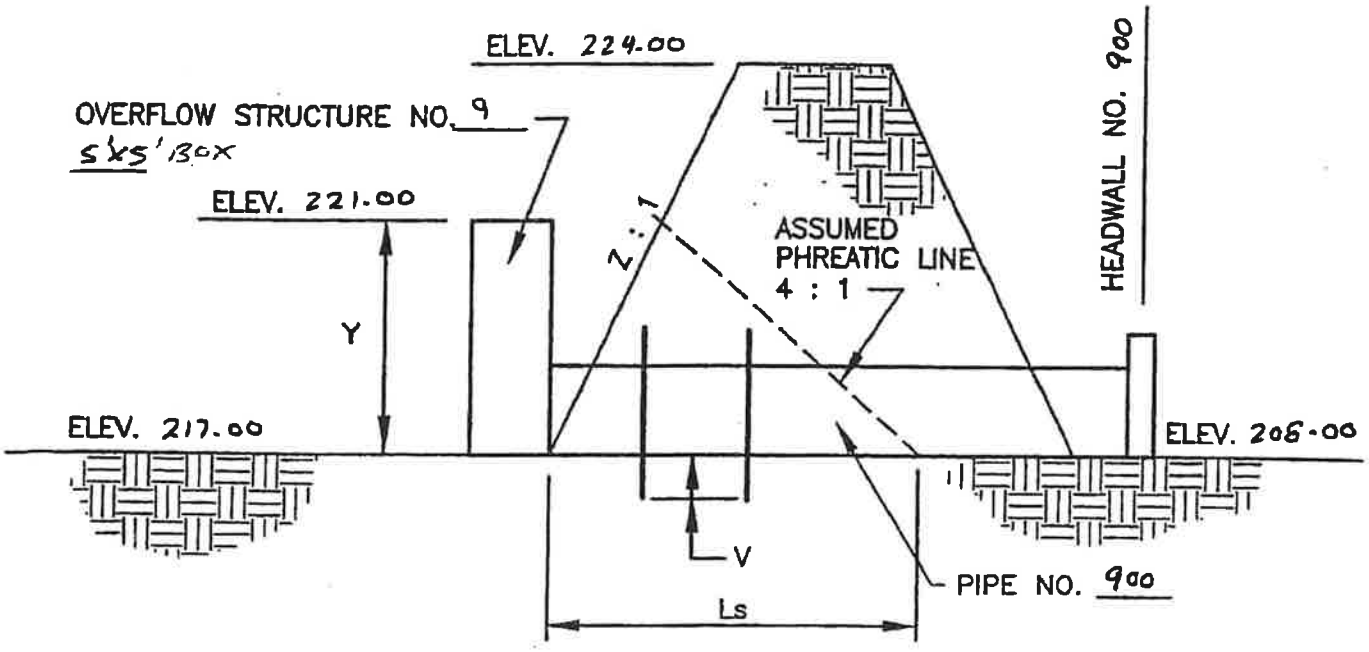
Source: USDA - SCS

**f. Anti-Seep Collar Design**

The seepage of water through the existing sediment pond dam along the carrier pipe could result in dam failure.

The proposed anti-seep collars have been designed to be located at intervals within the zone of saturation along the carrier pipe to increase the seepage length along the carrier pipe and thereby prevent piping or seepage along the carrier pipe.

# ANTI – SEEP COLLAR DESIGN




Ls = LENGTH IN SATURATION ZONE

Y = OVERFLOW STRUCTURE HEIGHT = 4.0 FEET

Z = INSIDE SLOPE OF LEVEE = 3

PIPE SLOPE = 9.68 % = 0.0968 FEET/FEET

$$Ls = Y ( Z + 4 ) \left( 1 + \frac{\text{PIPE SLOPE}}{0.25 - \text{PIPE SLOPE}} \right)$$

Ls = 46 FEET

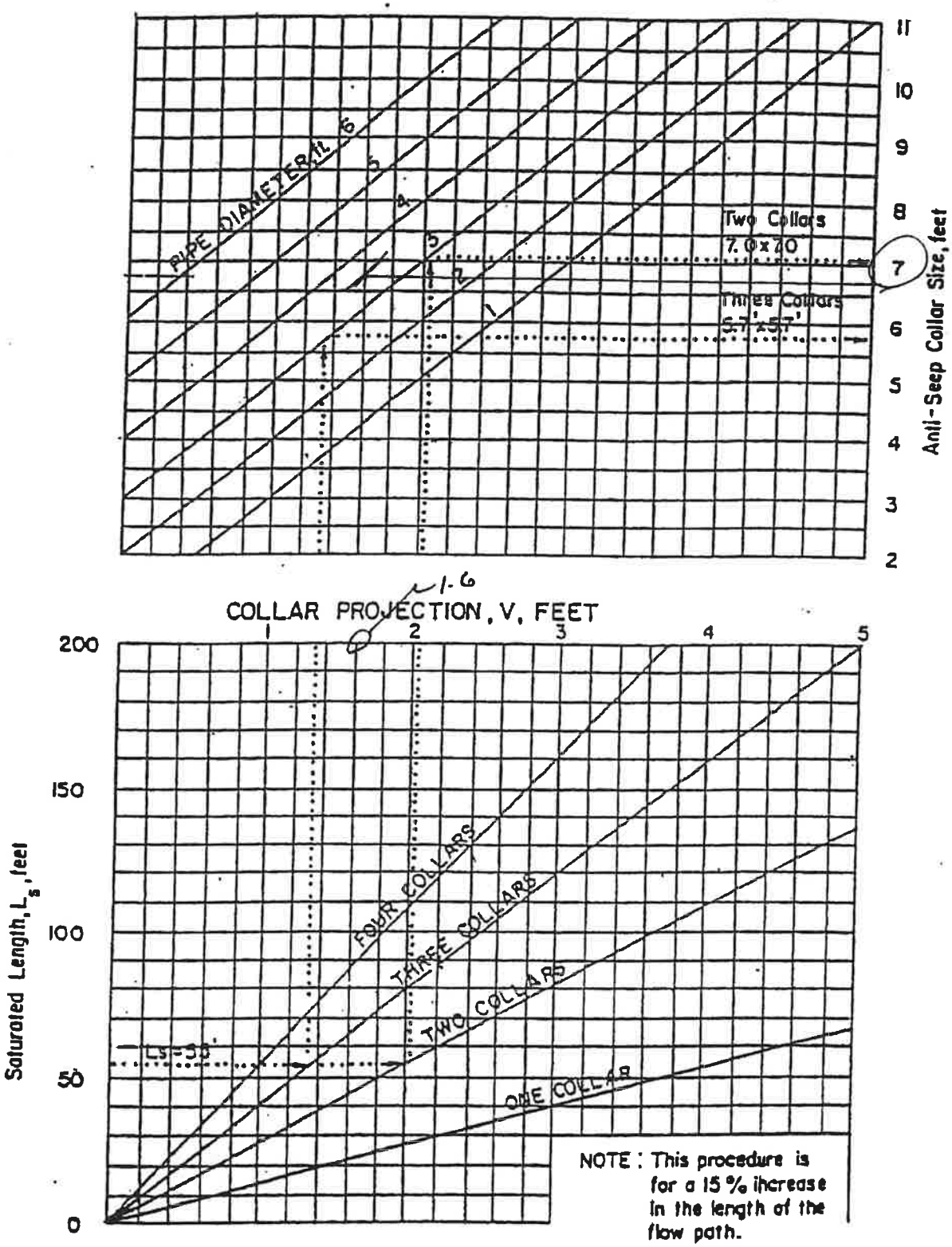
FROM ANTI – SEEP COLLAR DESIGN CHART ON THE NEXT PAGE :

V = COLLAR PROJECTION = 1.6 FEET

DIMENSIONS OF 12" THICK COLLAR = 8.0' X 8.0'

NUMBER OF REQUIRED COLLARS = 2

# ANTI-SEEP COLLAR DESIGN



**g. Overflow Structure Base Foundation Design**

The overflow structure and carrier pipe will be subject to a certain amount of buoyant force when the sediment pond is filled with storm water. In order to overcome this buoyant force and prevent the flotation of the overflow structure and carrier pipe, a concrete overflow structure base foundation and concrete carrier pipe encasement have been designed. The design calculations for the concrete overflow structure base foundation and carrier pipe encasement are included in this section.

**OVERFLOW STRUCTURE BASE FOUNDATION DESIGN**

A certain volume of concrete will be used to overcome the buoyancy of an empty overflow structure and carrier pipe that are below the assumed phreatic water surface. This volume is equal to:

Overflow Structure

= (L)(w)(h)(62.4) L = w = 5.0’ inside = 6.0’ outside

= (6.0)(6.0)(4.0)(62.4) h = height = 4.0’

= 8,986 #

Carrier Pipe = 3.1416($R_2^2$)(Ls)(62.4) Ls = length in saturation zone = 46’

= 3.1416(2.04)(2.04)(46)(62.4) $R_2$ = outside radius = 24.5" = 2.04’

= 37,528 # $r_2$ = inside radius = 21" = 1.75’

TOTAL WEIGHT

= 46,514 # x 1.5 (SAFETY FACTOR)

= 69,771 #

TOTAL REVISED VOLUME OF CONCRETE =
TOTAL WEIGHT / WEIGHT OF CONC. IN WATER

= 69,771/87.6 pcf (87.6 pcf = Wt. of conc. in submerged water)

= 796 C.F.

This volume of concrete will be made up from five areas.

1. Overflow Structures
2. Anti-Seep Collars
3. Carrier Pipe
4. Overflow Structure Base
5. Carrier Pipe Encasement

1. Overflow Structure = $(L_2 - l_2)h$

   $(6.0^2 - 5.0^2)(4.0)$ = 44 C.F.

   L = outside dimension of box = 6.0'

   l = inside dimension of box = 5.0'

   h = height of overflow structures = 4.0'

2. Anti-seep collars = area of square collar around carrier pipe x 12" thick x # of collars

   = [( 8.0' x 8.0' ) - $(3.1416)(R_2^2)$]

   x 1' x 2

   = 102 C.F.

   $R_2$ = outside radius of carrier pipe = 24.5" = 2.04'

   $r_2$ = inside radius of carrier pipe = 21" = 1.75'

3. Carrier Pipe

   = $3.1416 (R_2^2 - r_2^2)$ L = 159 C.F.

   L = length in saturation = 46'

4. Overflow Structure Base = Volume to handle riser bouyance x 1.2

   = (L)(w)h(62.4)(1.2)/weight of conc. in water

   L = w = 6.0' outside

   h = height = 4.0'

   = (6.0')(6.0')(4.0)(62.4)(1.2)/87.6

   = 123 C.F.

   Use 10.0' x 10.0' x 3.0' = 300

5. Carrier Pipe Encasement

   Must extend 5' into dam. Distance from overflow structure to dam is equal to 12.0'. Therefore, minimum encasement length will be 17.0'. A distance of 18' will be used for additional ballast.

   $[(4 \times 6) - (3.1416) R_2^2]$ 18

   Carrier pipe encasement volume = 197 C.F.

**TOTAL REQUIRED VOLUME = 796 C.F.**

| | | |
|---|---|---|
| Actual Total Volume | | |
| Overflow Structure | = | 44 C.F. |
| Anti-Seep Collars | = | 102 C.F. |
| Carrier Pipe | = | 159 C.F. |
| Overflow Structure Base | = | 300 C.F. |
| Carrier Pipe Encasement | = | 197 C.F. |

**TOTAL = 802 C.F. ⇒ Okay**

# 11. PROPOSED SEDIMENT POND NO. 10

## a. Sediment Storage and Settling Efficiency Calculations

As required in the "Alabama Handbook for Erosion Control, Sediment Control and Stormwater Management on Construction Sites and Urban Area", the sediment storage volume of the pond shall be at least 67 cubic yards per acre for the disturbed area draining into the pond (67 cubic yards is equivalent to ½ inch of sediment per acre of drainage area). The peak inflow rate for the 25 year storm event has also been used to calculate the minimum pond surface area needed for adequate settling efficiency. These calculations for the sediment pond are included below.

Sediment Storage Calculation

Assume maximum sediment from 50 disturbed acres.

50 Acres x 67 c.y./acre = 3,350 c.y. = 90,450 c.f.

This sediment volume corresponds to a depth of 0.46' or Elev. 202.46.

Dewatering opening is set at Elev. 205.00. Therefore, ample sediment storage volume is available.

Settling Efficiency Calculations

- Use 25 year storm event, Q25 Flow = 232 cfs
- Minimum Surface Area = .01 acre / cfs x Q25 Flow
  = .01 acre / cfs x 232 cfs
  = 2.32 acres = 101,059 s.f.
- Top of Overflow Structure = Elev. 209.00
  Surface Area @ Elev. 209.00 = 232,472 s.f.
- Adequate surface area is available for settling

# Pond Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022 Thursday, 01 / 30 / 2025

## Pond No. 1 - Pond No. 10

### Pond Data

**Contours -**User-defined contour areas. Average end area method used for volume calculation. Begining Elevation = 202.00 ft

### Stage / Storage Table

| Stage (ft) | Elevation (ft) | Contour area (sqft) | Incr. Storage (cuft) | Total storage (cuft) |
|---|---|---|---|---|
| 0.00 | 202.00 | 189,345 | 0 | 0 |
| 2.00 | 204.00 | 201,425 | 390,770 | 390,770 |
| 3.00 | 205.00 | 207,602 | 204,514 | 595,284 |
| 4.00 | 206.00 | 213,778 | 210,690 | 805,974 |
| 6.00 | 208.00 | 226,165 | 439,944 | 1,245,917 |
| 8.00 | 210.00 | 238,779 | 464,944 | 1,710,861 |
| 10.00 | 212.00 | 251,620 | 490,399 | 2,201,260 |

### Culvert / Orifice Structures

| | [A] | [B] | [C] | [PrfRsr] |
|---|---|---|---|---|
| **Rise (in)** | = 36.00 | 6.00 | 0.00 | Inactive |
| **Span (in)** | = 36.00 | 10.00 | 0.00 | 0.00 |
| **No. Barrels** | = 1 | 2 | 0 | 0 |
| **Invert El. (ft)** | = 205.00 | 205.10 | 0.00 | 0.00 |
| **Length (ft)** | = 87.00 | 0.00 | 0.00 | 0.00 |
| **Slope (%)** | = 8.05 | 0.00 | 0.00 | n/a |
| **N-Value** | = .013 | .013 | .013 | n/a |
| **Orifice Coeff.** | = 0.60 | 0.60 | 0.60 | 0.60 |
| **Multi-Stage** | = n/a | Yes | No | No |

### Weir Structures

| | [A] | [B] | [C] | [D] |
|---|---|---|---|---|
| **Crest Len (ft)** | = 20.00 | Inactive | Inactive | Inactive |
| **Crest El. (ft)** | = 209.00 | 0.00 | 0.00 | 0.00 |
| **Weir Coeff.** | = 3.33 | 3.33 | 3.33 | 3.33 |
| **Weir Type** | = 1 | --- | --- | --- |
| **Multi-Stage** | = Yes | No | No | No |

**Exfil.(in/hr)** = 0.000 (by Wet area)

**TW Elev. (ft)** = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).

### Stage / Storage / Discharge Table

| Stage ft | Storage cuft | Elevation ft | Clv A cfs | Clv B cfs | Clv C cfs | PrfRsr cfs | Wr A cfs | Wr B cfs | Wr C cfs | Wr D cfs | Exfil cfs | User cfs | Total cfs |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.00 | 0 | 202.00 | 0.00 | 0.00 | --- | --- | 0.00 | --- | --- | --- | --- | --- | 0.000 |
| 2.00 | 390,770 | 204.00 | 0.00 | 0.00 | --- | --- | 0.00 | --- | --- | --- | --- | --- | 0.000 |
| 3.00 | 595,284 | 205.00 | 0.00 | 0.00 | --- | --- | 0.00 | --- | --- | --- | --- | --- | 0.000 |
| 4.00 | 805,974 | 206.00 | 2.61 ic | 2.60 ic | --- | --- | 0.00 | --- | --- | --- | --- | --- | 2.598 |
| 6.00 | 1,245,917 | 208.00 | 5.81 ic | 5.81 ic | --- | --- | 0.00 | --- | --- | --- | --- | --- | 5.810 |
| 8.00 | 1,710,861 | 210.00 | 58.98 ic | 2.83 ic | --- | --- | 56.15 s | --- | --- | --- | --- | --- | 58.98 |
| 10.00 | 2,201,260 | 212.00 | 79.50 ic | 0.83 ic | --- | --- | 78.62 s | --- | --- | --- | --- | --- | 79.45 |

**b. Total Pond Dewatering at Top of Riser (Elev. 209.00)**

Retention time within the basin is an important factor in effective sediment retention. The overflow structure has been designed as specified below.

The 5' x 5' square concrete overflow structure has two 6"(h) x 10" (w) dewatering openings at an elevation of 205.00.

The calculation below has been performed to confirm that the dewatering (retention) time within the pond is between 24 and 72 hours. This dewatering time will ensure the storm water is retained for an adequate length of time to allow the sediment to settle (minimum 24 hours) and is also discharged gradually in an acceptable length of time to allow storage for future storm events (maximum 72 hours).

The dewatering time is calculated as follows:

$$T = \frac{A_s \times (2h)^{1/2}}{A_O \times C_d \times (20{,}428)}$$

$A_O$ = Surface Area of Dewatering Holes ($ft^2$)

$A_s$ = Surface Area Corresponding to top of riser elevation ($ft^2$)

h = Head of water above dewatering hole (ft)

$C_d$ = Coefficient of contraction for an orifice (use 0.6)

T = Time to dewater

T = 24 to 72 hours

$A_O$ = 0.83 s.f. @ Elev. 205.00 (2 - 6" x 10" rectangular openings)

$A_s$ = 232,472 s.f. @ Elev. 209.00

h = 209.00 – 205.00 = 4.0'

$$T = \frac{232{,}472\ (2 \times 4.0)^{1/2}}{(0.83)\ (0.6)\ (20{,}428)} = 64.6 \text{ hours}$$

**(Okay between 24 – 72 hours)**

**c. Reservoir Routing**

Reservoir routing is determined by using the HydraFlow Hydrographs Extension for AutoCad Civil 3D 2022 Computer Program.

Peak inflow rates (Q) are determined using the SCS Method and HydraFlow Hydrographs Extension for AutoCad Civil 3D 2022 Computer Program. Peak inflow rates are calculated for the 25 year and 100 year storm events and are summarized below.

Q25 = 232 cfs

Q100 = 329 cfs

The bottom of the pond has been set at 202.00. Dewatering of the pond is accomplished by two 6" x 10" rectangular openings at elevation 205.00.

For routing calculations, a 5 'x 5' rectangular riser with two 6" x 10" rectangular openings at elevation 205.00 was used. The top of the riser is at an elevation of 209.00. The bottom of the pond is elev. 202.00. The invert of the carrier pipe is elev. 205.00. The top of the levee around the sediment pond is at an elevation of 212.00.

The maximum height of sediment is elevation 202.46 which is below the elevation of the first dewatering opening (Elev. 205.00). For routing calculations, the starting water surface elevation was set at 205.00, assuming the remainder of the pond bottom is filled below the dewatering orifice invert elevation.

Based on the above information the reservoir routing calculations are performed and summarized below.

| STORM YEAR | PEAK INFLOW CFS | PEAK OUTFLOW CFS | PEAK ELEV. FEET |
|---|---|---|---|
| 25 | 232 | 5.8 | 207.96 |
| 100 | 329 | 10.9 | 209.14 |

Based on these routing calculations, the riser is large enough and the pond has sufficient storage volume to retain the sediment from 50 disturbed acres plus the 25 year storm event from the entire drainage area below the crest of the riser (elev. 209.00).

# Pond Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022 Thursday, 01 / 30 / 2025

## Pond No. 2 - Pond No. 10 perm pool

### Pond Data

**Contours -**User-defined contour areas. Average end area method used for volume calculation. Begining Elevation = 205.00 ft

### Stage / Storage Table

| Stage (ft) | Elevation (ft) | Contour area (sqft) | Incr. Storage (cuft) | Total storage (cuft) |
|---|---|---|---|---|
| 0.00 | 205.00 | 207,602 | 0 | 0 |
| 1.00 | 206.00 | 213,778 | 210,690 | 210,690 |
| 3.00 | 208.00 | 226,165 | 439,943 | 650,633 |
| 5.00 | 210.00 | 238,779 | 464,944 | 1,115,577 |
| 7.00 | 212.00 | 251,620 | 490,399 | 1,605,976 |

### Culvert / Orifice Structures

| | [A] | [B] | [C] | [PrfRsr] |
|---|---|---|---|---|
| **Rise (in)** | = 36.00 | 6.00 | 0.00 | Inactive |
| **Span (in)** | = 36.00 | 10.00 | 0.00 | 0.00 |
| **No. Barrels** | = 1 | 2 | 0 | 0 |
| **Invert El. (ft)** | = 205.00 | 205.10 | 0.00 | 0.00 |
| **Length (ft)** | = 87.00 | 0.00 | 0.00 | 0.00 |
| **Slope (%)** | = 8.05 | 0.00 | 0.00 | n/a |
| **N-Value** | = .013 | .013 | .013 | n/a |
| **Orifice Coeff.** | = 0.60 | 0.60 | 0.60 | 0.60 |
| **Multi-Stage** | = n/a | Yes | No | No |

### Weir Structures

| | [A] | [B] | [C] | [D] |
|---|---|---|---|---|
| **Crest Len (ft)** | = 20.00 | Inactive | Inactive | Inactive |
| **Crest El. (ft)** | = 209.00 | 0.00 | 0.00 | 0.00 |
| **Weir Coeff.** | = 3.33 | 3.33 | 3.33 | 3.33 |
| **Weir Type** | = 1 | --- | --- | --- |
| **Multi-Stage** | = Yes | No | No | No |

**Exfil.(in/hr)** = 0.000 (by Wet area)

**TW Elev. (ft)** = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).

### Stage / Storage / Discharge Table

| Stage ft | Storage cuft | Elevation ft | Clv A cfs | Clv B cfs | Clv C cfs | PrfRsr cfs | Wr A cfs | Wr B cfs | Wr C cfs | Wr D cfs | Exfil cfs | User cfs | Total cfs |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.00 | 0 | 205.00 | 0.00 | 0.00 | --- | --- | 0.00 | --- | --- | --- | --- | --- | 0.000 |
| 1.00 | 210,690 | 206.00 | 2.61 ic | 2.60 ic | --- | --- | 0.00 | --- | --- | --- | --- | --- | 2.598 |
| 3.00 | 650,633 | 208.00 | 5.81 ic | 5.81 ic | --- | --- | 0.00 | --- | --- | --- | --- | --- | 5.810 |
| 5.00 | 1,115,577 | 210.00 | 58.98 ic | 2.83 ic | --- | --- | 56.15 s | --- | --- | --- | --- | --- | 58.98 |
| 7.00 | 1,605,976 | 212.00 | 79.50 ic | 0.83 ic | --- | --- | 78.62 s | --- | --- | --- | --- | --- | 79.45 |

# Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022

| Hyd. No. | Hydrograph type (origin) | Peak flow (cfs) | Time interval (min) | Time to Peak (min) | Hyd. volume (cuft) | Inflow hyd(s) | Maximum elevation (ft) | Total strge used (cuft) | Hydrograph Description |
|---|---|---|---|---|---|---|---|---|---|
| 35 | SCS Runoff | 6.846 | 1 | 729 | 25,933 | ------ | ------ | ------ | Ditch No. 8 |
| 36 | Combine | 23.66 | 1 | 725 | 82,284 | 34, 35 | ------ | ------ | Pipe No. 1002 |
| 37 | SCS Runoff | 42.92 | 1 | 722 | 117,717 | ------ | ------ | ------ | Area to Pond No. 10 |
| 38 | Combine | 231.66 | 1 | 725 | 849,589 | 31, 36, 37 | ------ | ------ | Pond No. 10 Total Inflow |
| 39 | Reservoir | 5.757 | 1 | 1066 | 606,624 | 38 | 207.96 | 641,418 | Pond No. 10 perm pool |
| 40 | Reservoir | 63.67 | 1 | 751 | 849,574 | 38 | 210.30 | 309,968 | Pond No. 10 riser |

# Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022

| Hyd. No. | Hydrograph type (origin) | Peak flow (cfs) | Time interval (min) | Time to Peak (min) | Hyd. volume (cuft) | Inflow hyd(s) | Maximum elevation (ft) | Total strge used (cuft) | Hydrograph Description |
|---|---|---|---|---|---|---|---|---|---|
| 35 | SCS Runoff | 9.703 | 1 | 729 | 37,234 | ------ | ------ | ------ | Ditch No. 8 |
| 36 | Combine | 33.54 | 1 | 725 | 118,141 | 34, 35 | ------ | ------ | Pipe No. 1002 |
| 37 | SCS Runoff | 60.77 | 1 | 722 | 169,017 | ------ | ------ | ------ | Area to Pond No. 10 |
| 38 | Combine | 328.66 | 1 | 725 | 1,219,823 | 31, 36, 37 | ------ | ------ | Pond No. 10 Total Inflow |
| 39 | Reservoir | 10.91 | 1 | 980 | 833,963 | 38 | 209.14 | 915,087 | Pond No. 10 perm pool |
| 40 | Reservoir | 70.87 | 1 | 755 | 1,219,810 | 38 | 210.95 | 469,451 | Pond No. 10 riser |

**d. Emergency Spillway**

Worst Case

Assume the dewatering opening in the overflow structure is not operating and the starting water surface elevation is at the top of the riser (209.00) at the start of a 100 year storm event.

| | | |
|---|---|---|
| Top of Pond | = | 212.00 |
| Less Required Freeboard | = | 1.00 |
| Maximum Allowable Water Surface Elevation in Emergency Spillway | = | 11.00 |

Re-route the 100 year storm event through the 5' x 5' square overflow structure and 36" diameter carrier pipe.

From Hydrograph Summary Report, Line 40, the maximum flow out of the pond will be 71 cfs. The maximum water surface elevation is 210.89 which is less than the maximum allowable water surface elevation of 211.00.

Therefore, the overflow structure and carrier pipe will safely pass the 100 year storm event with a starting water surface elevation at 209.00.

# Pond Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022 Thursday, 01 / 30 / 2025

## Pond No. 3 - Pond No. 10 riser

### Pond Data

**Contours -**User-defined contour areas. Average end area method used for volume calculation. Begining Elevation = 209.00 ft

### Stage / Storage Table

| Stage (ft) | Elevation (ft) | Contour area (sqft) | Incr. Storage (cuft) | Total storage (cuft) |
|---|---|---|---|---|
| 0.00 | 209.00 | 232,472 | 0 | 0 |
| 1.00 | 210.00 | 238,779 | 235,626 | 235,626 |
| 3.00 | 212.00 | 251,620 | 490,399 | 726,025 |

### Culvert / Orifice Structures

| | [A] | [B] | [C] | [PrfRsr] |
|---|---|---|---|---|
| **Rise (in)** | = 36.00 | Inactive | 0.00 | Inactive |
| **Span (in)** | = 36.00 | 0.00 | 0.00 | 0.00 |
| **No. Barrels** | = 1 | 1 | 0 | 0 |
| **Invert El. (ft)** | = 205.00 | 0.00 | 0.00 | 0.00 |
| **Length (ft)** | = 87.00 | 0.00 | 0.00 | 0.00 |
| **Slope (%)** | = 8.05 | 0.00 | 0.00 | n/a |
| **N-Value** | = .013 | .013 | .013 | n/a |
| **Orifice Coeff.** | = 0.60 | 0.60 | 0.60 | 0.60 |
| **Multi-Stage** | = n/a | No | No | No |

### Weir Structures

| | [A] | [B] | [C] | [D] |
|---|---|---|---|---|
| **Crest Len (ft)** | = 20.00 | Inactive | Inactive | Inactive |
| **Crest El. (ft)** | = 209.00 | 0.00 | 0.00 | 0.00 |
| **Weir Coeff.** | = 3.33 | 3.33 | 3.33 | 3.33 |
| **Weir Type** | = 1 | --- | --- | --- |
| **Multi-Stage** | = Yes | No | No | No |

**Exfil.(in/hr)** = 0.000 (by Wet area)

**TW Elev. (ft)** = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).

### Stage / Storage / Discharge Table

| Stage ft | Storage cuft | Elevation ft | Clv A cfs | Clv B cfs | Clv C cfs | PrfRsr cfs | Wr A cfs | Wr B cfs | Wr C cfs | Wr D cfs | Exfil cfs | User cfs | Total cfs |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.00 | 0 | 209.00 | 0.00 | --- | --- | --- | 0.00 | --- | --- | --- | --- | --- | 0.000 |
| 1.00 | 235,626 | 210.00 | 58.34 ic | --- | --- | --- | 58.34 s | --- | --- | --- | --- | --- | 58.34 |
| 3.00 | 726,025 | 212.00 | 79.49 ic | --- | --- | --- | 79.43 s | --- | --- | --- | --- | --- | 79.43 |

# Hydrograph Summary Report

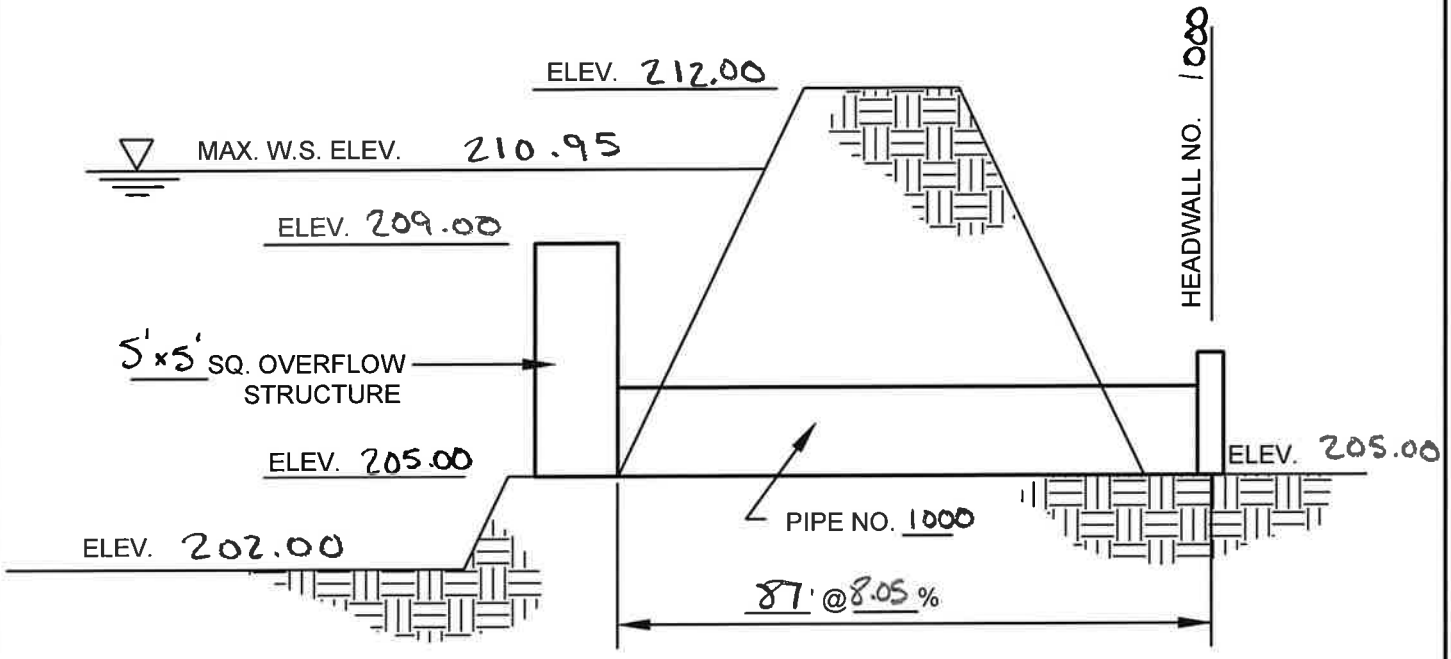
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022

| Hyd. No. | Hydrograph type (origin) | Peak flow (cfs) | Time interval (min) | Time to Peak (min) | Hyd. volume (cuft) | Inflow hyd(s) | Maximum elevation (ft) | Total strge used (cuft) | Hydrograph Description |
|---|---|---|---|---|---|---|---|---|---|
| 35 | SCS Runoff | 9.703 | 1 | 729 | 37,234 | ------ | ------ | ------ | Ditch No. 8 |
| 36 | Combine | 33.54 | 1 | 725 | 118,141 | 34, 35 | ------ | ------ | Pipe No. 1002 |
| 37 | SCS Runoff | 60.77 | 1 | 722 | 169,017 | ------ | ------ | ------ | Area to Pond No. 10 |
| 38 | Combine | 328.66 | 1 | 725 | 1,219,823 | 31, 36, 37 | ------ | ------ | Pond No. 10 Total Inflow |
| 39 | Reservoir | 10.91 | 1 | 980 | 833,963 | 38 | 209.14 | 915,087 | Pond No. 10 perm pool |
| 40 | Reservoir | 70.87 | 1 | 755 | 1,219,810 | 38 | 210.95 | 469,451 | Pond No. 10 riser |

**e. Overflow Structure and Carrier Pipe Design**

In order to confirm that the overflow structure, carrier pipe and emergency spillway pipe have been designed adequately to pass the maximum flow as modeled in the HydraFlow Hydrographs Extension for AutoCad Civil 3D 2022 Computer Program, the following design calculations have been included.

# OVERFLOW STRUCTURE NO. 10




## DESIGN OF OVERFLOW STRUCTURE AS EMERGENCY SPILLWAY

FLOW (Q) WORST CASE = 100 YEAR STORM EVENT OCCURS WHEN WATER SURFACE ELEVATION AT TOP OF OVERFLOW STRUCTURE AND ALL DEWATERING HOLES ARE PLUGGED

FLOW (Q) MAXIMUM = 71 CFS

HEAD (H) MAXIMUM = MAXIMUM WATER SURFACE ELEVATION WITH 1' OF FREEBOARD MINUS THE ELEVATION AT THE CREST OF THE OVERFLOW STRUCTURE

= 210.95 - 209.00 = 1.95 FEET

BASED ON ABOVE HEAD, USE 5'x5' SQ. OVERFLOW STRUCTURE

(SEE CHART ON NEXT PAGE)

## WEIR FLOW (Q) OVER RISER CREST FOR CIRCULAR RISERS WITH TRASH RACK

$Q = CLh^{3/2}$

$Q = 3.1 \times (\pi) \times (D/12) \times h^{3/2}$

Table 6-22.2

| HEAD-h In feet | Riser Diameter ($D_r$) In Inches | | | | | | | | HEAD-h In feet |
|---|---|---|---|---|---|---|---|---|---|
| | 12 | 18 | 24 | 30 | 36 | 48 | 54 | 60 | |
| | Flow In Cubic Feet Per Second | | | | | | | | |
| 0.1 | 0.3 | 0.5 | 0.6 | 0.8 | 0.9 | 1.2 | 1.4 | 1.5 | 0.1 |
| 0.2 | 0.9 | 1.3 | 1.7 | 2.2 | 2.6 | 3.5 | 3.9 | 4.4 | 0.2 |
| 0.3 | 1.6 | 2.4 | 3.2 | 4.0 | 4.8 | 6.4 | 7.2 | 8.0 | 0.3 |
| 0.4 | 2.5 | 3.7 | 4.9 | 6.2 | 7.4 | 9.9 | 11.1 | 12.3 | 0.4 |
| 0.6 | 4.5 | 6.8 | 9.1 | 11.3 | 13.6 | 18.1 | 20.4 | 22.6 | 0.6 |
| 0.8 | | 10.5 | 13.9 | 17.4 | 20.9 | 27.9 | 31.4 | 34.8 | 0.8 |
| 1.0 | | | 19.5 | 24.3 | 29.2 | 39.0 | 43.8 | 48.7 | 1.0 |
| 1.2 | | | 25.6 | 32.0 | 38.4 | 51.2 | 57.6 | 64.0 | 1.2 |
| 1.4 | | | | 40.3 | 48.4 | 64.5 | 72.6 | 80.7 | 1.4 |
| 1.6 | | | | 49.3 | 59.1 | 78.8 | 88.7 | 98.6 | 1.6 |
| 1.8 | | | | | 70.6 | 94.1 | 105.8 | 117.6 | 1.8 |
| 2.0 | | | | | 82.6 | 110.2 | 124.0 | 137.7 | 2.0 |
| 2.2 | | | | | | 127.1 | 143.0 | 158.9 | 2.2 |
| 2.4 | | | | | | | 162.9 | 181.0 | 2.4 |
| 2.6 | | | | | | | 183.7 | 204.1 | 2.6 |
| 2.8 | | | | | | | | 228.1 | 2.8 |
| 3.0 | | | | | | | | 253.0 | 3.0 |

### Pipe, Riser, and Trash Rack Proportions

Eq. 6-10 $D_r \geq (1.50)\ (D_{ps})$

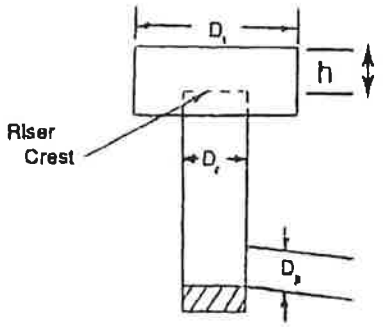
where $D_r$ = diameter of riser

$D_{ps}$ = diameter of principal spillway

Eq. 6-11 $D_t \geq (1.4)\ (D_r)$

where $D_t$ = diameter of trash rack

$D_r$ = diameter of riser




EXAMPLE: The peak runoff for a 2-year, 24-hour rain is 32 cfs. Select a pipe size for a head of 12 feet and length of 100 feet. From Table 6-15.1, 38.2 x 0.89 = 34 cfs discharge for a 24-inch diameter pipe.

Using Equation 6-10 $D_r \geq (1.5)\ (D_p)$

$D_r \geq (1.5)\ (24) \geq$ 36 inch diameter riser

Using Equation 6-11 $D_t \geq (1.4)\ (D_r)$

$D_t \geq (1.4)\ (36) \geq$ 50 inch diameter (Use 54 inch)

Determine h - From Table 6-15.2

$Q$ = 34 cfs $D_r$ = 36" h = 1.2'

NOTE: h = minimum distance between the crest of the riser and the crest of the emergency spillway.

# CARRIER PIPE NO. 1000

Q = 71 CFS WORST CASE

MAXIMUM HEADWATER = TOP OF LEEVE ELEVATION MINUS 1' FREEBOARD
= 212.00 - 1.00 = 211.00

HEAD (H) = MAXIMUM WATER ELEVATION ALLOWED MINUS THE CENTERLINE ELEVATION AT THE DOWNSTREAM END OF THE CARRIER PIPE
= 211.00 - 199.5 = 11.50

LENGTH (L) = 87'

LENGTH FACTOR = 0.97 FOR LENGTHS OTHER THAN 70'

Q (AVAILABLE) = Q FROM TABLE TIMES LENGTH FACTOR
= 131 X 0.97 = 127.00

Q (AVAILABLE) MUST BE GREATER THAN Q WORST CASE

**USE 36 " DIAMETER RCP CARRIER PIPE**

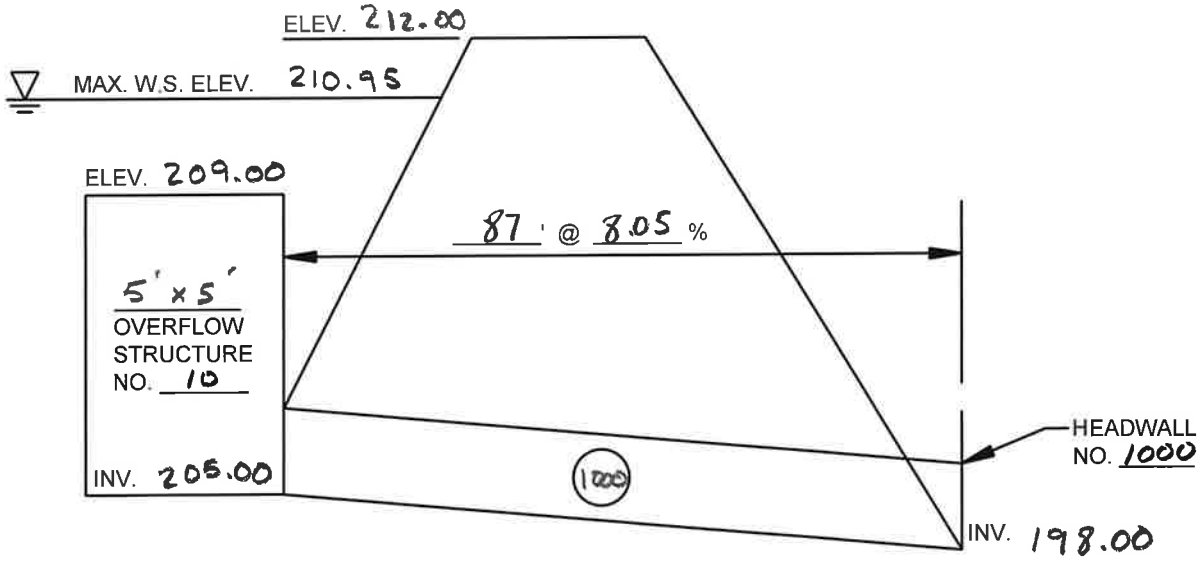


Table 6-25

PIPE FLOW CHART n = 0.025

FOR CORRUGATED METAL PIPE INLET $K_e = K_o + K_c = 1.0$ AND 70 FEET OF CORRUGATED METAL PIPE CONDUIT (full flow assumed)

Note correction factors for pipe lengths other than 70 feet

| H, in feet | diameter of pipe in inches | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 12" | 15" | 18" | 21" | 24" | 30" | 36" | 42" | 48" | 54" | 60" | 66" | 72" | 78" | 84" | 90" | 96" | 102" |
| 1 | 3.22 | 5.44 | 8.29 | 11.8 | 15.9 | 26.0 | 38.6 | 53.8 | 71.4 | 91.5 | 114 | 139 | 167 | 197 | 229 | 264 | 302 | 342 |
| 2 | 4.55 | 7.69 | 11.7 | 16.7 | 22.5 | 36.8 | 54.6 | 76.0 | 101 | 129 | 161 | 197 | 236 | 278 | 324 | 374 | 427 | 483 |
| 3 | 5.57 | 9.42 | 14.4 | 20.4 | 27.5 | 45.0 | 66.9 | 93.1 | 124 | 159 | 198 | 241 | 289 | 341 | 397 | 458 | 523 | 592 |
| 4 | 6.43 | 10.9 | 16.6 | 23.5 | 31.8 | 52.0 | 77.3 | 108 | 143 | 183 | 228 | 278 | 334 | 394 | 459 | 529 | 604 | 683 |
| 5 | 7.19 | 12.2 | 18.5 | 26.3 | 35.5 | 58.1 | 86.4 | 120 | 160 | 205 | 255 | 311 | 373 | 440 | 513 | 591 | 675 | 764 |
| 6 | 7.88 | 13.3 | 20.3 | 28.8 | 38.9 | 67.7 | 94.6 | 132 | 175 | 224 | 280 | 341 | 409 | 482 | 562 | 647 | 739 | 837 |
| 7 | 8.51 | 14.4 | 21.9 | 31.1 | 42.0 | 68.8 | 102 | 142 | 189 | 242 | 302 | 368 | 441 | 521 | 607 | 699 | 798 | 904 |
| 8 | 9.10 | 15.4 | 23.5 | 33.3 | 44.9 | 73.5 | 109 | 152 | 202 | 259 | 323 | 394 | 472 | 557 | 685 | 748 | 854 | 966 |
| 9 | 9.65 | 16.3 | 24.9 | 35.3 | 47.7 | 78.0 | 116 | 161 | 214 | 275 | 342 | 418 | 500 | 590 | 688 | 793 | 905 | 1025 |
| 10 | 10.2 | 17.2 | 26.2 | 37.2 | 50.2 | 82.2 | 122 | 170 | 226 | 289 | 361 | 440 | 527 | 622 | 725 | 836 | 954 | 1080 |
| 11 | 10.7 | 18.0 | 27.5 | 39.0 | 52.7 | 86.2 | 128 | 178 | 237 | 304 | 379 | 462 | 553 | 653 | 761 | 877 | 1001 | 1133 |
| 12 | 11.1 | 18.9 | 28.7 | 40.8 | 55.0 | 90.1 | 134 | 186 | 247 | 317 | 395 | 482 | 578 | 682 | 794 | 918 | 1045 | 1184 |
| 13 | 11.8 | 19.6 | 29.9 | 42.4 | 57.3 | 93.7 | 139 | 194 | 257 | 330 | 411 | 502 | 601 | 710 | 827 | 953 | 1088 | 1232 |
| 14 | 12.0 | 20.4 | 31.0 | 44.1 | 59.4 | 97.3 | 145 | 201 | 267 | 342 | 427 | 521 | 624 | 738 | 858 | 989 | 1129 | 1278 |
| 15 | 12.5 | 21.1 | 32.1 | 45.6 | 61.5 | 101 | 150 | 208 | 277 | 354 | 442 | 539 | 646 | 762 | 888 | 1024 | 1169 | 1323 |
| 16 | 12.9 | 21.8 | 33.2 | 47.1 | 63.5 | 104 | 155 | 215 | 286 | 366 | 457 | 557 | 667 | 787 | 917 | 1057 | 1207 | 1367 |
| 17 | 13.3 | 22.4 | 34.2 | 48.5 | 65.5 | 107 | 159 | 222 | 294 | 377 | 471 | 574 | 688 | 812 | 946 | 1090 | 1244 | 1409 |
| 18 | 13.7 | 23.1 | 35.2 | 49.9 | 67.4 | 110 | 164 | 228 | 303 | 388 | 484 | 591 | 708 | 835 | 973 | 1121 | 1280 | 1450 |
| 19 | 14.0 | 23.8 | 36.1 | 51.3 | 69.2 | 113 | 168 | 234 | 311 | 399 | 497 | 607 | 727 | 858 | 1000 | 1152 | 1315 | 1489 |
| 20 | 14.4 | 24.3 | 37.1 | 52.6 | 71.0 | 116 | 173 | 240 | 319 | 409 | 510 | 623 | 746 | 880 | 1026 | 1182 | 1350 | 1528 |
| 21 | 14.7 | 24.9 | 38.0 | 53.9 | 72.8 | 119 | 177 | 246 | 327 | 419 | 523 | 638 | 764 | 902 | 1051 | 1211 | 1383 | 1566 |
| 22 | 15.1 | 25.6 | 38.9 | 55.2 | 74.5 | 122 | 181 | 252 | 335 | 429 | 535 | 653 | 782 | 923 | 1078 | 1240 | 1415 | 1603 |
| 23 | 15.4 | 26.1 | 39.8 | 56.5 | 76.2 | 125 | 186 | 258 | 342 | 439 | 547 | 668 | 800 | 944 | 1100 | 1268 | 1447 | 1639 |
| 24 | 15.8 | 26.7 | 40.6 | 57.7 | 77.8 | 127 | 189 | 263 | 350 | 448 | 559 | 682 | 817 | 964 | 1123 | 1295 | 1478 | 1674 |
| 25 | 16.1 | 27.2 | 41.5 | 58.9 | 79.4 | 130 | 193 | 269 | 357 | 458 | 571 | 696 | 834 | 984 | 1147 | 1322 | 1509 | 1708 |
| 26 | 16.4 | 27.7 | 42.3 | 60.0 | 81.0 | 133 | 197 | 274 | 364 | 467 | 582 | 710 | 850 | 1004 | 1169 | 1348 | 1539 | 1742 |
| 27 | 16.7 | 28.3 | 43.1 | 61.2 | 82.5 | 135 | 201 | 279 | 371 | 476 | 593 | 723 | 867 | 1023 | 1192 | 1373 | 1568 | 1775 |
| 28 | 17.0 | 28.8 | 43.9 | 62.3 | 84.1 | 138 | 204 | 285 | 378 | 484 | 604 | 737 | 883 | 1041 | 1214 | 1399 | 1597 | 1808 |
| 29 | 17.3 | 29.3 | 44.7 | 63.4 | 85.5 | 140 | 208 | 290 | 384 | 493 | 615 | 750 | 898 | 1060 | 1235 | 1423 | 1625 | 1840 |
| 30 | 17.6 | 29.8 | 45.4 | 64.5 | 87.0 | 142 | 212 | 294 | 391 | 501 | 625 | 763 | 913 | 1078 | 1256 | 1448 | 1653 | 1871 |
| L, in feet | Correction Factors For Other Pipe Lengths | | | | | | | | | | | | | | | | | |
| 20 | 1.30 | 1.24 | 1.21 | 1.18 | 1.15 | 1.12 | 1.10 | 1.08 | 1.07 | 1.08 | 1.05 | 1.05 | 1.04 | 1.04 | 1.03 | 1.03 | 1.03 | 1.03 |
| 30 | 1.22 | 1.18 | 1.15 | 1.13 | 1.12 | 1.09 | 1.08 | 1.06 | 1.05 | 1.05 | 1.04 | 1.04 | 1.03 | 1.03 | 1.03 | 1.02 | 1.02 | 1.02 |
| 40 | 1.15 | 1.13 | 1.11 | 1.10 | 1.08 | 1.07 | 1.05 | 1.05 | 1.04 | 1.03 | 1.03 | 1.03 | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 |
| 50 | 1.09 | 1.08 | 1.07 | 1.06 | 1.05 | 1.04 | 1.04 | 1.03 | 1.03 | 1.02 | 1.02 | 1.02 | 1.02 | 1.01 | 1.01 | 1.01 | 1.01 | 1.01 |
| 60 | 1.04 | 1.04 | 1.03 | 1.03 | 1.03 | 1.02 | 1.02 | 1.02 | 1.01 | 1.01 | 1.01 | 1.01 | 1.01 | 1.01 | 1.01 | 1.01 | 1.01 | 1.01 |
| 70 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 80 | .98 | .97 | .97 | .97 | .98 | .98 | .98 | .99 | .99 | .99 | .99 | .99 | .99 | .99 | .99 | .99 | .99 | .99 |
| 90 | .93 | .94 | .94 | .95 | .95 | .96 | .97 | .97 | .98 | .98 | .98 | .98 | .98 | .99 | .99 | .99 | .99 | .99 |
| 100 | .90 | .91 | .92 | .93 | .93 | .95 | .95 | .96 | .97 | .97 | .97 | .98 | .98 | .98 | .98 | .98 | .98 | .99 |
| 120 | .84 | .86 | .87 | .89 | .90 | .91 | .93 | .94 | .94 | .95 | .96 | .96 | .98 | .97 | .97 | .97 | .97 | .98 |
| 140 | .80 | .82 | .83 | .85 | .86 | .88 | .90 | .91 | .92 | .93 | .94 | .94 | .95 | .95 | .96 | .96 | .96 | .97 |
| 160 | .76 | .78 | .80 | .82 | .83 | .86 | .88 | .89 | .90 | .91 | .92 | .93 | .94 | .94 | .95 | .95 | .95 | .96 |

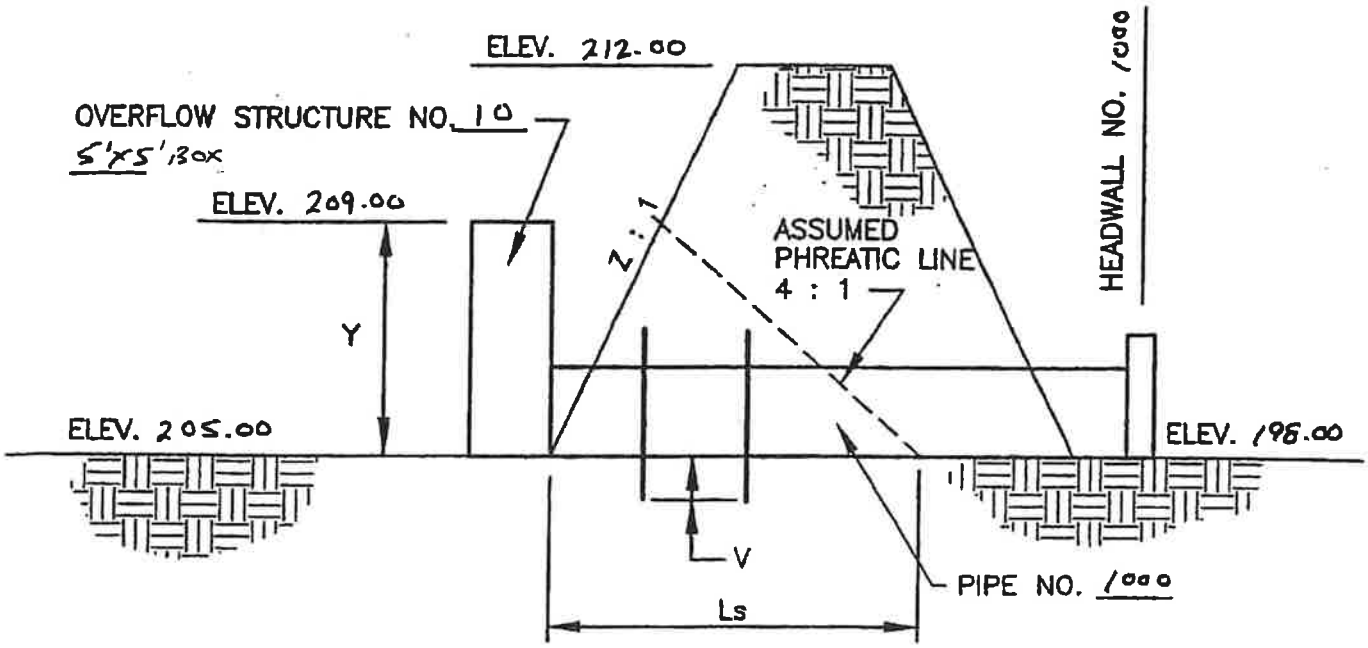
Source: USDA - SCS

**f. Anti-Seep Collar Design**

The seepage of water through the existing sediment pond dam along the carrier pipe could result in dam failure.

The proposed anti-seep collars have been designed to be located at intervals within the zone of saturation along the carrier pipe to increase the seepage length along the carrier pipe and thereby prevent piping or seepage along the carrier pipe.

# ANTI – SEEP COLLAR DESIGN




Ls = LENGTH IN SATURATION ZONE

Y = OVERFLOW STRUCTURE HEIGHT = 4.0 FEET

Z = INSIDE SLOPE OF LEVEE = 3

PIPE SLOPE = 8.05 % = 0.0805 FEET/FEET

$$Ls = Y ( Z + 4 ) \left( 1 + \frac{\text{PIPE SLOPE}}{0.25 - \text{PIPE SLOPE}} \right)$$

Ls = 41 FEET

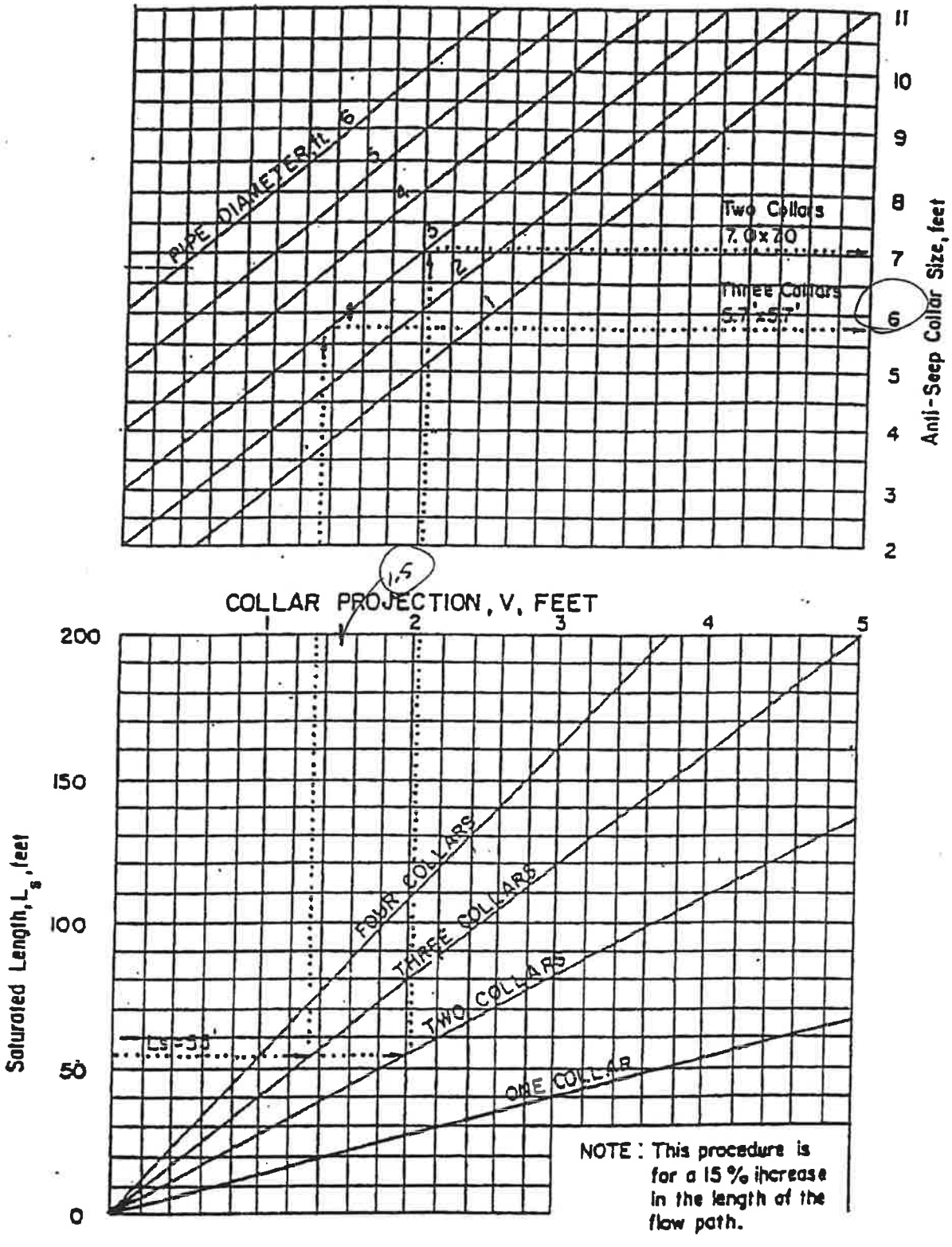
FROM ANTI – SEEP COLLAR DESIGN CHART ON THE NEXT PAGE :

V = COLLAR PROJECTION = 1.5 FEET

DIMENSIONS OF 12" THICK COLLAR = 7.0' × 7.0'

NUMBER OF REQUIRED COLLARS = 2

# ANTI-SEEP COLLAR DESIGN



**g. Overflow Structure Base Foundation Design**

The overflow structure and carrier pipe will be subject to a certain amount of buoyant force when the sediment pond is filled with storm water. In order to overcome this buoyant force and prevent the flotation of the overflow structure and carrier pipe, a concrete overflow structure base foundation and concrete carrier pipe encasement have been designed. The design calculations for the concrete overflow structure base foundation and carrier pipe encasement are included in this section.

**OVERFLOW STRUCTURE BASE FOUNDATION DESIGN**

A certain volume of concrete will be used to overcome the buoyancy of an empty overflow structure and carrier pipe that are below the assumed phreatic water surface. This volume is equal to:

Overflow Structure

= (L)(w)(h)(62.4) L = w = 5.0' inside = 6.0' outside

= (6.0)(6.0)(4.0)(62.4) h = height = 4.0'

= 8,986 #

Carrier Pipe = 3.1416($R_2^2$)(Ls)(62.4) Ls = length in saturation zone = 41'

= 3.1416(1.83)(1.83)(41)(62.4) $R_2$ = outside radius = 22" = 1.83'

= 26,917 # $r_2$ = inside radius = 18" = 1.5'

TOTAL WEIGHT

= 35,903 # x 1.5 (SAFETY FACTOR)

= 53,855 #

TOTAL REVISED VOLUME OF CONCRETE =
TOTAL WEIGHT / WEIGHT OF CONC. IN WATER

= 53,855/87.6 pcf (87.6 pcf = Wt. of conc. in submerged water)

= 615 C.F.

This volume of concrete will be made up from five areas.

1. Overflow Structures
2. Anti-Seep Collars
3. Carrier Pipe
4. Overflow Structure Base
5. Carrier Pipe Encasement

1. Overflow Structure = $(L_2 - l_2)h$

   $(6.0^2 – 5.0^2)(4.0)$ = 44 C.F.

   L = outside dimension of box = 6.0’

   l = inside dimension of box = 5.0’

   h = height of overflow structure = 4.0’

2. Anti-seep collars = area of square collar around carrier pipe x 12" thick x # of collars

   = [( 7.0' x 7.0' ) - $(3.1416)(R_2^2)$]

   x 1' x 2

   = 77 C.F.

   $R_2$ = outside radius of carrier pipe = 22" = 1.83’

   $r_2$ = inside radius of carrier pipe = 18" = 1.5’

3. Carrier Pipe

   = $3.1416 (R_2^2 - r_2^2)$ L = 142 C.F. L = length in saturation = 41’

4. Overflow Structure Base = Volume to handle riser bouyance x 1.2

   = (L)(w)h(62.4)(1.2)/weight of conc. in water

   L = w = 6.0’ outside

   h = height = 4.0’

   = (6.0’)(6.0’)(4.0)(62.4)(1.2)/87.6

   = 123 C.F.

   Use 10' x 10' x 2' = 200.0 C.F.

5. Carrier Pipe Encasement

   Must extend 5’ into dam. Distance from overflow structure to dam is equal to 12.0’. Therefore, minimum encasement length will be 17.0’:

   $[(4.0 \times 6.0) – (3.1416)\ R_2^2] \times 17’$

   Carrier pipe encasement volume = 229 C.F.

**TOTAL REQUIRED VOLUME = 615 C.F.**

Actual Total Volume

| | | |
|---|---|---|
| Overflow Structure | = | 44 C.F. |
| Anti-Seep Collars | = | 77 C.F. |
| Carrier Pipe | = | 142 C.F. |
| Overflow Structure Base | = | 200 C.F. |
| Carrier Pipe Encasement | = | 229 C.F. |
| **TOTAL** | **=** | **692 C.F. ⇒ Okay** |

# 12. PROPOSED SEDIMENT POND NO. 11

## a. Sediment Storage and Settling Efficiency Calculations

As required in the "Alabama Handbook for Erosion Control, Sediment Control and Stormwater Management on Construction Sites and Urban Area", the sediment storage volume of the pond shall be at least 67 cubic yards per acre for the disturbed area draining into the pond (67 cubic yards is equivalent to ½ inch of sediment per acre of drainage area). The peak inflow rate for the 25 year storm event has also been used to calculate the minimum pond surface area needed for adequate settling efficiency. These calculations for the sediment pond are included below.

Sediment Storage Calculation

Assume maximum sediment from 66 disturbed acres.

66 Acres x 67 c.y./acre = 4,422 c.y. = 119,394 c.f.

This sediment volume corresponds to a depth of 0.72' or Elev. 214.72.

Dewatering opening is set at Elev. 217.00. Therefore, ample sediment storage volume is available.

Settling Efficiency Calculations

- Use 25 year storm event, Q25 Flow = 320 cfs
- Minimum Surface Area = .01 acre / cfs x Q25 Flow
  = .01 acre / cfs x 320 cfs
  = 3.20 acres = 139,342 s.f.
- Top of Overflow Structure = Elev. 220.75
  Surface Area @ Elev. 220.75 = 201,900 s.f.
- Adequate surface area is available for settling

# Pond Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022 Thursday, 01 / 30 / 2025

## Pond No. 5 - Pond No. 11

### Pond Data

**Contours -**User-defined contour areas. Average end area method used for volume calculation. Begining Elevation = 214.00 ft

### Stage / Storage Table

| Stage (ft) | Elevation (ft) | Contour area (sqft) | Incr. Storage (cuft) | Total storage (cuft) |
|---|---|---|---|---|
| 0.00 | 214.00 | 160,586 | 0 | 0 |
| 2.00 | 216.00 | 172,587 | 333,173 | 333,173 |
| 3.00 | 217.00 | 178,709 | 175,648 | 508,821 |
| 4.00 | 218.00 | 184,831 | 181,770 | 690,591 |
| 6.00 | 220.00 | 197,176 | 382,007 | 1,072,598 |
| 8.00 | 222.00 | 209,774 | 406,950 | 1,479,548 |
| 10.00 | 224.00 | 222,519 | 432,293 | 1,911,841 |

### Culvert / Orifice Structures

| | [A] | [B] | [C] | [PrfRsr] |
|---|---|---|---|---|
| **Rise (in)** | = 54.00 | 6.00 | 6.00 | Inactive |
| **Span (in)** | = 54.00 | 24.00 | 24.00 | 0.00 |
| **No. Barrels** | = 1 | 2 | 2 | 0 |
| **Invert El. (ft)** | = 215.00 | 217.10 | 219.00 | 0.00 |
| **Length (ft)** | = 75.00 | 0.00 | 0.00 | 0.00 |
| **Slope (%)** | = 4.00 | 0.00 | 0.00 | n/a |
| **N-Value** | = .013 | .013 | .013 | n/a |
| **Orifice Coeff.** | = 0.60 | 0.60 | 0.60 | 0.60 |
| **Multi-Stage** | = n/a | Yes | Yes | No |

### Weir Structures

| | [A] | [B] | [C] | [D] |
|---|---|---|---|---|
| **Crest Len (ft)** | = 28.00 | Inactive | Inactive | Inactive |
| **Crest El. (ft)** | = 220.75 | 0.00 | 0.00 | 0.00 |
| **Weir Coeff.** | = 3.33 | 3.33 | 3.33 | 3.33 |
| **Weir Type** | = 1 | --- | --- | --- |
| **Multi-Stage** | = Yes | No | No | No |

**Exfil.(in/hr)** = 0.000 (by Wet area)

**TW Elev. (ft)** = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).

### Stage / Storage / Discharge Table

| Stage ft | Storage cuft | Elevation ft | Clv A cfs | Clv B cfs | Clv C cfs | PrfRsr cfs | Wr A cfs | Wr B cfs | Wr C cfs | Wr D cfs | Exfil cfs | User cfs | Total cfs |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.00 | 0 | 214.00 | 0.00 | 0.00 | 0.00 | --- | 0.00 | --- | --- | --- | --- | --- | 0.000 |
| 2.00 | 333,173 | 216.00 | 0.00 | 0.00 | 0.00 | --- | 0.00 | --- | --- | --- | --- | --- | 0.000 |
| 3.00 | 508,821 | 217.00 | 0.00 | 0.00 | 0.00 | --- | 0.00 | --- | --- | --- | --- | --- | 0.000 |
| 4.00 | 690,591 | 218.00 | 8.10 ic | 7.76 ic | 0.00 | --- | 0.00 | --- | --- | --- | --- | --- | 7.764 |
| 6.00 | 1,072,598 | 220.00 | 24.02 ic | 15.68 ic | 8.34 ic | --- | 0.00 | --- | --- | --- | --- | --- | 24.02 |
| 8.00 | 1,479,548 | 222.00 | 147.09 ic | 9.91 ic | 9.91 ic | --- | 127.27 s | --- | --- | --- | --- | --- | 147.09 |
| 10.00 | 1,911,841 | 224.00 | 196.86 ic | 3.61 ic | 3.61 ic | --- | 189.59 s | --- | --- | --- | --- | --- | 196.80 |

**b. Total Pond Dewatering at Top of Riser (Elev. 220.75)**

Retention time within the basin is an important factor in effective sediment retention. The overflow structure has been designed as specified below.

Since the overflow structure will have two stages, the dewatering time has been calculated for each stage. Stage 1 calculates the drawdown time of the maximum water surface elevation from the top of the riser to the orifice at elevation 219.00. Stage 2 calculates the drawdown time from the orifice at elevation 219.00 to the orifice at elevation 217.00.

The calculation below has been performed to confirm that the dewatering (retention) time within the pond is between 24 and 72 hours. This dewatering time will ensure the storm water is retained for an adequate length of time to allow the sediment to settle (minimum 24 hours) and is also discharged gradually in an acceptable length of time to allow storage for future storm events (maximum 72 hours).

The dewatering time is calculated as follows:

$$T = \frac{A_s \times (2h)^{1/2}}{A_O \times C_d \times (20{,}428)}$$

$A_O$ = Surface Area of Dewatering Holes ($ft^2$)

$A_s$ = Surface Area Corresponding to top of riser elevation ($ft^2$)

h = Head of water above dewatering hole (ft)

$C_d$ = Coefficient of contraction for an orifice (use 0.6)

T = Time to dewater

**Stage 1**

$T_1$

$A_O$ = 2.0 s.f. @ Elev. 219.00 (2 - 6" x 24" rectangular openings)

$A_s$ = 201,900 s.f. @ Elev. 220.75

h = 220.75 – 219.00 = 1.75'

$$T = \frac{201{,}900\ (2 \times 1.75)^{1/2}}{(2.0)\ (0.6)\ (20{,}428)} = 15.4 \text{ hours}$$

**Stage 2**

$T_2$

$A_O$ = 2.0 s.f. @ Elev. 217.00 (2 – 6" x 24" rectangular opening)

$A_s$ = 191,004 s.f. @ Elev. 219.00 (invert of orifice #2)

h = 219.00 – 217.00 = 2.00'

$$T = \frac{191{,}004\ (2 \times 2.00)^{1/2}}{(2.0)\ (0.6)\ (20{,}428)} = 15.6 \text{ hours}$$

$T_1 + T_2$ = 15.4 + 15.6 = 31.0 hours

**(Okay between 24 - 72 hours)**

**c. Reservoir Routing**

Reservoir routing is determined by using the HydraFlow Hydrographs Extension for AutoCad Civil 3D 2022 Computer Program.

Peak inflow rates (Q) are determined using the SCS Method and HydraFlow Hydrographs Extension for AutoCad Civil 3D 2022 Computer Program. Peak inflow rates are calculated for the 25 year and 100 year storm events and are summarized below.

Q25 = 320 cfs

Q100 = 454 cfs

The bottom of the pond has been set at 214.00. Dewatering of the pond is accomplished by two 6" x 24" rectangular opening beginning at an invert elevation of 217.00 and two 6" x 24" rectangular openings at elevation 219.00.

For routing calculations, a 7' x 7' rectangular riser with two 6" x 24" rectangular openings at an invert elevation of 217.00 and two 6" x 24" rectangular openings at elevation 219.00 were used. The top of the riser is at an elevation of 220.75. The bottom of the pond is elev. 214.00. The invert of the carrier pipe is elev. 215.00. The top of the levee around the sediment pond is at an elevation of 224.00.

The maximum height of sediment is elevation 214.72 which is below the elevation of the first dewatering opening (Elev. 217.00). For routing calculations, the starting water surface elevation was set at 217.00, assuming the remainder of the pond bottom is filled below the dewatering orifice invert elevation.

Based on the above information the reservoir routing calculations are performed and summarized below.

| STORM YEAR | PEAK INFLOW CFS | PEAK OUTFLOW CFS | PEAK ELEV. FEET |
|---|---|---|---|
| 25 | 320 | 26.9 | 220.36 |
| 100 | 454 | 80.2 | 221.40 |

Based on these routing calculations, the riser is large enough and the pond has sufficient storage volume to retain the sediment from 66 disturbed acres plus the 25 year storm event from the entire drainage area below the crest of the riser (elev. 220.75).

# Pond Report



## Pond No. 6 - Pond No. 11 perm pool

### Pond Data

**Contours -**User-defined contour areas. Average end area method used for volume calculation. Begining Elevation = 217.00 ft

### Stage / Storage Table

| Stage (ft) | Elevation (ft) | Contour area (sqft) | Incr. Storage (cuft) | Total storage (cuft) |
|---|---|---|---|---|
| 0.00 | 217.00 | 178,709 | 0 | 0 |
| 1.00 | 218.00 | 184,831 | 181,770 | 181,770 |
| 3.00 | 220.00 | 197,176 | 382,007 | 563,777 |
| 5.00 | 222.00 | 209,774 | 406,950 | 970,727 |
| 7.00 | 224.00 | 222,519 | 432,293 | 1,403,020 |

### Culvert / Orifice Structures

| | [A] | [B] | [C] | [PrfRsr] |
|---|---|---|---|---|
| **Rise (in)** | = 54.00 | 6.00 | 6.00 | Inactive |
| **Span (in)** | = 54.00 | 24.00 | 24.00 | 0.00 |
| **No. Barrels** | = 1 | 2 | 2 | 0 |
| **Invert El. (ft)** | = 215.00 | 217.10 | 219.00 | 0.00 |
| **Length (ft)** | = 75.00 | 0.00 | 0.00 | 0.00 |
| **Slope (%)** | = 4.00 | 0.00 | 0.00 | n/a |
| **N-Value** | = .013 | .013 | .013 | n/a |
| **Orifice Coeff.** | = 0.60 | 0.60 | 0.60 | 0.60 |
| **Multi-Stage** | = n/a | Yes | Yes | No |

### Weir Structures

| | [A] | [B] | [C] | [D] |
|---|---|---|---|---|
| **Crest Len (ft)** | = 28.00 | Inactive | Inactive | Inactive |
| **Crest El. (ft)** | = 220.75 | 0.00 | 0.00 | 0.00 |
| **Weir Coeff.** | = 3.33 | 3.33 | 3.33 | 3.33 |
| **Weir Type** | = 1 | --- | --- | --- |
| **Multi-Stage** | = Yes | No | No | No |

**Exfil.(in/hr)** = 0.000 (by Wet area)

**TW Elev. (ft)** = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).

### Stage / Storage / Discharge Table

| Stage ft | Storage cuft | Elevation ft | Clv A cfs | Clv B cfs | Clv C cfs | PrfRsr cfs | Wr A cfs | Wr B cfs | Wr C cfs | Wr D cfs | Exfil cfs | User cfs | Total cfs |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.00 | 0 | 217.00 | 0.00 | 0.00 | 0.00 | --- | 0.00 | --- | --- | --- | --- | --- | 0.000 |
| 1.00 | 181,770 | 218.00 | 32.95 ic | 7.76 ic | 0.00 | --- | 0.00 | --- | --- | --- | --- | --- | 7.764 |
| 3.00 | 563,777 | 220.00 | 32.95 ic | 15.68 ic | 8.34 ic | --- | 0.00 | --- | --- | --- | --- | --- | 24.02 |
| 5.00 | 970,727 | 222.00 | 147.09 ic | 9.91 ic | 9.91 ic | --- | 127.27 s | --- | --- | --- | --- | --- | 147.09 |
| 7.00 | 1,403,020 | 224.00 | 196.86 ic | 3.61 ic | 3.61 ic | --- | 189.62 s | --- | --- | --- | --- | --- | 196.84 |

# Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022

| Hyd. No. | Hydrograph type (origin) | Peak flow (cfs) | Time interval (min) | Time to Peak (min) | Hyd. volume (cuft) | Inflow hyd(s) | Maximum elevation (ft) | Total strge used (cuft) | Hydrograph Description |
|---|---|---|---|---|---|---|---|---|---|
| 35 | SCS Runoff | 11.09 | 1 | 725 | 36,027 | ------ | ------ | ------ | Area to DD17 |
| 36 | Combine | 53.55 | 1 | 724 | 165,837 | 34, 35 | ------ | ------ | DD17 |
| 37 | SCS Runoff | 6.659 | 1 | 737 | 32,332 | ------ | ------ | ------ | Area to Ditch No. 4 |
| 38 | Combine | 202.19 | 1 | 725 | 737,162 | 23, 36, 37 | ------ | ------ | Ditch No. 4 |
| 39 | SCS Runoff | 5.358 | 1 | 733 | 23,779 | ------ | ------ | ------ | DD18 |
| 40 | SCS Runoff | 6.865 | 1 | 723 | 20,015 | ------ | ------ | ------ | Area to DD19 |
| 41 | Combine | 10.40 | 1 | 724 | 43,794 | 39, 40 | ------ | ------ | DD19 |
| 42 | SCS Runoff | 8.919 | 1 | 723 | 26,003 | ------ | ------ | ------ | Area to DD20 |
| 43 | Combine | 19.19 | 1 | 724 | 69,797 | 41, 42 | ------ | ------ | DD20 |
| 44 | SCS Runoff | 9.568 | 1 | 725 | 29,814 | ------ | ------ | ------ | Area to DD21 |
| 45 | Combine | 28.75 | 1 | 724 | 99,611 | 43, 44 | ------ | ------ | DD21 |
| 46 | SCS Runoff | 12.40 | 1 | 725 | 38,635 | ------ | ------ | ------ | DD22 |
| 47 | SCS Runoff | 11.95 | 1 | 725 | 37,224 | ------ | ------ | ------ | Area to DD23 |
| 48 | Combine | 24.34 | 1 | 725 | 75,859 | 46, 47 | ------ | ------ | DD23 |
| 49 | SCS Runoff | 12.94 | 1 | 725 | 42,032 | ------ | ------ | ------ | Area to DD24 |
| 50 | Combine | 37.29 | 1 | 725 | 117,891 | 48, 49 | ------ | ------ | DD24 |
| 51 | SCS Runoff | 14.89 | 1 | 725 | 48,370 | ------ | ------ | ------ | Area to DD25 |
| 52 | Combine | 52.18 | 1 | 725 | 166,261 | 50, 51 | ------ | ------ | DD25 |
| 53 | Combine | 282.51 | 1 | 725 | 1,003,034 | 38, 45, 52 | ------ | ------ | DI. 1101 |
| 54 | SCS Runoff | 38.13 | 1 | 722 | 104,566 | ------ | ------ | ------ | Area to Pond No. 11 |
| 55 | Combine | 320.43 | 1 | 725 | 1,139,858 | 53, 54 | ------ | ------ | Pond No. 11 Total Inflow |
| 56 | Reservoir | 26.85 | 1 | 810 | 1,109,307 | 55 | 220.36 | 637,084 | Pond No. 11 perm pool |
| 57 | Reservoir | 151.67 | 1 | 740 | 1,139,856 | 55 | 222.20 | 300,066 | Pond No. 11 riser |

# Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022

| Hyd. No. | Hydrograph type (origin) | Peak flow (cfs) | Time interval (min) | Time to Peak (min) | Hyd. volume (cuft) | Inflow hyd(s) | Maximum elevation (ft) | Total strge used (cuft) | Hydrograph Description |
|---|---|---|---|---|---|---|---|---|---|
| 35 | SCS Runoff | 15.73 | 1 | 725 | 51,727 | ------ | ------ | ------ | Area to DD17 |
| 36 | Combine | 75.87 | 1 | 724 | 238,106 | 34, 35 | ------ | ------ | DD17 |
| 37 | SCS Runoff | 9.453 | 1 | 736 | 46,422 | ------ | ------ | ------ | Area to Ditch No. 4 |
| 38 | Combine | 287.24 | 1 | 725 | 1,058,406 | 23, 36, 37 | ------ | ------ | Ditch No. 4 |
| 39 | SCS Runoff | 7.608 | 1 | 733 | 34,141 | ------ | ------ | ------ | DD18 |
| 40 | SCS Runoff | 9.730 | 1 | 723 | 28,737 | ------ | ------ | ------ | Area to DD19 |
| 41 | Combine | 14.81 | 1 | 724 | 62,879 | 39, 40 | ------ | ------ | DD19 |
| 42 | SCS Runoff | 12.64 | 1 | 723 | 37,334 | ------ | ------ | ------ | Area to DD20 |
| 43 | Combine | 27.24 | 1 | 724 | 100,213 | 41, 42 | ------ | ------ | DD20 |
| 44 | SCS Runoff | 13.56 | 1 | 724 | 42,807 | ------ | ------ | ------ | Area to DD21 |
| 45 | Combine | 40.80 | 1 | 724 | 143,019 | 43, 44 | ------ | ------ | DD21 |
| 46 | SCS Runoff | 17.57 | 1 | 724 | 55,472 | ------ | ------ | ------ | DD22 |
| 47 | SCS Runoff | 16.93 | 1 | 724 | 53,445 | ------ | ------ | ------ | Area to DD23 |
| 48 | Combine | 34.50 | 1 | 724 | 108,917 | 46, 47 | ------ | ------ | DD23 |
| 49 | SCS Runoff | 18.36 | 1 | 725 | 60,349 | ------ | ------ | ------ | Area to DD24 |
| 50 | Combine | 52.80 | 1 | 725 | 169,265 | 48, 49 | ------ | ------ | DD24 |
| 51 | SCS Runoff | 21.12 | 1 | 725 | 69,449 | ------ | ------ | ------ | Area to DD25 |
| 52 | Combine | 73.92 | 1 | 725 | 238,714 | 50, 51 | ------ | ------ | DD25 |
| 53 | Combine | 401.00 | 1 | 725 | 1,440,139 | 38, 45, 52 | ------ | ------ | DI. 1101 |
| 54 | SCS Runoff | 53.98 | 1 | 722 | 150,135 | ------ | ------ | ------ | Area to Pond No. 11 |
| 55 | Combine | 454.38 | 1 | 725 | 1,636,586 | 53, 54 | ------ | ------ | Pond No. 11 Total Inflow |
| 56 | Reservoir | 80.20 | 1 | 757 | 1,604,348 | 55 | 221.40 | 849,414 | Pond No. 11 perm pool |
| 57 | Reservoir | 174.96 | 1 | 744 | 1,636,585 | 55 | 222.88 | 447,280 | Pond No. 11 riser |

**d. Emergency Spillway**

Worst Case

Assume the dewatering opening in the overflow structure is not operating and the starting water surface elevation is at the top of the riser (220.75) at the start of a 100 year storm event.

| | | |
|---|---|---|
| Top of Pond | = | 224.00 |
| Less Required Freeboard | = | 1.00 |
| Maximum Allowable Water Surface Elevation in Emergency Spillway | = | 223.00 |

Re-route the 100 year storm event through the 7' x 7' square overflow structure and 54" diameter carrier pipe.

From Hydrograph Summary Report, Line 57, the maximum flow out of the pond will be 175 cfs. The maximum water surface elevation is 222.88, which is less than the maximum allowable water surface elevation of 223.00.

Therefore, the overflow structure and carrier pipe will safely pass the 100 year storm event with a starting water surface elevation at 220.75.

# Pond Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022 Thursday, 01 / 30 / 2025

## Pond No. 7 - Pond No. 11 riser

### Pond Data

**Contours -**User-defined contour areas. Average end area method used for volume calculation. Begining Elevation = 220.75 ft

### Stage / Storage Table

| Stage (ft) | Elevation (ft) | Contour area (sqft) | Incr. Storage (cuft) | Total storage (cuft) |
|---|---|---|---|---|
| 0.00 | 220.75 | 201,900 | 0 | 0 |
| 1.25 | 222.00 | 209,774 | 257,296 | 257,296 |
| 3.25 | 224.00 | 222,519 | 432,293 | 689,589 |

### Culvert / Orifice Structures

| | [A] | [B] | [C] | [PrfRsr] |
|---|---|---|---|---|
| **Rise (in)** | = 54.00 | Inactive | Inactive | Inactive |
| **Span (in)** | = 54.00 | 0.00 | 0.00 | 0.00 |
| **No. Barrels** | = 1 | 1 | 0 | 0 |
| **Invert El. (ft)** | = 215.00 | 0.00 | 0.00 | 0.00 |
| **Length (ft)** | = 75.00 | 0.00 | 0.00 | 0.00 |
| **Slope (%)** | = 4.00 | 0.00 | 0.00 | n/a |
| **N-Value** | = .013 | .013 | .013 | n/a |
| **Orifice Coeff.** | = 0.60 | 0.60 | 0.60 | 0.60 |
| **Multi-Stage** | = n/a | No | No | No |

### Weir Structures

| | [A] | [B] | [C] | [D] |
|---|---|---|---|---|
| **Crest Len (ft)** | = 28.00 | Inactive | Inactive | Inactive |
| **Crest El. (ft)** | = 220.75 | 0.00 | 0.00 | 0.00 |
| **Weir Coeff.** | = 3.33 | 3.33 | 3.33 | 3.33 |
| **Weir Type** | = 1 | --- | --- | --- |
| **Multi-Stage** | = Yes | No | No | No |

**Exfil.(in/hr)** = 0.000 (by Wet area)

**TW Elev. (ft)** = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).

### Stage / Storage / Discharge Table

| Stage ft | Storage cuft | Elevation ft | Clv A cfs | Clv B cfs | Clv C cfs | PrfRsr cfs | Wr A cfs | Wr B cfs | Wr C cfs | Wr D cfs | Exfil cfs | User cfs | Total cfs |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.00 | 0 | 220.75 | 0.00 | --- | --- | --- | 0.00 | --- | --- | --- | --- | --- | 0.000 |
| 1.25 | 257,296 | 222.00 | 143.25 ic | --- | --- | --- | 130.31 | --- | --- | --- | --- | --- | 130.31 |
| 3.25 | 689,589 | 224.00 | 196.65 ic | --- | --- | --- | 196.63 s | --- | --- | --- | --- | --- | 196.63 |

# Hydrograph Summary Report

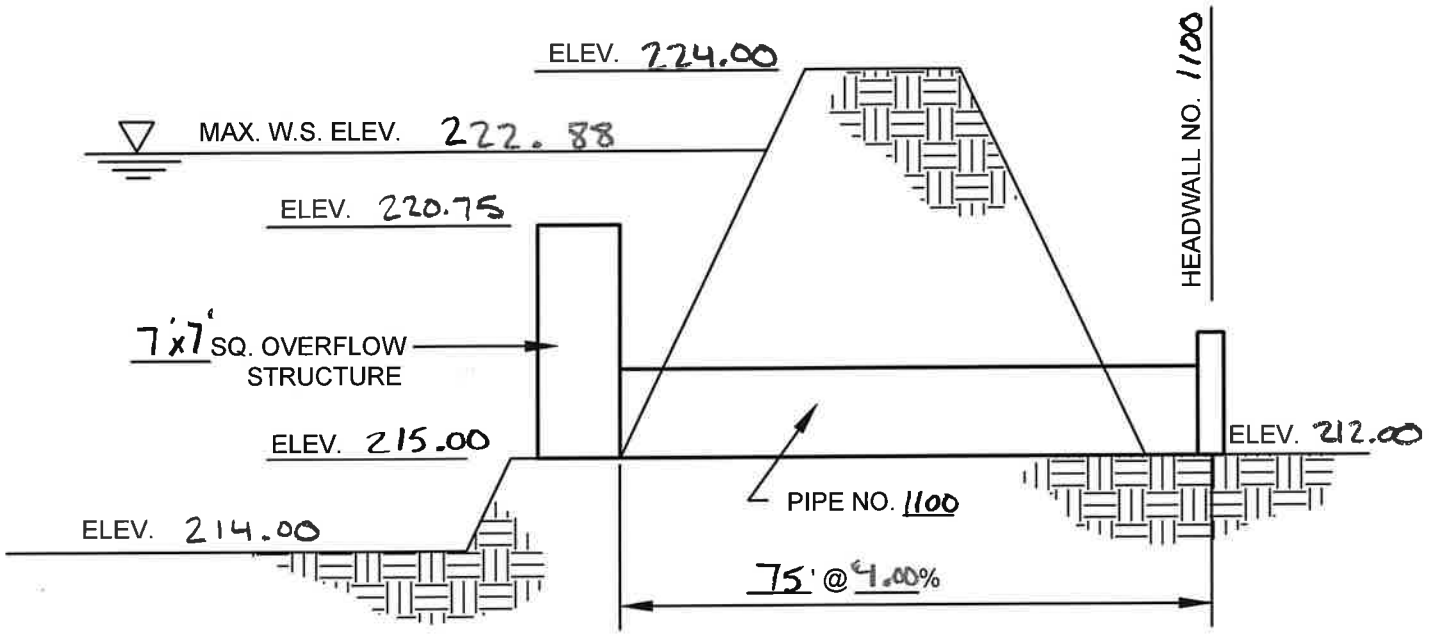
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022

| Hyd. No. | Hydrograph type (origin) | Peak flow (cfs) | Time interval (min) | Time to Peak (min) | Hyd. volume (cuft) | Inflow hyd(s) | Maximum elevation (ft) | Total strge used (cuft) | Hydrograph Description |
|---|---|---|---|---|---|---|---|---|---|
| 35 | SCS Runoff | 15.73 | 1 | 725 | 51,727 | ------ | ------ | ------ | Area to DD17 |
| 36 | Combine | 75.87 | 1 | 724 | 238,106 | 34, 35 | ------ | ------ | DD17 |
| 37 | SCS Runoff | 9.453 | 1 | 736 | 46,422 | ------ | ------ | ------ | Area to Ditch No. 4 |
| 38 | Combine | 287.24 | 1 | 725 | 1,058,406 | 23, 36, 37 | ------ | ------ | Ditch No. 4 |
| 39 | SCS Runoff | 7.608 | 1 | 733 | 34,141 | ------ | ------ | ------ | DD18 |
| 40 | SCS Runoff | 9.730 | 1 | 723 | 28,737 | ------ | ------ | ------ | Area to DD19 |
| 41 | Combine | 14.81 | 1 | 724 | 62,879 | 39, 40 | ------ | ------ | DD19 |
| 42 | SCS Runoff | 12.64 | 1 | 723 | 37,334 | ------ | ------ | ------ | Area to DD20 |
| 43 | Combine | 27.24 | 1 | 724 | 100,213 | 41, 42 | ------ | ------ | DD20 |
| 44 | SCS Runoff | 13.56 | 1 | 724 | 42,807 | ------ | ------ | ------ | Area to DD21 |
| 45 | Combine | 40.80 | 1 | 724 | 143,019 | 43, 44 | ------ | ------ | DD21 |
| 46 | SCS Runoff | 17.57 | 1 | 724 | 55,472 | ------ | ------ | ------ | DD22 |
| 47 | SCS Runoff | 16.93 | 1 | 724 | 53,445 | ------ | ------ | ------ | Area to DD23 |
| 48 | Combine | 34.50 | 1 | 724 | 108,917 | 46, 47 | ------ | ------ | DD23 |
| 49 | SCS Runoff | 18.36 | 1 | 725 | 60,349 | ------ | ------ | ------ | Area to DD24 |
| 50 | Combine | 52.80 | 1 | 725 | 169,265 | 48, 49 | ------ | ------ | DD24 |
| 51 | SCS Runoff | 21.12 | 1 | 725 | 69,449 | ------ | ------ | ------ | Area to DD25 |
| 52 | Combine | 73.92 | 1 | 725 | 238,714 | 50, 51 | ------ | ------ | DD25 |
| 53 | Combine | 401.00 | 1 | 725 | 1,440,139 | 38, 45, 52 | ------ | ------ | DI. 1101 |
| 54 | SCS Runoff | 53.98 | 1 | 722 | 150,135 | ------ | ------ | ------ | Area to Pond No. 11 |
| 55 | Combine | 454.38 | 1 | 725 | 1,636,586 | 53, 54 | ------ | ------ | Pond No. 11 Total Inflow |
| 56 | Reservoir | 80.20 | 1 | 757 | 1,604,348 | 55 | 221.40 | 849,414 | Pond No. 11 perm pool |
| 57 | Reservoir | 174.96 | 1 | 744 | 1,636,585 | 55 | 222.88 | 447,280 | Pond No. 11 riser |

**e. Overflow Structure and Carrier Pipe Design**

In order to confirm that the overflow structure, carrier pipe and emergency spillway pipe have been designed adequately to pass the maximum flow as modeled in the HydraFlow Hydrographs Extension for AutoCad Civil 3D 2022 Computer Program, the following design calculations have been included.

# OVERFLOW STRUCTURE NO. 11




# DESIGN OF OVERFLOW STRUCTURE AS EMERGENCY SPILLWAY

FLOW (Q) WORST CASE = 100 YEAR STORM EVENT OCCURS WHEN WATER SURFACE ELEVATION AT TOP OF OVERFLOW STRUCTURE AND ALL DEWATERING HOLES ARE PLUGGED

FLOW (Q) MAXIMUM = 175 CFS

HEAD (H) MAXIMUM = MAXIMUM WATER SURFACE ELEVATION WITH 1' OF FREEBOARD MINUS THE ELEVATION AT THE CREST OF THE OVERFLOW STRUCTURE

= 222.88 - 220.75 = 2.13 FEET

BASED ON ABOVE HEAD, USE 7'x 7 ' SQ. OVERFLOW STRUCTURE

(SEE CHART ON NEXT PAGE)

## WEIR FLOW (Q) OVER RISER CREST FOR CIRCULAR RISERS WITH TRASH RACK

$Q = CLh^{3/2}$

$Q = 3.1 \times (\pi) \times (D/12) \times h^{3/2}$

Table 6-22.2

| HEAD-h in feet | Riser Diameter ($D_r$) in inches | | | | | | | | HEAD-h in feet |
|---|---|---|---|---|---|---|---|---|---|
| | 12 | 18 | 24 | 30 | 36 | 48 | 54 | 60 | |
| | Flow in Cubic Feet Per Second | | | | | | | | |
| 0.1 | 0.3 | 0.5 | 0.6 | 0.8 | 0.9 | 1.2 | 1.4 | 1.5 | 0.1 |
| 0.2 | 0.9 | 1.3 | 1.7 | 2.2 | 2.6 | 3.5 | 3.9 | 4.4 | 0.2 |
| 0.3 | 1.6 | 2.4 | 3.2 | 4.0 | 4.8 | 6.4 | 7.2 | 8.0 | 0.3 |
| 0.4 | 2.5 | 3.7 | 4.9 | 6.2 | 7.4 | 9.9 | 11.1 | 12.3 | 0.4 |
| 0.6 | 4.5 | 6.8 | 9.1 | 11.3 | 13.6 | 18.1 | 20.4 | 22.6 | 0.6 |
| 0.8 | | 10.5 | 13.9 | 17.4 | 20.9 | 27.9 | 31.4 | 34.8 | 0.8 |
| 1.0 | | | 19.5 | 24.3 | 29.2 | 39.0 | 43.8 | 48.7 | 1.0 |
| 1.2 | | | 25.6 | 32.0 | 38.4 | 51.2 | 57.6 | 64.0 | 1.2 |
| 1.4 | | | | 40.3 | 48.4 | 64.5 | 72.6 | 80.7 | 1.4 |
| 1.6 | | | | 49.3 | 59.1 | 78.8 | 88.7 | 98.6 | 1.6 |
| 1.8 | | | | | 70.6 | 94.1 | 105.8 | 117.6 | 1.8 |
| 2.0 | | | | | 82.6 | 110.2 | 124.0 | 137.7 | 2.0 |
| 2.2 | | | | | | 127.1 | 143.0 | 158.9 | 2.2 |
| 2.4 | | | | | | | 162.9 | 181.0 | 2.4 |
| 2.6 | | | | | | | 183.7 | 204.1 | 2.6 |
| 2.8 | | | | | | | | 228.1 | 2.8 |
| 3.0 | | | | | | | | 253.0 | 3.0 |

### Pipe, Riser, and Trash Rack Proportions

Eq. 6-10 $D_r \geq (1.50)\ (D_{ps})$

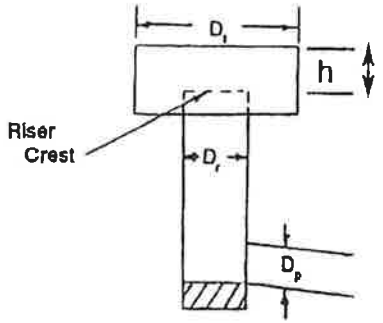
where $D_r$ = diameter of riser

$D_{ps}$ = diameter of principal spillway

Eq. 6-11 $D_t \geq (1.4)\ (D_r)$

where $D_t$ = diameter of trash rack

$D_r$ = diameter of riser




EXAMPLE: The peak runoff for a 2-year, 24-hour rain is 32 cfs. Select a pipe size for a head of 12 feet and length of 100 feet. From Table 6-15.1, 38.2 x 0.89 = 34 cfs discharge for a 24-inch diameter pipe.

Using Equation 6-10 $D_r \geq (1.5)\ (D_p)$

$D_r \geq (1.5)\ (24) \geq$ 36 inch diameter riser

Using Equation 6-11 $D_t \geq (1.4)\ (D_r)$

$D_t \geq (1.4)\ (36) \geq$ 50 inch diameter (Use 54 inch)

Determine h - From Table 6-15.2

Q = 34 cfs $D_r$ = 36" h = 1.2'

NOTE: h = minimum distance between the crest of the riser and the crest of the emergency spillway.

# CARRIER PIPE NO. 1100

Q = 175 CFS WORST CASE

MAXIMUM HEADWATER = TOP OF LEEVE ELEVATION MINUS 1' FREEBOARD
= 224.00 - 1.00 = 223.00

HEAD (H) = MAXIMUM WATER ELEVATION ALLOWED MINUS THE CENTERLINE ELEVATION AT THE DOWNSTREAM END OF THE CARRIER PIPE
= 223.00 - 214.25 = 8.75

LENGTH (L) = 75

LENGTH FACTOR = 1.0 FOR LENGTHS OTHER THAN 70'

Q (AVAILABLE) = Q FROM TABLE TIMES LENGTH FACTOR
= 271 X 1.0 = 271.0

Q (AVAILABLE) MUST BE GREATER THAN Q WORST CASE

**USE 54 " DIAMETER RCP CARRIER PIPE**

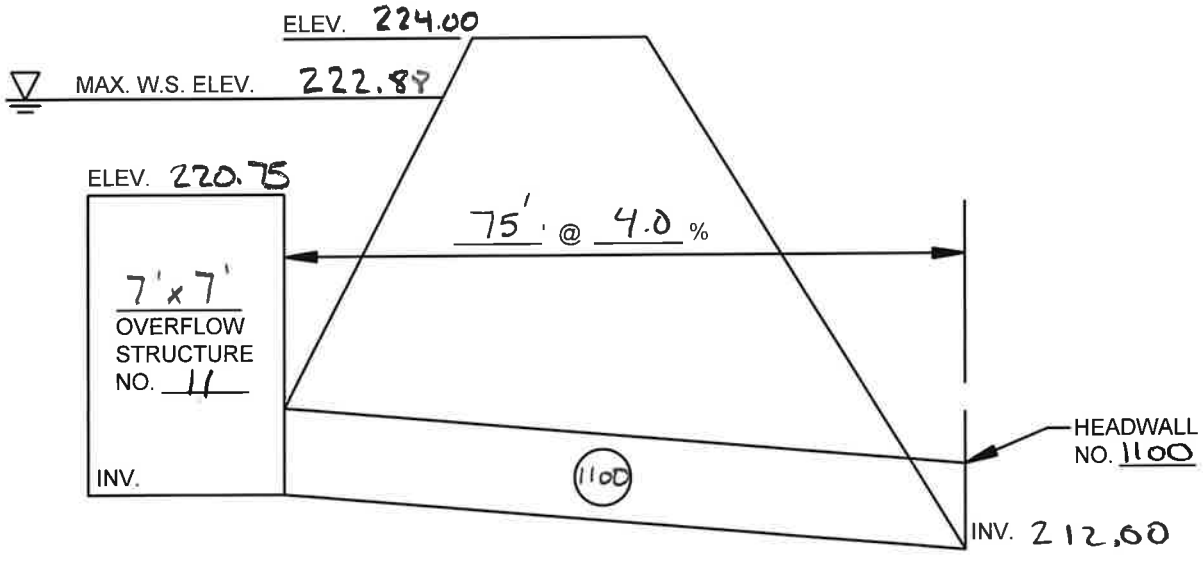


Table 6-25

## PIPE FLOW CHART n = 0.025

FOR CORRUGATED METAL PIPE INLET $K_a = K_e + K_b = 1.0$ AND 70 FEET OF CORRUGATED METAL PIPE CONDUIT (full flow assumed)

Note correction factors for pipe lengths other than 70 feet

diameter of pipe in inches

| H, in feet | 12" | 15" | 18" | 21" | 24" | 30" | 36" | 42" | 48" | 54" | 60" | 66" | 72" | 78" | 84" | 90" | 96" | 102" |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3.22 | 5.44 | 8.29 | 11.8 | 15.9 | 26.0 | 38.8 | 53.8 | 71.4 | 91.5 | 114 | 139 | 167 | 197 | 229 | 264 | 302 | 342 |
| 2 | 4.55 | 7.69 | 11.7 | 16.7 | 22.5 | 36.8 | 54.8 | 76.0 | 101 | 129 | 161 | 197 | 236 | 278 | 324 | 374 | 427 | 483 |
| 3 | 5.57 | 9.42 | 14.4 | 20.4 | 27.5 | 45.0 | 66.9 | 93.1 | 124 | 159 | 198 | 241 | 289 | 341 | 397 | 458 | 523 | 592 |
| 4 | 6.43 | 10.9 | 16.6 | 23.5 | 31.8 | 52.0 | 77.3 | 108 | 143 | 183 | 228 | 278 | 334 | 394 | 459 | 529 | 604 | 683 |
| 5 | 7.19 | 12.2 | 18.5 | 26.3 | 35.5 | 58.1 | 86.4 | 120 | 160 | 205 | 255 | 311 | 373 | 440 | 513 | 591 | 675 | 764 |
| 6 | 7.88 | 13.3 | 20.3 | 28.8 | 38.9 | 67.7 | 94.6 | 132 | 175 | 224 | 280 | 341 | 409 | 482 | 562 | 647 | 739 | 837 |
| 7 | 8.51 | 14.4 | 21.9 | 31.1 | 42.0 | 68.8 | 102 | 142 | 189 | 242 | 302 | 368 | 441 | 521 | 607 | 699 | 798 | 904 |
| 8 | 9.10 | 15.4 | 23.5 | 33.3 | 44.9 | 73.5 | 109 | 152 | 202 | 259 | 323 | 394 | 472 | 557 | 685 | 748 | 854 | 966 |
| 9 | 9.65 | 16.3 | 24.9 | 35.3 | 47.7 | 78.0 | 116 | 161 | 214 | 275 | 342 | 418 | 500 | 590 | 688 | 793 | 905 | 1025 |
| 10 | 10.2 | 17.2 | 26.2 | 37.2 | 50.2 | 82.2 | 122 | 170 | 226 | 289 | 361 | 440 | 527 | 622 | 725 | 836 | 954 | 1080 |
| 11 | 10.7 | 18.0 | 27.5 | 39.0 | 52.7 | 86.2 | 128 | 178 | 237 | 304 | 379 | 462 | 553 | 653 | 761 | 877 | 1001 | 1133 |
| 12 | 11.1 | 18.9 | 28.7 | 40.8 | 55.0 | 90.1 | 134 | 188 | 247 | 317 | 395 | 482 | 578 | 682 | 794 | 916 | 1046 | 1184 |
| 13 | 11.6 | 19.6 | 29.9 | 42.4 | 57.3 | 93.7 | 139 | 194 | 257 | 330 | 411 | 502 | 601 | 710 | 827 | 953 | 1088 | 1232 |
| 14 | 12.0 | 20.4 | 31.0 | 44.1 | 59.4 | 97.3 | 145 | 201 | 267 | 342 | 427 | 521 | 624 | 736 | 858 | 989 | 1129 | 1278 |
| 15 | 12.5 | 21.1 | 32.1 | 45.6 | 61.5 | 101 | 150 | 208 | 277 | 354 | 442 | 539 | 646 | 762 | 886 | 1024 | 1169 | 1323 |
| 16 | 12.9 | 21.8 | 33.2 | 47.1 | 63.5 | 104 | 155 | 215 | 286 | 366 | 457 | 557 | 667 | 787 | 917 | 1057 | 1207 | 1367 |
| 17 | 13.3 | 22.4 | 34.2 | 48.5 | 65.5 | 107 | 159 | 222 | 294 | 377 | 471 | 574 | 688 | 812 | 946 | 1090 | 1244 | 1409 |
| 18 | 13.7 | 23.1 | 35.2 | 49.9 | 67.4 | 110 | 164 | 228 | 303 | 388 | 484 | 591 | 708 | 835 | 973 | 1121 | 1280 | 1450 |
| 19 | 14.0 | 23.8 | 36.1 | 51.3 | 69.2 | 113 | 168 | 234 | 311 | 399 | 497 | 607 | 727 | 858 | 1000 | 1152 | 1315 | 1489 |
| 20 | 14.4 | 24.3 | 37.1 | 52.6 | 71.0 | 116 | 173 | 240 | 319 | 409 | 510 | 623 | 746 | 880 | 1028 | 1182 | 1350 | 1528 |
| 21 | 14.7 | 24.9 | 38.0 | 53.9 | 72.8 | 119 | 177 | 246 | 327 | 419 | 523 | 638 | 764 | 902 | 1051 | 1211 | 1383 | 1566 |
| 22 | 15.1 | 25.5 | 38.9 | 55.2 | 74.5 | 122 | 181 | 252 | 335 | 429 | 535 | 653 | 782 | 923 | 1076 | 1240 | 1415 | 1603 |
| 23 | 15.4 | 26.1 | 39.8 | 56.5 | 76.2 | 125 | 186 | 258 | 342 | 439 | 547 | 668 | 800 | 944 | 1100 | 1268 | 1447 | 1639 |
| 24 | 15.8 | 26.7 | 40.6 | 57.7 | 77.8 | 127 | 189 | 263 | 350 | 448 | 559 | 682 | 817 | 964 | 1123 | 1295 | 1478 | 1674 |
| 25 | 16.1 | 27.2 | 41.5 | 58.9 | 79.4 | 130 | 193 | 269 | 357 | 458 | 571 | 698 | 834 | 984 | 1147 | 1322 | 1509 | 1708 |
| 26 | 16.4 | 27.7 | 42.3 | 60.0 | 81.0 | 133 | 197 | 274 | 364 | 467 | 582 | 710 | 850 | 1004 | 1169 | 1348 | 1539 | 1742 |
| 27 | 16.7 | 28.3 | 43.1 | 61.2 | 82.5 | 135 | 201 | 279 | 371 | 476 | 593 | 723 | 867 | 1023 | 1192 | 1373 | 1568 | 1775 |
| 28 | 17.0 | 28.8 | 43.9 | 62.3 | 84.1 | 138 | 204 | 285 | 378 | 484 | 604 | 737 | 883 | 1041 | 1214 | 1399 | 1597 | 1808 |
| 29 | 17.3 | 29.3 | 44.7 | 63.4 | 85.5 | 140 | 208 | 290 | 384 | 493 | 615 | 750 | 898 | 1060 | 1235 | 1423 | 1625 | 1840 |
| 30 | 17.6 | 29.8 | 45.4 | 64.5 | 87.0 | 142 | 212 | 294 | 391 | 501 | 625 | 763 | 913 | 1078 | 1256 | 1448 | 1653 | 1871 |
| L, in feet | Correction Factors For Other Pipe Lengths | | | | | | | | | | | | | | | | | |
| 20 | 1.30 | 1.24 | 1.21 | 1.18 | 1.16 | 1.12 | 1.10 | 1.08 | 1.07 | 1.06 | 1.05 | 1.05 | 1.04 | 1.04 | 1.03 | 1.03 | 1.03 | 1.03 |
| 30 | 1.22 | 1.18 | 1.15 | 1.13 | 1.12 | 1.09 | 1.08 | 1.06 | 1.05 | 1.05 | 1.04 | 1.04 | 1.03 | 1.03 | 1.03 | 1.02 | 1.02 | 1.02 |
| 40 | 1.15 | 1.13 | 1.11 | 1.10 | 1.08 | 1.07 | 1.05 | 1.05 | 1.04 | 1.03 | 1.03 | 1.03 | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 |
| 50 | 1.09 | 1.08 | 1.07 | 1.06 | 1.05 | 1.04 | 1.04 | 1.03 | 1.03 | 1.02 | 1.02 | 1.02 | 1.02 | 1.01 | 1.01 | 1.01 | 1.01 | 1.01 |
| 60 | 1.04 | 1.04 | 1.03 | 1.03 | 1.03 | 1.02 | 1.02 | 1.02 | 1.01 | 1.01 | 1.01 | 1.01 | 1.01 | 1.01 | 1.01 | 1.01 | 1.01 | 1.01 |
| 70 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 80 | .98 | .97 | .97 | .97 | .98 | .98 | .98 | .99 | .99 | .99 | .99 | .98 | .99 | .99 | .99 | .99 | .99 | .99 |
| 90 | .93 | .94 | .94 | .95 | .95 | .96 | .97 | .97 | .98 | .98 | .98 | .98 | .98 | .99 | .99 | .99 | .99 | .99 |
| 100 | .90 | .91 | .92 | .93 | .93 | .95 | .95 | .96 | .97 | .97 | .97 | .98 | .98 | .98 | .98 | .98 | .98 | .99 |
| 120 | .84 | .86 | .87 | .89 | .90 | .91 | .93 | .94 | .94 | .95 | .96 | .96 | .96 | .97 | .97 | .97 | .97 | .98 |
| 140 | .80 | .82 | .83 | .85 | .86 | .88 | .90 | .91 | .92 | .93 | .94 | .94 | .95 | .95 | .96 | .96 | .96 | .97 |
| 160 | .76 | .78 | .80 | .82 | .83 | .86 | .88 | .89 | .90 | .91 | .92 | .93 | .94 | .94 | .95 | .95 | .95 | .96 |

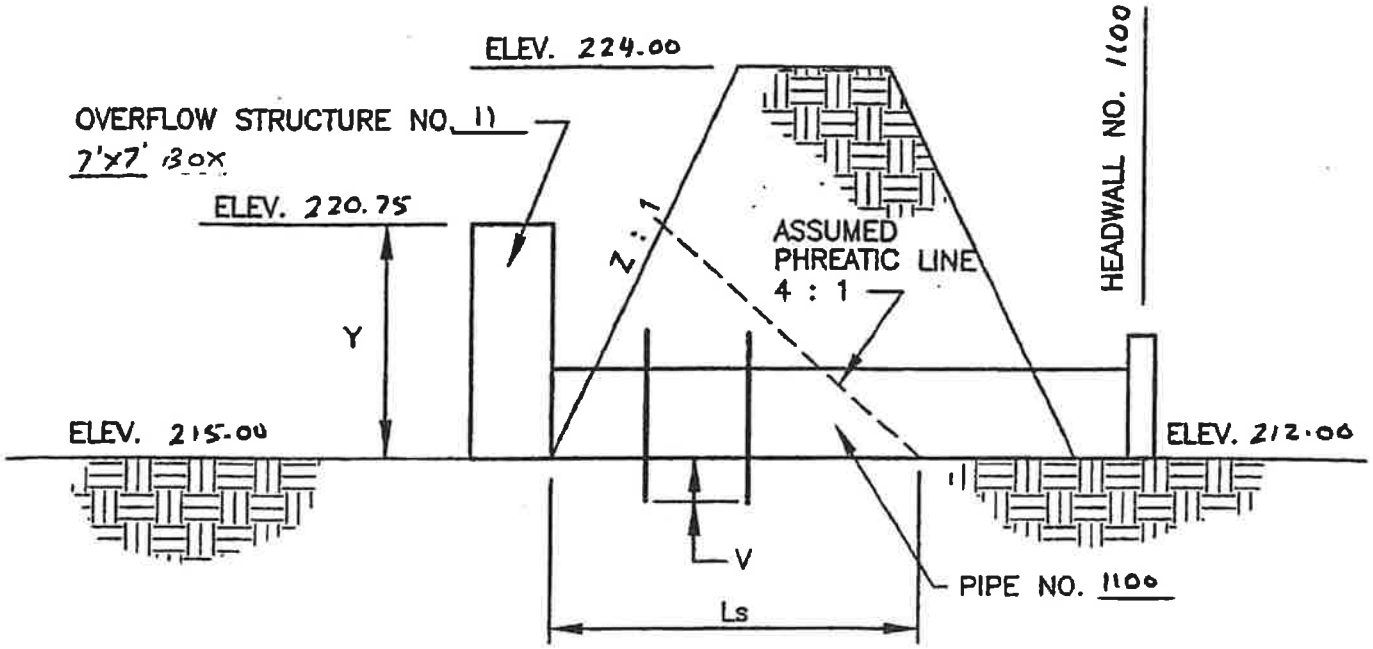
Source: USDA - SCS

**f. Anti-Seep Collar Design**

The seepage of water through the existing sediment pond dam along the carrier pipe could result in dam failure.

The proposed anti-seep collars have been designed to be located at intervals within the zone of saturation along the carrier pipe to increase the seepage length along the carrier pipe and thereby prevent piping or seepage along the carrier pipe.

# ANTI – SEEP COLLAR DESIGN




Ls = LENGTH IN SATURATION ZONE

Y = OVERFLOW STRUCTURE HEIGHT = 5.75 FEET

Z = INSIDE SLOPE OF LEVEE = 3

PIPE SLOPE = 4.0 % = 0.040 FEET/FEET

$$Ls = Y ( Z + 4 ) \left( 1 + \frac{\text{PIPE SLOPE}}{0.25 - \text{PIPE SLOPE}} \right)$$

Ls = 48 FEET

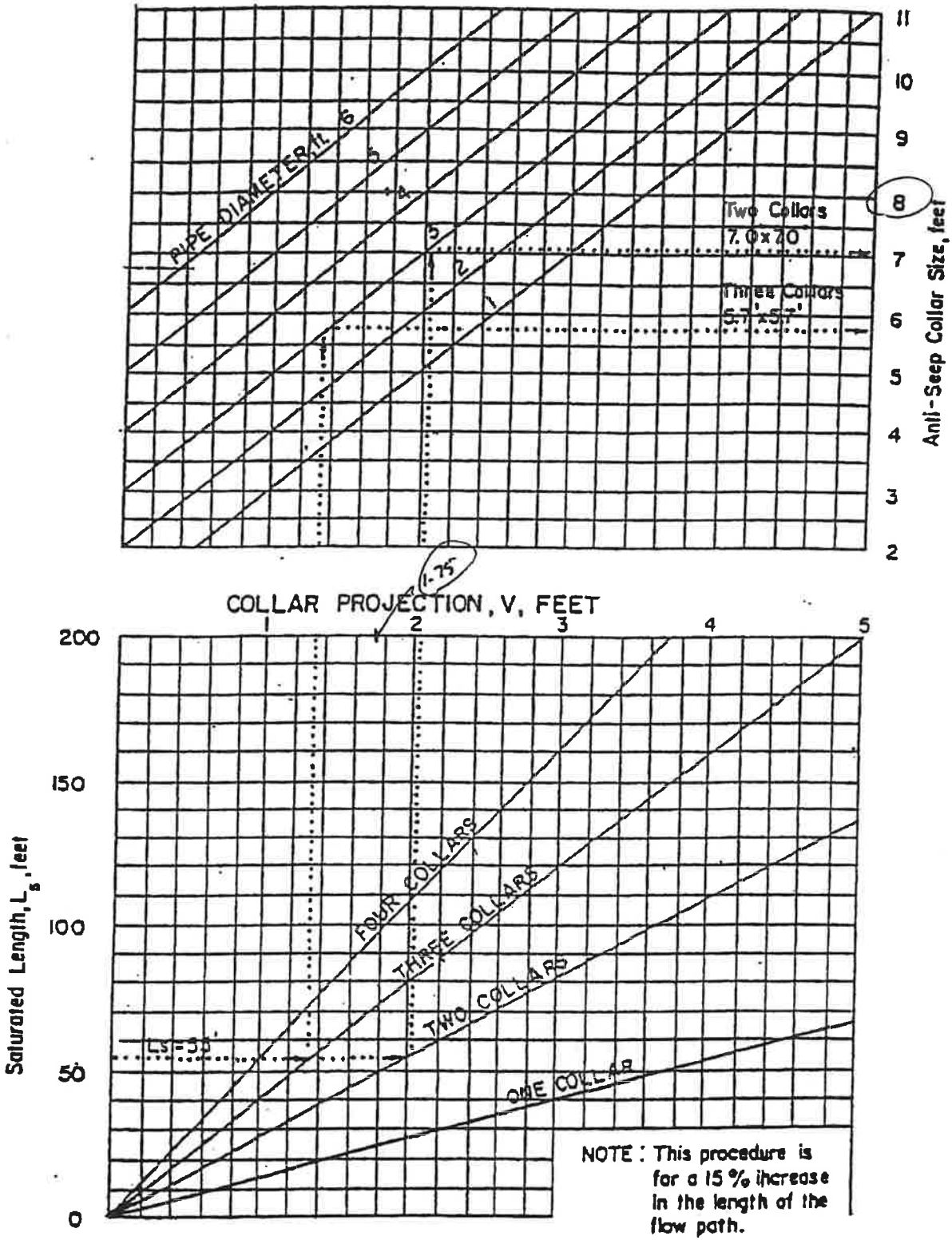
FROM ANTI – SEEP COLLAR DESIGN CHART ON THE NEXT PAGE :

V = COLLAR PROJECTION = 1.75 FEET

DIMENSIONS OF 12" THICK COLLAR = 9.0' X 9.0'

NUMBER OF REQUIRED COLLARS = 2

# ANTI-SEEP COLLAR DESIGN



**g. Overflow Structure Base Foundation Design**

The overflow structure and carrier pipe will be subject to a certain amount of buoyant force when the sediment pond is filled with storm water. In order to overcome this buoyant force and prevent the flotation of the overflow structure and carrier pipe, a concrete overflow structure base foundation and concrete carrier pipe encasement have been designed. The design calculations for the concrete overflow structure base foundation and carrier pipe encasement are included in this section.

**OVERFLOW STRUCTURE BASE FOUNDATION DESIGN**

A certain volume of concrete will be used to overcome the buoyancy of an empty overflow structure and carrier pipe that are below the assumed phreatic water surface. This volume is equal to:

Overflow Structure

= (L)(w)(h)(62.4) L = w = 7.0' inside = 8.0' outside

= (8.0)(8.0)(5.75)(62.4) h = height = 5.75'

= 22,963 #

Carrier Pipe = 3.1416($R_2^2$)(Ls)(62.4) Ls = length in saturation zone = 48'

= 3.1416(2.71)(2.71)(48)(62.4) $R_2$ = outside radius = 32.5" = 2.71'

= 69,106 # $r_2$ = inside radius = 27" = 2.25'

TOTAL WEIGHT

= 92,069 # x 1.5 (SAFETY FACTOR)

= 138,104 #

TOTAL REVISED VOLUME OF CONCRETE =

TOTAL WEIGHT / WEIGHT OF CONC. IN WATER

= 138,104/87.6 pcf (87.6 pcf = Wt. of conc. in submerged water)

= 1,577 C.F.

This volume of concrete will be made up from five areas.

1. Overflow Structures
2. Anti-Seep Collars
3. Carrier Pipe
4. Overflow Structure Base
5. Carrier Pipe Encasement

1. Overflow Structure = $(L_2 - l_2)h$

   $(8.0^2 – 7.0^2)(5.75)$ = 86 C.F.

   L = outside dimension of box = 8.0’

   l = inside dimension of box = 7.0’

   h = height of overflow structure = 5.75’

2. Anti-seep collars = area of square collar around carrier pipe x 12" thick x # of collars

   = [( 9.0' x 9.0' ) - $(3.1416)(R_2^2)$]

   x 1' x 2

   = 116 C.F.

   $R_2$ = outside radius of carrier pipe = 32.5" = 2.71’

   $r_2$ = inside radius of carrier pipe = 27" = 2.25’

3. Carrier Pipe

   = 3.1416 ($R_2^2$ - $r_2^2$) L = 344 C.F.

   L = length in saturation = 48’

4. Overflow Structure Base = Volume to handle riser bouyance x 1.2

   = (L)(w)h(62.4)(1.2)/weight of conc. in water

   L = w = 8.0’ outside

   h = height = 5.75’

   = (8.0’)(8.0’)(5.75)(62.4)(1.2)/87.6

   = 315 C.F.

   Use 12’ x 12' x 3' = 432.0 C.F.

5. Carrier Pipe Encasement

   Must extend 5’ into dam. Distance from overflow structure to dam is equal to 17.25’. Therefore, minimum encasement length will be 22.25’. Will use 26.5 for additional ballast.

   [(5.75 x 8.0) – (3.1416) $R_2^2$] x 26.5’

   Carrier pipe encasement volume = 608 C.F.

**TOTAL REQUIRED VOLUME = 1,577 C.F.**

Actual Total Volume

| | | |
|---|---|---|
| Overflow Structure | = | 86 C.F. |
| Anti-Seep Collars | = | 116 C.F. |
| Carrier Pipe | = | 344 C.F. |
| Overflow Structure Base | = | 432 C.F. |
| Carrier Pipe Encasement | = | 608 C.F. |
| **TOTAL** | **=** | **1,586 C.F. ⇒ Okay** |

# 2025 MAJOR MODIFICATION APPLICATION

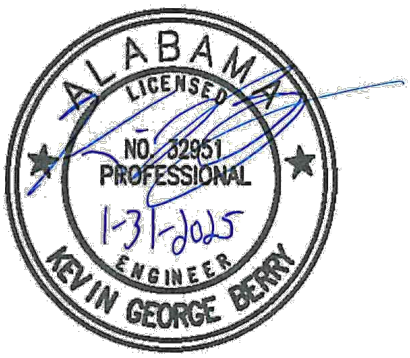
## ARROWHEAD LANDFILL
## PERMIT #53-03

## PERRY COUNTY ASSOCIATES, LLC
## PERRY COUNTY, ALABAMA

## JANUARY 2025

## VOLUME 2 OF 2

HHNT
HODGES, HARBIN, NEWBERRY & TRIBBLE, INC.
*Consulting Engineers*

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# TABLE OF CONTENTS

## VOLUME 1 of 2

**1.0 INTRODUCTION**

**2.0 DESIGN AND OPERATIONS**

2.1 General Design Standards for Disposal Facilities (335-13-4-.11)
2.2 Plans and Operational Reports (335-13-4-.12)
2.3 Site Geology and Hydrology (335-13-4-.13)
2.4 Groundwater Resources (335-13-4-.14)
2.5 Cover (335-13-4-.15)
2.6 Explosive Gases (335-13-4-.16)
2.7 Drainage (335-13-4-.17)
2.8 Liners and Leachate Collection (335-13-4-.18)
2.9 Access (335-13-4-.19)
2.10 Closure and Post-Closure (335-13-4-.20)
2.11 General Operational Standards for Landfill Units (335-13-4-.21)
2.12 Specific Requirements for Municipal Solid Waste Landfills (335-13-4-.22)
2.13 Septic Tank Pumpings and Sewage Sludge (335-13-4-.24)
2.14 Requirements for Management and Disposal of Special Waste (335-13-4-.26).
2.15 Recordkeeping Requirements (335-13-4-.29).

**3.0 CLOSURE PLAN**

3.1 Closure and Post-Closure (335-13-4-.20).

**4.0 POST CLOSURE CARE PLAN**

4.1 Closure and Post-Closure (335-13-4-.20).

**5.0 CONSTRUCTION QUALITY ASSURANCE (CQA) PLAN**

**6.0 TECHNICAL SPECIFICATIONS**

**7.0 ENVIRONMENTAL MONITORING PLAN**

**8.0 LEACHATE COLLECTION SYSTEM CALCULATIONS**

**9.0 STORMWATER, EROSION AND SEDIMENT CONTROL DESIGN CALCULATIONS**

## VOLUME 2 of 2

**10.0 FINANCIAL ASSURANCE**

**11.0 PROHIBITED WASTE EXCLUSION PLAN**

**12.0 GEOTECHNICAL DESIGN CALCULATIONS**

**APPENDIX**

A. Permit Application (Form 439)

B. Application Fee

C. List of Adjacent Property Owners & Addresses

D. Site Location Map

E. Site Analysis Report, prepared by JJ&G Inc. & dated September 2005 - (Hydrogeologic Evaluation)

F. Alabama Historical Commission Clearance Letter

G. Updated FEMA Flood Insurance Rate Map

H. Statement of Consistency from the Alabama-Tombigbee Regional Commission

I. Host Government Approval

J. CCR Acceptance Plan

# 10.0 FINANCIAL ASSURANCE

*335-13-4-.28 Financial Assurance Criteria.*

*(1) The requirements of 335-13-4-.28 apply to owners and operators of all MSWLF, except owners or operators who are state or federal government entities whose debts and liabilities are the debts and liabilities of the State or the United States.*

**This facility is subject to these requirements.**

*(2) Financial Assurance for Closure.*

*(a) The owner or operator shall have a detailed written estimate, in current dollars, of the cost of hiring a third party to close the largest area of all landfill cells at the MSWLF ever requiring a final cover as required under 335-13-4-.20 at any time during the active life in accordance with the closure plan. The owner or operator shall place the closure cost estimate in the operating record and submit a copy of the estimate to ADEM for approval.*

**A closure estimate meeting this criteria is included in this section. Currently, the largest (worst case) expected open area for this facility is when the last cell in Tract No. 1 is constructed and approximately 95.6 acres is still open. As future cells are constructed in each tract, the closure cost estimate must be updated and appropriate financial assurance provided.**

*1. The closure cost estimate shall equal the cost of closing the largest area of the MSWLF ever requiring a final cover at any time during the active life when the extent and manner of its operation would make closure the most expensive, as indicated by its closure plan. The cost estimate shall include the costs of continuing the operation of the gas collection and control systems as may be required in 335-3-10-.02(75) or 335-3-19, as applicable.*

**Estimated cost of maintaining the gas system is included in the post-closure estimate. The gas system must be installed prior to closure. Estimates of gas system improvements at time of closure are included in the closure estimate.**

*2. During the active life of the MSWLF, the owner or operator shall annually adjust the closure cost estimate for inflation.*

**The costs will be adjusted annually for inflation.**

*3. The owner or operator shall increase the closure cost estimate and the amount of financial assurance provided under 335-13-4-*

*.28(2)(b) if changes to the closure plan or landfill conditions increase the maximum cost of closure at any time during the remaining active life.*

**This will be evaluated annually at the time of closure cost update.**

4. *The owner or operator may reduce the closure cost estimate and the amount of financial assurance provided under 335-13-4-.28(2)(b) if the cost estimate exceeds the maximum cost of closure at any time during the remaining life of the MSWLF. The owner or operator shall place the justification for the reduction of the closure cost estimate and the amount of financial assurance in the operating record and submit a copy of the justification and new estimate to ADEM for approval.*

(b) *The owner or operator of a MSWLF shall establish financial assurance for closure of the MSWLF in compliance with 335-13-4-.28(5). The owner or operator shall provide continuous coverage for closure until released from financial assurance requirements by ADEM.*

**A Financial Assurance Mechanism in accordance with ADEM Regulations has been provided to ADEM.**

(3) *Financial Assurance for Post-Closure Care.*

(a) *The owner or operator shall have a detailed written estimate, in current dollars, of the cost of hiring a third party to conduct post-closure care for the MSWLF in compliance with the post-closure requirements in 335-13-4-.20(3). The post-closure cost estimate used to demonstrate financial assurance in 335-13-4-.28(3)(b) shall account for the total costs of conducting post-closure care, including annual and periodic costs as described in the post-closure plan over the entire post-closure care period. The owner or operator shall place the estimate in the operating record and submit a copy of the estimate to ADEM for approval.*

**The required post-closure cost estimate is attached for post-closure of the entire facility.**

1. *The cost estimate for post-closure care shall be based on the most expensive costs of post-closure care during the post-closure care period.*

**The post-closure estimate is based on the cost for post-closure of the entire 425 acre facility.**

2. *During the active life of the MSWLF and during the post-closure care period, the owner or operator shall annually adjust the post-closure cost estimate for inflation.*

**The post-closure cost will be adjusted annually for inflation.**

3. *The owner or operator shall increase the post-closure care cost estimate and the amount of financial assurance provided under 335-13-4-.28(3)(b) if changes in the post-closure plan or MSWLF conditions increase the maximum costs of post-closure care.*

   **This will be evaluated annually at the time of post-closure cost update.**

4. *The owner or operator may reduce the post-closure cost estimate and the amount of financial assurance provided under 335-13-4-.28(3)(b) if the cost estimate exceeds the maximum costs of post-closure care remaining over the post-closure care period. The owner or operator shall place the justification for the reduction of the post-closure cost estimate and the amount of financial assurance in the operating record and submit a copy of the justification and new estimate to ADEM for approval.*

*(b) The owner or operator of a MSWLF shall establish, in accordance with 335-13-4-.28(5), financial assurance for the costs of post-closure care required under 335-13-4-.20(3). The owner or operator shall provide continuous coverage for post-closure care until released from financial assurance requirements for post-closure care under 335-13-4-.20(3)(e).*

**A Financial Assurance Mechanism in accordance with ADEM Regulations has been provided to ADEM.**

*(4) Financial Assurance for Corrective Action.*

*(a) An owner or operator of a MSWLF required to undertake a corrective action program under 335-13-4-.27(5) shall have a detailed written estimate, in current dollars, of the cost of hiring a third party to perform the corrective action in accordance with the program required under 335-13-4-.27(5). The corrective action cost estimate shall account for the total costs of corrective action activities as described in the corrective action plan for the entire corrective action period. The owner or operator shall place the estimate in the operating record and a copy submitted to ADEM for approval.*

1. *The owner or operator shall annually adjust the estimate for inflation until the corrective action program is completed in accordance with 335-13-4-.27(5).*

2. *The owner or operator shall increase the corrective action cost estimate and the amount of financial assurance provided under 335-13-4-.28(4)(b) if changes in the corrective action program or MSWLF conditions increase the maximum costs of corrective action.*

*3. The owner or operator may reduce the amount of the corrective action cost estimate and the amount of financial assurance provided under 335-13-4-.28(4)(b) if the cost estimate exceeds the maximum remaining costs of corrective action. The owner or operator shall place the justification for the reduction of the corrective action cost estimate and the amount of financial assurance in the operating record and submit a copy of the justification and new estimate to ADEM for approval.*

*(b) The owner or operator of a MSWLF required to undertake a corrective action program under 335-13-4-.27(5) shall establish, in a manner in accordance with 335-13-4-.28(5), financial assurance for the most recent corrective action program. The owner or operator shall provide continuous coverage for corrective action until released from financial assurance requirements for corrective action by demonstrating compliance with 335-13-4-.27(5)(1) and (m).*

*(5) Allowable Mechanisms for Financial Assurance. Allowable mechanisms used to demonstrate financial assurance under 335-13-4-.28 shall ensure that the funds necessary to meet the costs of closure, post-closure care, and corrective action for known releases will be available whenever they are needed. Owners and operators shall choose from the options specified in 335-13-4-.28(5)(a) through (j).*

**The Owner will use an approved Financial Assurance Mechanism.**

# CLOSURE ESTIMATE

**ARROWHEAD LANDFILL**
**Worst Case Closure Scenario = 95.6 Acres**

**CLOSURE COSTS for FINANCIAL ASSURANCE**

**UPDATED JANUARY 2025**

| | Item | Approx. Qty. | Unit | Unit Price | Cost |
|---|---|---|---|---|---|
| 1. | Mobilization, Bonds, Surveying | 1.00 | L.S. | $25,750.00 | $25,750.00 |
| 2. | Soil Subgrade Preparation | 4,164,336.00 | S.F. | $0.19 | $791,223.84 |
| 3. | 24" Erosion Layer (includes topsoil and protective soil cover) | 308,469.00 | C.Y. | $7.52 | $2,319,686.88 |
| 4. | 12" ($1x10^{-5}$ cm/sec) Compacted Soil Liner | 154,235.00 | C.Y. | $8.55 | $1,318,709.25 |
| 5. | Geocomposite Drainage System | | | | |
| | Material | 4,164,336.00 | S.F. | $0.59 | $2,456,958.24 |
| | Labor | 4,164,336.00 | S.F. | $0.18 | $749,580.48 |
| 6. | 40 mil FML (Material and Installation) | 4,164,336.00 | S.F. | $0.65 | $2,706,818.40 |
| 7. | Anchor Trench | 6,830.00 | L.F. | $10.30 | $70,349.00 |
| 8. | Sideslope Terrace Construction | 30,711.00 | L.F. | $25.75 | $790,808.25 |
| 9. | Seed | 9,560.00 | Lbs | $6.18 | $59,080.80 |
| 10. | Fertilizer | 191.20 | Tons | $463.50 | $88,621.20 |
| 11. | Lime | 191.20 | Tons | $61.80 | $11,816.16 |
| 12. | Mulch | 95.60 | Ac | $283.25 | $27,078.70 |
| 13. | Labor for Seeding, Fertilizing, Lime & Mulching | 95.60 | Ac | $334.75 | $32,002.10 |
| 14. | Downdrain Construction | 6,729.00 | L.F. | $36.05 | $242,580.45 |
| 15. | Silt Fence | 12,370.00 | L.F. | $3.86 | $47,748.20 |
| 16. | Outlet Protection | 350.00 | S.Y. | $36.05 | $12,617.50 |
| 17. | Drainage Structure Construction | 1.00 | L.S. | $13,390.00 | $13,390.00 |
| 18. | Final Disposal of Waste and Cleanup | 200.00 | Tons | $56.65 | $11,330.00 |
| 19. | Sediment Basin Cleanout | 5,000.00 | C.Y. | $6.18 | $30,900.00 |
| 20. | Methane Gas Vents | 96.00 | Ea. | $1,545.00 | $148,320.00 |
| 21. | Engineering and Closure Certification | 1.00 | L.S. | $29,355.00 | $29,355.00 |
| 22. | Refuse Limits Survey | 1.00 | L.S. | $29,870.00 | $29,870.00 |
| | **TOTAL CLOSURE COSTS (2025)** | | | | **$12,014,594.45** |

Notes: a) This closure cost is based on 2025 cost.

b) All costs shown include labor, materials, and equipment.

c) The cost estimate equals the cost of closing the total remaining open area of Tract No. 1. after Cell No. 9 is completed (95.6 acres)

d) During the active life of the facility, the owner and/or operator must annually adjust the closure cost estimate for inflation.

e) Approximately 8.8 acres of the total 95.6 acres have previously had a final closure cap installed and will have waste placed on top of the cap in the future.

# CLOSURE ESTIMATE

**ARROWHEAD LANDFILL**

**POST CLOSURE CARE COSTS for FINANCIAL ASSURANCE**

**UPDATED JANUARY 2025**

| Item No. | Item | Qty. | Unit | Unit Price | Cost |
|---|---|---|---|---|---|
| 1. | Water Monitoring Schedule | | | | |
| | Groundwater | 41 | Semi-Annually | $820.00 | $67,240.00 |
| | Surface Water | 13 | Semi-Annually | $824.00 | $21,424.00 |
| 2. | Methane Gas Monitoring | 1 | Quarterly | $2,290.00 | $9,160.00 |
| 3. | Erosion and Sedimentation Controls including repair of final cap and slope failures | 1 | L.S. | $13,390.00 | $13,390.00 |
| 4. | Sediment Basin Maintenance / Cleanout | 2,000 | C.Y. | $6.18 | $12,360.00 |
| 5. | Engineering Inspections | 1 | Quarterly | $2,318.00 | $9,272.00 |
| 6. | Leachate Collection, Treatment and Analysis | 1 | L.S. | $5,717.00 | $5,717.00 |
| 7. | Methane Gas Vent Monitoring | 1 | L.S. | $2,369.00 | $2,369.00 |
| | **TOTAL YEARLY POST-CLOSURE COSTS (2025)** | | | | **$140,932.00** |
| | **TOTAL POST-CLOSURE COSTS (30 YEARS)** | | | | **$4,227,960.00** |

Notes:
a) This post-closure cost is based on 2025 cost.
b) All costs shown include labor, materials, and equipment.
c) Cost of semi-annual groundwater and quarterly methane gas monitoring is based on current costs for these services.
d) During the active life of the facility unit and during the post-closure care period, the owner and/or operator will annually adjust the post-closure cost estimate for inflation.
e) The above cost estimate is based on the most expensive costs (entire site) of the post-closure care during the post-closure care period.
f) Methane gas vent monitoring (MSW) includes sampling and analysis of gas from one methane gas vent per acre.

# 11.0 PROHIBITED WASTE EXCLUSION PLAN

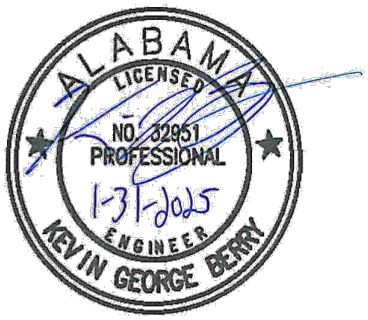
# PROHIBITED WASTE EXCLUSION PLAN

## 2025 MAJOR MODIFICATION APPLICATION
## ARROWHEAD LANDFILL

## ARROWHEAD ENVIRONMENTAL PARTNERS, LLC
## PERRY COUNTY, ALABAMA

## JANUARY 2025

HHNT
HODGES, HARBIN, NEWBERRY & TRIBBLE, INC.
*Consulting Engineers*

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# TABLE OF CONTENTS

1. INTRODUCTION ..... 1

2. PROHIBITED WASTE EXCLUSION PLAN ..... 2

3. IDENTIFICATION ..... 6

4. SEGREGATION ..... 7

5. DISPOSAL ..... 8

6. RECORDKEEPING ..... 9

7. TRAINING ..... 10

8. APPENDIX ..... 11

A. Applicable Alabama Department Of Environmental Management Rules

B. Personnel Training Log Sheet

C. Load Inspection Form

# 1. INTRODUCTION

The Arrowhead Landfill is located in incorporated Perry County and is currently permitted to receive non-hazardous municipal solid waste. An important part of the landfill operations that requires attention by the Landfill Operator is the preclusion of prohibited waste from the landfill. The intention of this Plan is to fully remove prohibited waste from disposal at this landfill. The Plan includes sections on identification, segregation, disposal, recordkeeping, and training. Operation personnel shall be properly trained, as outlined in Section 7, to implement this Plan.

# 2. PROHIBITED WASTE EXCLUSION PLAN

1. General

Pursuant to the Rules for the Land Division – Solid Waste Program, Chapter 335-13-4-.21(1)(b), the Operator has developed this Plan to exclude prohibited waste from being disposed at this facility. Excerpts from these rules are included for reference in Appendix A. These prohibited materials include free liquids, lead acid batteries, radioactive wastes, regulated medical waste, regulated PCB wastes, and regulated hazardous wastes. These are more specifically defined in Chapters 335-13-1-.03.

2. Non-Conforming Waste Review

In order to ensure that incoming loads do not contain prohibited wastes, personnel who are trained to recognize prohibited wastes will make random inspections, keep records of such inspections and notify the Alabama Department of Environmental Management (ADEM) if prohibited wastes are discovered at the facility. These procedures will be made a part of the Facility Operating Record. The random inspections will be conducted at a minimum of every 4,000 tons of waste received or every five (5) days. More frequent random inspections may be conducted at the discretion of the site personnel. A randomly selected load shall be spread in an area adjacent to the working face and inside the footprint and carefully inspected. Any prohibited waste noted will be cause for rejection of the entire load. A load inspection form is attached in Appendix C to document these inspections.

Also, tipping-area personnel trained to recognize prohibited wastes will be designated for the detection of non-conforming waste. They will observe each load as it is deposited on the tipping area. Records of each inspection will be made and kept as a part of the Facility Operating Record. Liquid containers which do not have the ends removed will be rejected. Likewise, lead acid batteries, regulated medical waste, radioactive wastes, regulated PCB wastes, and regulated hazardous wastes will be rejected. If the non-conforming hazardous materials are delivered by a hauler, the inspector will make a record of the materials and the hauler and report him to the Operator and the Director of ADEM. Haulers will be required to remove these materials from the facility. If the same hauler is caught for a second time, the hauler will be banned from bringing any waste to the facility. If the culprit is not caught and identified, the cost of disposition of the waste will be borne by the Owner.

The Operator will use a qualified hazardous waste handling company to properly dispose of any non-conforming materials that are brought to the facility. This waste will be immediately transported to an appropriate disposal facility.

In all cases, notification of ADEM will be made if a prohibited waste is discovered at the facility.

3. Waste Acceptance or Rejection

The acceptance or rejection of particular waste is based on the following factors:

*Federal, State and Local regulations, laws, and/or permit conditions

*Waste characteristics

*Operations and equipment limitations

Of these three (3) items, the regulations, laws and/or permit conditions affect most of the waste excluded from this site. Wastes specifically excluded by these regulations, laws, and permit conditions include free liquids, lead acid batteries, radioactive waste, regulated medical wastes, regulated PCB waste, and regulated quantities of hazardous wastes.

a. Liquid Waste Restrictions at Facility

(1) Bulk or non-containerized liquid waste will not be accepted.

(2) For purposes of this section:

"Liquid waste" means any waste material that is determined to contain "free liquids" as defined by Method 9095 (Paint Filter Liquids Test), as described in "Test Methods for Evaluating Solid Wastes, Physical/Chemical Methods" (EPA Pub. No. SW-846).

b. Lead Acid Batteries

Lead acid batteries are automobile type batteries. These items, whether from an automobile, a truck, a tractor, or other equipment are categorically excluded from this facility.

c. Medical Waste (335-17-1)

Medical Waste shall mean the following:

(1) Animal Waste - carcasses and body parts of animals exposed to human infectious agents as a result of the animal being used for the production and/ or testing of biologicals and pharmaceuticals or in research. Bulk blood, blood components and potentially infectious body fluids from these animals shall be handled as human blood and body fluids. All materials discarded from surgical procedures involving these animals which are grossly contaminated with bulk blood, blood components, or body fluids shall be treated as specified for surgical waste.

(2) Blood and Body Fluids - all human bulk blood, bulk blood components (serum and plasma, for example), and bulk laboratory specimens of blood, tissue, semen, vaginal secretions, cerebrospinal fluid, synovial fluid, pleural fluid, peritoneal fluid, pericardial fluid, and amniotic fluid. Precautions do not apply to feces, nasal secretions, sputum, sweat, tears, urine or vomitus unless they contain visible blood. Free-flowing material or items saturated to the point of dripping liquids containing visible blood or blood components would be treated/handled as bulk blood and bulk blood components.

(3) Microbiological Waste - discarded cultures and stocks of human infectious agents and associated microbiologicals; human and animal cell cultures from medical and pathological laboratories; cultures and stocks of infectious agents from research and industrial laboratories; waste from the production of biologicals; discarded live and attenuated vaccines; culture dishes and

devices used to transfer, inoculate and mix cultures. Only those animal vaccines which are potentially infectious to humans (Strain 19 Brucellosis Vaccine, Feline Pneumonitis Vaccine, contagious Eczema Vaccine for Sheep, Newcastle Disease Vaccine, Anthrax Spore Vaccine, and Venezuelan Equine Encephalitis Vaccine) shall be considered microbiological waste.

(4) Pathological Waste - all discarded human tissues, organs, and body parts which are removed during surgery, obstetrical procedures, autopsy, laboratory, embalming, or other medical procedures, or traumatic amputation. Extracted teeth are not included in this definition.

(5) Renal Dialysis Waste - all liquid waste from renal dialysis contaminated with peritoneal fluid or with human blood visible to the human eye. Solid renal dialysis waste is considered medical waste if it is saturated, having the potential to drip or splash regulated blood or body fluids.

(6) Sharps - any used or unused discarded article that may cause punctures or cuts and which has been or is intended for use in animal or human medical care, medical research, or in laboratories utilizing microorganisms. Such waste includes, but is not limited to, hypodermic needles, IV tubing with needles attached, scalpel blades, and syringes (with or without a needle attached). Items listed above that have been removed from their original sterile containers are included in this definition. Glassware, blood vials, pipettes, and similar items are to be handled as sharps if they are contaminated with blood or body fluids.

(7) Surgical Waste - all materials discarded from surgical procedures which are contaminated with human bulk blood, blood components, or body fluids, including but not limited to, disposable gowns, dressings, sponges, lavage tubes, drainage sets, underpads, and surgical gloves. Discarded surgical material is considered medical waste if it is saturated, having the potential to drip or splash regulated blood or body fluids contained in (b) above. Extracted teeth are not included in this definition.

d. Radioactive Waste

Radioactive waste is any material which exhibits radioactive characteristics. This waste is categorically prohibited from this facility.

e. Hazardous Waste

Please see the definition from the ADEM Rules (335-14-2-.01(3)) attached in Appendix A of this Plan.

f. Whole Tires

In accordance with ADEM Rule 335-13-4-.21(1)(i) whole tires will not be disposed of in this facility after December 31, 2027. Whole tires shall be at a minimum shredded or cut into thirds or smaller pieces prior to disposal. Incidental whole tires received in loads of solid waste may be disposed, provided the whole tires constitute a de minimis portion of the overall load of waste.

4. Site Operations

Recognition of these wastes by the landfill personnel is imperative. The landfill personnel will be trained to detect this material and call it to the attention of the Operator. When material of this type is detected in the daily operation, the material is immediately segregated from the remainder of the waste stream and cordoned off. The hauler who delivered that waste to the facility is then notified to return to the facility and remove the material. All hazardous material inadvertently delivered to the facility is to be removed by the hauler within 24 hours.

5. Waste Acceptance Protocol

For those generators or haulers with special waste, the facility will use a protocol for testing those wastes prior to acceptance. The protocol includes:

a. Written certification from the generator the waste is non-hazardous.

b. The generator must also provide a description of the waste and include, if possible, the Safety Data Sheet (SDS) and any TCLP analysis.

c. The generator will also provide the ADEM approval stating the facility can accept the waste.

d. Approval from ADEM.

Records of this data will be kept in the Facility Operating Record.

# 3. IDENTIFICATION

Identification of prohibited waste is the most crucial step in assuring this material is not disposed in the landfill. This identification should be encouraged prior to loading the waste for transportation to the facility, and further required as a review of all waste that is unloaded at the site.

These items should be searched for in the waste delivered to the landfill by landfill personnel. They must be completely excluded from the disposed waste, so every person at the working face must locate and remove any of these wastes from the landfill. This can best be accomplished by spreading each load in a very thin lift and removing any prohibited waste.

# 4. SEGREGATION

Segregation of the prohibited waste from the acceptable waste stream is critical. To accomplish this, a container shall be kept within 50 yards of the daily working face in which to place any prohibited waste. Prohibited waste may be placed in plastic trash bags for short periods of time, prior to hand carrying this material to the designated container.

The container shall be placed in a position that it will not interfere with the landfill operations, and it shall be clearly labeled for prohibited waste only. When the container reaches a point where it is 75% full, it shall be hauled to an acceptable disposal site. The landfill shall not operate without an acceptable container for prohibited waste.

The Owner will provide safety equipment and training for its employees on the removal and storage of prohibited waste. Prohibited waste discovered at the facility must be reported to ADEM.

# 5. DISPOSAL

Since it is expected that the quantity of prohibited waste material at this facility will be very small, it is recommended the material segregated from the waste stream be carried to an appropriate disposal facility on a regular basis. Under no circumstances should the material removed from the waste stream be accumulated. The landfill is not allowed to treat, store, or dispose of regulated quantities of hazardous waste. Prohibited waste must be removed as frequently as needed but at least weekly.

# 6. RECORDKEEPING

Recordkeeping of prohibited waste is important, therefore the landfill operations staff shall:

1. maintain a daily log listing the prohibited waste recovered from the landfill working face;
2. maintain a log showing all loads carried to other disposal facilities;
3. maintain a miscellaneous log with any other information deemed appropriate by the operations staff; and
4. maintain the load inspections forms as required by this Plan.

Copies of all records shall be maintained on-site in the Facility Operating Record.

# 7. TRAINING

At least twice a year the Landfill Operator shall hold a training meeting to educate all landfill personnel on procedures utilized at the landfill facility to recognize and exclude prohibited waste and safety precautions. Additionally, all new personnel shall be trained to recognize and exclude prohibited waste at the onset of employment.

Training shall include explaining procedures for the recognition of the following prohibited wastes: free liquids, lead acid batteries, radioactive waste, regulated medical waste, regulated PCB's, and regulated hazardous waste. Training shall address identification of prohibited wastes by visual inspection. Training shall address common characteristics of prohibited waste of which landfill personnel need to be aware. Some characteristics of prohibited waste include, but are not limited to: hazardous waste labels or markings, leaking containers, excess liquid, powders or dust, presence of sludges, unusual or bright colors, unusual odors, large containers capable of holding liquids, smoke, etc. Training shall further include instructions to landfill personnel of safety precautions to follow upon recognition of a prohibited waste and safety precautions to follow when the landfill personnel is at the landfill facility. The Landfill Operator shall also dedicate a section in these training meetings to the procedures to follow once the prohibited waste is recognized. These procedures shall include, but are not limited to: notification, handling, and documentation.

The Landfill Operator may hold as many training meetings as he deems necessary throughout the year, but a minimum of two (2) a year must be conducted to properly train employees. Records of these training meetings shall be retained in the Facility Operating Record. A personnel training log is attached in Appendix B for the Operator to document training.

# 8. APPENDIX

A. Applicable Alabama Department of Environmental Management Rules

B. Personnel Training Log Sheet

C. Load Inspection Form

# A. APPLICABLE ALABAMA DEPARTMENT OF ENVIRONMENTAL MANAGEMENT RULES

(42) Disposal Area – that portion of the facility that is designated for disposal, as defined in 335-13-1-.03.

(43) Drill Cuttings - solid materials generated by subsurface drilling operations.

(44) Dune - (see definition of primary dune system)

(45) Endangered or Threatened Species - any species listed as such pursuant to Section 4 of the Endangered Species Act of 1973, as amended.

(46) Electric Generating Plants – an industrial site, or that portion of an industrial site, that produces electricity, to be used either on-site or off-site.

(47) Engineer - a person currently registered as a professional engineer with the State of Alabama Board of Registration for Professional Engineers and Land Surveyors.

(48) Explosive Gas - a gas that is explosive under ordinary conditions as used herein generally refers to methane ($CH_4$).

(49) Facility - all contiguous land, structures and other appurtenances used for the processing, treatment, storage or disposal of solid waste, or the recovery of recyclable materials from solid waste, whether or not authorized or permitted, including, but not limited to, waste disposal areas and waste disposed therein.

(50) Facility Structures - any buildings and sheds or utility or drainage lines on the facility.

(51) Fault - a fracture or a zone of fractures in any material along which strata on one side have been displaced with respect to that on the other side.

(52) Financial Assurance – a financial arrangement by the owner or operator of a municipal solid waste landfill which guarantees the availability of funds which may be used to close, provide post-closure care, or conduct corrective action at that facility if the owner or operator fails to properly execute his or her responsibilities under this article and any rules promulgated by the Department for closure, post-closure care, or corrective action and the terms of any permit issued for operation of that facility.

(53) Floodplain - the lowland and relatively flat areas adjoining inland and coastal waters, including flood prone areas of offshore islands, which are inundated by the 100-year flood.

(54) Foundry Waste - waste, including but not limited to, slag, sand, baghouse dust, etc. generated from foundry smelting and metal casting processes.

(55) Free Liquids - liquids which readily separate from the solid portion of a waste under ambient temperature and pressure as determined by the Paint Filter Test referenced in USEPA Publication SW-846, Method 9095.

(56) Garbage - putrescible animal and vegetable waste resulting from the handling, preparation, cooking and consumption of food, including, but not limited to, waste from markets, storage facilities, handling and sale of produce and other food products and excepting such materials that may be serviced by garbage grinders and handled as household sewage.

(57) Gas Condensate - the liquid generated as a result of the gas collection and recovery process at the landfill unit.

(58) Generation – the act or process of producing solid waste. Solid waste shall be considered to be generated at the point that waste materials are first discarded or collected, regardless of any subsequent materials recovery or recycling.

(59) Generator - any person who utilizes any process or conducts any activity which results in the production of solid waste.

(60) Groundwater - water below the land surface in the zone of saturation.

(61) Hazardous constituents – those substances listed in 335-14-2 Appendix VIII and/or 335-14-5 Appendix IX and include hazardous constituents released from solid waste, hazardous waste, or hazardous waste constituents that are reaction by-products.

(62) Hazardous Waste - those wastes defined in, and regulated under, Division 14 of the ADEM Administrative Code.

(63) Health Department – an approved county or district health department, including the Alabama State Department of Public Health and the affected state and county health department.

(64) Health Officer – the State or affected county health officer or his or her designee.

(65) Holocene - the most recent epoch of the Quaternary period, extending from the end of the Pleistocene Epoch, at 11,700 years before present, to the present.

(66) Household Waste - any solid waste, including, but not limited to, garbage, trash, and sanitary waste in septic tanks

derived from households, including single and multiple residences, hotels and motels, bunkhouses, ranger stations, crew quarters, campgrounds, picnic grounds, and day-use recreation areas. Sanitary waste in septic tanks shall be considered as household waste only when it is disposed in a landfill or unauthorized dump and its inclusion as a household waste shall in no way prohibit or supersede the authority of the Department or the Health Department to regulate onsite sewage systems or the management of sanitary waste in septic tanks.

(67) Incinerator or Combustion Unit - a device designed to burn that portion of garbage and rubbish which will be consumed at temperatures generally ranging 1600 degrees Fahrenheit or over. The unburned residue from an incinerator, including metal, glass, and the like shall be called ashes.

(68) Industrial Landfill (ILF) Unit - a discrete area of land or an excavation that receives industrial solid waste and may in addition receive construction/demolition waste and/or rubbish and that is not a land application unit, surface impoundment, injection well, or waste pile, as those terms are defined in this rule.

(69) Industrial Solid Waste - solid waste generated by manufacturing or industrial processes that is not a hazardous waste regulated under Chapters 22 to 30, inclusive, of Title 22, Code of Ala. 1975, and the regulations promulgated thereunder.

(70) Infectious Agent - any organism (such as a virus or a bacterium) that is capable of causing disease or adverse health impacts in humans by invasion and multiplication in body tissues, fluids or secretions.

(71) Injection Well - a bored, drilled, or driven shaft or dug hole which is used for the injection of pollutants.

(72) Innocent Landowner – an owner of real property upon which there is located an unauthorized dump and who meets all of the following conditions:

(a) The solid waste was disposed of on the property after the owner acquired title to the property or the waste was disposed of before the owner acquired title to the property and the owner lacked actual knowledge of the waste after conducting reasonable due diligence or title was acquired by bequest or devise.

(b) The owner did not have knowledge that the waste was being disposed of on the property or the owner took steps, including, but not limited to, posting signs to prevent disposal on the property.

(c) The owner did not participate in or consent to the disposal of solid waste on the property.

(d) The owner did not receive any financial benefit from the disposal of solid waste on the property.

(e) Title to the property was not transferred to the owner for the purpose of evading liability for operating an unauthorized dump.

(f) The person or persons responsible for disposing of the solid waste on the property, in doing so, was not acting as an agent for the owner.

(73) Karst Terrains - areas where karst topography, with its characteristic surface and subterranean features, is developed as the result of dissolution of limestone, dolomite, or other soluble rock. Characteristic physiographic features present in karst terrains include, but are not limited to, sinkholes, sinking streams, caves, large springs, and blind valleys.

(74) Land Application Unit - an area where wastes are applied onto or incorporated into the soil surface (excluding manure spreading operations) for agricultural purposes or for treatment and disposal.

(75) Landfill (LF) – a method of compaction and earth or alternative cover of solid wastes other than those containing garbage or other putrescible wastes, including, but not limited to, tree limbs and stumps, demolition materials, incinerator residues, and like materials not constituting a health or nuisance hazard, where cover need not be applied on a per day used basis.

(76) Landfill (LF) Unit - this term shall include MSWLF, C/DLF, ILF units.

(77) Land Surveyor - a person currently registered as a land surveyor with the State of Alabama Board of Registration for Professional Engineers and Land Surveyors.

(78) Lateral Expansion - a horizontal expansion of the waste boundaries of an existing landfill unit.

(79) Leachate - any liquid, including any soluble, suspended or miscible components in the liquid, that has percolated through or emerged from solid waste other than construction/demolition waste and or rubbish.

(80) Leachate Recirculation - the recycling or reintroduction of leachate into or on a landfill unit constructed with liners and leachate collection systems.

(81) Lift - the compacted vertical thickness of a horizontal series of cells which have been accumulated and covered with earth or some other approved alternative cover. The cover may be either daily, weekly, intermediate, or final as required.

(82) Liquid Waste - any waste material that is determined to contain "free liquids" as defined by Method 9095 (Paint Filter Liquids Test), as described in "Test Methods for Evaluating Solid Wastes, Physical/Chemical Methods" (EPA Pub. No. SW-846), and is not considered bladeable.

(83) Lithified Earth Material - all rock, including all naturally occurring and naturally formed aggregates or masses of minerals or small particles of older rock that formed by crystallization of magma or by induration of loose sediments. This term does not include man-made materials, such as fill, concrete, and asphalt, or unconsolidated earth materials, soil, or regolith lying at or near the earth surface.

(84) Lower Explosive Limit (LEL) - the lowest percent by volume of a mixture of explosive gases which will propagate a °flame in air at 25 C and atmospheric pressure. For methane (CH4) the LEL is considered to be 5 percent.

(85) Materials Recovery Facility - a solid waste management facility that provides for the extraction from solid waste of recyclable materials, materials suitable for use as a fuel or soil amendment, or any combination of those materials. A materials recovery facility shall be deemed to be a solid waste treatment facility.

(86) Maximum Contaminant Level (MCL) – the maximum permissible level of a contaminant allowed in the saturated zone unless occurring naturally or found to already exist during background sampling.

(87) Maximum Horizontal Acceleration in Lithified Earth Material - the maximum expected horizontal acceleration depicted on a seismic hazard map, with a 90 percent or greater probability that the acceleration will not be exceeded in 250 years, or the maximum expected horizontal acceleration based on a site-specific seismic risk assessment.

(88) Medical Waste – any infectious solid or liquid waste from a medical waste generator, as defined in chapter 335-17-1.

(89) Municipal Solid Waste Landfill (MSWLF) Unit - a discrete area of land or an excavation that receives household waste and that is not a land application unit, surface impoundment, injection well, or waste pile. A municipal solid waste landfill may also receive other types of solid wastes, such as commercial solid waste, nonhazardous sludge, very small quantity generator waste, industrial solid waste,

construction/demolition waste, and rubbish. A municipal solid waste landfill is a sanitary landfill. Such a landfill may be publicly or privately owned. A MSWLF unit may be a new MSWLF unit, an existing MSWLF unit or a lateral expansion.

(90) Off-site - not a part of what is defined as on-site.

(91) On-site - the same or geographically contiguous property which may be divided by public or private right-of-way. Non-contiguous properties owned by the same person or entity connected by a right-of-way which he controls and to which the public does not have access, is also considered on-site property.

(92) One Hundred-Year flood - a flood that has a one percent or greater chance of recurring in any given year or a flood of a magnitude equaled or exceeded once in 100 years on the average over a significantly long period.

(93) Open Burning - the combustion of any material without the following characteristics:

(a) Control of combustion air to maintain adequate temperature for efficient combustion.

(b) Containment of the combustion-reaction in an enclosed device to provide sufficient residence time and mixing for complete combustion, and

(c) Control of emission of the gaseous combustion products.

(94) Operating Record - a collection of documents relating to the permitting or operation of any landfill unit as listed in rule 335-13-4-.29.

(95) Operator - the person(s) having direct supervision over and responsibility for the daily operation of a landfill unit or part of a landfill unit.

(96) Owner - the person(s) who owns a facility or part of a facility.

(97) Partial Closure - the closure of a discrete part of a facility in accordance with the applicable closure requirements of rule 335-13-4-.20. For example, partial closure may include the closure of a trench, a unit operation, a landfill cell or a pit, while other parts of the same facility continue in operation or will be placed in operation in the future.

(98) Permit - written authorization granted to a person by the Department to operate a solid waste management facility for the disposal of solid waste.

(99) Permittee - any person possessing a valid permit issued by the Department to dispose of solid waste. This person is responsible for the overall operation of a solid waste facility.

(100) Person - any individual, trust, firm, joint stock company, corporation (including a government corporation), partnership, agent, agency, association, State, municipality, commission, political subdivision of a state, any interstate body, or any other private or public legal entity.

(101) Personnel - all persons who work at or supervise the operations of a solid waste facility, and whose actions or inactions may responsible for achieving compliance with the requirements of this Division.

(102) Petroleum Contaminated Waste (PCW) - any material, including but not limited to soil, debris, absorbent pads/ booms, oil dry, etc., that has been exposed to petroleum products in such a manner that the petroleum product can be detected by a total petroleum hydrocarbon (TPH) analysis using Standard Method 503 D & E, EPA Methods 9071 or 418.1 (Spectrophotometric, Infrared, and that analysis exceeds 100 ppm TPH.

(103) Poor Foundation Conditions - those areas where features exist which indicate that a natural or man-induced event may result in inadequate foundation support for the structural components of a landfill unit.

(104) Post Closure - the activities, including monitoring and maintenance at the site, following completion of closure activities if solid waste will remain at the site after closure.

(105) Practice - any operating method, technique or procedure for the management of solid waste.

(106) Primary Dune System - for this definition, refer to Division 8 of the ADEM Administrative Code.

(107) Private Solid Waste Management Facility – a solid waste management facility that is operated exclusively by and for a private solid waste generator for the purpose of accepting solid waste generated on-site or by the permittee.

(108) Product – any material which is an intended output or result of a fabrication, manufacturing or production process, and is sold and distributed in the stream of commerce for

consumption, use, or further processing into another desired .commodity A product must be managed as an item of value in a controlled manner and is not to be managed as a discarded material.

(109) Proposed site - total acreage as identified by the legal survey included in the application submitted to the Department.

(110) Public Solid Waste Management Facility - a solid waste management facility that accepts solid waste from the public generally or for a fee, or any solid waste management facility that is not a private solid waste management facility.

(111) Qualified Groundwater Scientist - a scientist or engineer who has received a baccalaureate or post-graduate degree in the natural sciences or engineering and has sufficient training and experience in groundwater hydrology and related fields as may be demonstrated by state registration, professional certifications, or completion of accredited university programs that enable that individual to make sound professional judgments regarding groundwater monitoring, contaminant fate and transport, and corrective-action.

(112) Recovered Materials – those materials which have known recycling potential; which can be feasibly recycled; which have been diverted or removed from the solid waste stream for recycling, whether or not requiring subsequent separation and processing; and which have a substantial portion that are consistently used in the manufacture of products which may otherwise be produced from raw or virgin materials. Recovered materials shall not include solvents or materials, except sawdust, bark, and paper materials that are destined for incineration, energy recovery, or any use which constitutes disposal. Recovered materials shall only be those materials for which during the calendar year (commencing on January 1), the amount of material recycled or diverted from the solid waste stream for recycling and transferred to a different site for recycling equals at least 75 percent by weight or volume of the amount of that material accumulated at the beginning of the period.

(113) Recovered Materials Processing Facility - a facility primarily engaged in the storage, processing, and resale or reuse of recovered materials. A recovered materials processing facility is not a solid waste management facility; however, any solid waste resulting from the operation of a facility shall be subject to all applicable laws and regulations relating to solid waste and shall be deemed to be generated for purposes of reporting pursuant to solid waste reduction goals, at the point of collection of the recovered materials from which the solid waste resulted.

(114) Recyclable Materials - those materials which are capable of being recycled, whether or not the materials have been diverted or removed from the solid waste stream.

(115) Recycling - any process by which materials are collected, separated, stored, recovered, or processed and reused or returned to use in the form of raw materials or products, but does not include the use of materials as a fuel, or for any use which constitutes disposal.

(116) Relevant Point of Compliance - That point within the first saturated zone at which groundwater quality must be in compliance with water quality standards set forth by rule 335-13-4-.27. Groundwater monitoring wells are to be located in order to yield samples that are representative of the quality of groundwater passing the relative point of compliance.

(117) Representative Sample - a sample of a universe or whole (e.g., waste pile, lagoon, and groundwater) which can be expected to exhibit the average properties of the universe or whole. See EPA publication SW-846, Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, Chapter 9 for a discussion and examples of representative samples.

(118) Rubbish - nonputrescible solid wastes, excluding ashes, consisting of both combustible and noncombustible wastes. Combustible rubbish includes paper, rags, cartons, wood, furniture, rubber, plastics, and similar materials. Noncombustible rubbish includes glass, crockery, metal cans, metal furniture and like materials which will not burn at ordinary incinerator temperatures, not less than 1600 degree F. Uncontaminated concrete, soil, brick, waste asphalt paving, ash resulting from the combustion of untreated wood, rock, yard trimmings, leaves, stumps, limbs and similar materials are excluded from this definition.

(119) Run-Off - any rainwater, leachate, or other liquid that drains over land from any part of a facility.

(120) Run-On - any rainwater, leachate, or other liquid that drains over land onto any part of a facility.

(121) Salvaging - the controlled removal for reuse of material from a solid waste landfill unit.

(122) Sanitary Landfill - a controlled area of land upon which solid waste is deposited and is compacted and covered with compacted earth or an alternative cover each day as deposited, with no on-site burning of wastes, and so located, contoured and drained that it will not constitute a source of water pollution as determined by the Department. See definition of “Municipal Solid Waste Landfill Unit.”

(g) "Sham recycling". A hazardous secondary material found to be sham recycled is considered discarded and a solid waste. Sham recycling is recycling that is not legitimate recycling as defined in 335-14-1-.03(23).

(3) Definition of hazardous waste.

(a) A solid waste, as defined in 335-14-2-.01(2), is a hazardous waste if:

1. It is not excluded from regulation as a hazardous waste under 335-14-2-.01(4)(b); and

2. It meets any of the following criteria:

(i) It exhibits any of the characteristics of hazardous waste identified in 335-14-2-.03. However, any mixture of a waste from the extraction, beneficiation, and processing of ores and minerals excluded under 335-14-2-.01(4)(b)7. and any other solid waste exhibiting a characteristic of hazardous waste under 335-14-2-.03 is a hazardous waste only if it exhibits a characteristic that would not have been exhibited by the excluded waste alone if such mixture had not occurred, or if it continues to exhibit any of the characteristics exhibited by the non-excluded wastes prior to mixture. Further, for the purposes of applying the Toxicity Characteristic to such mixtures, the mixture is also a hazardous waste if it exceeds the maximum concentration for any contaminant listed in Table I of 335-14-2-.03(5) that would not have been exceeded by the excluded waste alone if the mixture had not occurred or if it continues to exceed the maximum concentration for any contaminant exceeded by the nonexempt waste prior to mixture.

(ii) It is listed in 335-14-2-.04 and has not been excluded from the lists in 335-14-2-.04 under 335-14-1-.03(2);

(iii) Reserved.

(iv) It is a mixture of solid waste and one or more hazardous wastes listed in 335-14-2-.04 and has not been excluded from 335-14-2-.01(3)(a)2. under 40 CFR 260.20 and 335-14-1-.03(2), 335-14-2-.01(3)(g), or 335-14-2-.01(3)(h); however, the following mixtures of solid wastes and hazardous wastes listed in 335-14-2-.04 are not hazardous wastes (except by application of 335-14-2-.01(3)(a)2.(i) or (a)2.(ii)) if the generator can demonstrate that the mixture consists of wastewater, the discharge of which is subject to regulation under either Section 402 or Section 307(b) of the Clean Water Act (including wastewater at generators which have eliminated the discharge of wastewater), and:

(I) One or more of the following spent solvents listed in 335-14-2-.04(2) — benzene, carbon tetrachloride, tetrachloroethylene, trichloroethylene or the scrubber waters derived-from the combustion of these spent solvents — provided that the maximum total weekly usage of these solvents (other than the amounts that can be demonstrated not to be discharged to wastewater) divided by the average weekly flow of wastewater into the headworks of the facility's wastewater treatment or pretreatment system does not exceed one part per million or the total measured concentration of these

solvents entering the headworks of the facility's wastewater treatment system (at facilities subject to regulation under the Clean Air Act, as amended, at 40 CFR parts 60, 61, or 63, or at facilities subject to an enforceable limit in a federal operating permit that minimizes fugitive emissions), does not exceed 1 part per million on an average weekly basis. Any facility that uses benzene as a solvent and claims this exemption must use an aerated biological wastewater treatment system and must use only lined surface impoundments or tanks prior to secondary clarification in the wastewater treatment system. Facilities that choose to measure concentration levels must file a copy of their sampling and analysis plan with the State Director ("Director" as defined in 335-14-1-.02). A facility must file a copy of a revised sampling and analysis plan only if the initial plan is rendered inaccurate by changes in the facility's operations. The sampling and analysis plan must include the monitoring point location (headworks), the sampling frequency and methodology, and a list of constituents to be monitored. A facility is eligible for the direct monitoring option once they receive confirmation that the sampling and analysis plan has been received by the Director. The Director may reject the sampling and analysis plan if he/she finds that, the sampling and analysis plan fails to include the above information; or the plan parameters would not enable the facility to calculate the weekly average concentration of these chemicals accurately. If the Director rejects the sampling and analysis plan or if the Director finds that the facility is not following the sampling and analysis plan, the Director shall notify the facility to cease the use of the direct monitoring option until such time as the bases for rejection are corrected; or

(II) One or more of the following spent solvents listed in 335-14-2-.04(2)—methylene chloride, 1,1,1-trichloroethane, chlorobenzene, o-dichlorobenzene, cresols, cresylic acid, nitrobenzene, toluene, methyl ethyl ketone, carbon disulfide, isobutanol, pyridine, spent chlorofluorocarbon solvents, 2-ethoxyethanol, or the scrubber waters derived-from the combustion of these spent solvents — provided that the maximum total weekly usage of these solvents (other than the amounts that can be demonstrated not to be discharged to wastewater) divided by the average weekly flow of wastewater into the headworks of the facility's wastewater treatment or pretreatment system does not exceed 25 parts per million or the total measured concentration of these solvents entering the headworks of the facility's wastewater treatment system (at facilities subject to regulation under the Clean Air Act as amended, at 40 CFR parts 60, 61, or 63, or at facilities subject to an enforceable limit in a federal operating permit that minimizes fugitive emissions), does not exceed 25 parts per million on an average weekly basis. Facilities that choose to measure concentration levels must file a copy of their sampling and analysis plan with the State Director, ("Director" as defined in 335-14-1-.02). A facility must file a copy of a revised sampling and analysis plan only if the initial plan is rendered inaccurate by changes in the facility's operations. The sampling and analysis plan must include the monitoring point location (headworks), the sampling frequency and methodology, and a list of constituents to be monitored. A facility is eligible for the direct monitoring option once they receive confirmation that the sampling and analysis plan has been received by the Director. The Director may reject the sampling and analysis plan if he/she finds that, the sampling and analysis plan fails to include the above information; or the plan parameters would not enable the facility to calculate the weekly average concentration of these chemicals accurately. If the Director rejects the sampling and analysis plan or if the Director finds that the facility is not following the sampling and analysis plan, the

Director shall notify the facility to cease the use of the direct monitoring option until such time as the bases for rejection are corrected; or

(III) One of the following wastes listed in 335-14-2-.04(3), provided that the wastes are discharged to the refinery oil recovery sewer before primary oil/water/solids separation -- heat exchanger bundle cleaning sludge from the petroleum refining industry (EPA Hazardous Waste Number K050), crude oil storage tank sediment from petroleum refining operations (EPA Hazardous Waste Number K169), clarified slurry oil tank sediment and/or in-line filter/separation solids from petroleum refining operations (EPA Hazardous Waste Number K170), spent hydrotreating catalyst (EPA Hazardous Waste Number K171), and spent hydrorefining catalyst (EPA Hazardous Waste Number K172); or

(IV) A discarded hazardous waste, commercial chemical product, or chemical intermediate listed in 335-14-2-.04(2) through (4), arising from de minimis losses of these materials. For purposes of 335-14-2-.04, "de minimis" losses are inadvertent releases to a wastewater treatment system, including those from normal material handling operations (e.g., spills from the unloading or transfer of materials from bins or other containers, leaks from pipes, valves or other devices used to transfer materials); minor leaks of process equipment, storage tanks or containers; leaks from well maintained pump packings and seals; sample purgings; relief device discharges, discharges from safety showers and rinsing and cleaning of personal safety equipment; and rinsate from empty containers or from containers that are rendered empty by that rinsing. Any manufacturing facility that claims an exemption for de minimis quantities of wastes listed in 335-14-2-.04(2) through (3), or any nonmanufacturing facility that claims an exemption for de minimis quantities of wastes listed in 335-14-2-.04 must either have eliminated the discharge of wastewaters or have included in its Clean Water Act permit application or submission to its pretreatment control authority the constituents for which each waste was listed (335-14-2-Appendix VII); and the constituents in the table “Treatment Standards for Hazardous Wastes” in 335-14-9-.04(1) for which each waste has a treatment standard (i.e., Land Disposal Restriction constituents). A facility is eligible to claim the exemption once the permit writer or control authority has been notified of possible de minimis releases via the Clean Water Act permit application or the pretreatment control authority submission. A copy of the Clean Water permit application or the submission to the pretreatment control authority must be placed in the facility's on-site files; or

(V) Wastewater resulting from laboratory operations containing toxic (T) wastes listed in 335-14-2-.04, provided that the annualized average flow of laboratory wastewater does not exceed one percent of total wastewater flow into the headworks of the facility's wastewater treatment or pretreatment system, or provided the wastes combined annualized average concentration does not exceed one part per million in the headworks of the facility's wastewater treatment or pretreatment facility. Toxic (T) wastes used in laboratories that are demonstrated not to be discharged to wastewater are not to be included in this calculation; or

(VI) One or more of the following wastes listed in 335-14-2-.04(3) — wastewaters from the production of carbamates and carbamoyl oximes (EPA Hazardous Waste No. K157) — provided that the maximum weekly usage of formaldehyde, methyl chloride, methylene chloride, and triethylamine (including all amounts that cannot be

demonstrated to be reacted in the process, destroyed through treatment, or is recovered, i.e., what is discharged or volatilized) divided by the average weekly flow of process wastewater prior to any dilution into the headworks of the facility's wastewater treatment system does not exceed a total of 5 parts per million by weight or the total measured concentration of these chemicals entering the headworks of the facility's wastewater treatment system (at facilities subject to regulation under the Clean Air Act as amended, at 40 CFR parts 60, 61, or 63, or at facilities subject to an enforceable limit in a federal operating permit that minimizes fugitive emissions), does not exceed 5 parts per million on an average weekly basis. Facilities that choose to measure concentration levels must file a copy of their sampling and analysis plan with the State Director ("Director" as defined in 335-14-1-.02). A facility must file a copy of a revised sampling and analysis plan only if the initial plan is rendered inaccurate by changes in the facility's operations. The sampling and analysis plan must include the monitoring point location (headworks), the sampling frequency and methodology, and a list of constituents to be monitored. A facility is eligible for the direct monitoring option once they receive confirmation that the sampling and analysis plan has been received by the Director. The Director may reject the sampling and analysis plan if he/she finds that, the sampling and analysis plan fails to include the above information; or the plan parameters would not enable the facility to calculate the weekly average concentration of these chemicals accurately. If the Director rejects the sampling and analysis plan or if the Director finds that the facility is not following the sampling and analysis plan, the Director shall notify the facility to cease the use of the direct monitoring option until such time as the bases for rejection are corrected; or

(VII) Wastewaters derived from the treatment of one of more of the following wastes listed in 335-14-2-.04(3) — organic waste (including heavy ends, still bottoms, light ends, spent solvents, filtrates, and decantates) from the production of carbamates and carbamoyl oximes (EPA Hazardous Waste No. K156) — provided, that the maximum concentration of formaldehyde, methyl chloride, methylene chloride, and triethylamine prior to any dilutions into the headworks of the facility's wastewater treatment system does not exceed a total of 5 milligrams per liter or the total measured concentration of these chemicals entering the headworks of the facility's wastewater treatment system (at facilities subject to regulation under the Clean Air Act as amended, at 40 CFR parts 60, 61, or 63, or at facilities subject to an enforceable limit in a federal operating permit that minimizes fugitive emissions), does not exceed 5 milligrams per liter on an average weekly basis. Facilities that choose to measure concentration levels must file a copy of their sampling and analysis plan with the State Director ("Director" as defined in 335-14-1-.02). A facility must file a copy of a revised sampling and analysis plan only if the initial plan is rendered inaccurate by changes in the facility's operations. The sampling and analysis plan must include the monitoring point location (headworks), the sampling frequency and methodology, and a list of constituents to be monitored. A facility is eligible for the direct monitoring option once they receive confirmation that the sampling and analysis plan has been received by the Director. The Director may reject the sampling and analysis plan if he/she finds that, the sampling and analysis plan fails to include the above information; or the plan parameters would not enable the facility to calculate the weekly average concentration of these chemicals accurately. If the Director rejects the sampling and analysis plan or if the Director finds that the facility is not following the sampling and analysis plan, the Director shall notify the facility to cease the use of the direct monitoring option until such time as the bases for rejection are corrected.

(v) Rebuttable presumption for used oil. Used oil containing more than 1000 ppm total halogens is presumed to be a hazardous waste because it has been mixed with halogenated hazardous waste listed in 335-14-2-.04. Persons may rebut this presumption by demonstrating that the used oil does not contain hazardous waste (for example, to show that the used oil does not contain significant concentrations of halogenated hazardous constituents listed in 335-14-2-Appendix VIII.)

(I) The rebuttable presumption does not apply to metalworking oils/fluids containing chlorinated paraffins, if they are processed, through a tolling agreement, to reclaim metalworking oils/fluids. The presumption does apply to metalworking oils/fluids if such oils/fluids are recycled in any other manner, or disposed.

(II) The rebuttable presumption does not apply to used oils contaminated with chlorofluorocarbons (CFCs) removed from refrigeration units where the CFCs are destined for reclamation. The rebuttable presumption does apply to used oils contaminated with CFCs that have been mixed with used oil from sources other than refrigeration units.

(b) A solid waste which is not excluded from regulation under 335-14-2-.01(3)(a)1. becomes a hazardous waste when any of the following events occur:

1. In the case of a waste listed in 335-14-2-.04, when the waste first meets the listing description set forth in 335-14-2-.04;

2. In the case of a mixture of solid waste and one or more listed hazardous wastes, when a hazardous waste listed in 335-14-2-.04 is first added to the solid waste;

3. In the case of any other waste (including a waste mixture), when the waste exhibits any of the characteristics identified in 335-14-2-.03.

(c) Unless or until it meets the criteria of 335-14-2-.01(3)(d):

1. A hazardous waste will remain a hazardous waste;

2.(i) Except as otherwise provided in 335-14-2-.01(2)(c)2.(ii), 335-14-2-.01(3)(g), or 335-14-2-.01(3)(h), any solid waste generated from the treatment, storage, or disposal of a hazardous waste, including any sludge, spill residue, ash, emission control dust, or leachate (but not including precipitation run-off) is a hazardous waste (However, materials that are reclaimed from solid wastes and that are used beneficially are not solid wastes and hence are not hazardous wastes under this provision unless the reclaimed material is burned for energy recovery or used in a manner constituting disposal.);

(ii) The following solid wastes are not hazardous even though they are generated from the treatment, storage, or disposal of hazardous waste, unless they exhibit one or more of the characteristics of hazardous waste:

(I) Waste pickle liquor sludge generated by lime stabilization of spent pickle liquor from the iron and steel industry (SIC codes 331 and 332).

(II) Waste from burning any of the materials exempted from regulation by 335-14-2-.01(6)(a)3.(iii) through (iv).

(III)(1) Nonwastewater residues, such as slag, resulting from high temperature metals recovery (HTMR) processing of K061, K062 or F006 waste, in units identified as rotary kilns, flame reactors, electric furnaces, plasma arc furnaces, slag reactors, rotary hearth furnace/electric furnace combinations or industrial furnaces [as defined in 335-14-1-.02(1)], that are disposed in Subtitle D unit(s) (which are in compliance with the applicable requirements of ADEM Administrative Code Division 335-13, Solid Waste Program Rules, and which are authorized to receive such wastes), provided that these residues meet the generic exclusion levels identified in the tables in 335-14-2-.01(3)(c) for all constituents, and exhibit no characteristics of hazardous waste. Testing requirements must be incorporated in a facility's waste analysis plan or a generator's self-implementing waste analysis plan; at a minimum, composite samples of residues must be collected and analyzed quarterly and/or when the process or operation generating the waste changes. Persons claiming this exclusion in an enforcement action will have the burden of proving by clear and convincing evidence that the material meets all of the exclusion requirements.

| **Constituent** | **Maximum for any single composite sample--TCLP (mg/L)** |
|---|---|
| Generic exclusion levels for K061 and K062 nonwastewater HTMR residues | |
| Antimony | 0.10 |
| Arsenic | 0.50 |
| Barium | 7.6 |
| Beryllium | 0.010 |
| Cadmium | 0.050 |
| Chromium (total) | 0.33 |
| Lead | 0.15 |
| Mercury | 0.009 |
| Nickel | 1.0 |
| Selenium | 0.16 |
| Silver | 0.30 |
| Thallium | 0.020 |
| Zinc | 70 |
| Generic exclusion levels for F006 nonwastewater HTMR residues | |
| Antimony | 0.10 |
| Arsenic | 0.50 |
| Barium | 7.6 |
| Beryllium | 0.010 |
| Cadmium | 0.050 |
| Chromium (total) | 0.33 |
| Cyanide (total) (mg/kg) | 1.8 |
| Lead | 0.15 |

| Constituent | Maximum for any single composite sample--TCLP (mg/L) |
|---|---|
| Mercury | 0.009 |
| Nickel | 1.0 |
| Selenium | 0.16 |
| Silver | 0.30 |
| Thallium | 0.020 |
| Zinc | 70 |

(III)(2) A one-time notification and certification must be placed in the facility's files and sent to EPA Region 4 and to the Department for K061, K062 or F006 HTMR residues that meet the generic exclusion levels for all constituents and do not exhibit any characteristics that are sent to Subtitle D unit(s) regulated pursuant to Division 335-13 Rules. The notification and certification that is placed in the generator's or treater's files must be updated if the process or operation generating the waste changes and/or if the Subtitle D unit receiving the waste changes. However, the generator or treater need only notify EPA Region 4 and the Department on an annual basis if such changes occur. Such notification and certification should be sent to EPA Region 4 and the Department by the end of the calendar year, but no later than December 31. The notification must include the following information: The name and address of the Subtitle D unit(s) regulated pursuant to Division 335-13 Rules receiving the waste shipments; the EPA Hazardous Waste Number(s) and treatability group(s) at the initial point of generation; and, the treatment standards applicable to the waste at the initial point of generation. The certification must be signed by an authorized representative and must state as follows: “I certify under penalty of law that the generic exclusion levels for all constituents have been met without impermissible dilution and that no characteristic of hazardous waste is exhibited. I am aware that there are significant penalties for submitting a false certification, including the possibility of fine and imprisonment.”

(IV) Biological treatment sludge from the treatment of one of the following wastes listed in 335-14-2-.04(3) - organic waste (including heavy ends, still bottoms, light ends, spent solvents, filtrates, and decantates) from the production of carbamates and carbamoyl oximes (EPA Hazardous Waste No. K156), and wastewaters from the production of carbamates and carbamoyl oximes (EPA Hazardous Waste No. K157).

(V) Catalyst inert support media separated from one of the following wastes listed in 335-14-2-.04(3)--Spent hydrotreating catalyst (EPA Hazardous Waste Number K171), and spent hydrorefining catalyst (EPA Hazardous Waste Number K172).

(d) Any solid waste described in 335-14-2-.01(3)(c) is not a hazardous waste if it meets the following criteria:

1. In the case of any solid waste, it does not exhibit any of the characteristics of hazardous waste identified in 335-14-2-.03. (However, wastes that exhibit a characteristic at the point of generation may still be subject to the

requirements of 335-14-9, even if they no longer exhibit a characteristic at the point of land disposal.)

2. In the case of a waste which is a listed waste under 335-14-2-.04, contains a waste listed under 335-14-2-.04 or is derived from a waste listed in 335-14-2-.04, it also has been excluded from 335-14-2-.01(3)(c) under 335-14-1-.03(2).

(e) [**Reserved]**

(f) Notwithstanding 335-14-2-.01(3)(a) through (d) and provided the debris as defined in 335-14-9 does not exhibit a characteristic identified in 335-14-2-.03, the following materials are not subject to regulation under 335-14-1 through 335-14-9:

1. Hazardous debris as defined in 335-14-9 that has been treated using one of the required extraction or destruction technologies specified in 335-14-9-.04(6) [see Table 1, 40 CFR 268.45]; persons claiming this exclusion in an enforcement action will have the burden of proving by clear and convincing evidence that the material meets all of the exclusion requirements; or

2. Debris as defined in 335-14-9 that the Department, considering the extent of contamination, has determined is no longer contaminated with hazardous waste.

(g)1. A hazardous waste that is listed in 335-14-2-.04 solely because it exhibits one or more characteristics of ignitability as defined under 35-14-2-.03(2), corrosivity as defined under 335-14-2-.03(3), or reactivity as defined under 335-14-2-.03(4) is not a hazardous waste, if the waste no longer exhibits any characteristic of hazardous waste identified in 335-14-2-.03.

2. The exclusion described in 335-14-2-.01(3)(g)1. also pertains to:

(i) Any mixture of a solid waste and a hazardous waste listed in 335-14-2-.04 solely because it exhibits the characteristics of ignitability, corrosivity, or reactivity as regulated under 335-14-2-.01(3)(a)2.(iv); and

(ii) Any solid waste generated from treating, storing, or disposing of a hazardous waste listed in 335-14-2-.04 solely because it exhibits the characteristics of ignitability, corrosivity, or reactivity as regulated under 335-14-2-.01(3)(c)2.(i).

3. Wastes excluded under 335-14-2-.01(3) are subject to 335-14-9 (as applicable), even if they no longer exhibit a characteristic at the point of land disposal.

4. Any mixture of a solid waste excluded from regulation under 335-14-2-.01(4)(b)7. and a hazardous waste listed in 335-14-2-.04 solely because it exhibits one or more of the characteristics of ignitability, corrosivity, or reactivity as regulated under 335-14-2-.01(3)(a)2.(iv) is not a hazardous waste, if the mixture no longer exhibits any characteristic of hazardous waste identified in 335-14-2-.03 for which the hazardous waste listed in 335-14-2-.04 was listed.

(h)1. Hazardous waste containing radioactive waste is no longer a hazardous waste when it meets the eligibility criteria and conditions of 335-14-7-.14 ("eligible radioactive mixed waste").

2. The exemption described in 335-14-2-.01(3)(h)1. also pertains to:

(i) Any mixture of a solid waste and an eligible radioactive mixed waste; and

(ii) Any solid waste generated from treating, storing, or disposing of an eligible radioactive mixed waste.

3. Waste exempted under 335-14-2-.01(3) must meet the eligibility criteria and specified conditions in 335-14-7-.14(3) and 335-14-7-.14(4) (for storage and treatment) and in 335-14-7-.14(12) and 335-14-7-.14(13) (for transportation and disposal). Waste that fails to satisfy these eligibility criteria and conditions is regulated as hazardous waste.

(4) Exclusions.

(a) "Materials which are not solid wastes". The following materials are not solid wastes for the purpose of 335-14-2:

1. (i) Domestic sewage; and

(ii) Any mixture of domestic sewage and other wastes that passes through a sewer system to a publicly-owned treatment works for treatment, except as prohibited by 335-14-7-.16(5) and Clean Water Act requirements at 40 CFR 403.5(b);

2. Industrial wastewater discharges that are point source discharges subject to regulation under Section 402 of the federal Clean Water Act, as amended. This exclusion applies only to the actual point source discharge. It does not exclude industrial wastewaters while they are being collected, stored, or treated before discharge, nor does it exclude sludges that are generated by industrial wastewater treatment;

3. Irrigation return flows;

4. Source, special nuclear or by-product material as defined by the Atomic Energy Act of 1954, as amended, 42 U.S.C. 2011 et seq.;

5. Materials subjected to in-situ mining techniques which are not removed from the ground as part of the extraction process;

6. Pulping liquors (i.e., black liquor) that are reclaimed in a pulping liquor recovery furnace and then reused in the pulping process, unless it is accumulated speculatively as defined in 335-14-1-.02;

7. Spent sulfuric acid used to produce virgin sulfuric acid provided it is not accumulated speculatively as defined in 335-14-1-.02(1);

are removed from the property and no unpermitted discharges to waters have occurred.

**Author:** Russell A. Kelly, S. Scott Story, Heather M. Jones
**Statutory Authority:** Code of Ala. 1975, §§22-27-3, 22-27-4, 22-27-7.
**History:** November 18, 1981; **Amended:** July 21, 1988. **Amended:** Filed September 28, 1993; effective November 2, 1993. **Amended:** Filed June 21, 1996; effective July 26, 1996. **Amended:** Filed April 24, 2018; effective June 8, 2018. **Amended:** Published October 29, 2021; effective December 13, 2021.

## 335-13-4-.21 General Operational Standards For Landfill Units.

Any person or agency operating or planning to operate a landfill unit shall operate and maintain the facility consistent with this Division. General requirements for operating and maintaining an acceptable landfill unit shall be:

(1) General Operation.

(a) The operation and use of the landfill unit shall be as stipulated in the permit.

(b) Waste accepted at the facility shall be strictly controlled so as to allow only waste stipulated in the permit or otherwise as may be approved by the Department. The permittee of any facility permitted under these rules must have in the operating record a plan describing procedures the permittee will implement for detecting and preventing the disposal of free liquids, regulated hazardous wastes, regulated medical wastes, and regulated PCB wastes at the facility. This plan must include at a minimum:

1. Random inspections of incoming loads to ensure that incoming loads do not contain free liquids, regulated hazardous wastes, regulated medical wastes, or regulated PCB wastes.

2. Inspection of suspicious loads.

3. Records of all inspections to include the origin of waste suspected to be regulated hazardous, regulated medical, or regulated PCB waste if known; transporters, to include transfer stations and all handlers of the waste en route to the disposal site; and any certifications from generators provided to the permittee or facility personnel. These records must be maintained on file in the operating record of the facility.

4. Training of facility personnel to recognize free liquids, regulated hazardous wastes, regulated medical wastes, and regulated PCB wastes.

5. Procedures for notifying the proper authorities if free liquids, regulated hazardous wastes, regulated medical wastes, or regulated PCB wastes are discovered at the facility.

6. Methods to identify all industrial users of the facility, producers of special wastes, and transporters of these wastes.

(c) Prior to disposal of industrial waste and/or medical waste, the permittee shall obtain from each generator a written certification that the material to be disposed does not contain free liquids, regulated hazardous wastes, regulated medical wastes, or regulated PCB wastes.

1. This certification may be based on laboratory analysis of the waste on a case-by-case basis, or documentation supporting the generator's knowledge of the wastestreams(s), or as may be required by the Department.

2. Copies of the certification shall be submitted to the Department for disposal approval and for any specific requirements prior to disposal. After submittal of the required certification, the Department shall have five (5) working days to respond. If no response is given, the permittee may dispose of the material as proposed.

3. In the case of one-time emergency disposal requests, the permittee shall submit the required certification no later than five (5) days after the disposal of waste.

4. Certification shall be renewed or revised biennially (every two years) or at such time that operational changes at the point of generation could render the waste hazardous, whichever is more frequent and submitted to the Department for approval.

5. Copies of these certifications and approvals shall be maintained on file in the operating record of the facility and shall be made available for the Department upon request.

6. The above requirements notwithstanding and, as may otherwise be required, pursuant to Division 13 rules, generators will not be required to submit certification to the Department provided that:

(i) The waste will be disposed of at a non-commercial industrial waste landfill which has been permitted by

the Department, and is owned either exclusively or mutually by the generator(s) of the waste, and which disposes of waste generated only by the owner(s);

(ii) The wastestream(s) to be disposed of are specifically described in the Solid Waste Landfill Permit issued by the Department or in the final application as referenced by the permit for the site designated to receive the waste;

(iii) The required certification, as described above, is maintained on-site by the owner(s) of the landfill; and

(iv) The required certification, as described above, is made available for inspection by the Department upon request.

(d) The landfill unit shall be operated in such a manner that there will be no water pollution or unauthorized discharge.

1. Any discharge resulting from a landfill unit or practice may require:

(i) A National Pollutant Discharge Elimination System (NPDES) permit under the Alabama Water Pollution Control Act as issued by the Department.

(ii) A dredge or fill permit from the Army Corps of Engineers as required under Section 404 of the Clean Water Act, as amended; or

(iii) That a non-point source of surface waters does not violate an area wide or statewide water quality management plan that has been approved under the Alabama Water Pollution Control Act.

2. The groundwater shall not be contaminated as specified by this Division.

(e) The historic and certified disposal areas shall be identified with a sufficient number of permanent markers which are at least visible from one marker to the next.

(f) Measuring or weighing devices shall be required for all municipal solid waste landfill units accepting solid waste. All solid waste shall be properly measured or weighed prior to disposal unless otherwise approved by the Department.

(g) Deep rooted vegetation (with roots that may grow below the six inch erosion layer) shall be prohibited as vegetative cover.

(h) With the exception of very small quantity generator waste disposed of in municipal solid waste landfills, regulated hazardous waste, as defined by Division 14 of the ADEM Administrative Code, is prohibited from disposal in a non-hazardous landfill unit.

(i) Except as provided in paragraph 1. below, a landfill shall not dispose of whole tires after December 31, 2027. Whole tires shall at a minimum be shredded or cut into thirds or smaller pieces prior to disposal.

1. Incidental whole tires received in loads of solid waste may be disposed, provided the whole tires constitute a de minimis portion of the overall load of waste.

2. "De minimis" refers to a small amount of material or number of items, as applicable, commingled and incidentally disposed of with other solid waste.

(2) Open Burning.

(a) Open burning of solid waste at any landfill unit is prohibited unless approved by the Department as follows:

1. Clearing debris at the landfill unit such as trees and stumps may be burned if prior approval is received from the Department and the Alabama Forestry Commission.

2. Emergency clean-up debris resulting from catastrophic incidents may be burned at a permitted landfill unit if consistent with the intent of this Division and air pollution control requirements. Prior approval must be received from this Department and other appropriate agencies.

3. If approved, the burning shall not occur over previously filled areas or within 200 feet of existing disposal operations unless otherwise specified by the Department and such burning shall not cause a public nuisance or pose a threat to public health.

(b) The person or agency requesting permission to burn solid waste shall apply in writing to the Department, outlining why a burn request should be granted. This request should include, but not be limited to, specifically what areas will be utilized, types of waste to be burned, the projected starting and completion dates for the project, and the projected days and hours of operation.

**Author:** Russell A. Kelly, S. Scott Story, Heather M. Jones, Jason Wilson

**Statutory Authority:** Code of Ala. 1975, §§22-22A-5, 22-27-3, 22-27-4, 22-27-7, 22-27-47, 22-27-48.

**Section 22-30-3**

**Definitions.**

When used in this chapter and except where the context prohibits, the following words and terms shall have the following meanings:

(1) COMMISSION. The Environmental Management Commission of the Alabama Department of Environmental Management as created by Section 22-22A-6.

(2) DEPARTMENT. The Alabama Department of Environmental Management as created by Section 22-22A-4.

(3) DIRECTOR. The Director of the Alabama Department of Environmental Management.

(4) DISPOSAL. The discharge, deposit, injection, dumping, spilling, leaking or placing of any hazardous waste into or on any land or water so that such hazardous waste or any constituent thereof may enter the environment or be emitted into the air or discharged into any waters, including ground waters.

(5) HAZARDOUS WASTE. A solid waste, or combination of solid wastes, which, because of its quantity, concentration or physical, chemical or infectious characteristics may:

a. Cause, or significantly contribute to, an increase in mortality or an increase in serious irreversible, or incapacitating reversible, illness; or

b. Pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported or disposed of, or otherwise managed.

(6) HAZARDOUS WASTE GENERATION. The act or process of producing hazardous waste.

(7) HAZARDOUS WASTE MANAGEMENT. The systematic control of the collection, source separation, storage, transportation, processing, treatment, recovery and disposal of hazardous wastes.

(8) MANIFEST. The form adopted by the department used for identifying the quantity, composition, origin, routing and destination of hazardous waste during its transportation from the point of generation to the point of disposal, treatment or storage.

(9) PERSON. Any and all persons, natural or artificial, including, but not limited to any individual, partnership, association, society, joint stock company, firm, company, corporation, institution, trust, estate, or other legal entity or other business organization or any governmental entity, and any successor, representative, agent or agency of the foregoing.

(10) RCRA. The Federal Resource Conservation and Recovery Act of 1976, 42 U.S.C. §6901 et seq., as amended.

(11) SOLID WASTE. Any garbage, refuse, sludge from a waste treatment plant, water supply treatment plant or air pollution control facility and other discarded material, including solid, liquid, semisolid or contained gaseous material resulting from industrial, commercial, mining and agricultural operations and from community activities, including any material to be discarded by a generator, but such term does not include solid or dissolved material in domestic sewage, or solid or dissolved materials in irrigation return flows or industrial discharges which are point sources subject to permits under Section 402 of the Federal Water Pollution Control Act, as amended (86 Stat. 880), or source, special nuclear or by-product material as defined by the Atomic Energy Act of 1954, as amended (68 Stat. 923).

(12) STORAGE. The actual or intended containment of wastes, either on a temporary basis or for a period of years, in such a manner as not to constitute disposal of such wastes.

(13) TRADE SECRET. Such term includes, but is not limited to, any formula, plan, pattern, process, tool, mechanism, compound or procedure, as well as production data or compilation of information, financial and marketing data, which is not patented, which is known only to certain individuals within a commercial concern who are using it to fabricate, produce or compound an article of trade or a service having commercial value, and which gives its user an opportunity to obtain a business advantage over competitors who do not know of it.

(14) TREATMENT. Any method, technique or process including neutralization, designed to change the physical, chemical or biological character or composition of any hazardous waste so as to neutralize such waste or so as to render such waste nonhazardous, safer for transport, amenable for recovery, amenable for storage or reduced in volume. Such term includes any activity or processing designed to change the physical form or chemical composition of hazardous waste so as to render it nonhazardous.

***(Acts 1978, 2nd Ex. Sess., No. 129, p. 1843, §3; Acts 1982, No. 82-612, p. 1111, §11(h); Acts 1984, No. 84-50, §1; Acts 1987, No. 87-807, p. 1590, §3.)***

## B. PERSONNEL TRAINING LOG SHEET

**Personnel Training Log Sheet**

| By my signature, I certify that I have received training regarding procedures used to recognize and exclude prohibited waste and safety precautions with handling and storing prohibited waste. | | |
|---|---|---|
| DATE | EMPLOYEE NAME (PRINTED) | EMPLOYEE SIGNATURE |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| COMMENTS: | | |

## C. LOAD INSPECTION FORM

# LOAD INSPECTION FORM

Date: _____ Time: _____am/pm

Inspection Type: 1) Random Inspection _____
2) Suspicious Load _____

Reason for Suspicion: _____

## SOURCE INFORMATION

1) Waste Hauler Name _____
2) Driver Name _____
3) Vehicle ID No. _____
4) Waste Generator Name _____

## INSPECTION RESULTS

1) Describe Waste Inspected _____

_____

2) Prohibited Wastes Present? _____ Yes _____ No
3) Containers (drums, cans) Present? _____ Yes _____ No
4) Approved MSW Waste _____ Yes _____ No
5) Other Observations _____

_____

_____

6) Disposition _____ Load Accepted
_____ Load Rejected
_____ Operator / ADEM Notified

_____ (Waste Inspector)

(Signature)

*(This form may be revised or updated as necessary by the Landfill Operator to meet the needs at this facility.)*

# 12.0 GEOTECHNICAL DESIGN CALCULATIONS

# REPORT OF GEOTECHNICAL EVALUATION – MAJOR MODIFICATION SUPPORT

ARROWHEAD LANDFILL
PERRY COUNTY, ALABAMA
FACILITY PERMIT #53-03

**Prepared For:**
Arrowhead Environmental Partners, LLC
65 Challenger Road (Suite 312)
Ridgefield Park, New Jersey 07660

BLE Project Number J24-4999-66

**January 30, 2025**

BUNNELL LAMMONS ENGINEERING
6004 Ponders Court, Greenville, SC 29615
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BLECORP.COM

BUNNELL LAMMONS ENGINEERING

January 30, 2025

Arrowhead Environmental Partners, LLC
65 Challenger Road (Suite 312)
Ridgefield Park, NJ 07660

Attention: Mr. William W. Gay
Divisional Vice President

**Subject:** **Geotechnical Report - Major Modification Support**
**Arrowhead Landfill**
Perry County, Alabama
Facility Permit #53-03
BLE Project Number J24-4999-66

Dear Mr. Gay,

Bunnell-Lammons Engineering, Inc. (BLE) has performed geotechnical-engineering analyses associated with a proposed vertical expansion at the Arrowhead Landfill in Perry County, Alabama and in support of a major modification of the landfill design by Hodges, Harbin, Newberry & Tribble, Inc. (HHNT). Geotechnical analysis associated with the proposed expansion landfill design performed by BLE includes:

1. Subgrade settlement estimates of the bottom liner system and calculation of the post-settlement slope of the leachate collection system piping,
2. Cushioning analysis of the bottom geomembrane liner system at the revised base of the existing and proposed disposal cells,
3. Pipe stress analysis of the leachate collection system piping,
4. Global slope stability analysis of the existing and proposed waste slopes at representative cross-sections in planned interim and final grade conditions, with recommendations for minimum interface friction shear strength values of the bottom liner system,
5. Transmissivity analysis of the geocomposite drainage media in the final cover system, and
6. Veneer sliding stability analysis of representative cross sections of the bottom liner system and final cover system.

Our services were performed in general accordance with our authorized proposal dated July 11, 2024, addressed to Arrowhead Environmental Partners, LLC. This report presents our understanding of the project, our evaluation and analysis results, and our geotechnical recommendations for project design and construction.

## EXECUTIVE SUMMARY

BLE has performed a review of the Arrowhead Landfill historical permitting, construction documents, and waste placement practices and performed geotechnical analysis in support of the major modification to the landfill design by HHNT.

Based on the subgrade conditions in existing Tract 1 and the future Tract 2 and 3 footprints along with the proposed final waste heights, the ultimate settlement of the bottom liner systems in future Tracts are estimated to range up to 43-inches (3.6 feet). At proposed leachate collection alignments, pipe slope intervals are estimated to exhibit a minimum 0.77% post-settlement slope with negligible differential settlement or longitudinal strain of the bottom liner system components. In accordance with Alabama Department of Environmental Management (ADEM) Rule 335-13-4-.11 (2), the minimum estimated groundwater separation to the soil liner subgrade elevation in the existing and proposed tracts is greater than the minimum 5 feet separation requirement. It is noted that the first saturated zone beneath the facility is located within the Eutaw Formation aquifer at depths of approximately 440 to 570 feet below ground surface. The potentiometric surface for wells installed into the Eutaw Formation aquifer groundwater ranges from about 80 to 150 feet below ground surface (~ 440.0 to 563 feet below ground surface to the Eutaw Formation with stabilized potentiometric water levels from ~ 80 to 150 feet below ground surface). The uppermost physical presence of groundwater is at the top of the Eutaw Formation and below the confining Selma Group clay and chalk.

Leachate collection pipe stress analysis was performed for the designed leachate collection system piping in existing Tract 1 and future Tracts 2 and 3 to assess the factor of safety against pipe crushing, buckling, and ring deflection under the proposed maximum final waste loads. Acceptable factors of safety were identified under the proposed final grade conditions and design considerations for the bottom liner system and leachate collection piping in existing Tract 1 and proposed Tracts 2 and 3.

Cushion geotextile analysis was evaluated for the bottom liner systems in the existing and proposed Tracts. The existing and proposed cumulative minimum 24-osy cushion geotextile fabric beneath the No. 57 stone in the leachate collection system achieves acceptable factors of safety against puncture of the underlying geomembrane in Tracts 1 and 2 under the proposed final grade conditions. Tract 3 will require a minimum of 30-osy cushion geotextile fabric to achieve acceptable factors of safety under the proposed final grade conditions.

The global stability of representative interim and proposed final perimeter waste slopes in the existing and proposed Tracts was modeled and resulted in acceptable factors of safety for multiple waste slope shearing modes. The recommended minimum interface shear strengths for the bottom liner system components of future landfill cells are provided in this report. Veneer sliding stability of the protective cover and final cover system was also performed to identify the minimum required interface friction shear strength of the liner system geosynthetic components. The transmissivity of the drainage layer in the final cover system was analyzed to determine the required geocomposite properties to convey the estimated maximum stormwater infiltration through the protective cover layer.

Our report includes calculation documentation for each geotechnical analysis performed. Design and construction recommendations related to future landfill construction are also presented.

We appreciate the opportunity to serve as your geotechnical consultant at the site. If you have any questions concerning this report, please do not hesitate to contact us at (864) 288-1265.

Sincerely,

**BUNNELL-LAMMONS ENGINEERING, INC.**

William D. Yarbray, E.I.T.
Staff Engineering Associate

Tanner Whitesell, E.I.T
Staff Engineering Associate

ALABAMA LICENSED No. 36952 PROFESSIONAL 1/30/25 ENGINEER LAWRENCE A. SIMONSON

Larry A. Simonson, P.E.
Senior Geotechnical Engineer
Licensed, Alabama No. 36952

cc: Mr. Kevin Berry, P.E. – HHNT
Mr. Clint Courson, P.E. – HHNT

BUNNELL LAMMONS ENGINEERING

**TABLE OF CONTENTS**


**1.0 PROJECT INFORMATION ..... 1**
1.1 Historical Site Information ..... 1
1.2 Review of Cell Construction Bottom Liner Systems ..... 2
1.3 Review of Available Waste Information ..... 3
1.4 Engineering Site Visit ..... 3

**2.0 SUMMARY OF SITE GEOLOGY AND SUBSURFACE CONDITIONS ..... 3**
**2.1 Regional Geology ..... 3**

**3.0 ANALYSIS AND DESIGN RECOMMENDATIONS ..... 4**
**3.1 Subgrade Settlement ..... 4**
3.1.1 General Settlement Analysis Conditions ..... 4
3.1.2 Estimated Subgrade Settlement Results ..... 5
**3.2 Bottom Liner and Leachate Collection System Analyses ..... 5**
3.2.1 Pipe Stress Analysis ..... 5
3.2.2 Geomembrane Puncture Resistance Analysis ..... 6
**3.3 Global Slope Stability ..... 6**
3.3.1 Global Slope Stability Analysis Conditions ..... 7
3.3.2 Slope Stability Analysis Results – Final Landfill Slope Conditions in Tract 1 ..... 7
3.3.3 Slope Stability Analysis Results – Final Landfill Slope Conditions in Tract 2 ..... 8
3.3.4 Slope Stability Analysis Results – Final Landfill Slope Conditions in Tract 3 ..... 8
3.3.5 Slope Stability Analysis Results – Interim Landfill Slope Conditions in Tracts 1, 2, and 3 ..... 8
**3.4 Veneer Sliding Stability ..... 8**
3.4.1 Base Liner Protective Cover Veneer Sliding ..... 9
3.4.2 Final Cover Veneer Sliding ..... 9
**3.5 Final Cover Drainage Layer Analysis ..... 10**

**4.0 RECOMMENDATIONS FOR LANDFILL DESIGN AND OPERATION ..... 11**
**4.1 Subgrade Preparation ..... 11**
4.1.1 Grading and Subgrade Preparation ..... 11
4.1.2 Water Control Measures ..... 11
4.1.3 Structural Fill ..... 12
**4.2 Bottom Liner and Leachate Collection System ..... 12**
4.2.1 Leachate Collection Piping ..... 12
4.2.2 Bottom Liner Cushioning ..... 13
**4.3 Waste Slope Stability Considerations ..... 13**
4.3.1 Bottom Liner System ..... 13
4.3.2 Waste and Pore Pressure Conditions ..... 14
**4.4 Veneer Sliding Stability ..... 15**
4.4.1 Protective Cover Veneer Sliding ..... 16
4.4.2 Recommended Interface Shear Strengths of Final Cover System Components ..... 16
**4.5 Final Cover System Design ..... 16**
4.5.1 Geocomposite Drainage Media ..... 16

**5.0 CONCLUSION ..... 17**

## APPENDICES

**Appendix A: Figures**

| | |
|---|---|
| **Figure 1:** | **Site Location Map** |
| **Figure 2A:** | **Existing Conditions: Tract 1** |
| **Figure 2B:** | **Groundwater Contour Elevations: Tract 1** |
| **Figure 2C:** | **Initial Landfill Grades: Tract 1** |
| **Figure 2D:** | **Proposed Final Landfill Grades: Tract 1** |
| **Figure 3A:** | **Existing Conditions: Tract 2** |
| **Figure 3B:** | **Groundwater Contour Elevations: Tract 2** |
| **Figure 3C:** | **Initial Landfill Grades: Tract 2** |
| **Figure 3D:** | **Proposed Final Landfill Grades: Tract 2** |
| **Figure 4A:** | **Existing Conditions: Tract 3** |
| **Figure 4B:** | **Groundwater Contour Elevations: Tract 3** |
| **Figure 4C:** | **Initial Landfill Grades: Tract 3** |
| **Figure 4D:** | **Proposed Final Landfill Grades: Tract 3** |
| **Figure 5:** | **Stability Cross Sections: A-A', B-B', C-C', and D-D'** |
| **Figure 6:** | **Stability Cross Sections: E-E', F-F', and G-G'** |
| **Figure 7:** | **Settlement Cross Sections: S-1, S-2, S-3, and S-4** |
| **Figure 8:** | **Settlement Cross Sections: S-5, and S-6** |

**Appendix B: Historical Landfill Construction & Operation Records**
- **Summary of Constructed Base Liner System Components by Cell Area**

**Appendix C: Subgrade Settlement Calculations**
- **Subgrade Settlement Analysis Summary Tables**
- **Settlement Estimates at Point Locations**
- **Referenced Historical Boring Logs – BLE, 2007.**

**Appendix D: Bottom Liner System Analysis**
- **Pipe Stress Analysis**
- **Geomembrane Puncture Resistance Analysis**

**Appendix E: Global Slope Stability Analysis Documentation**
- **Seismic Design Hazard Parameters**
- **Historical CQA Interface Friction Laboratory Test Results**
- **Slope Stability Analysis Interface Shear Strength Relationships**
- **Slope Stability Analysis Model Results**

**Appendix F: Veneer Stability Analysis**
- **Protective Cover Veneer Stability**
- **Final Cover Veneer Stability**

**Appendix G: Final Cover Drainage Layer Analysis**
- **GDM Transmissivity Analysis**

**Appendix H: Important Information about This Geotechnical-Engineering Report**

## 1.0 PROJECT INFORMATION

The Arrowhead Landfill is located southeast of Uniontown, Alabama. The permittee is Perry County Associates LLC. The existing design for the facility was proposed by Hodges, Harbin, Newberry, and Tribble, Inc. (HHNT). Existing Tract 1 of the landfill currently consists of Cell No. 1 through 8. Cell No. 9 is currently being constructed.

We understand that the proposed Major Modification Application plans to steepen the slopes of landfill Tracts 1, 2, and 3 from their currently permitted grade of four-horizontal to one-vertical (4H:1V) to a proposed grade of three-horizontal to one-vertical (3H:1V). The proposed Major Modification Application also plans to deepen portions of the base grades from their currently designed depths to the depths originally permitted prior to the 2016 Permit Renewal. The facility has retained HHNT to redesign the facility and to prepare an application for a major modification to the permit. HHNT requested that BLE prepare this report to provide support services for the major modification to include geotechnical services as described herein.

BLE has extensive experience with the site conditions at the facility having served as the geotechnical engineer and construction quality assurance (CQA) engineer for the existing landfill cell construction projects. We also performed a partial geotechnical evaluation of Tract 1 in 2007. BLE is also the hydrogeological consultant for the facility providing water quality compliance services and BLE prepared the facility's current environmental monitoring plan (EMP) in 2021.

Site plan figures showing the site's location, topographic conditions, and construction and design grades are presented in **Figures 1 and 2A – 4D** in **Appendix A** of this report.

### 1.1 Historical Site Information

Data from previously performed hydrogeologic investigations, engineering analyses, and construction quality assurance documentation relevant to the major modification referenced in our geotechnical analyses include the following:

- *Solid Waste Permit Application – Landfill Design & Operation Plan,* Perry County Associates Landfill, prepared by Jordan, Jones & Goulding, Inc., dated September 2005.
- *Report of Geotechnical Exploration and Laboratory Testing – Perry Uniontown Landfill*, BLE Project No. J06-4999-01, dated January 16, 2007.
- *Construction Quality Assurance Report – Construction of Cells No. 4 and 5*, BLE project No. J07-4999-04, dated August 2, 2007.
- *Construction Quality Assurance Report – Construction of Cell No. 3*, BLE project No. J07-4999-04, dated October 2, 2007.
- *Construction Quality Assurance Report – Construction of Tract 1 West Cells No. 4 and 5*, BLE project No. J09-4999-17, dated November 6, 2009.
- *Construction Quality Assurance Report – Construction of Tract 1 West Cell No. 3 West*, BLE project No. J09-4999-17, dated January 13, 2010.
- *Construction Quality Assurance Report – Construction of Tract 1 West Cell No. 2*, BLE project No. J09-4999-17, dated February 25, 2010.
- *Construction Quality Assurance Report – Construction of Tract 1 West Cell No. 1*, BLE project No. J09-4999-17, dated May 12, 2010.

- *Engineering Stability and Settlement Evaluations of the Proposed Tract 1, 2, and 3 Horizontal Expansion to Arrowhead Landfill, Uniontown, Alabama*, prepared by Golder Associates, dated March 30, 2011.
- *Construction Quality Assurance (CQA) Report – Construction of Cell No. 6A*, BLE project No. J12-4999-31, dated March 22, 2013.
- *2016 Solid Waste Permit Renewal Application – Arrowhead Landfill, Permit #53-03*, by Hodges, Harbin, Newberry & Tribble, Inc., dated March 2016.
- *Construction Quality Assurance (CQA) Report – Construction of Cell No. 6B*, BLE project No. J19-4999-48, dated February 3, 2020.
- *Review of Interface Friction Test Results – Construction of Cell No. 7, Arrowhead Landfill,* BLE Project Number J22-4999-55, dated July 6, 2022.
- *Final Certification Report, Construction Quality Assurance Services, Arrowhead Landfill – Cell No. 7 Construction*, prepared by Atlantic Coast Consulting, Inc. (ACC), dated September 2022.
- *Report of Geotechnical Exploration – Renewable Natural Gas Facility, Arrowhead Landfill,* BLE Project No. J24-4999-65, dated September 9, 2024.

### 1.2 Review of Cell Construction Bottom Liner Systems

Construction records have been reviewed via the available construction quality assurance (CQA) reports as part of this engineering evaluation in support of the proposed major modification to the landfill design. A summary of the referenced bottom liner system components documented during each cell construction is presented in **Appendix B**. The base liner system in the proposed cells is assumed to consist of the following components, as designed by the "Bottom Liner and Protective Cover Systems" (Detail 19) in the Permit Renewal dated March 2016, (from top to bottom):

- 12-inches of soil protective cover ($k \geq 1 \times 10^{-2}$ cm/s)
- Minimum 8-osy cushion geotextile
- 60-mil textured high density polyethylene (HDPE) geomembrane layer
- 24-inches of compacted clay liner ($k \leq 1 \times 10^{-7}$ cm/s)

In areas where leachate collection pipes are planned the leachate collection system design includes:

- 8-inch diameter SDR-9, perforated HDPE leachate collection pipes.
- ASTM No. 57 stone for leachate collection drainage filter.
- Additional minimum 16-ounce per square yard (osy) non-woven cushion geotextile beneath the leachate collection stone (for a cumulative mass/area of 24-osy).

The constructed base liner system of the existing cells (Cell Nos. 1-8) within Tract 1 were reported in CQA documentation by BLE (Cell Nos. 1-6B, and recently constructed Cell No. 8) and Atlantic Coast Consulting, Inc. (Cell No. 7). The bottom liner system consists of (from top to bottom):

- 12 to 24-inches of soil protective cover ($k \geq 1 \times 10^{-2}$ cm/s)
- 24-osy cushion geotextile
- 60-mil textured high density polyethylene (HDPE) geomembrane layer
- 24-inches of compacted clay liner ($k \leq 1 \times 10^{-7}$ cm/s)

### 1.3 Review of Available Waste Information

BLE requested general waste constituent information for inclusion in our stability evaluation. Based on correspondence, we understand the site has received up to little (< 1%) high moisture content waste, as a percentage of the current overall waste stream. High moisture content waste (HMCW) is generally defined as waste with a moisture content of greater than or equal to 40%, calculated by the weight of moisture divided by total weight of waste. We understand the site is to continue little to no acceptance of HMCW. The total waste disposal tonnage ranges from 6,500 tons per day (tpd) to 8,000 tpd in the past year. The site intends to take a tonnage rate as high as 10,000 tpd in the coming years. The Permit currently allows a waste acceptance rate of 15,000 tpd.

Based on our discussions with the owner, leachate removal quantities generally correspond to the rainfall data, indicating that the leachate collection system is functional. The landfill has utilized perforated HDPE leachate collection pipes encapsulated in washed ASTM No. 57 gradation stone for the leachate collection system. At the time of this report, the site does not have an active landfill gas extraction system with which to measure any potential perched liquid levels within the waste.

### 1.4 Engineering Site Visit

As a part of our evaluation, BLE senior geotechnical engineer Mr. Larry Simonson, P.E. performed a site reconnaissance on August 19, 2024. The purpose of the site visit was to observe the existing landfill conditions for signs of instability such as bulging, cracking, or widespread leachate seeps. In summary, the site visit did not reveal items of concern or any conditions which should be accounted for in our analysis for the proposed vertical expansion.

## 2.0 SUMMARY OF SITE GEOLOGY AND SUBSURFACE CONDITIONS

The following represents the general subsurface soil and groundwater conditions at the site based on our site experience and review of available site records.

### 2.1 Regional Geology

Geologic conditions for this site summarized herein are described in the *Solid Waste Permit Application, Volume 1 of 2, Site Analysis, Perry County Associates Landfill*, dated September 2005, prepared by Jordan, Jones, and Goulding (JJ&G) which has been previously reviewed and approved by ADEM.

The site is underlain by Cretaceous-age Coastal Plain sediments comprised of the Selma Group (clay and chalk) overlying the Eutaw Formation (sand).

Regionally, the Selma Group is comprised of the Ripley Formation, Demopolis Chalk, Arcola Limestone Member, and Mooreville chalk. Locally, the Selma Group generally consists of about 440 to 563 feet of low permeability, gray, clay and chalk at the landfill site. The upper 10 to 20 feet near the ground surface consists of brown clay, which represents the upper weathered portion of the formation. Underlying the Selma Group is the Eutaw Formation, which consists of gray glauconitic fine to medium sand and is a regional water supply aquifer.

The uppermost physical presence of groundwater and first saturated zone is located 440 to 570 feet below ground surface at the top of the Eutaw Formation below the confining Selma Group clay and chalk. The Selma Group strata are unsaturated, are not an aquifer, and serve as the confining layer for the underlying Eutaw Formation. The potentiometric surface for wells installed into the Eutaw Formation aquifer groundwater ranges from about 80 to 150 feet below ground surface. Site plan figures showing the potentiometric groundwater elevation contours observed in September 2023 are presented in **Figures 2B, 3B, and 4B** in **Appendix A** of this report.

## 3.0 ANALYSIS AND DESIGN RECOMMENDATIONS

The analyses of landfill - subgrade soil interaction and stability of the planned waste mound, and the performance of the base liner and final cover systems - are performed and reported herein. The analyses have been based on electronic design drawings prepared by HHNT, the available geotechnical boring and laboratory test data, and our extensive site experience. The analyses were performed and reviewed by a registered professional engineer specializing in geotechnical engineering of municipal solid waste landfills. The geotechnical analyses are presented in **Appendices C – G** of this report.

### 3.1 Subgrade Settlement

Subgrade settlement of the bottom liner system in Tracts 1, 2, and 3 was estimated at representative locations along six (6) selected leachate collection pipe alignments (S-1, S-2, S-3, S-4, S-5, and S-6) as part of an evaluation of the post-settlement slope of the leachate collection piping when subjected to the overburden pressure associated with the proposed 3H:1V final grades. In accordance with Alabama DEM Rule 335-13-4-.11 (2), a minimum 5-foot separation between the liner system and the site groundwater elevations is required to be maintained. Settlement analysis summary tables and results are included in **Appendix C** of this report.

#### 3.1.1 General Settlement Analysis Conditions

Analysis for settlement of the subgrade profile consisted of performing consolidation settlement analyses along the leachate collection lines under the proposed maximum waste thickness for each Tract. Compressibility parameters for the soil profile were estimated based on historical laboratory testing as detailed in **Appendix B** of this Report. The analysis conservatively assumed the stress increase within the subgrade materials was equal to the uniform surcharge pressure of the overlying waste mound at a given point. The surcharge pressures were estimated based on a total unit weight of 85 pounds per cubic foot (pcf) for municipal solid waste (MSW). The maximum waste thickness is estimated to be approximately 238 feet in existing Tract 1, 269 feet in future Tract 2, and 330 feet in future Tract 3.

Reference boring logs from historical monitoring points or borings were used to generalize the subsurface profile in the vicinity of the designated settlement analysis point. Twenty-three (23) settlement analysis points were selected along the six (6) proposed leachate collection pipe alignments in Tracts 1, 2, and 3. The locations designated for the settlement analysis are shown in **Figures 2C, 3C, and 4C** in **Appendix A**.

### 3.1.2 Estimated Subgrade Settlement Results

Estimated subgrade settlements at the selected analysis locations range from 0.0 feet at the eastern portion of Cell No. 5 in Tract 1 to 3.6 feet in Cell No. 6 in Tract 3. The typical soil profile generalized from the referenced boring logs consists exclusively of very stiff to very hard clay soils. All existing and future cell pipe segments analyzed in this evaluation were calculated to have positive post-settlement slope towards the respective sump of each cell.

Total and differential subgrade settlements caused by the waste loading are expected to be within acceptable limits of the structural components including the bottom liner and leachate collection system of the existing and future cells. The greatest differential settlement between adjacent settlement analysis points is 1.94 ft over a horizontal distance of 404 feet. This is equivalent to a 0.48 ft vertical difference over a 100-foot-long section which results in a longitudinal strain of approximately 0.0012%. This value is well below the allowable tensile strain of HDPE geomembrane, which is conservatively selected as 3%.

## 3.2 Bottom Liner and Leachate Collection System Analyses

### 3.2.1 Pipe Stress Analysis

The planned maximum waste heights in existing Tract 1 and future Tracts 2 and 3 were analyzed to compare the estimated overburden stress to the structural loading capacity of the leachate collection system piping. The planned maximum waste height over the HDPE central leachate collection piping used in the existing landfill cells and proposed cells were evaluated against the maximum planned overburden stress to compute a factor of safety against pipe wall crushing, buckling, and ring deflection. Results of the pipe stress analyses for each landfill stage are presented in **Appendix D**.

Based on review of historic CQA documentation, as summarized in **Appendix B** of this report, the central leachate collection piping in the existing cells of Tract 1 consisted of 8-inch SDR-9, HDPE pipe with 2 feet of stone mounding above the pipe. For the central trunklines of existing Tract 1, two separate pipe formula designations were used in construction (PE3408 and PE4710). Additionally, secondary 4-inch SDR-9, HDPE pipe having no stone mounding above the pipe, was analyzed. Each analyzed case is representative of the maximum planned waste height for each pipe material constructed.

It is planned that an 8-inch SDR-9 or SDR-7, HDPE pipe with 2 feet of stone mounding above the pipe is to be constructed in future landfill cells. Analysis was performed to determine the maximum waste height that can be constructed using an 8-inch SDR-9 or SDR-7 HDPE pipe. It was determined that a maximum waste height of 280 feet above the leachate collection system pipe results in acceptable factors of safety for an 8-inch SDR-9, HDPE pipe with 2 feet of stone above the pipe. Additionally, it was determined that a maximum waste height of 330 feet above the leachate collection system pipe results in acceptable factors of safety for an 8-inch SDR-7, HDPE pipe with 2 feet of stone above the pipe.

### 3.2.2 Geomembrane Puncture Resistance Analysis

The bearing pressure associated with the planned final grades in Tracts 1, 2, and 3 was compared to the estimated allowable bearing pressures of the 60-mil HDPE geomembrane in the bottom liner system to resist puncture from protruding gravel pieces in the leachate collection system drainage aggregate.

As outlined in **Section 1.2** of this report, the constructed leachate collection system in the existing Cells of Tract 1 consists of a cumulative 24 ounce per square yard (osy) geotextile fabric for cushioning. The proposed leachate collection system in future landfill cells is designed to consist of the same cumulative geotextile cushioning. Therefore, the maximum pressure induced by the No. 57 stone onto the underlying geotextile fabrics and geomembrane was based on the tallest final grade waste height in each Tract. Modification factors related to the No. 57 stone characteristics and reduction factors related to the geotextile long-term performance were considered in this analysis. Based on review of historical CQA documentation, it is apparent that rounded to subrounded river gravel was used for construction of the leachate collection drainage stone in prior cell construction. Therefore, a subrounded drainage stone was conservatively assumed for existing and proposed cells.

BLE has selected a target factor of safety of 5.0 to align with published literature by Rowe et al., 2019[1] and Brachman and Gudina, 2008[2]. The referenced literature shows that strains on the order of 6% associated with long-term stress cracking of geomembranes can occur with cushioning materials which show a factor safety equal to as high as 3.0. Therefore, we have selected a factor of safety on the order of 5.0 for use in design due to the critical nature of geomembrane puncture protection.

Based on our analysis presented herein, acceptable factors of safety are achieved for the proposed final grade conditions in Tract 1 and 2, the maximum allowable waste height overlaying the proposed 24-osy geotextile mass is 275 feet of waste. However, under the proposed maximum waste height of 330 feet in future Tract 3, it was determined that an additional 6 osy of cushioning geotextile is needed beneath the No. 57 stone (for a total of 30 osy) to achieve acceptable factors of safety for the proposed final grade conditions in future Tract 3. Analysis results are presented in **Appendix D** of this report.

## 3.3 Global Slope Stability

Global slope stability analysis was performed for the expected 3H:1V interim and proposed final landfill waste slopes in Tracts 1, 2, and 3. Cross sections of representative slope areas across the existing and future Tract footprints were selected based on proposed slope height and bottom liner geometry. Representative cross sections in Tracts 1, 2, and 3 are depicted, in **Figures 2D, 3D, and 4D** in **Appendix A.**

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[1] Rowe, K., & Yi, Y. (2019). Magnitude and significance of tensile strains in geomembrane landfill liners. *Geomembranes and Geotextiles*, 439-458.
[2] Brachman, R., & Gudina, S. (2008). Geomembrane strains from coarse gravel and wrinkles in a GM/GCL composite Liner. *Geotextiles and Geomembranes 26* (2008) 488-497.

A summary of the methodology and the analysis results are provided in the subsequent sections. Detailed descriptions and conditions for the global slope stability analysis are provided in **Appendix E** of this report.

### 3.3.1 Global Slope Stability Analysis Conditions

Landfill slope stability is a function of the slope geometry, waste and subgrade strengths, waste placement rates, moisture conditions, and other factors.

Cross section A-A' was selected to represent the tallest final 3H:1V waste slope of Tract 1. Cross section B-B' represents the tallest 3H:1V final waste slope of Tract 2. Cross sections C-C' and D-D' represent the tallest 3H:1V final waste slopes of Tract 3. Cross sections E-E', F-F', and G-G' were selected to represent the expected 3H:1V interim waste slopes prior to achieving final grade conditions in Tract 1, 2, and 3, respectively. Therefore, the generalized interim waste slope in Tract 1 was modeled with the toe of the waste terminating in future Cell No. 9. For future Tract 2, the toe of waste was modeled terminating in future Cell No. 9. For future Tract 3, the toe of waste was modeled terminating in future Cell No. 9.

The global stability analysis of each cross section considered subgrade, interface-sliding, and waste-limited potential shearing modes of the interim and/or final landfill configuration using the modeling program Slide2D by RocScience. Slope stability is quantified by limit equilibrium factors of safety, where the limit of static equilibrium would be represented by a factor of safety equal to 1.0, and factors of safety greater than 1.0 represent a stable condition. For the static, peak shear strength condition of the interface components of the bottom liner system, a target factor of safety (FS) $\geq$ 1.5 was designated as the recommended minimum for the final grade conditions. For large-displacement strength conditions of the bottom liner system interfaces, which represent a worst-case condition for interface strengths, a target FS $\geq$ 1.1 is designated as the recommended minimum for the final grade conditions. Interim slopes which represent short-term conditions are designed to achieve a target FS $\geq$ 1.3. For the pseudo-static (seismic) conditions, a target factor of safety (FS) > 1.0 was designated as the recommended minimum for the final grade conditions. These minimum values are in alignment with generally accepted engineering practice and the U.S. Army Corp of Engineers Engineering and Design Manual, Em1110-2-1902.

The shear strength parameters for the subsurface soil were determined from the soil types encountered by the borings and our experience with materials similar to those encountered on this site. Material properties of the municipal solid waste are estimated using values commonly referenced in geotechnical practice for typical MSW materials. For interface sliding shear conditions, interface shear strengths of geosynthetic interface components of existing and future liner systems, were modeled using available shear testing data and estimated based on our experience with similar materials when site-specific test data was not available. Shear strength parameters used in this analysis are outlined in **Appendix E** of this report.

### 3.3.2 Slope Stability Analysis Results – Final Landfill Slope Conditions in Tract 1

The lowest calculated results for each of the shearing modes in the final landfill slope conditions for the analyzed cross section are presented in Tables 4 and 5 within **Appendix E** of this report. As shown in **Appendix E**, acceptable factors of safety are achieved under long-term static and seismic final grade

conditions for interface sliding, global, and waste-only modes of slope deformation for the Tract 1 east and west slopes as represented by cross section A-A'.

#### 3.3.3 Slope Stability Analysis Results – Final Landfill Slope Conditions in Tract 2

The lowest calculated results for each for the shearing modes in the final landfill slope conditions for the analyzed cross section are presented in Table 6 within **Appendix E** of this report. As shown in **Appendix E**, acceptable factors of safety are achieved under long-term static and seismic final grade conditions for interface sliding, global, and waste-only modes of slope deformation for the Tract 2 south slope as represented by cross section B-B'.

#### 3.3.4 Slope Stability Analysis Results – Final Landfill Slope Conditions in Tract 3

The lowest calculated results for each for the shearing modes in the final landfill slope conditions for the analyzed cross sections are presented in Tables 7 and 8 within **Appendix E** of this report. As shown in **Appendix E**, acceptable factors of safety are achieved under long-term static and seismic final grade conditions for interface sliding, global, and waste-only modes of slope deformation for the Tract 3 northwest and south slopes as represented by cross sections C-C' and D-D', respectively. An acceptable factor of safety is achieved for the proposed approximate 3H:1V northwest perimeter fill slope as represented by cross section C-C'.

#### 3.3.5 Slope Stability Analysis Results – Interim Landfill Slope Conditions in Tracts 1, 2, and 3

Generalized interim waste slopes were evaluated to reflect a potential uniform 3H:1V slope with the toe of waste terminating within the expected subsequent cell in each tract as presented in section 3.3.1 of this report.

The lowest calculated results for each for the shearing modes in the interim landfill slope conditions for the analyzed cross sections are presented in Table 9 within **Appendix E** of this report. As shown in **Appendix E**, acceptable factors of safety are achieved under static short-term interim grade conditions for interface sliding, global, and waste-only modes of slope deformation for the anticipated interim 3H:1V waste slopes in Tract 1, 2, and 3 as represented by cross sections E-E', F-F' and G-G', respectively.

### 3.4 Veneer Sliding Stability

Veneer sliding stability analyses for the proposed side slopes of the bottom liner system and the final cover system were performed utilizing the design grading plans for Tracts 1, 2, and 3 prepared by HHNT. Details of the veneer stability analyses are presented in **Appendix F.**

### 3.4.1 Base Liner Protective Cover Veneer Sliding

The sliding resistance for the planned side slopes of the bottom liner and leachate collection system was analyzed as a finite slope using the method developed by Koerner and Soong (2005)[3]. The 3H:1V, 52-foot tall, southern side slope in future Cell No. 10 of Tract 3 was analyzed for veneer stability in static and dynamic equipment loading conditions, representative of the tallest interim slope conditions expected during construction of the bottom liner system in Tracts 1, 2, and 3. The dynamic loading condition considered a Caterpillar D6 bulldozer operating in an uphill direction.

A minimum required interface shear strength of the bottom liner system components was determined to calculate an acceptable factor of safety for a potential veneer-type failure along the geosynthetic interfaces. A peak interface shear strength equivalent to a secant friction angle of 27 degrees was identified for normal loads expected during cell construction. A factor of safety greater than the recommended minimum 1.5 was calculated for both the static and dynamic conditions analyzed.

A detailed summary of the recommended minimum interface shear strength values associated with acceptable factors of safety for global slope stability (as noted in Section 3.3 and 3.4) and veneer sliding stability is provided in Section 4.3 of this report. Each interface of the bottom liner system should have a minimum shear strength (combination of friction and cohesion / adhesion at the anticipated normal load) equivalent to the values provided in Section 4.3**.**

### 3.4.2 Final Cover Veneer Sliding

The veneer sliding resistance for the planned 3H:1V slopes of the final cover system was analyzed as finite slopes using the method by Koerner and Soong (2005). Veneer stability was analyzed for both static and seismic conditions as the closure system will be a long-term slope condition.

The following final cover system obtained from detail 8 of Sheet 17 from the 2016 Permit Renewal Plan Set by HHNT, and also proposed for the Major Modification was used for this analysis (from top to bottom):

- 6 inches of vegetative cover
- 18-inches of protective soil cover
- Geocomposite drainage media
- 40-mil textured LLDPE geomembrane
- 12-inches of compacted low permeability soil liner, $k \leq 1.0 \times 10^{-5}$ cm/s
- 12-inches of intermediate cover above the waste

A lower bound of shear strength was used to calculate the factor of safety for a veneer-sliding failure mode of the final cover soils above the geosynthetic interfaces. The analysis indicates that a final cover system cover soil and geocomposite drainage media with a peak interface shear strength represented by a friction angle of 30 degrees or more will achieve an acceptable factor of safety of 1.5 for static conditions.

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[3] Koerner, R.M. and Soong, T-Y. (2005). *Analysis and Design of Veneer Cover Soils*. Geosynthetics International, Special Issue on Giroud Lectures, 12, No. 1, pp. 28-49.

Veneer stability of the final cover system was calculated considering seismic conditions using a seismic coefficient ($k_s$) of 0.20 for the estimated maximum horizontal acceleration at the crest of a waste slope as described in the RCRA Seismic Design Guidance. This considers amplification of the peak horizontal acceleration of 0.13g at the landfill bottom liner elevation through the waste mass to an amplified peak ground acceleration of 0.20g at the elevation of the final cover system. A factor of safety of FS = 1.0 is achieved indicating acceptable stability in a seismic condition. Estimated slope deformations up to 30 cm (12 in), are generally considered an acceptable deformation for a cover system as it can be observed and repaired[4].

Limit equilibrium slope stability analysis was performed using the computer program Slope/W on a tack-on storm water berm over the 3H:1V final cap as a part of the veneer stability analysis. The tack on berm was modeled after Detail 10 of Sheet 17 from the 2016 Permit Renewal Plan Set by HHNT and also proposed for the Major Modification. The berm geometry considered has a 4-ft top-width, 2.0 ft depth from top to invert, a 2H:1V back slope and 1.5H:1V outside slope. The analysis considered the worst-case conditions including independent conditions of a flooded/full berm scenario. The resulting factor of safety is 1.5 for the flooded, static condition and a factor of safety of 1.0 for the flooded, seismic condition. Therefore, the proposed tack-on storm water berm stability is considered acceptable.

### 3.5 Final Cover Drainage Layer Analysis

The purpose of the transmissivity analysis is to determine the required transmissivity of the geosynthetic drainage media (GDM) to be installed above the textured geomembrane liner (FML) of the proposed final cover system. Based on the procedure presented in Qian et al. (2002)[5], the required transmissivity is dependent on the fluid supply rate, the drainage length, and the inclination of the GDM layer. The analysis assumes that the GDM is allowed to drain from outlets at a minimum 40 vertical feet on the 3:1 H:V slopes based on HHNT's proposed final grading plans. The fluid supply rate is limited by the long-term permeability of the erosion layer soil, which is assumed for this evaluation to be representative of the on-site clayey soils. A long-term permeability (k) equal to $1.0 \times 10^{-6}$ cm/s was conservatively used for our analysis. Reduction factors were considered to account for a potential reduction in drainage efficiency of the GDM in a long-term condition. A factor of safety of F.S. $\geq$ 2.0 was also considered in our evaluation.

Based on the analysis, the recommended minimum transmissivity for the final cover liner system GDM is $9.7 \times 10^{-6}$ $m^2/s$. The use of more permeability erosion layer soils would result in a larger minimum transmissivity for the final cover liner system GDM. A double-sided geocomposite such as SKAPS TN 270-2 (or equivalent) is estimated to provide the minimum required transmissivity under short-term and long-term (reduced supply rate) conditions of the final cover system. Based on our experience with the available on-site borrow soils, we anticipate clayey soils will be designated for the protective cover soil

[4] Qian, X. Koerner, R., & Gray, D. (2001). Geotechnical Aspects of landfill Design. Prentice Hall.
[5] Qian, X, Koerner, R.M, & Gray, D.H., (2002). *Geotechnical Aspects of Landfill Design and Construction*. Prentice Hall, New Jersey.

layer in the final cover system. For clayey cover soil (greater than 50% fines) the geotextile should have a maximum AOS (O95) of 0.22mm. A non-woven, 8-osy geotextile, similar to the SKAPS GE 180 (AOS of 0.180mm), will meet the require properties listed by AASHTO M288-96 (Table 2-2 in Richardson et al., 2000). If the selected protective cover soil material has a PI > 15, the soil is not susceptible to suffusion and therefore there is limited clogging potential[6]. To prevent potential clogging of the geonet, a D85 particle size greater than 0.1mm is conservatively recommended for potential protective cover material.

The results of the analysis are included in **Appendix G** of this report.

## 4.0 RECOMMENDATIONS FOR LANDFILL DESIGN AND OPERATION

Based on the geotechnical analyses performed in support of the proposed vertical expansion, the following recommendations are provided for use in the design of the future landfill cells in Tracts 1, 2, and 3.

### 4.1 Subgrade Preparation

#### 4.1.1 Grading and Subgrade Preparation

Excavation is expected in future cells of Tracts 1, 2, and 3 to achieve design subgrade elevation. Upon excavating to the design subgrade elevations, the subgrade surface should be proof rolled to evaluate for potential soft underlying layers. The proof roll should be performed with a loaded, off-road haul truck such as a CAT 740 or equivalent. The proof roll vehicle should make at least four passes over each location, with the last two passes perpendicular to the first two where practical. Any areas which wave, rut or deflect excessively and continue to do so after several passes of the proof-roller should be excavated to firmer soils. The proofrolling and over-excavation operations should be carefully monitored by an experienced engineering technician working under the direction of the geotechnical engineer. Over-excavated soils should be backfilled with compacted structural fill.

If excessive deflection is due to `the presence of moisture, drying may be required to provide a stable foundation. Proofrolling should not be performed when the ground is frozen or wet from recent precipitation.

#### 4.1.2 Water Control Measures

The uppermost physical presence of groundwater and first saturated zone is located 440 to 570 feet below ground surface at the top of the Eutaw Formation below the confining Selma Group clay and chalk. The Selma Group strata are unsaturated, are not an aquifer, and serve as the confining layer for the underlying Eutaw Formation. The potentiometric surface for wells installed into the Eutaw Formation aquifer groundwater ranges from about 80 to 150 feet below ground surface. Therefore, groundwater will not be encountered during excavation. The contractor should be prepared to promptly remove any surface water

[6] Richardson, G. N., Giroud, J.P., and Zhao, A. (2000), Design of Lateral Drainage Systems for Landfills.

from the construction area. This may be accomplished by means of gravity ditches and pumping from filtered sumps.

#### 4.1.3 Structural Fill

Structural fill placement is expected to achieve the design grade elevation in portions of the proposed cell floors and perimeter berms in Tracts 1, 2, and 3. In areas to receive structural fill to achieve the design grade the underlying soils should be suitable for placement of overlying fill. Unsuitable soil such as organic soil (peat) and soft sediment should be removed to firm, in-situ soil. Proofrolling should be performed to determine the extent of unsuitable soils in excavated conditions prior to structural fill placement.

Moisture modification may be required to achieve a suitable subgrade condition prior to structural fill placement. A granular soil bridge lift, not exceeding 24 inches in thickness, may be utilized for certain conditions during subgrade preparation when reviewed by a geotechnical engineer prior to implementation.

Structural fill to form the landfill base grades should be placed in horizontal loose lifts of no greater than 10-inches thick. Each lift should be compacted to a minimum of 95% of the standard Proctor maximum dry density within 3% of the optimum moisture content (+/- 3%). Structural fill material should primarily consist of the following USCS classifications: SC, SM, SP, SW, ML, CL and CH having a maximum particle size of 3 inches. On-site soil used for structural fill shall have a standard Proctor maximum dry density (ASTM D698) of greater than 95 pcf.

Before filling operations begin, representative samples of each proposed fill material should be collected and tested to determine the compaction and classification characteristics. The maximum dry density and optimum moisture content should be determined. Once earthwork filling begins, density tests should be performed by an experienced engineering technician working under the direction of the geotechnical engineer to measure the degree of compaction being obtained. Density testing frequency should be in accordance with the current CQA Plan Requirements but should be not less than 1 test per 1,000 cy of in-place structural fill.

### 4.2 Bottom Liner and Leachate Collection System

The following section details our design recommendations associated with the leachate collection system pipe corresponding to the analysis in **Section 3.2**.

#### 4.2.1 Leachate Collection Piping

The maximum waste thickness is estimated to be approximately 238 feet in existing Tract 1, 269 feet in future Tract 2, and 330 feet in future Tract 3, which is expected to induce overburden loads on the bottom liner system of about 20,000, 23,000, and 28,100 psf, respectively. Arching will occur over the leachate collection columns and piping, as overburden stress is transferred to the embedding gravel, and will reduce the effective stress on the pipe wall. As outlined in **Section 3.2** of this report, it was determined that an 8-inch SDR-9, HDPE pipe with 2 feet of stone mounding above the pipe, results in acceptable factors of safety for a maximum height of 280 feet of waste. An 8-inch SDR-7, HDPE pipe with 2 feet of stone

mounding above the pipe, results in acceptable factors of safety for a maximum height of 330 feet of waste. If the pipe used for construction of future landfill cells differs from the assumptions made for this analysis, presented herein, BLE should be notified to update our analysis using the constructed material properties of the pipe.

#### 4.2.2 Bottom Liner Cushioning

The minimum bottom liner cushioning for ASTM No. 57 stone in the leachate collection columns, which is assumed to be subrounded, is 24-osy total geotextile mass. As outlined in **Section 3.2** of this report, the maximum waste height that can be placed on the proposed 24-osy geotextile mass is 275 feet. It was determined that an additional 6-osy is required (a total of 30-osy) for the proposed final waste heights in Tract 3 (330 feet of waste). The use of a more angular drainage stone will require an increase in geotextile mass/area needed beneath the drainage stone to achieve the recommended factor of safety against puncture. Note that the required cushioning may be achieved by combining the mass per unit area for all geotextiles between the stone and the geomembrane: geocomposite geotextile and cushion geotextile.

The gravel is recommended to have a nominal grain size (D50) of 17mm. The gravel is to be non-carbonaceous, that is, having a calcium carbonate equivalence of less than 15% when measured using ASTM D3042.

For this analysis, the typical waste constituents were assumed to be of a mild nature in terms of chemical and biological degradation. Leachate testing is recommended to be performed if the waste constituents change considerably to include a significant percentage of industrial or other chemical waste products which are expected to increase the degradation potential of the leachate in contact with the bottom liner system. Degradation of the fabric geotextile would effectively reduce the overall cushioned mass and reduce the protection of the geomembrane. Evaluation of future waste stream characteristics and the impact on leachate corrosivity should be performed prior to future cell construction to incorporate additional geotextile cushion layers below the aggregate in the leachate collection columns, as necessary.

### 4.3 Waste Slope Stability Considerations

The following sections detail our design recommendations associated with the slope stability analysis in **Section 3.3**.

#### 4.3.1 Bottom Liner System

Prior to the construction of each landfill waste cell, the interface shear strength between each of the proposed layers of the bottom liner systems should be confirmed by direct shear testing in accordance with the procedure outlined in ASTM D5321 and ASTM D6243 using samples of the materials proposed to be used. Interface shear testing programs typically require 4 weeks or more to complete due to laboratory availability and shear rates.

The minimum average interface shear and internal shear strength values required to achieve the slope stability factors of safety provided herein are represented by the interface angles noted in **Table 1**.

**Table 1: Recommended Minimum Interface Shear Strengths – Bottom Liner System Future Landfill Cells**

| Normal Load (psf) | Peak Shear Strength, Secant Friction Angle | Large-Displacement Shear Strength Secant Friction Angle (2) |
|---|---|---|
| 1,000 | 510 (27°) | 250 (14.0°) |
| 8,000 | 2069 (14.5°) | 1125 (8.0°) |
| 15,000 | 3188 (12.0°) | 1842 (7.0°) |
| 20,000 | 4069 (11.5°) | 2279 (6.5°) |

Note (1): For each landfill waste cell construction project, a minimum of 2 tests should be performed for each interface, including the soil liner to the lowermost geosynthetic liner, and should cover the normal loads in **Table 1**. Test results should be reviewed by a geotechnical engineer specializing in solid waste landfills and experienced in interface friction testing. The average of the 2 tests should exceed the values in **Table 1** with none of the tests being less than 80% of the listed value.
Note (2): The large-displacement values should be obtained from the interface with the lowest peak shear strength.
Note (3): The shear strength may be considered a combination of cohesion and friction angle at each normal load.
Note (4): Peak shear strength at 1,000 psf required to achieve an acceptable factor of safety for veneer stability of the base liner system.

If the strengths shown are not achieved, the slope stability analysis conditions can be reviewed to assess the stability of the conditions of a particular landfill cell and the results of the interface friction testing. Note that the interface shear strength for the 1,000 psf normal load is based on the veneer stability condition with a factor of safety of 1.5 for the tallest 3H:1V bottom liner side slope for the future landfill cells.

### 4.3.2 Waste and Pore Pressure Conditions

Internal waste drainage and dewatering should be planned to prevent the buildup of pore pressure as waste placement occurs. In addition, the presence of landfill gas pressure within the landfill should be controlled through an active landfill gas extraction system.

High moisture content waste, and non-solidified, low permeability sludges and other low shear strength waste, have the potential to clog the leachate collection and removal systems. Therefore, the monitoring of the leachate removal rates from the landfill should be periodically compared to anticipated rates for MSW landfills in the southeastern United States. Should the leachate removal rate become lower than anticipated, signs of consistent perched liquid appear in landfill gas wells, or widespread leachate outbreaks become apparent, further dewatering should be performed to prevent elevated landfill pore pressures which could lead to instability. High moisture content waste (HMCW) should not be placed within 50 feet (horizontal) of the landfill slopes including the interim, 3H:1V landfill slopes and should not be used in sliver fills. Placement of HMCW should be well-mixed with the other waste materials so that the overall material retains the properties of typical MSW detailed in our **Appendix E**.

The presence of elevated pore pressures, widespread or numerous leachate seeps on the landfill side slopes, or zones of relatively low strength waste should be reported to BLE or other qualified geotechnical engineer specializing in solid waste landfills for evaluation. Occurrences of perched liquid levels within the waste measured through landfill gas wells or piezometers should be reviewed by a geotechnical engineer specializing in solid waste landfills to evaluate the impact on global stability. Global stability is a function

of shear strength, pore pressure, filling rate, and slope geometry; therefore, each of these factors should be confirmed during future waste stability evaluations.

We recommend that BLE be consulted for the following conditions as they may impact slope stability:

- HMCW disposal exceeds 20% for future waste streams,
- Leachate recirculation is performed.
- Waste filling results in up to 100 vertical feet of waste filling over a period of 12 months or less for a given area.
- Non-MSW waste constituents which make up more than 10% of the total landfill tonnage, e.g., coal combustion residuals or industrial wastes streams.
- Should non-MSW waste constituents be planned to be installed as a monofill within a landfill cell, impacts to landfill stability should be assessed.
- Increasing the waste tonnage to more than 10,000 tons per day.

We recommend the following operational best practices be continued to maintain waste slope stability:

- When beginning new waste lifts over previous waste lifts, cover soils are to be removed to provide continuous waste to waste contact.
- The leachate collection system will maintain the height of liquid (head) on the geomembrane liner at or below 30 centimeters (12 inches)
- Leachate and landfill gas are to be properly controlled as the waste placement progresses to prevent excess pore pressures from gas and liquids.
- Waste should be placed and compacted in horizontal lifts in an uphill direction, starting from the lowest elevation of each cell then working upward in horizontal lifts. Downhill placement and compaction of waste will result in lower compaction, lower density, and a reduction in the bonding of the new to old waste in the lift which leads to less shear strength of the waste.
- Each waste lift is to be keyed into the existing slope, i.e., sliver fills are to be properly benched to provide waste-to-waste contact.
- Intermediate landfill slopes should be buttressed by an edge of cell berm, i.e., avoid placing the toe of a waste slope un-buttressed within the floor of a cell.

The results of the geotechnical analyses presented in this report indicate that the proposed landfill configuration will result in acceptable factors of safety for slope stability when considering the analysis conditions, recommended waste placement conditions included herein, and the landfill controls the pore pressures from liquids within the waste. The conditions included in **Appendix E** are important to the performance of the landfill slopes and deviations from the conditions described in the analysis should be reviewed by a geotechnical engineer.

### 4.4 Veneer Sliding Stability

The following sections detail our design recommendations associated with the veneer stability planned bottom liner system and final cover system corresponding to the analysis items in **Section 3.4** of this report.

### 4.4.1 Protective Cover Veneer Sliding

Interface friction requirements associated with the bottom liner system and protective cover interfaces are incorporated into **Table 1** in **Section 4.3** of this report. Materials which meet the listed interface shear strength values have been modeled to result in acceptable factors of safety against both veneer sliding (during construction) and waste mass interface-sliding (during landfill operation) modes of instability.

### 4.4.2 Recommended Interface Shear Strengths of Final Cover System Components

To provide adequate stability for the final grade 3H:1V inclination, the final cover system components should be tested to result in a minimum peak interface shear strength of **30 degrees at normal loads up to 3,000 psf**. Requirements are summarized in **Table 2**.

**Table 2: Recommended Minimum Interface Shear Strength Values - Final Cover System**

| Normal Load Range (psf)(1) | Peak Shear Strength<br>Friction Angle / Cohesion (psf) |
|---|---|
| 0-3,000 | 30°/ 0 psf |

Note (1): Interface friction testing should be performed at 500 psf, 1,500 psf, and 3,000 psf for the closure system components.
Note (2): The shear strength may be considered a combination of cohesion and friction angle at each normal load.

Shear strengths used in our analysis are estimates of long-term strength reduced over time following weathering and material deterioration. Strength degradation (softening) of soil is dependent on multiple factors including the climate, vegetation and root system within the soil mass, and clay mineral composition.

Adequate veneer stability is contingent upon achieving the shear strengths described in this report and adequate drainage of the final cover and bottom liner systems. We recommend that all cover material for the final cover system be spread in the uphill direction by low ground pressure, tracked equipment with ground pressure less than or equal to 6 psi. Tracked equipment should not spin or slip during spreading of material upslope and should minimize pushing the dozer blade into the slope during the spreading of protective cover. Haul truck traffic should operate on minimum 4-foot-thick haul roads when operating over the final cover geosynthetics. Use of a smooth slip sheet when pulling geocomposite down slope over the textured liner interfaces is recommended to be used by the liner installer to prevent shearing of the cover geotextile and polishing of the liner which would reduce the available shear strength of the interface.

## 4.5 Final Cover System Design

The following section details our design recommendations associated with the final cover drainage analysis in **Section 3.5**.

### 4.5.1 Geocomposite Drainage Media

The minimum recommended transmissivity of the geocomposite drainage media (GDM) is $9.7 \times 10^{-6}$ $m^2/s$. A double-sided geocomposite such as SKAPS TN 270-2-8 (or equivalent) is estimated to provide the

minimum required transmissivity under short-term and long-term (reduced supply rate) conditions of the final cover system.

We recommend conformance testing be performed on the planned protective soil cover material prior to ordering the geocomposite for a closure restrictive cover construction project. The following conformance testing is recommended:

- Remolded Permeability (Flex Wall Permeability) ASTM D5084
- Particle Size Distribution – ASTM D422
- Geocomposite Transmissivity - ASTM D4716

Geocomposite drainage media should be tested at a gradient of 0.33 under 500 psf normal load for 100 hours. The test should be completed using site soils planned for use as the protective soil layer underlain by the textured LLDPE geomembrane.

The analysis assumes that the GDM is allowed to drain from outlets at a minimum 40 vertical feet on the 3:1 H:V slopes based on HHNT's proposed final grading plans. The GDM is to be drained above planned storm water benches to allow for the infiltrated water to weep out of the GDM and cover soils via perforated piping and into the surface storm water conveyance ditches. At elevations of outlets, the GDM is to be terminated and wrapped around a lateral perforated plastic pipe. The lateral pipe would then have T junctions to 4-inch solid plastic pipe outlets at a minimum of every 200 lateral feet, which would daylight above a storm water conveyance ditch.

Based on our experience with the available on-site borrow soils, we anticipate clayey soils will be designated for the protective cover soil layer in the final cover system. For clayey cover soil (greater than 50% fines) the geotextile should have a maximum AOS (O95) of 0.22mm. A non-woven, 8-osy geotextile, similar to the SKAPS GE 180 (AOS of 0.180mm), will meet the require properties listed by AASHTO M288-96 (Table 2-2 in Richardson et al., 2000). If the selected protective cover soil material has a PI > 15, the soil is not susceptible to suffusion and therefore there is limited clogging potential[7]. To prevent potential clogging of the geonet, a D85 particle size greater than 0.1mm is conservatively recommended for potential protective cover material.

If the protective cover soil material elected for final cover construction exhibits permeability and/or grain-size gradation values different than those assumed in this report, a review of the drainage layer analysis should be performed by a geotechnical engineer experienced in solid waste landfills.

## 5.0 CONCLUSION

The results of the geotechnical analyses presented in this report indicate that the proposed landfill configuration will result in acceptable subgrade settlements and the waste slopes and veneer layers will

[7] Richardson, G. N., Giroud, J.P., and Zhao, A. (2000), Design of Lateral Drainage Systems for Landfills.

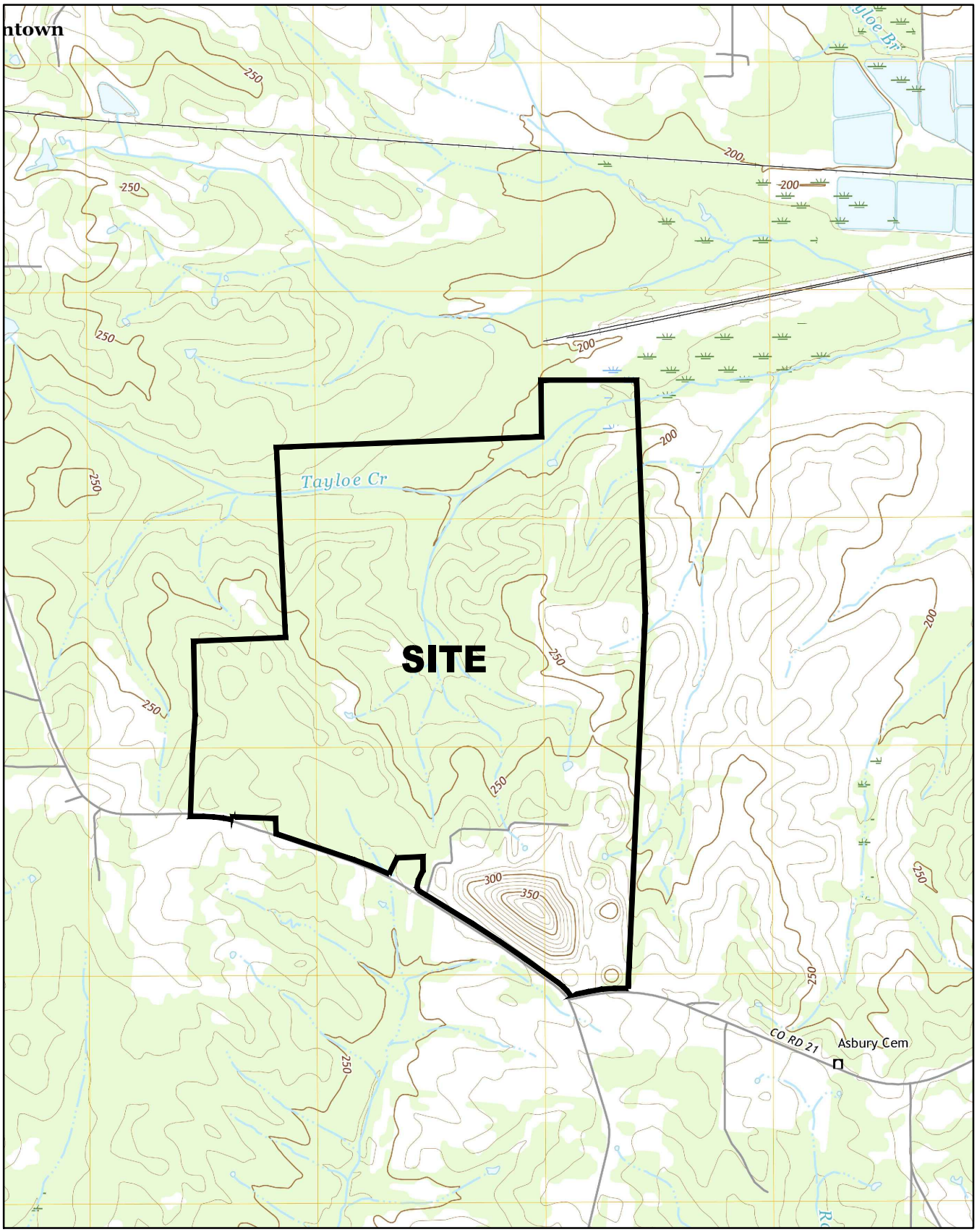
provide appropriate factors of safety for stability when considering the design conditions and waste placement conditions evaluated herein. Design recommendations were provided for bottom liner geosynthetics, leachate collection piping, and final cover geosynthetics and soil components.

The findings contained herein are based upon the data that was reviewed and documented in this report along with our experience on similar projects. Subsurface conditions may vary significantly between the referenced geotechnical borings. General guidance for the review of this geotechnical report is presented in **Appendix H**. The discovery of any additional information concerning the conditions of the site should be reported to us for our review so that we can reassess potential geotechnical impacts and modify our recommendations, if necessary.

Bunnell-Lammons Engineering, Inc. appreciates the opportunity to provide professional geotechnical services on this project. If you have any questions concerning this report or the attached calculations, please contact us.

# APPENDIX A

# FIGURES




2000 1000 0 2000 4000

APPROXIMATE SCALE IN FEET

REFERENCE:
USGS TOPOGRAPHIC MAP, 7.5 MINUTE SERIES, UNIONTOWN EAST, AL. QUADRANGLE, 2020.

| | | | |
|---|---|---|---|
| DRAWN: | KLW | DATE: | 11-11-24 |
| CHECKED: | WDY | CAD: | ARROWHLF-66SLM |
| APPROVED: | LAS | JOB NO: | J24-4999-66 |

BUNNELL LAMMONS ENGINEERING
6004 Ponders Court, Greenville, SC 29615
Phone: (864) 288-1265 Fax: (864) 288-4430

**SITE LOCATION MAP**
MAJOR MODIFICATION SUPPORT
ARROWHEAD LANDFILL
PERRY COUNTY, ALABAMA

FIGURE
1

LEGEND:

EXISTING TOPOGRAPHY 2'
10'

PROPERTY BOUNDARY

PROPERTY BUFFER

EXISTING CELL BOUNDARY

PROPOSED CELL BOUNDARY

REFERENCE:

TRACT 1 EXISTING TOPOGRAPHY AND EXISTING CELL BOUNDARIES OBTAINED FROM ELECTRONIC DRAWING TITLED "EMAIL – T1–FINAL GRADES", PROVIDED BY HODGES, HARBIN, NEWBERRY & TRIBBLE, INC. ON SEPTEMBER 13, 2024.

| REVISIONS | | |
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| No. | DESCRIPTION | BY |
| | | |
| | | |
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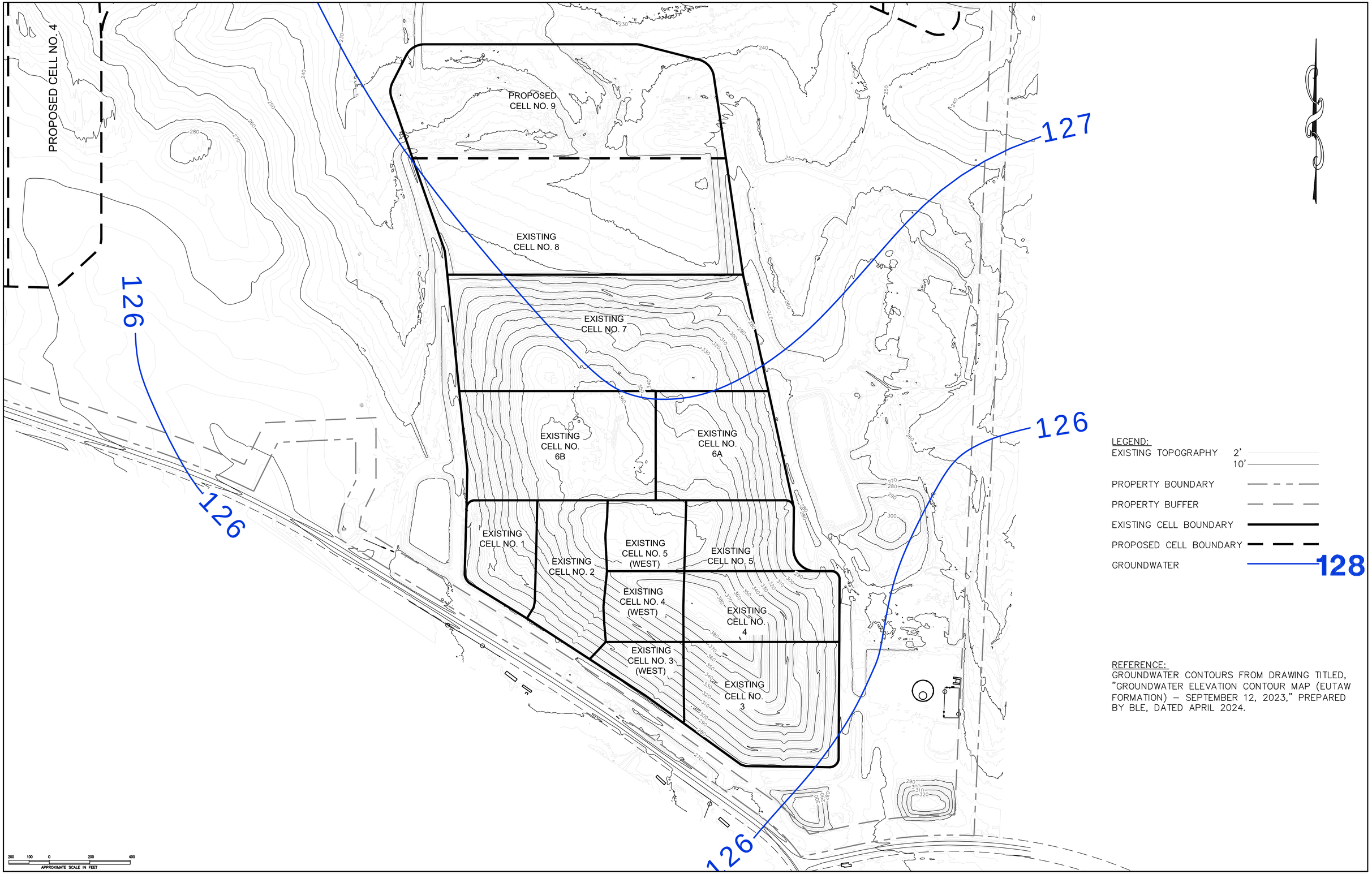
DRAWN: KLW
CHECKED: WDY
APPROVED: LAS

DATE: 1–29–25
CAD FILE: ARROWHLF–66PROD
JOB NO: J24–4999–66

BUNNELL LAMMONS ENGINEERING
6004 Ponders Court, Greenville, SC 29615
(864) 288-1255

EXISTING CONDITIONS: TRACT 1
MAJOR MODIFICATION SUPPORT
ARROWHEAD LANDFILL
PERRY COUNTY, ALABAMA

FIGURE NO.
2A




REFERENCE:
GROUNDWATER CONTOURS FROM DRAWING TITLED, "GROUNDWATER ELEVATION CONTOUR MAP (EUTAW FORMATION) – SEPTEMBER 12, 2023," PREPARED BY BLE, DATED APRIL 2024.

| REVISIONS | | |
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CHECKED: WDY
APPROVED: LAS

DATE: 1-29-25
CAD FILE: ARROWHLF-66PROD
JOB NO: J24-4999-66

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GROUNDWATER CONTOUR ELEVATIONS: TRACT 1
MAJOR MODIFICATION SUPPORT
ARROWHEAD LANDFILL
PERRY COUNTY, ALABAMA

FIGURE NO.
2B

LEGEND:

| | |
|---|---|
| INITIAL LANDFILL GRADES | 2' / 10' |
| PROPERTY BOUNDARY | |
| PROPERTY BUFFER | |
| EXISTING CELL BOUNDARY | |
| PROPOSED CELL BOUNDARY | |
| EXISTING LEACHATE COLLECTION LINE | |
| PROPOSED LEACHATE COLLECTION LINE | |
| SETTLEMENT ANALYSIS CROSS SECTION LOCATION | 0+00 1+00 2+00 3+00 |
| SETTLEMENT ANALYSIS POINT | S-2A |

REFERENCES:

1. INITIAL GRADES FOR CELL NOS. 1 AND 2 OBTAINED FROM ELECTRONIC DRAWING TITLED CELL 1 AND CELL 2 – 1002-007 CERT-CELL2-R, PROVIDED BY HODGES, HARBIN, NEWBERRY & TRIBBLE, INC. ON SEPTEMBER 27, 2024.
2. INITIAL GRADES FOR CELL NO. 3 OBTAINED FROM ELECTRONIC DRAWING TITLED TOP OF CLAY LINER GRADING PLAN, PREPARED BY HODGES, HARBIN, NEWBERRY & TRIBBLE, INC., DATED MAY 2007.
3. INITIAL GRADES FOR CELL NOS. 4 AND 5 OBTAINED FROM ELECTRONIC DRAWING TITLED CLAY GRADE CERTIFICATION MAP – CELLS 4 & 5, PREPARED BY MARTIN SURVEY ASSOCIATES, INC., DATED JUNE 2007.
4. INITIAL GRADES FOR CELL NO. 6A OBTAINED FROM ELECTRONIC DRAWING TITLED CLAY ASBUILT CERTIFICATION SURVEY, PREPARED BY WELLSTON ASSOCIATES LAND SURVEYORS, LLC, DATED DECEMBER 2012.
5. INITIAL GRADES FOR CELL NO. 6B OBTAINED FROM ELECTRONIC DRAWING TITLED CLAY ASBUILT CERTIFICATION SURVEY, PREPARED BY WELLSTON ASSOCIATES LAND SURVEYORS, LLC, DATED JULY 2019.
6. INITIAL GRADES FOR CELL NO. 7 OBTAINED FROM ELECTRONIC DRAWING TITLED CLAY ASBUILT CERTIFICATION SURVEY, PREPARED BY WELLSTON ASSOCIATES LAND SURVEYORS, LLC, DATED MAY 2022.
7. INITIAL GRADES FOR CELL NO. 8 OBTAINED FROM ELECTRONIC DRAWING TITLED CLAY ASBUILT CERTIFICATION SURVEY, PREPARED BY SURVEYING AND MAPPING, LLC, DATED AUGUST 2024.
8. PROPOSED INITIAL GRADES FOR CELL NO. 9 OBTAINED FROM ELECTRONIC DRAWING TITLED ARROWHEAD CELL 9 AND LEACHATE, PROVIDED BY HODGES, HARBIN, NEWBERRY & TRIBBLE, INC., ON SEPTEMBER 27, 2024.

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DRAWN: KLW
CHECKED: WDY
APPROVED: LAS

DATE: 1-29-25
CAD FILE: ARROWHLF-66PROD
JOB NO: J24-4999-66

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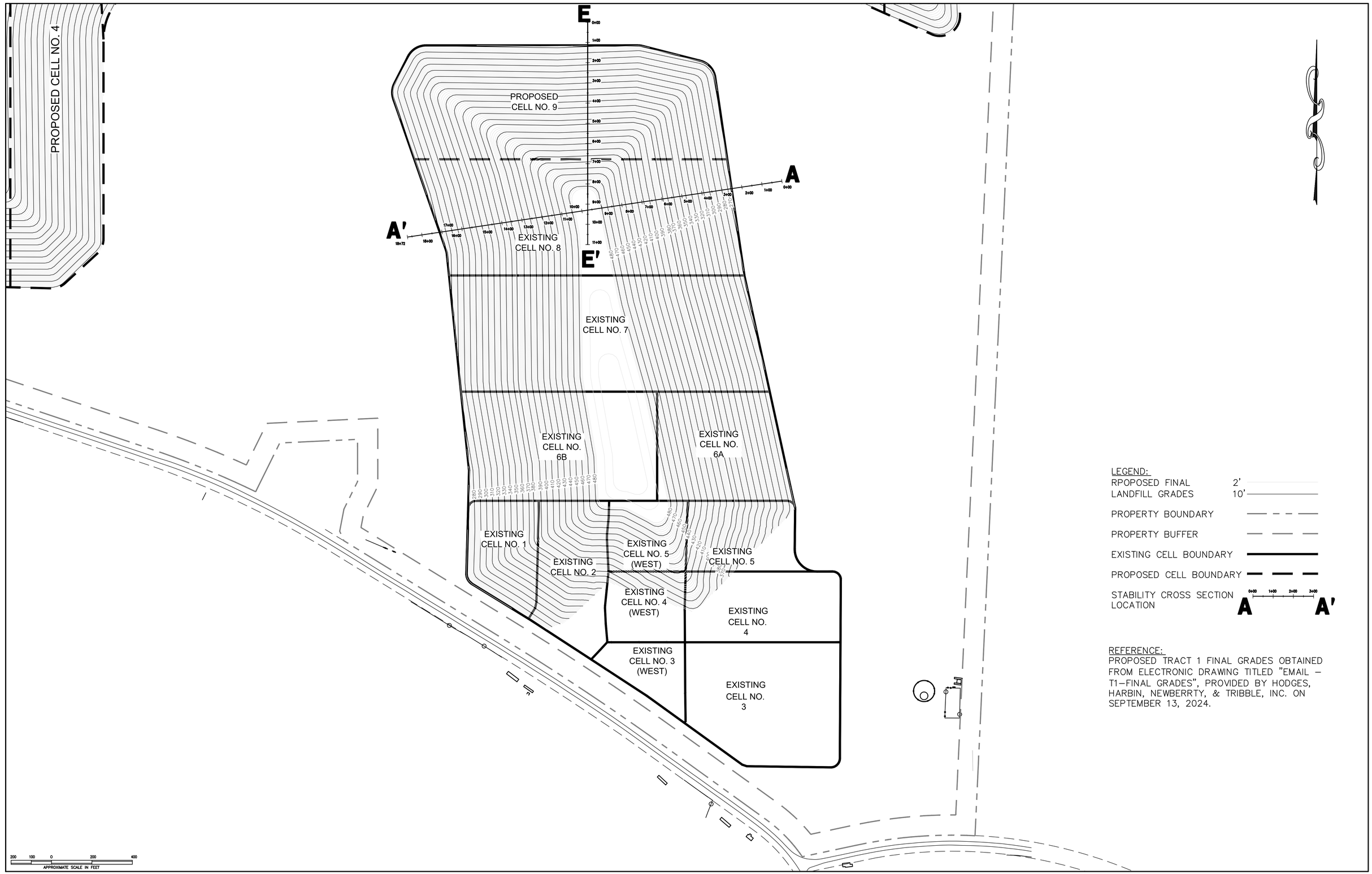
INITIAL LANDFILL GRADES: TRACT 1
MAJOR MODIFICATION SUPPORT
ARROWHEAD LANDFILL
PERRY COUNTY, ALABAMA

FIGURE NO.
2C




LEGEND:

| | |
|---|---|
| RPOPOSED FINAL LANDFILL GRADES | 2' / 10' |
| PROPERTY BOUNDARY | |
| PROPERTY BUFFER | |
| EXISTING CELL BOUNDARY | |
| PROPOSED CELL BOUNDARY | |
| STABILITY CROSS SECTION LOCATION | A — A' |

REFERENCE:
PROPOSED TRACT 1 FINAL GRADES OBTAINED FROM ELECTRONIC DRAWING TITLED "EMAIL – T1–FINAL GRADES", PROVIDED BY HODGES, HARBIN, NEWBERRTY, & TRIBBLE, INC. ON SEPTEMBER 13, 2024.

| REVISIONS | | |
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DRAWN: KLW
CHECKED: WDY
APPROVED: LAS

DATE: 1-29-25
CAD FILE: ARROWHLF-66PROD
JOB NO: J24-4999-66

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(864) 288-1265

PROPOSED FINAL LANDFILL GRADES: TRACT 1
MAJOR MODIFICATION SUPPORT
ARROWHEAD LANDFILL
PERRY COUNTY, ALABAMA

FIGURE NO. 2D

LEGEND:

EXISTING TOPOGRAPHY 2'
10'

PROPERTY BOUNDARY

PROPERTY BUFFER

EXISTING CELL BOUNDARY

PROPOSED CELL BOUNDARY

REFERENCE:

TRACT 2 EXISTING TOPOGRAPHY AND PROPOSED CELL BOUNDARIES OBTAINED FROM ELECTRONIC DRAWING TITLED "EMAIL – TRACT 2", PROVIDED BY HODGES, HARBIN, NEWBERRY & TRIBBLE, INC. ON SEPTEMBER 13, 2024.

200 100 0 200 400
APPROXIMATE SCALE IN FEET

| REVISIONS | | |
|---|---|---|
| No. | DESCRIPTION | BY |
| | | |
| | | |
| | | |

| | |
|---|---|
| DRAWN: | KLW |
| CHECKED: | WDY |
| APPROVED: | LAS |

| | |
|---|---|
| DATE: | 1-29-25 |
| CAD FILE: | ARROWHLF-66PROD |
| JOB NO: | J24-4999-66 |

BUNNELL LAMMONS ENGINEERING
6004 Ponders Court, Greenville, SC 29615
(864) 288-1255

EXISTING CONDITIONS: TRACT 2
MAJOR MODIFICATION SUPPORT
ARROWHEAD LANDFILL
PERRY COUNTY, ALABAMA

FIGURE NO.
3A

LEGEND:

EXISTING TOPOGRAPHY 2'
10'

PROPERTY BOUNDARY

PROPERTY BUFFER

EXISTING CELL BOUNDARY

PROPOSED CELL BOUNDARY

GROUNDWATER 128

REFERENCE:
GROUNDWATER CONTOURS FROM DRAWING TITLED, "GROUNDWATER ELEVATION CONTOUR MAP (EUTAW FORMATION) – SEPTEMBER 12, 2023," PREPARED BY BLE, DATED APRIL 2024.

PROPOSED CELL NO. 1
PROPOSED CELL NO. 2
PROPOSED CELL NO. 3
PROPOSED CELL NO. 4
PROPOSED CELL NO. 5
PROPOSED CELL NO. 6
PROPOSED CELL NO. 7
PROPOSED CELL NO. 8
PROPOSED CELL NO. 9
EXISTING CELL NO. 8
CAHAR
126
127
128

200 100 0 200 400
APPROXIMATE SCALE IN FEET

| REVISIONS | | |
|---|---|---|
| No. | DESCRIPTION | BY |
| | | |
| | | |
| | | |
| | | |

DRAWN: KLW
CHECKED: WDY
APPROVED: LAS

DATE: 1-29-25
CAD FILE: ARROWHLF-66PROD
JOB NO: J24-4999-66

BLE BUNNELL LAMMONS ENGINEERING
6004 Ponders Court, Greenville, SC 29615
(864) 298-1265

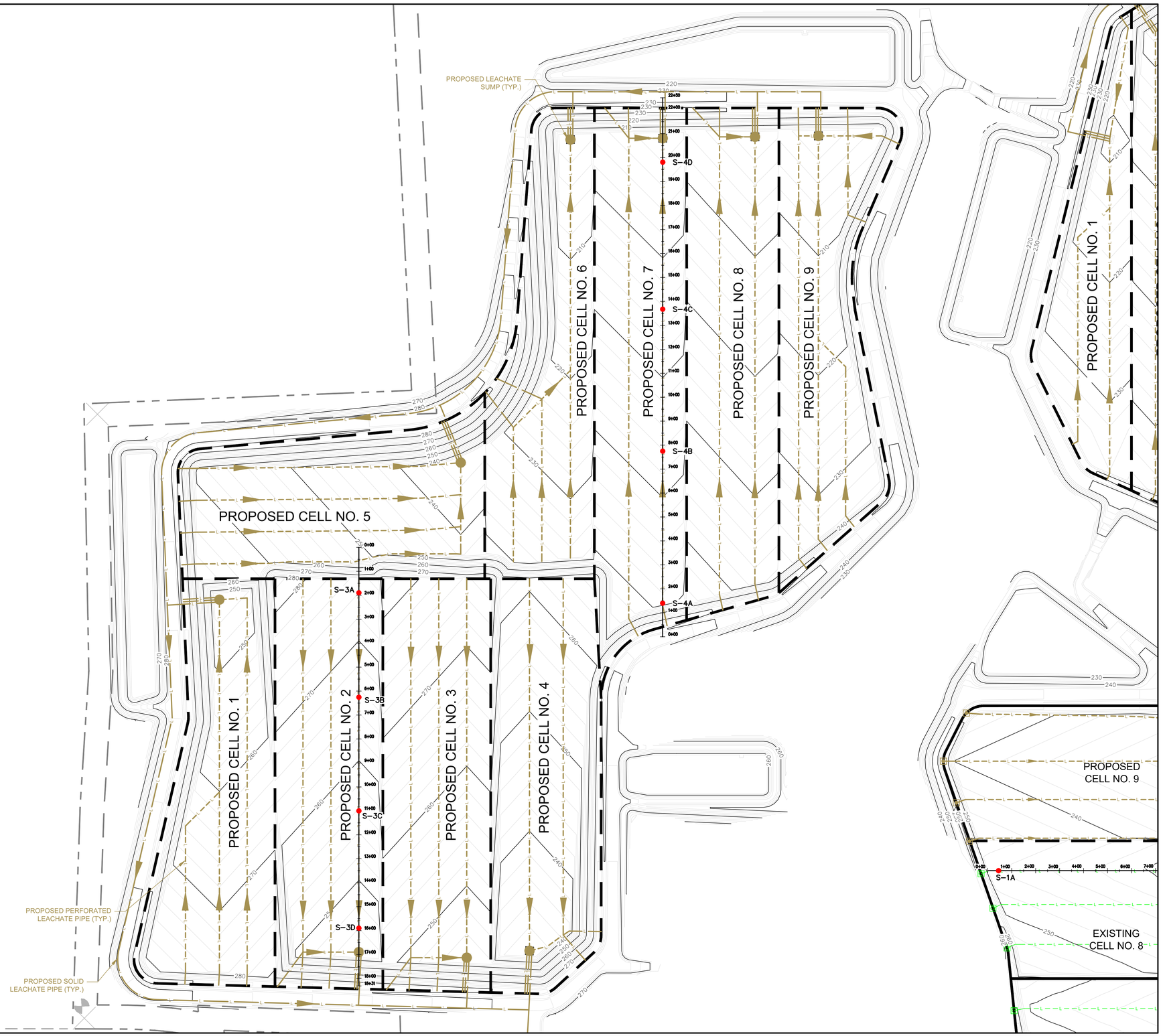
GROUNDWATER CONTOUR ELEVATIONS: TRACT 2
MAJOR MODIFICATION SUPPORT
ARROWHEAD LANDFILL
PERRY COUNTY, ALABAMA

FIGURE NO.
3B

LEGEND:

| | |
|---|---|
| INITIAL LANDFILL GRADES | 2' / 10' |
| PROPERTY BOUNDARY | |
| PROPERTY BUFFER | |
| EXISTING CELL BOUNDARY | |
| PROPOSED CELL BOUNDARY | |
| EXISTING LEACHATE COLLECTION LINE | |
| PROPOSED LEACHATE COLLECTION LINE | |
| SETTLEMENT ANALYSIS CROSS SECTION LOCATION | 0+00 1+00 2+00 3+00 |
| SETTLEMENT ANALYSIS POINT | S-2A |

REFERENCE:
PROPOSED INITIAL GRADES FOR TRACT 2 OBTAINED FROM ELECTRONIC DRAWING TITLED "EMAIL – TRACT 2", PROVIDED BY HODGES, HARBIN, NEWBERRY & TRIBBLE, INC., ON SEPTEMBER 27, 2024.




200 100 0 200 400
APPROXIMATE SCALE IN FEET

| REVISIONS | | |
|---|---|---|
| No. | DESCRIPTION | BY |
| | | |
| | | |
| | | |

DRAWN: KLW
CHECKED: WDY
APPROVED: LAS

DATE: 1-29-25
CAD FILE: ARROWHLF-66PROD
JOB NO: J24-4999-66


BLE BUNNELL LAMMONS ENGINEERING
6004 Ponders Court, Greenville, SC 29615
(864) 288-1265


INITIAL LANDFILL GRADES: TRACT 2
MAJOR MODIFICATION SUPPORT
ARROWHEAD LANDFILL
PERRY COUNTY, ALABAMA

FIGURE NO.
3C

LEGEND:

| | |
|---|---|
| RPOPOSED FINAL LANDFILL GRADES | 2' / 10' |
| PROPERTY BOUNDARY | |
| PROPERTY BUFFER | |
| EXISTING CELL BOUNDARY | |
| PROPOSED CELL BOUNDARY | |
| STABILITY CROSS SECTION LOCATION | B — B' |

REFERENCE:
PROPOSED TRACT 2 FINAL GRADES OBTAINED FROM ELECTRONIC DRAWING TITLED "EMAIL – TRACT 2", PROVIDED BY HODGES, HARBIN, NEWBERRTY, & TRIBBLE, INC. ON SEPTEMBER 13, 2024.

200 100 0 200 400
APPROXIMATE SCALE IN FEET

| REVISIONS | | |
|---|---|---|
| No. | DESCRIPTION | BY |
| | | |

DRAWN: KLW
CHECKED: WDY
APPROVED: LAS

DATE: 1-29-25
CAD FILE: ARROWHLF-66PROD
JOB NO: J24-4999-66

BUNNELL LAMMONS ENGINEERING
6004 Ponders Court, Greenville, SC 29615
(864) 288-1265

PROPOSED FINAL LANDFILL GRADES: TRACT 2
MAJOR MODIFICATION SUPPORT
ARROWHEAD LANDFILL
PERRY COUNTY, ALABAMA

FIGURE NO.
3D

LEGEND:

EXISTING TOPOGRAPHY 2'
10'

PROPERTY BOUNDARY

PROPERTY BUFFER

EXISTING CELL BOUNDARY

PROPOSED CELL BOUNDARY

REFERENCE:

TRACT 3 EXISTING TOPOGRAPHY AND PROPOSED CELL BOUNDARIES OBTAINED FROM ELECTRONIC DRAWING TITLED "EMAIL – TRACT 3", PROVIDED BY HODGES, HARBIN, NEWBERRY & TRIBBLE, INC. ON SEPTEMBER 13, 2024.

| REVISIONS | | |
|---|---|---|
| No. | DESCRIPTION | BY |
| | | |
| | | |
| | | |

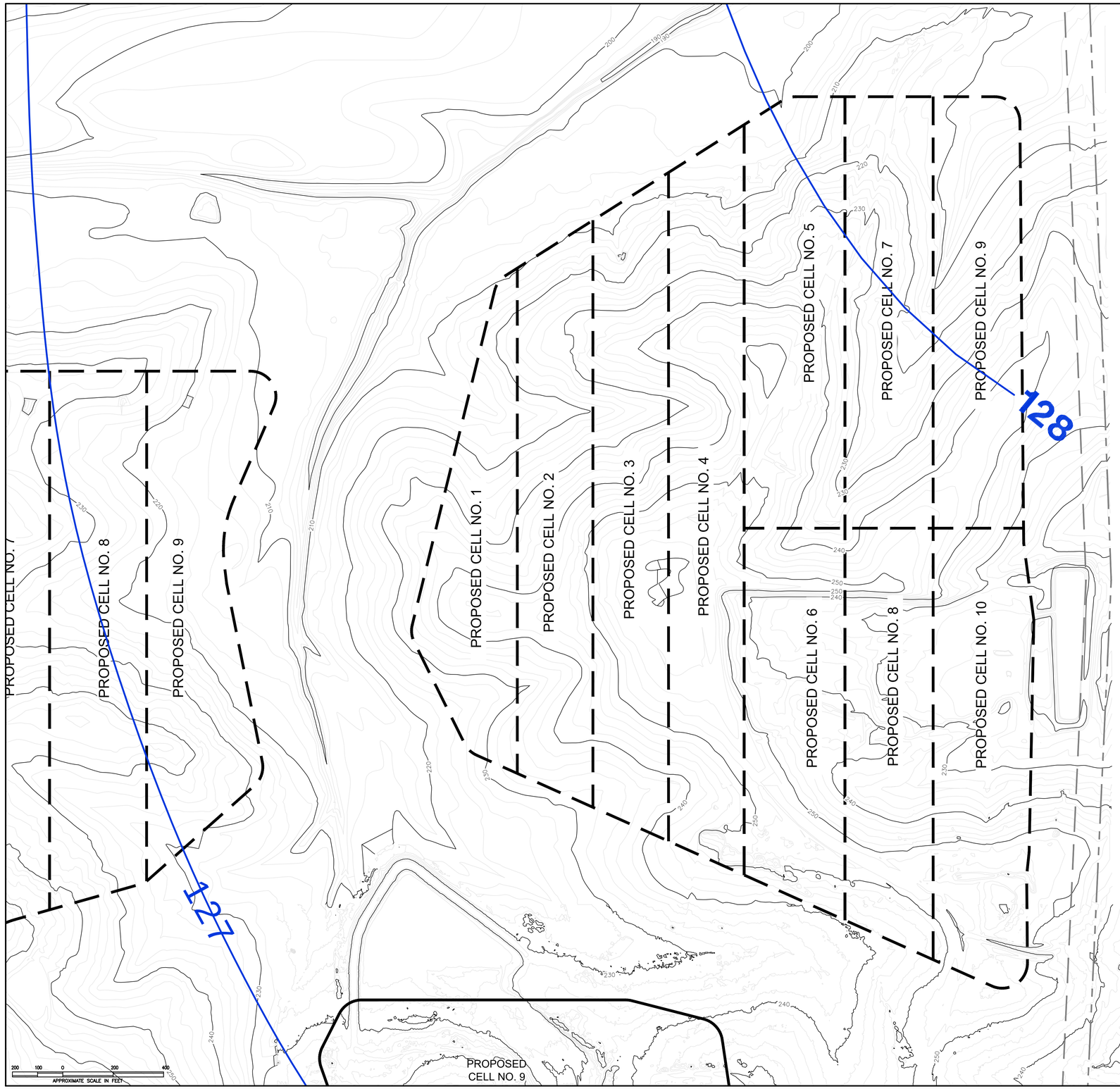
DRAWN: KLW
CHECKED: WDY
APPROVED: LAS

DATE: 1-29-25
CAD FILE: ARROWHLF-66PROD
JOB NO: J24-4999-66

BLE BUNNELL LAMMONS ENGINEERING
6004 Ponders Court, Greenville, SC 29615
(864) 298-1265

EXISTING CONDITIONS: TRACT 3
MAJOR MODIFICATION SUPPORT
ARROWHEAD LANDFILL
PERRY COUNTY, ALABAMA

FIGURE NO.
4A




LEGEND:

EXISTING TOPOGRAPHY 2'
10'

PROPERTY BOUNDARY

PROPERTY BUFFER

EXISTING CELL BOUNDARY

PROPOSED CELL BOUNDARY

GROUNDWATER 128

REFERENCE:
GROUNDWATER CONTOURS FROM DRAWING TITLED, "GROUNDWATER ELEVATION CONTOUR MAP (EUTAW FORMATION) – SEPTEMBER 12, 2023," PREPARED BY BLE, DATED APRIL 2024.

| REVISIONS | | |
|---|---|---|
| No. | DESCRIPTION | BY |
| | | |
| | | |
| | | |

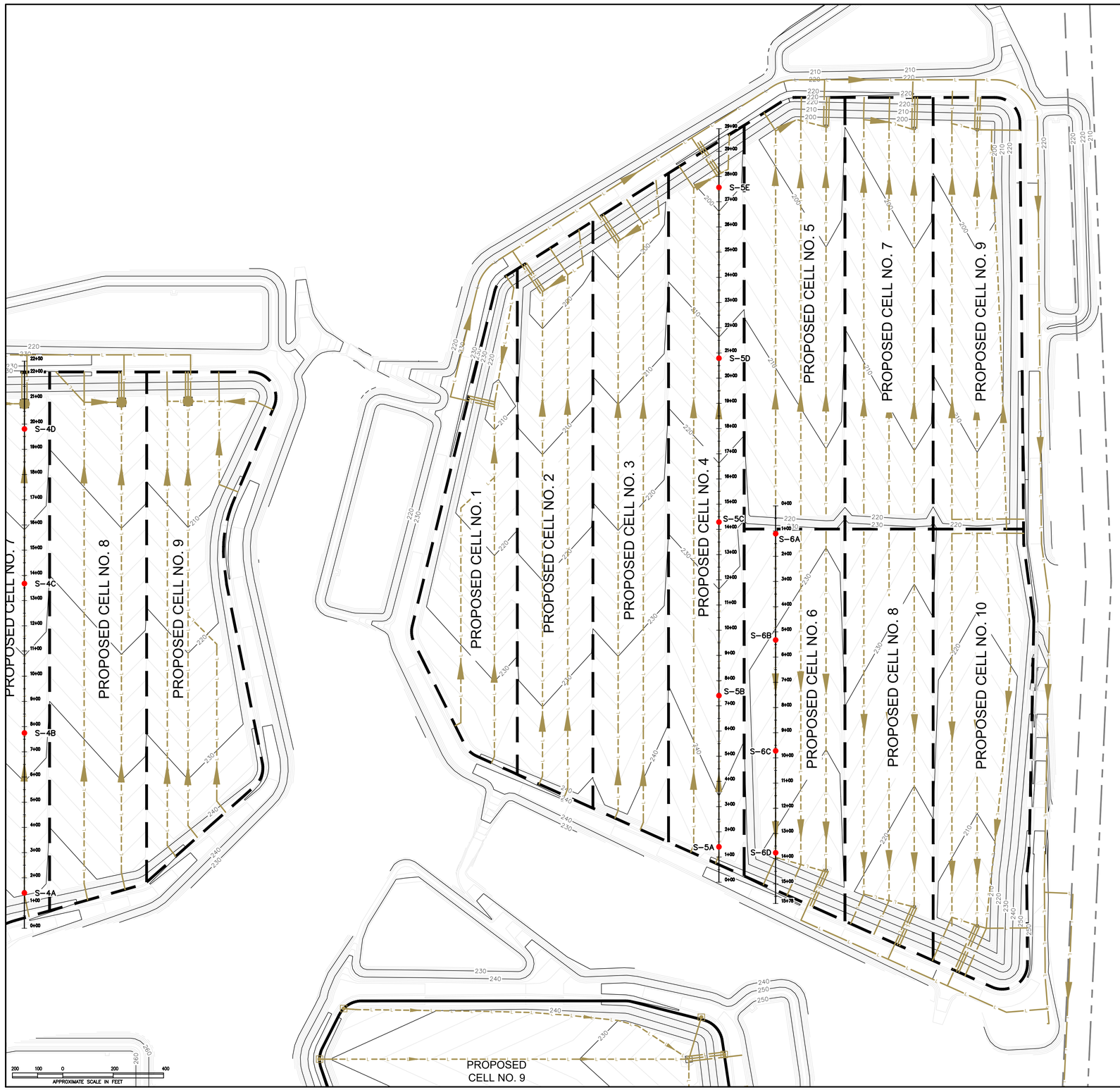
DRAWN: KLW
CHECKED: WDY
APPROVED: LAS

DATE: 1-29-25
CAD FILE: ARROWHLF-66PROD
JOB NO: J24-4999-66

BLE BUNNELL LAMMONS ENGINEERING
6004 Ponders Court, Greenville, SC 29615
(864) 298-1265

GROUNDWATER CONTOUR ELEVATIONS: TRACT 3
MAJOR MODIFICATION SUPPORT
ARROWHEAD LANDFILL
PERRY COUNTY, ALABAMA

FIGURE NO.
4B




LEGEND:

| | |
|---|---|
| INITIAL LANDFILL GRADES | 2' / 10' |
| PROPERTY BOUNDARY | |
| PROPERTY BUFFER | |
| EXISTING CELL BOUNDARY | |
| PROPOSED CELL BOUNDARY | |
| EXISTING LEACHATE COLLECTION LINE | |
| PROPOSED LEACHATE COLLECTION LINE | |
| SETTLEMENT ANALYSIS CROSS SECTION LOCATION | 0+00 1+00 2+00 3+00 |
| SETTLEMENT ANALYSIS POINT | S-2A |

REFERENCE:
PROPOSED INTIAL GRADES FOR TRACT 3 OBTAINED FROM ELECTRONIC DRAWING TITLED "EMAIL – TRACT 3", PROVIDED BY HODGES, HARBIN, NEWBERRY & TRIBBLE, INC., ON SEPTEMBER 27, 2024.

| REVISIONS | | |
|---|---|---|
| No. | DESCRIPTION | BY |
| | | |

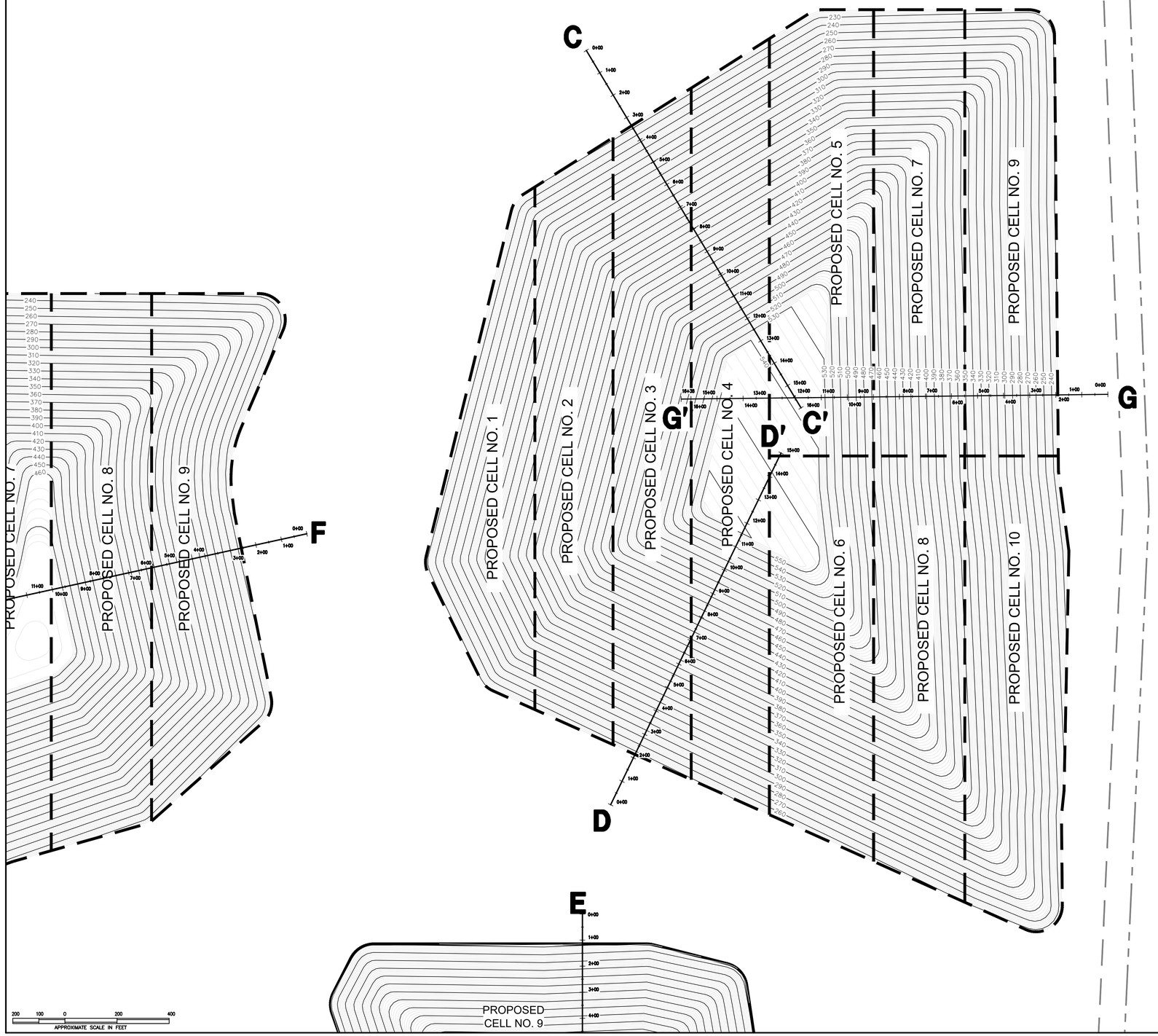
DRAWN: KLW
CHECKED: WDY
APPROVED: LAS

DATE: 1-29-25
CAD FILE: ARROWHLF-66PROD
JOB NO: J24-4999-66

BLE BUNNELL LAMMONS ENGINEERING
6004 Ponders Court, Greenville, SC 29615
(864) 298-1265

INITIAL LANDFILL GRADES: TRACT 3
MAJOR MODIFICATION SUPPORT
ARROWHEAD LANDFILL
PERRY COUNTY, ALABAMA

FIGURE NO.
4C




LEGEND:

| | |
|---|---|
| RPOPOSED FINAL LANDFILL GRADES | 2' / 10' |
| PROPERTY BOUNDARY | |
| PROPERTY BUFFER | |
| EXISTING CELL BOUNDARY | |
| PROPOSED CELL BOUNDARY | |
| STABILITY CROSS SECTION LOCATION | C — C' |

REFERENCE:

PROPOSED TRACT 3 FINAL GRADES OBTAINED FROM ELECTRONIC DRAWING TITLED "EMAIL – TRACT 3 – R", PROVIDED BY HODGES, HARBIN, NEWBERRTY, & TRIBBLE, INC. ON JANUARY 28, 2025.

| REVISIONS | | |
|---|---|---|
| No. | DESCRIPTION | BY |
| | | |

DRAWN: KLW
CHECKED: WDY
APPROVED: LAS

DATE: 1-29-25
CAD FILE: ARROWHLF-66PROD
JOB NO: J24-4999-66

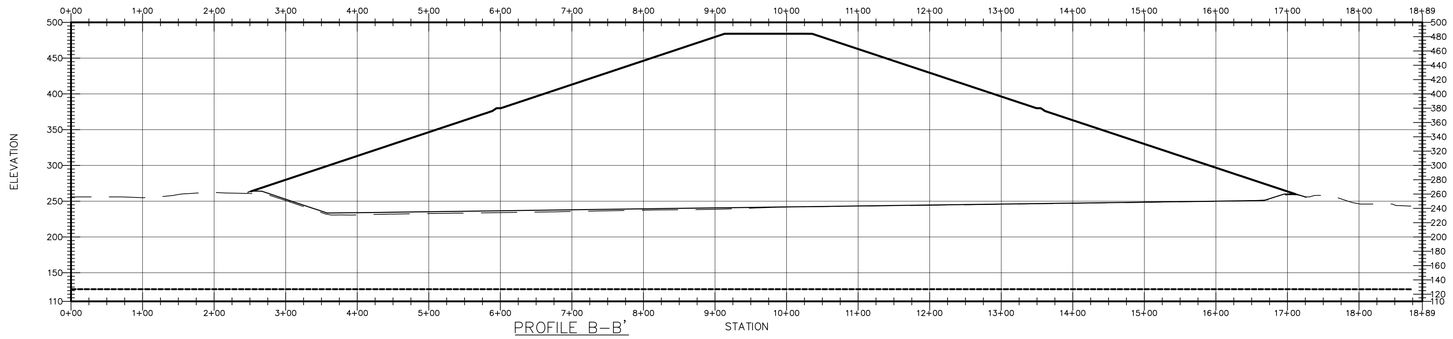
BLE BUNNELL LAMMONS ENGINEERING
6004 Ponders Court, Greenville, SC 29615
(864) 298-1265

PROPOSED FINAL LANDFILL GRADES: TRACT 3
MAJOR MODIFICATION SUPPORT
ARROWHEAD LANDFILL
PERRY COUNTY, ALABAMA

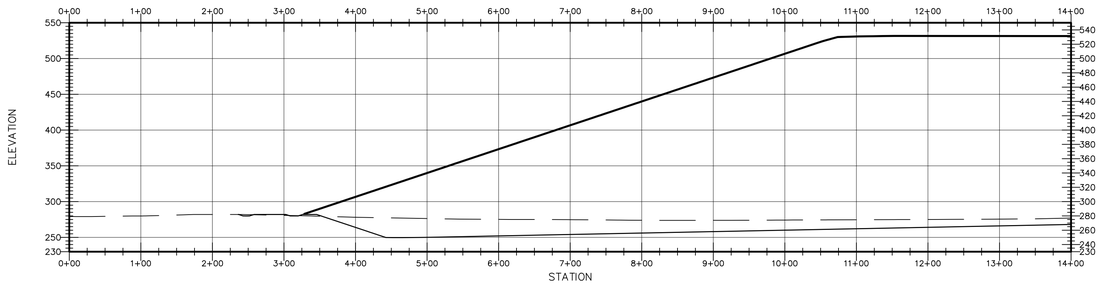
FIGURE NO.
4D

LEGEND:
EXISTING TOPOGRAPHY
INITIAL LANDFILL GRADES
PROPOSED LANDFILL FINAL GRADES
GROUNDWATER

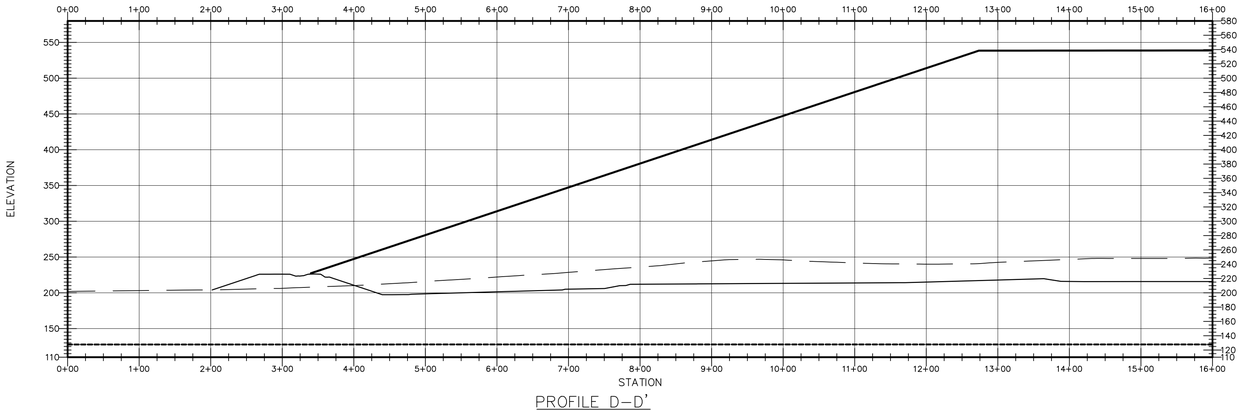
PROFILE A–A'



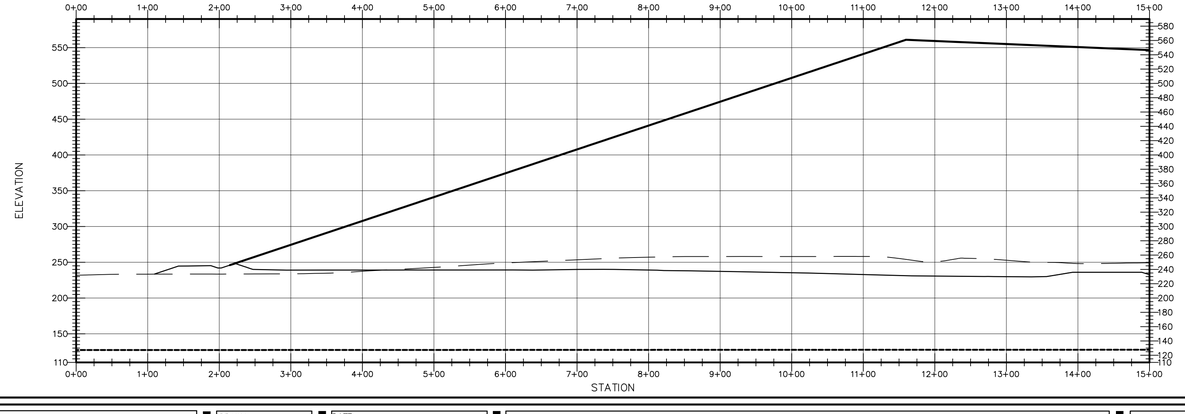

PROFILE B–B'




PROFILE C–C'




PROFILE D–D'




HORIZONTAL SCALE: 1"=100'
VERTICAL SCALE: 1"=100'

| REVISIONS | | |
|---|---|---|
| No. | DESCRIPTION | BY |
| | | |
| | | |
| | | |

DRAWN: KLW
CHECKED: WDY
APPROVED: LAS

DATE: 1-29-25
CAD FILE: ARROWHLF-66PROD
JOB NO: J24-4999-66

BUNNELL LAMMONS ENGINEERING
6004 Ponders Court, Greenville, SC 29615
(864) 288-1265

STABILITY CROSS SECTIONS: A–A', B–B', C–C', AND D–D'
MAJOR MODIFICATION SUPPORT
ARROWHEAD LANDFILL
PERRY COUNTY, ALABAMA

FIGURE NO. 5

LEGEND:

EXISTING TOPOGRAPHY

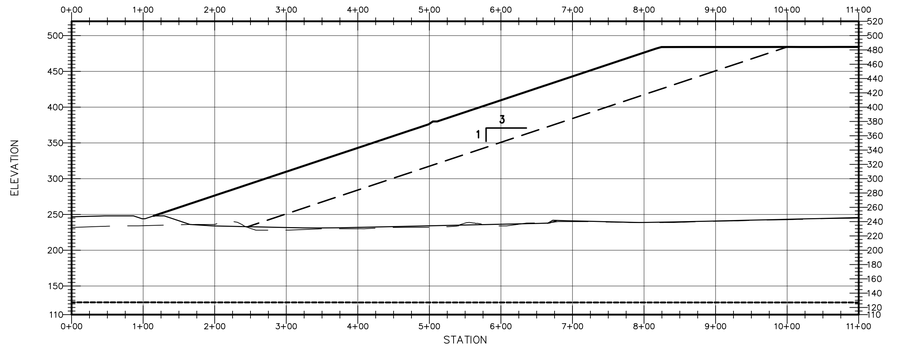
INITIAL LANDFILL GRADES

PROPOSED LANDFILL FINAL GRADES

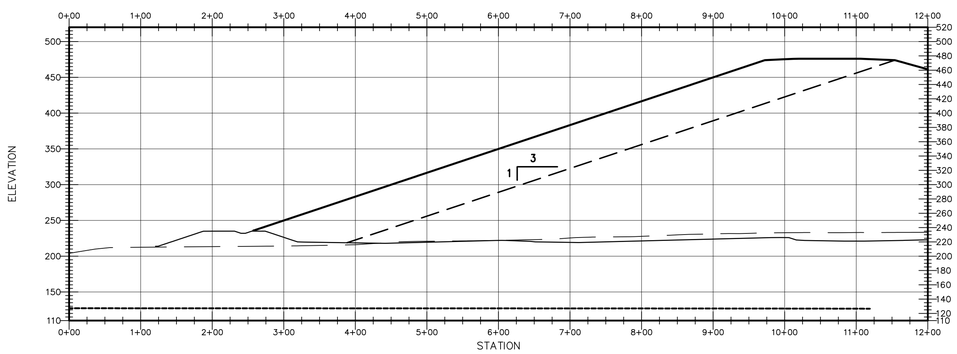
GROUNDWATER

HYPOTHETICAL INTERIM GRADES

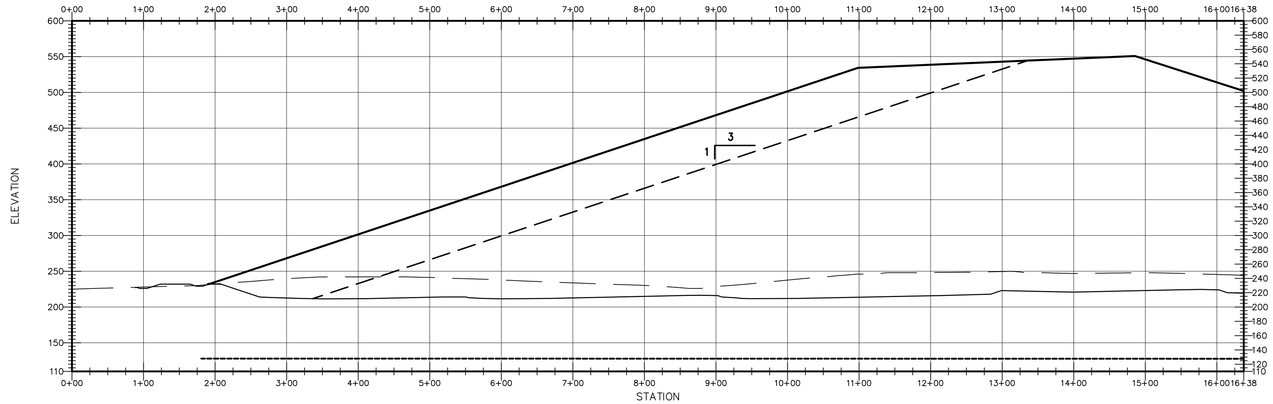
PROFILE E–E'




PROFILE F–F'




PROFILE G–G'




NOTE:
HYPOTHETICAL 3H:1V INTERIM GRADES SHOWN TO ILLUSTRATE THE MODELED GEOMETRY FOR THE PERFORMED SLOPE STABILITY ANALYSIS.

HORIZONTAL SCALE: 1"=100'
VERTICAL SCALE: 1"=100'

| REVISIONS | | |
|---|---|---|
| No. | DESCRIPTION | BY |
| | | |
| | | |
| | | |

DRAWN: KLW
CHECKED: WDY
APPROVED: LAS

DATE: 1-29-25
CAD FILE: ARROWHLF-66PROD
JOB NO: J24-4999-66

BUNNELL LAMMONS ENGINEERING
6004 Ponders Court, Greenville, SC 29615
(864) 298-1255

STABILITY CROSS SECTIONS: E–E', F–F', AND G–G'
MAJOR MODIFICATION SUPPORT
ARROWHEAD LANDFILL
PERRY COUNTY, ALABAMA

FIGURE NO.
6

LEGEND:

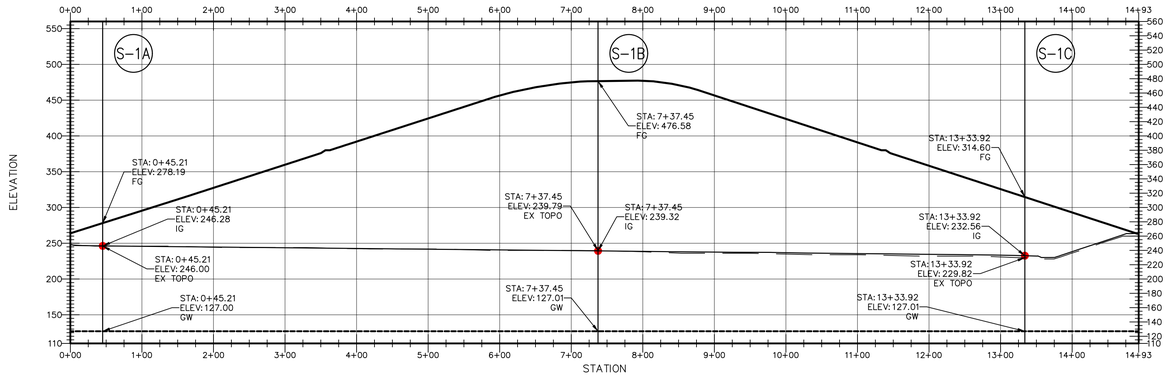
EXISTING TOPOGRAPHY

INITIAL LANDFILL GRADES

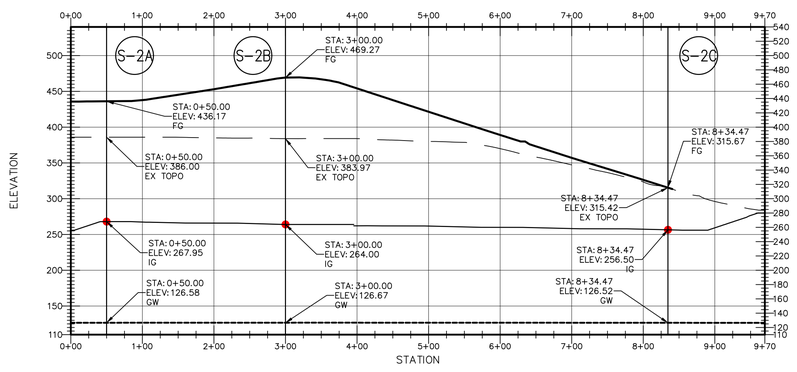
PROPOSED LANDFILL FINAL GRADES

GROUNDWATER

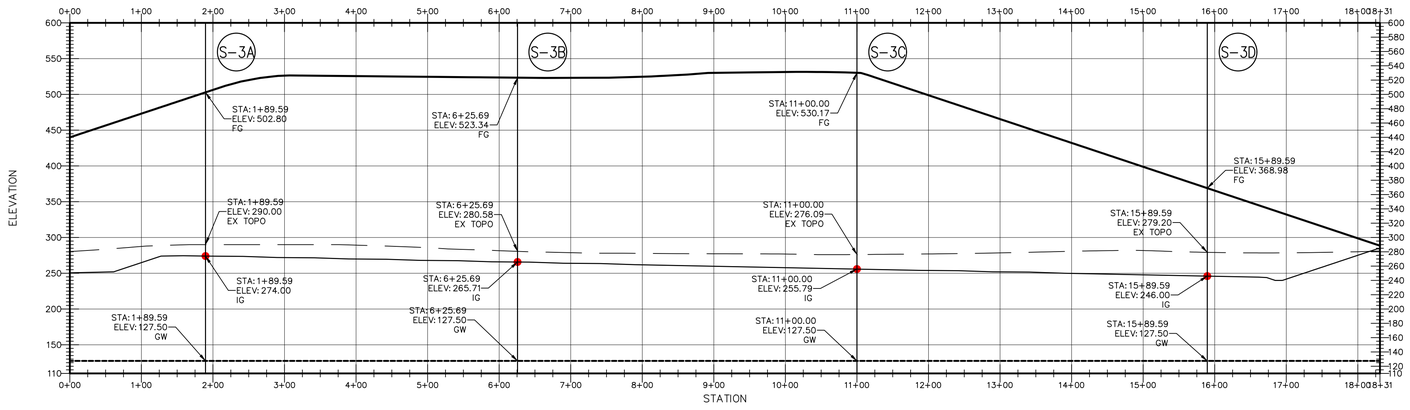
## SETTLEMENT CROSS SECTION S-1



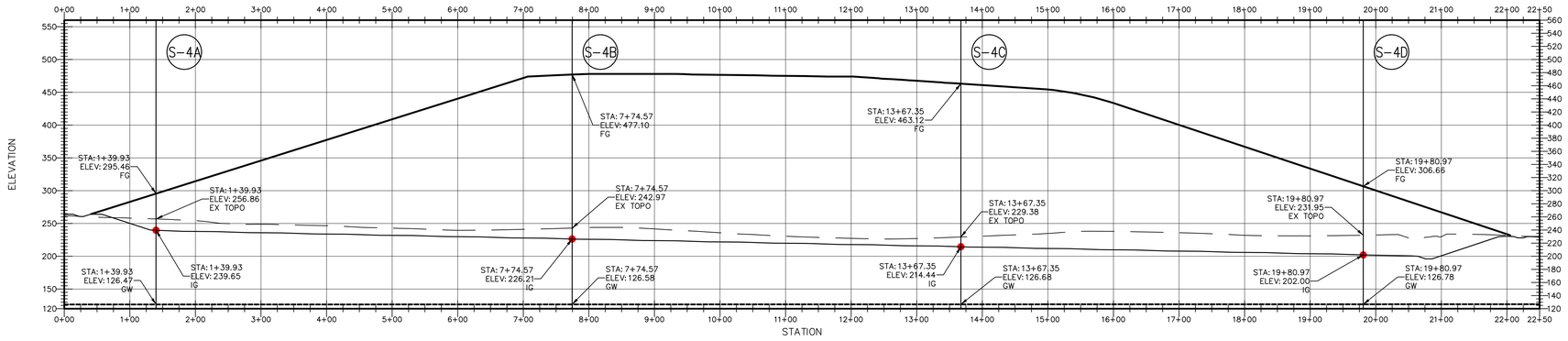

## SETTLEMENT CROSS SECTION S-2




## SETTLEMENT CROSS SECTION S-3




## SETTLEMENT CROSS SECTION S-4




HORIZONTAL SCALE: 1"=100'
VERTICAL SCALE: 1"=100'

| REVISIONS | | |
|---|---|---|
| No. | DESCRIPTION | BY |
| | | |
| | | |
| | | |

DRAWN: KLW
CHECKED: WDY
APPROVED: LAS

DATE: 1-29-25
CAD FILE: ARROWHLF-66PROD
JOB NO: J24-4999-66


BUNNELL LAMMONS ENGINEERING
6004 Ponders Court, Greenville, SC 29615
(864) 298-1265


SETTLEMENT CROSS SECTIONS: S-1, S-2, S-3, AND S-4
MAJOR MODIFICATION SUPPORT
ARROWHEAD LANDFILL
PERRY COUNTY, ALABAMA

FIGURE NO. 7

LEGEND:

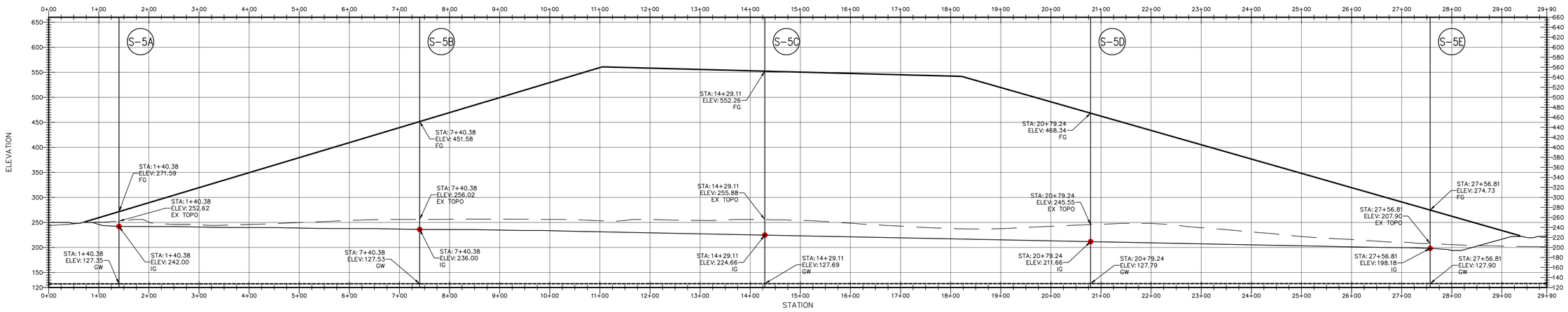
EXISTING TOPOGRAPHY — — — — —

INITIAL LANDFILL GRADES ———————

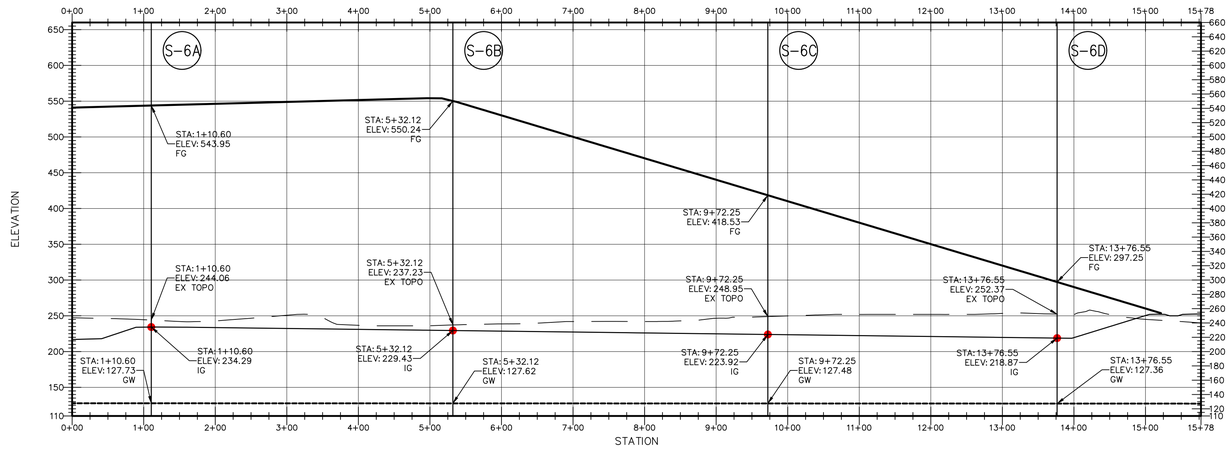
PROPOSED LANDFILL FINAL GRADES ———————

GROUNDWATER - - - - - - - - - -

## SETTLEMENT CROSS SECTION S-5




## SETTLEMENT CROSS SECTION S-6




HORIZONTAL SCALE: 1"=100'
VERTICAL SCALE: 1"=100'

| REVISIONS | | |
|---|---|---|
| No. | DESCRIPTION | BY |
| | | |
| | | |
| | | |

DRAWN: KLW
CHECKED: WDY
APPROVED: LAS

DATE: 1-29-25
CAD FILE: ARROWHLF-66PROD
JOB NO: J24-4999-66


BUNNELL LAMMONS ENGINEERING
6004 Ponders Court, Greenville, SC 29615
(864) 298-1255


SETTLEMENT CROSS SECTIONS: S-5 AND S-6
MAJOR MODIFICATION SUPPORT
ARROWHEAD LANDFILL
PERRY COUNTY, ALABAMA

FIGURE NO. 8

# APPENDIX B

# HISTORICAL LANDFILL CONSTRUCTION & OPERATION RECORDS

**SUMMARY OF CELL CONSTRUCTION COMPONENTS FROM HISTORICAL CQA REPORT REVIEW**
**MAJOR MODIFICATION SUPPORT**
**ARROWHEAD LANDFILL**
**PERRY COUNTY, ALABAMA**
**BLE PROJECT NO. J24-4999-66**

| Cell No. | CQA Report Date (Month, Year) | CQA Firm | Soil Component | Liner Geosynthetic | Drainage Geosynthetic | Protective Cover | LCS Piping |
|---|---|---|---|---|---|---|---|
| **Tract 1, Cell Nos. 4 & 5 (east)** | **August, 2007** | **Bunnell-Lammons Engineering, Inc. (BLE)** | Earthwork consisted of cut on the order of 30 feet. Limited structural fill on cell emankments. Clay liner, 24 inches of k ≤ 10-7 cm/s | Textured 60-mil HDPE FML | 24-osy nonwoven geotextile | 24-inches of fine to coarse sand, k ≥ 1x10-2 cm/s | 8-inch perforated HDPE (SDR-9, PE 3408) surrounded by No. 57 stone and No. 78 filter stone. LCS system underlain by geotextile |
| **Tract 1, Cell No. 3 (east)** | **October, 2007** | **BLE** | Earthwork consisted of cut on the order of 30 feet. Limited structural fill on cell emankments. Clay liner, 24 inches of k ≤ 10-7 cm/s | Textured 60-mil HDPE FML | 24-osy nonwoven geotextile | 24-inches of fine to coarse sand, k ≥ 1x10-2 cm/s | 8-inch perforated HDPE (SDR-9, PE 3408) surrounded by No. 57 stone and No. 78 filter stone. LCS system underlain by geotextile |
| **Tract 1, Cell Nos. 4 & 5 (west)** | **November, 2009** | **BLE** | Earthwork consisted of cut on the order of 30 feet. Limited structural fill on cell emankments. Clay liner, 24 inches of k ≤ 10-7 cm/s | Textured 60-mil HDPE FML | 24-osy nonwoven geotextile | 12-inches of fine to coarse sand, k ≥ 1x10-2 cm/s | 8-inch perforated HDPE (SDR-9, PE 3408) surrounded by No. 57 stone and No. 78 filter stone. LCS system underlain by geotextile |
| **Tract 1, Cell No. 3 (west)** | **January, 2010** | **BLE** | Earthwork consisted of cut on the order of 12 feet. Limited structural fill on cell emankments. Clay liner, 24 inches of k ≤ 10-7 cm/s | Textured 60-mil HDPE FML | 24-osy nonwoven geotextile | 12-inches of fine to coarse sand, k ≥ 1x10-2 cm/s | 8-inch perforated HDPE (SDR-9, PE 3408) surrounded by No. 57 stone and No. 78 filter stone. LCS system underlain by geotextile |
| **Tract 1, Cell No. 1** | **May, 2010** | **BLE** | Earthwork consisted of cut on the order of 12 feet. Limited structural fill on cell emankments. Clay liner, 24 inches of k ≤ 10-7 cm/s | Textured 60-mil HDPE FML | 24-osy nonwoven geotextile | 12-inches of fine to coarse sand, k ≥ 1x10-2 cm/s | 8-inch perforated HDPE (SDR-9, PE 3408) surrounded by No. 57 stone and No. 78 filter stone. LCS system underlain by geotextile |
| **Tract 1, Cell No. 2** | **February, 2010** | **BLE** | Earthwork consisted of cut on the order of 21 feet. Limited structural fill on cell emankments. Clay liner, 24 inches of k ≤ 10-7 cm/s | Textured 60-mil HDPE FML | 24-osy nonwoven geotextile | 12-inches of fine to coarse sand, k ≥ 1x10-2 cm/s | 8-inch perforated HDPE (SDR-9, PE 3408) surrounded by No. 57 stone and No. 78 filter stone. LCS system underlain by geotextile |
| **Tract 1, Cell No. 6A** | **March, 2013** | **BLE** | Earthwork consisted of cut on the order of 52 feet. Limited structural fill upper portions of eastern slope. Clay liner, 24 inches of k ≤ 10-7 cm/s | Textured 60-mil HDPE FML | 24-osy nonwoven geotextile | 12-inches of fine to coarse sand, k ≥ 1x10-2 cm/s | 8-inch perforated HDPE (SDR-9, PE 3408) surrounded by No. 57 stone and No. 78 filter stone. LCS system underlain by geotextile |
| **Tract 1, Cell No. 6B** | **February, 2020** | **BLE** | Earthwork consisted of cut on the order of 15 feet. Limited structural fill on western berm. Clay liner, 24 inches of k ≤ 10-7 cm/s | Textured 60-mil HDPE FML | 24-osy nonwoven geotextile | 12-inches of fine to coarse sand, k ≥ 1x10-2 cm/s | 8-inch perforated HDPE (SDR-9, PE 4710) surrounded by No. 57 stone and No. 78 filter stone. LCS system underlain by geotextile |
| **Tract 1, Cell No. 7** | **September, 2022** | **Atlantic Coast Consulting, Inc. (ACC)** | Clay liner, 24 inches of k ≤ 10-7 cm/s | Textured 60-mil HDPE FML | 24-osy nonwoven geotextile | 12-inches of fine to coarse sand, k ≥ 1x10-2 cm/s | 8-inch perforated HDPE (SDR-9, PE 4710) surrounded by No. 57 stone and No. 78 filter stone. LCS system underlain by geotextile |

**Prepared by:** **David Yarbray, EIT**
**Checked by:** **Larry Simonson, PE**

# APPENDIX C

# SUBGRADE SETTLEMENT CALCULATIONS

# CALCULATION DOCUMENTATION
# SUBGRADE SETTLEMENT ANALYSIS

## MAJOR MODIFICATION SUPPORT
## ARROWHEAD LANDFILL
## PERRY COUNTY, ALABAMA

BLE Project No. J24-4999-66

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Date: January 30, 2025

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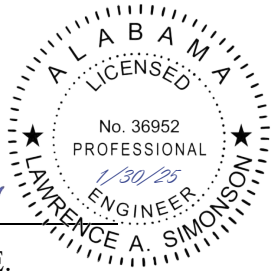


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# SUBGRADE SETTLEMENT ANALYSIS
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## PURPOSE

Estimate settlement at the clay liner subgrade caused by the weight of overlying solid waste and final cover at select leachate collection alignments within the existing and proposed cells at Arrowhead Landfill located in Perry County, Alabama. Settlement was estimated at intervals along the alignment of the proposed leachate collection piping lines in Tract 1, 2, and 3. The post-settlement slope of the leachate collection lines were estimated between the analysis point intervals to assess that the leachate collection lines had positive drainage towards the low points in each alignment. In accordance with Alabama DEM Rule 335-13-4-.11 (2), a minimum 5-foot separation between the designed liner system elevation and the groundwater elevation was maintained after the estimated subgrade settlement.

## DESCRIPTION OF ANALYSIS

### General Conditions

1. Settlement was estimated at six (6) select leachate drainage alignments. Settlement was estimated in each leachate collection alignment at point intervals near the top of the sump area (the "low" pint in the leachate collection line), the middle and high floor elevation areas.
2. Earth and waste loads on the clay liner subgrade were determined from the proposed final and initial landfill grades obtained from electronic drawing files provided by Hodges, Harbin, Newberry, & Tribble, Inc. (HHNT) dated September 2024.
3. Unit weights for municipal solid waste (MSW) waste, protective cover soil, and clay liner were conservatively selected to calculate the net pressure at each analyzed point location. The estimated unit weight of MSW is based on literature values.[1]
4. Subsurface soils consist of limestone (chalk) and clayey sediments. The soils encountered in the referenced borings are dominantly clay materials. Referenced boring logs are attached.
5. Groundwater elevations for the analysis were referenced from the drawing titled *Groundwater Elevation Contour map (Eutaw Formation) – September 12, 2023*, by BLE, dated April 2024.
6. This analysis conservatively follows conventional, long-term, primary consolidation settlement in the cohesive clayey in-situ layers. BLE used historical soil test boring and laboratory test data presented in previous evaluations performed at the site to develop the consolidation parameters for the cohesive in-situ soils at the site for use in this analysis. The following average soil layer properties were used to determine the consolidation parameters used for this analysis and are provided in Table 1 below:

**Table 1: Average Subsurface Layer Properties from Historical Lab Testing**

| Layer | LL, % | PI, % | PL, % | Moisture Content, % | Dry Density, pcf | Specific Gravity | Degree of Saturation, % | Void Ratio, e |
|---|---|---|---|---|---|---|---|---|
| *Subsurface Clay* | 53 | 35 | 18 | 22.8 | 93.7 | 2.7 | 77 | 0.7 |

The values in Table 1 were used to estimate values of degree of saturation *S*, and void ratio *e*. Table 1 was also referenced to estimate consolidation parameters including compression index $C_c$ and recompression index $C_r$, using industry accepted correlations for each compression index. Primary consolidation parameters used in this analysis are provided in Table 2 below:

**Table 2: Estimated Primary Consolidation Parameters**

| Layer | Compression Index, Cc[1] | Recompression Index, Cr[2] | OCR[3] |
|---|---|---|---|
| *Subsurface Clay* | 0.13 | 0.03 | 1.40 |

Table 2 Notes:

1) Holtz, Kovacs, & Sheahan Correlation, $Cc = 0.30(e-0.27)^2$.
2) $Cr = 0.2(Cc)$
3) For this analysis, an over consolidation ratio (OCR) of 1.40 was conservatively assumed based on historical site consolidation laboratory testing[3].

Reference 1: *Unit Weight of Municipal Solid Waste,* Zekkos, D. et al., Journal of Geotechnical and Geoenvironmental Engineering, ASCE, October 2006.

Reference 2: Holtz, R. D., Kovacs, W.D., & Sheahan, T.C. (2011). *An Introduction to Geotechnical Engineering, Second Edition*. Pearson Education, Inc.

Reference 3: *Report of Geotechnical Exploration and Laboratory Testing – Perry Uniontown Landfill*, by BLE, dated January 16, 2007.

Reference 4: *Report of Geotechnical Exploration – Renewable Natural Gas Facility*, by BLE, dated September 9, 2024.

# Settlement Analysis Summary Tables

# SURCHARGE DETERMINATION
# SETTLEMENT CALCULATIONS
# MAJOR MODIFICIATION SUPPORT

**ARROWHEAD LANDFILL**
PERRY COUNTY, ALABAMA
BLE Project No. J24-4999-66

| Tract No. (1) | Rel. Elevation | Settlement Point (A) | Settlement Alignment (A) | Station Number (A) | Pre-Construction Ground Elevation at Point Feet | Estimated Groundwater Elevation[4] Feet | Elevation of Top of Clay Liner[2] (Pipe Elev) Feet | Elevation of Clay Liner Subgrade Feet | Elevation Top of Protective Cover Feet | Final Grade Elevation[3] Feet | Layer Thickness | | | | Cut (-) / Fill (+) Above Design Subgrade Feet | Pre-Construction Overburden Pressure (B) at Design Subgrade Elevation psf | Total Surcharge at Clay Liner Subgrade Elevation psf | Net Surcharge (C) at Clay Liner Subgrade Elevation psf |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | Clay Liner Feet | Protective Cover Feet | Waste Feet | Final Cover Feet | | | | |
| Tract 1 | High | S-1A | S-1 | 0+45.21 | 246.00 | 127.00 | 246.28 | 244.28 | 248.28 | 278.19 | 2.0 | 2.0 | 25.9 | 4.0 | -1.7 | 206 | 3,122 | 2,916 |
| | Mid | S-1B | S-1 | 7+37.45 | 239.79 | 127.01 | 239.32 | 237.32 | 241.32 | 476.58 | 2.0 | 2.0 | 231.3 | 4.0 | -2.5 | 296 | 20,577 | 20,281 |
| | Low | S-1C | S-1 | 13+33.92 | 229.82 | 127.01 | 232.56 | 230.56 | 234.56 | 314.60 | 2.0 | 2.0 | 76.0 | 4.0 | +0.7 | 0 | 7,383 | 7,383 |
| | High | S-2A | S-2 | 0+74.71 | 386.00 | 126.58 | 267.95 | 265.95 | 269.95 | 436.36 | 2.0 | 2.0 | 162.4 | 4.0 | - | 10,204 | 14,725 | 4,521 |
| | Mid | S-2B | S-2 | 3+00.00 | 383.97 | 126.67 | 264.00 | 262.00 | 266.00 | 469.27 | 2.0 | 2.0 | 199.3 | 4.0 | - | 10,367 | 17,858 | 7,490 |
| | Low | S-2C | S-2 | 8+34.47 | 315.42 | 126.52 | 256.50 | 254.50 | 258.50 | 315.67 | 2.0 | 2.0 | 53.2 | 4.0 | - | 5,178 | 5,439 | 261 |
| Tract 2 | High | S-3A | S-3 | 1+89.59 | 290.00 | 127.50 | 274.00 | 272.00 | 276.00 | 502.80 | 2.0 | 2.0 | 222.8 | 4.0 | -18.0 | 2,160 | 19,858 | 17,698 |
| | Mid 1 | S-3B | S-3 | 6+25.69 | 280.58 | 127.50 | 265.71 | 263.71 | 267.71 | 523.34 | 2.0 | 2.0 | 251.6 | 4.0 | -16.9 | 2,024 | 22,309 | 20,284 |
| | Mid 2 | S-3C | S-3 | 11+00.00 | 276.09 | 127.50 | 255.79 | 253.79 | 257.79 | 530.17 | 2.0 | 2.0 | 268.4 | 4.0 | -22.3 | 2,676 | 23,732 | 21,056 |
| | Low | S-3D | S-3 | 15+89.59 | 279.20 | 127.50 | 246.00 | 244.00 | 248.00 | 368.98 | 2.0 | 2.0 | 117.0 | 4.0 | -35.2 | 4,224 | 10,863 | 6,639 |
| | High | S-4A | S-4 | 1+39.93 | 256.86 | 126.47 | 239.65 | 237.65 | 241.65 | 295.46 | 2.0 | 2.0 | 49.8 | 4.0 | -19.2 | 2,305 | 5,154 | 2,849 |
| | Mid 1 | S-4B | S-4 | 7+74.57 | 242.97 | 126.58 | 226.21 | 224.21 | 228.21 | 477.10 | 2.0 | 2.0 | 244.9 | 4.0 | -18.8 | 2,251 | 21,736 | 19,484 |
| | Mid 2 | S-4C | S-4 | 13+67.35 | 229.38 | 126.68 | 214.44 | 212.44 | 216.44 | 463.12 | 2.0 | 2.0 | 242.7 | 4.0 | -16.9 | 2,033 | 21,548 | 19,515 |
| | Low | S-4D | S-4 | 19+80.97 | 231.95 | 126.78 | 202.00 | 200.00 | 204.00 | 306.66 | 2.0 | 2.0 | 98.7 | 4.0 | -32.0 | 3,834 | 9,306 | 5,472 |
| Tract 3 | High | S-5A | S-5 | 1+40.38 | 252.62 | 127.35 | 242.00 | 240.00 | 244.00 | 271.59 | 2.0 | 2.0 | 23.6 | 4.0 | -12.6 | 1,514 | 2,925 | 1,411 |
| | Mid 1 | S-5B | S-5 | 7+40.38 | 256.02 | 127.53 | 236.00 | 234.00 | 238.00 | 451.58 | 2.0 | 2.0 | 209.6 | 4.0 | -22.0 | 2,642 | 18,734 | 16,092 |
| | Mid 2 | S-5C | S-5 | 14+29.11 | 255.88 | 127.69 | 224.66 | 222.66 | 226.66 | 552.26 | 2.0 | 2.0 | 321.6 | 4.0 | -33.2 | 3,986 | 28,256 | 24,270 |
| | Mid 3 | S-5D | S-5 | 20+79.24 | 245.55 | 127.79 | 211.66 | 209.66 | 213.66 | 468.34 | 2.0 | 2.0 | 250.7 | 4.0 | -35.9 | 4,307 | 22,228 | 17,921 |
| | Low | S-5E | S-5 | 27+56.81 | 207.90 | 127.90 | 198.18 | 196.18 | 200.18 | 274.73 | 2.0 | 2.0 | 70.6 | 4.0 | -11.7 | 1,406 | 6,917 | 5,510 |
| | High | S-6A | S-6 | 1+10.60 | 244.06 | 127.73 | 234.29 | 232.29 | 236.29 | 543.95 | 2.0 | 2.0 | 303.7 | 4.0 | -11.8 | 1,412 | 26,731 | 25,319 |
| | Mid 1 | S-6B | S-6 | 5+32.12 | 237.23 | 127.62 | 229.43 | 227.43 | 231.43 | 550.24 | 2.0 | 2.0 | 314.8 | 4.0 | -9.8 | 1,176 | 27,679 | 26,503 |
| | Mid 2 | S-6C | S-6 | 9+72.25 | 248.95 | 127.48 | 223.92 | 221.92 | 225.92 | 418.53 | 2.0 | 2.0 | 188.6 | 4.0 | -27.0 | 3,244 | 16,952 | 13,708 |
| | Low | S-6D | S-6 | 13+76.55 | 252.37 | 127.36 | 218.87 | 216.87 | 220.87 | 297.25 | 2.0 | 2.0 | 72.4 | 4.0 | -35.5 | 4,260 | 7,072 | 2,812 |

**Notes:**
(A) Settlement point locations shown on BLE Figure 2C, 3C, and 4C.
(B) Pre-Construction Overburden Pressure Above Clay Liner Subgrade Elevation = (Pre-constr. Ground elevation - Design Subgrade Elevation) * (weight of structural fill)
(C) Net Surcharge = final cover weight + weight of waste down to protective cover + protective cover weight + clay liner weight - (Pre-Construction Overburden)
Red values input from cross sections in BLE Figures 7 and 8.

| Material | Unit Weight, pcf | Thickness, ft |
|---|---|---|
| MSW | 85 | varies |
| CLAY LINER | 120 | 2 |
| PROTECTIVE COVER | 120 | 2 |
| FINAL COVER | 110 | 4 |
| WATER | 62.4 | n/a |
| STRUCTURAL FILL | 125 | varies |
| EXISTING SOIL OVERBURDEN | 120 | varies |

**References:**

1. Major Modification - Vertical Expansion Preliminary Drawings - Arrowhead Landfill, by Hodges, Harbin, Newberry & Tribble, inc. (HHNT), provided September 2024.
2. Proposed landfill Initial and final Grades taken from electronic drawings provided by HHNT September 2024
3. Existing landfill top of clay liner grades taken from electronic drawing as-builts provided by HHNT September 2024.
4. Groundwater contour elevations taken from drawing titled "Groundwater elevation Contour Map (Eutaw Formation) - September 12, 2023." by BLE, dated April 2024.


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*checked by:* Tanner Whitese, E.I.T.
*reviewed by:* Larry Simonson, P.E.

**POST-SETTLEMENT SLOPE OF SELECTED LEACHATE LINES**
**MAJOR MODIFICATION SUPPORT**
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BLE Project J24-4999-66

| Settlement Alignment | Subgrade Settlement | | | Leachate Line Segment Low to Middle | | | | | | | Leachate Line Segment Middle to High | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Low Point (Pt. Reference Number*) Feet | Middle Point (Pt. Reference Number*) Feet | High Point (Pt. Reference Number*) Feet | Low Sta. | Low Elev. Feet | Middle Sta. | Middle Elev. Feet | Line Length Feet | Initial Line Slope % | Post Settlement Slope Low-Middle % | Middle Sta. | Middle Elev. Feet | High Sta. | High Elev. Feet | Line Length Feet | Initial Line Slope % | Post Settlement Slope Mid1 - Mid2 % |
| S-1 | 1.7 S-1C | 3.2 S-1B | 0.6 S-1A | 13+33.92 | 232.56 | 7+37.45 | 239.32 | 596 | 1.13 | 0.88 | 7+37.45 | 239.32 | 0+45.21 | 246.28 | 692 | 1.01 | 1.37 |
| S-2 | 0.0 S-2C | 1.7 S-2B | 1.1 S-2A | 8+34.47 | 256.50 | 3+00.00 | 264.00 | 534 | 1.40 | 1.09 | 3+00.00 | 264.00 | 0+74.71 | 267.95 | 225 | 1.75 | 2.02 |

Notes:
1. Subgrade settlement values are reported for subsurface layers below the clay liner.
2. Leachate collection line elevations are taken as the top of clay liner for the purpose of this analysis.

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**POST-SETTLEMENT SLOPE OF SELECTED LEACHATE LINES**
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| Settlement | Subgrade Settlement | | | | Leachate Line Segment Low to Middle 2 | | | | | | | Leachate Line Segment Middle 2 to Middle 1 | | | | | | | Leachate Line Segment Middle 1 to High | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Alignment | Low Point | Middle Point 2 | Middle Point 1 | High Point | Low Sta. | Low Elev. | Middle 2 Sta. | Middle 2 Elev. | Line Length | Initial Line Slope | Post Settlement Slope Low-Middle | Middle 2 Sta. | Middle 2 Elev. | Middle 1 Sta. | Middle 1 Elev. | Line Length | Initial Line Slope | Post Settlement Slope Mid1 - Mid2 | Middle 1 Sta. | Middle 1 Elev. | High Sta. | High Elev. | Line Length | Initial Line Slope | Post Settlement Slope Middle-High |
| | (Pt. Reference Number*) | | | | | Feet | | Feet | | | | | Feet | | Feet | | | | | Feet | | Feet | | | | |
| | Feet | Feet | Feet | Feet | | | | | Feet | % | % | | | | | Feet | % | % | | | | | Feet | % | % |
| S-3 | 1.5 S-3D | 3.2 S-3C | 3.2 S-3B | 3.0 S-3A | 15+89.59 | 246.00 | 11+00.00 | 255.79 | 490 | 2.00 | 1.65 | 11+00.00 | 255.79 | 6+25.69 | 265.71 | 474 | 2.09 | 2.10 | 6+25.69 | 263.71 | 1+89.59 | 272.00 | 436 | 1.90 | 1.95 |
| S-4 | 1.3 S-4D | 3.1 S-4C | 3.1 S-4B | 0.6 S-4A | 19+80.97 | 202.00 | 13+67.35 | 214.44 | 614 | 2.03 | 1.73 | 13+67.35 | 214.44 | 7+74.57 | 226.21 | 593 | 1.99 | 1.99 | 7+74.57 | 224.21 | 1+39.93 | 237.65 | 635 | 2.12 | 2.51 |
| S-6 | 0.6 S-6D | 2.5 S-6C | 3.6 S-6B | 3.6 S-6A | 13+76.55 | 218.87 | 9+72.25 | 223.92 | 404 | 1.25 | 0.77 | 9+72.25 | 223.92 | 5+32.12 | 229.43 | 440 | 1.25 | 1.01 | 5+32.12 | 227.43 | 1+10.60 | 232.29 | 422 | 1.15 | 1.17 |

Notes:
1. Subgrade settlement values are reported for subsurface layers below the clay liner.
2. Leachate collection line elevations are taken as the top of clay liner for the purpose of this analysis.

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**POST-SETTLEMENT SLOPE OF SELECTED LEACHATE LINES**
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| Settlement Alignment | Subgrade Settlement | | | | | Leachate Line Segment Low to Middle 3 | | | | | | | Leachate Line Segment Middle 3 to Middle 2 | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Low Point | Middle Point 3 | Middle Point 2 | Middle Point 1 | High Point | Low | | Middle 3 | | Line Length | Initial Line Slope | Post Settlement Slope Low-Middle | Middle 3 | | Middle 2 | | Line Length | Initial Line Slope | Post Settlement Slope Mid1 - Mid2 |
| (Pt. Reference Number*) | | | | | | Sta. | Elev. Feet | Sta. | Elev. Feet | | | | Sta. | Elev. Feet | Sta. | Elev. Feet | | | |
| | Feet | Feet | Feet | Feet | Feet | | | | | Feet | % | % | | | | | Feet | % | % |
| S-5 | 1.3 S-5E | 3.0 S-5D | 3.5 S-5C | 2.8 S-5B | 0.1 S-5A | 27+56.81 | 198.18 | 20+79.24 | 211.66 | 678 | 1.99 | 1.74 | 20+79.24 | 211.66 | 14+29.11 | 224.66 | 650 | 2.00 | 1.92 |

| Leachate Line Segment Middle 2 to Middle 1 | | | | | | | Leachate Line Segment Middle 1 to High | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Middle 2 | | Middle 1 | | Line Length | Initial Line Slope | Post Settlement Slope Middle-High | Middle 1 | | High | | Line Length | Initial Line Slope | Post Settlement Slope Middle-High |
| Sta. | Elev. Feet | Sta. | Elev. Feet | | | | Sta. | Elev. Feet | Sta. | Elev. Feet | | | |
| | | | | Feet | % | % | | | | | Feet | % | % |
| 14+29.11 | 224.66 | 7+40.38 | 236.00 | 689 | 1.65 | 1.75 | 7+40.38 | 236.00 | 1+40.38 | 242.00 | 600 | 1.00 | 1.44 |

Notes:
1. Subgrade settlement values are reported for subsurface layers below the clay liner.
2. Leachate collection line elevations are taken as the top of clay liner for the purpose of this analysis.

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# Settlement Estimates at Point Locations

# SUBGRADE SETTLEMENT CALCULATIONS
# MAJOR MODIFICATION SUPPORT

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| **Settlement Point:** | **S-1A** | **Pre-Construction Grade (ft)** | **246** | **Groundwater Elev (ft)** | **127** | **Design Subgrade (ft)** | **244.28** |
|---|---|---|---|---|---|---|---|

| Subsurface Layer | Upper Elevation (feet) | Lower Elevation (feet) | Layer Thickness (feet) | SPT Blow Count (bpf) | Total Soil Unit Weight (pcf) | Effective Soil Unit Weight (pcf) | Net Surcharge Pressure (psf) | Overburden Pressure at Mid-Point of Layer [$\sigma'v_0$] (psf) | Final Vertical Pressure at Mid-Point of Layer [$\sigma'v_f$] (psf) | Consolidation Parameters | | | | Constrained Elastic Modulus, M | | | | Immediate Settlement (inches) | Recomp. Primary Consol. (inches) | Virgin Primary Consol. (inches) | Layer Settlement (inches) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | Pc (ksf) | e | $C_r$ | $C_c$ | Elastic Modulus [1] (ksf) | Poissons Ratio, μ | M (ksf) | Strain (%) | | | | |
| Sandy CLAY [CUT] | 246.0 | 244.3 | 2 | - | 120 | 120 | 2,916 | 0 | 2,916 | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | 0.0 |
| Sandy CLAY | 244.3 | 184.3 | 60 | - | 120 | 120 | 2,916 | 3,600 | 6,516 | 5.0 | 0.7 | 0.03 | 0.13 | --- | --- | --- | --- | --- | 1.6 | 6.0 | 7.6 |
| Total Compressible Subsurface | | | 60 | feet | | | | | | | | | | | | | | | | | |

| | |
|---|---|
| **TOTAL SETTLEMENT (INCHES)** | **7.6** |
| **TOTAL SETTLEMENT (FEET)** | **0.6** |

Notes: 1) Settlement conservatively assumed to occur in the upper 60 feet of the eutaw formation below the landfill subgrade.

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| **Settlement Point:** | **S-1B** | **Pre-Construction Grade (ft)** | **240** | **Groundwater Elev (ft)** | **127.01** | **Design Subgrade (ft)** | **237.32** |
|---|---|---|---|---|---|---|---|

| Subsurface Layer | Upper Elevation (feet) | Lower Elevation (feet) | Layer Thickness (feet) | SPT Blow Count (bpf) | Total Soil Unit Weight (pcf) | Effective Soil Unit Weight (pcf) | Net Surcharge Pressure (psf) | Overburden Pressure at Mid-Point of Layer [$\sigma'v_0$] (psf) | Final Vertical Pressure at Mid-Point of Layer [$\sigma'v_f$] (psf) | Consolidation Parameters | | | | Constrained Elastic Modulus, M | | | | Immediate Settlement (inches) | Recomp. Primary Consol. (inches) | Virgin Primary Consol. (inches) | Layer Settlement (inches) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | Pc (ksf) | e | $C_r$ | $C_c$ | Elastic Modulus [1] (ksf) | Poissons Ratio, μ | M (ksf) | Strain (%) | | | | |
| Sandy CLAY [CUT] | 239.8 | 237.3 | 2 | - | 120 | 120 | 20,281 | 0 | 20,281 | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | 0.0 |
| Sandy CLAY | 237.3 | 177.3 | 60 | - | 120 | 120 | 20,281 | 3,600 | 23,881 | 5.0 | 0.7 | 0.03 | 0.13 | --- | --- | --- | --- | --- | 1.6 | 36.5 | 38.1 |
| Total Compressible Subsurface | | | 60 | feet | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | **TOTAL SETTLEMENT (INCHES)** | | | | | | | **38.1** |
| | | | | | | | | | | | | | | **TOTAL SETTLEMENT (FEET)** | | | | | | | **3.2** |

Notes: 1) Settlement conservatively assumed to occur in the upper 60 feet of the eutaw formation below the landfill subgrade.

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# SUBGRADE SETTLEMENT CALCULATIONS
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| **Settlement Point:** | **S-1C** | **Pre-Construction Grade (ft)** | **230** | **Groundwater Elev (ft)** | **127.01** | **Design Subgrade (ft)** | **230.56** |
|---|---|---|---|---|---|---|---|

| Subsurface Layer | Upper Elevation (feet) | Lower Elevation (feet) | Layer Thickness (feet) | SPT Blow Count (bpf) | Total Soil Unit Weight (pcf) | Effective Soil Unit Weight (pcf) | Net Surcharge Pressure (psf) | Overburden Pressure at Mid-Point of Layer [$\sigma'v_0$] (psf) | Final Vertical Pressure at Mid-Point of Layer [$\sigma'v_f$] (psf) | Consolidation Parameters | | | | Constrained Elastic Modulus, M | | | | Immediate Settlement (inches) | Recomp. Primary Consol. (inches) | Virgin Primary Consol. (inches) | Layer Settlement (inches) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | Pc (ksf) | e | $C_r$ | $C_c$ | Elastic Modulus [1] (ksf) | Poissons Ratio, μ | M (ksf) | Strain (%) | | | | |
| Sandy CLAY | 230.6 | 170.6 | 60 | - | 120 | 120 | 7,383 | 3,600 | 10,983 | 5.0 | 0.7 | 0.03 | 0.13 | --- | --- | --- | --- | --- | 1.6 | 18.3 | 19.9 |
| Total Compressible Subsurface | | | 60 | feet | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | **TOTAL SETTLEMENT (INCHES)** | | | | | | | **19.9** |
| | | | | | | | | | | | | | | **TOTAL SETTLEMENT (FEET)** | | | | | | | **1.7** |

Notes: 1) Settlement conservatively assumed to occur in the upper 60 feet of the eutaw formation below the landfill subgrade.

Prepared by: David Yarbray, E.I.T
Checked by: Tanner Whitesell, E.I.T.
Reviewed by: Larry Simonson, P.E.

# SUBGRADE SETTLEMENT CALCULATIONS
# MAJOR MODIFICATION SUPPORT

ARROWHEAD LANDFILL
PERRY COUNTY, ALABAMA
BLE Project No. J24-4999-66

**Settlement Point:** S-2A **Pre-Construction Grade (ft)** 386 **Groundwater Elev (ft)** 126.58 **Design Subgrade (ft)** 265.95

| Subsurface Layer | Upper Elevation (feet) | Lower Elevation (feet) | Layer Thickness (feet) | SPT Blow Count (bpf) | Total Soil Unit Weight (pcf) | Effective Soil Unit Weight (pcf) | Net Surcharge Pressure (psf) | Overburden Pressure at Mid-Point of Layer [σ'v0] (psf) | Final Vertical Pressure at Mid-Point of Layer [σ'vf] (psf) | Consolidation Parameters | | | | Constrained Elastic Modulus, M | | | | Immediate Settlement (inches) | Recomp. Primary Consol. (inches) | Virgin Primary Consol. (inches) | Layer Settlement (inches) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | Pc (ksf) | e | $C_r$ | $C_c$ | Elastic Modulus [1] (ksf) | Poissons Ratio, μ | M (ksf) | Strain (%) | | | | |
| Sandy CLAY | 266.0 | 206.0 | 60 | - | 120 | 120 | 4,521 | 3,600 | 8,121 | 5.0 | 0.7 | 0.03 | 0.13 | --- | --- | --- | --- | --- | 1.6 | 11.2 | 12.8 |
| Total Compressible Subsurface | | | 60 | feet | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | **TOTAL SETTLEMENT (INCHES)** | | | **12.8** |
| | | | | | | | | | | | | | | | | | | **TOTAL SETTLEMENT (FEET)** | | | **1.1** |

Notes: 1) Settlement conservatively assumed to occur in the upper 60 feet of the eutaw formation below the landfill subgrade.

Prepared by: Tanner Whitesell, E.I.T.
Checked by: David Yarbray, E.I.T.
Reviewed by: Larry Simonson, P.E.

# SUBGRADE SETTLEMENT CALCULATIONS
# MAJOR MODIFICATION SUPPORT

ARROWHEAD LANDFILL
PERRY COUNTY, ALABAMA
BLE Project No. J24-4999-66

**Settlement Point:** S-2B **Pre-Construction Grade (ft)** 383.97 **Groundwater Elev (ft)** 126.67 **Design Subgrade (ft)** 262

| Subsurface Layer | Upper Elevation (feet) | Lower Elevation (feet) | Layer Thickness (feet) | SPT Blow Count (bpf) | Total Soil Unit Weight (pcf) | Effective Soil Unit Weight (pcf) | Net Surcharge Pressure (psf) | Overburden Pressure at Mid-Point of Layer [$\sigma'v_0$] (psf) | Final Vertical Pressure at Mid-Point of Layer [$\sigma'v_f$] (psf) | Consolidation Parameters: Pc (ksf) | e | $C_r$ | $C_c$ | Constrained Elastic Modulus, M: Elastic Modulus [1] (ksf) | Poissons Ratio, μ | M (ksf) | Strain (%) | Immediate Settlement (inches) | Recomp. Primary Consol. (inches) | Virgin Primary Consol. (inches) | Layer Settlement (inches) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sandy CLAY | 262.0 | 202.0 | 60 | - | 120 | 120 | 7,490 | 3,600 | 11,091 | 5.0 | 0.7 | 0.03 | 0.13 | --- | --- | --- | --- | --- | 1.6 | 18.5 | 20.1 |
| Total Compressible Subsurface | | | 60 | feet | | | | | | | | | | | | | | | | | |

| | |
|---|---|
| **TOTAL SETTLEMENT (INCHES)** | **20.1** |
| **TOTAL SETTLEMENT (FEET)** | **1.7** |

Notes: 1) Settlement conservatively assumed to occur in the upper 60 feet of the eutaw formation below the landfill subgrade.

Prepared by: Tanner Whitesell, E.I.T.
Checked by: David Yarbray, E.I.T.
Reviewed by: Larry Simonson, P.E.

# SUBGRADE SETTLEMENT CALCULATIONS
# MAJOR MODIFICATION SUPPORT

ARROWHEAD LANDFILL
PERRY COUNTY, ALABAMA
BLE Project No. J24-4999-66

**Settlement Point:** S-2C **Pre-Construction Grade (ft)** 315.42 **Groundwater Elev (ft)** 126.52 **Design Subgrade (ft)** 254.5

| Subsurface Layer | Upper Elevation (feet) | Lower Elevation (feet) | Layer Thickness (feet) | SPT Blow Count (bpf) | Total Soil Unit Weight (pcf) | Effective Soil Unit Weight (pcf) | Net Surcharge Pressure (psf) | Overburden Pressure at Mid-Point of Layer [$\sigma'v_0$] (psf) | Final Vertical Pressure at Mid-Point of Layer [$\sigma'v_f$] (psf) | Consolidation Parameters Pc (ksf) | e | $C_r$ | $C_c$ | Constrained Elastic Modulus, M Elastic Modulus [1] (ksf) | Poissons Ratio, μ | M (ksf) | Strain (%) | Immediate Settlement (inches) | Recomp. Primary Consol. (inches) | Virgin Primary Consol. (inches) | Layer Settlement (inches) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sandy CLAY | 254.5 | 194.5 | 60 | - | 120 | 120 | 261 | 3,600 | 3,861 | 5.0 | 0.7 | 0.03 | 0.13 | --- | --- | --- | --- | --- | 0.3 | --- | 0.3 |
| Total Compressible Subsurface | | | 60 | feet | | | | | | | | | | | | | | | | | |

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|---|---|
| **TOTAL SETTLEMENT (INCHES)** | **0.3** |
| **TOTAL SETTLEMENT (FEET)** | **0.0** |

Notes: 1) Settlement conservatively assumed to occur in the upper 60 feet of the eutaw formation below the landfill subgrade.

Prepared by: Tanner Whitesell, E.I.T.
Checked by: David Yarbray, E.I.T.
Reviewed by: Larry Simonson, P.E.

# SUBGRADE SETTLEMENT CALCULATIONS
# MAJOR MODIFICATION SUPPORT

ARROWHEAD LANDFILL
PERRY COUNTY, ALABAMA
BLE Project No. J24-4999-66

| **Settlement Point:** | **S-3A** | **Pre-Construction Grade (ft)** | **290** | **Groundwater Elev (ft)** | **127.5** | **Design Subgrade (ft)** | **272** |
|---|---|---|---|---|---|---|---|

| Subsurface Layer | Upper Elevation (feet) | Lower Elevation (feet) | Layer Thickness (feet) | SPT Blow Count (bpf) | Total Soil Unit Weight (pcf) | Effective Soil Unit Weight (pcf) | Net Surcharge Pressure (psf) | Overburden Pressure at Mid-Point of Layer [$\sigma'v_0$] (psf) | Final Vertical Pressure at Mid-Point of Layer [$\sigma'v_f$] (psf) | Consolidation Parameters | | | | Constrained Elastic Modulus, M | | | | Immediate Settlement (inches) | Recomp. Primary Consol. (inches) | Virgin Primary Consol. (inches) | Layer Settlement (inches) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | Pc (ksf) | e | $C_r$ | $C_c$ | Elastic Modulus [1] (ksf) | Poissons Ratio, μ | M (ksf) | Strain (%) | | | | |
| Sandy CLAY [CUT] | 290.0 | 272.0 | 18 | - | 120 | 120 | 17,698 | 0 | 17,698 | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | 0.0 |
| Sandy CLAY | 272.0 | 212.0 | 60 | - | 120 | 120 | 17,698 | 3,600 | 21,298 | 5.0 | 0.7 | 0.03 | 0.13 | --- | --- | --- | --- | --- | 1.6 | 33.8 | 35.4 |
| Total Compressible Subsurface | | | 60 | feet | | | | | | | | | | | | | | | | | |

| | |
|---|---|
| **TOTAL SETTLEMENT (INCHES)** | **35.4** |
| **TOTAL SETTLEMENT (FEET)** | **3.0** |

Notes: 1) Settlement conservatively assumed to occur in the upper 60 feet of the eutaw formation below the landfill subgrade.

Prepared by: Tanner Whitesell, E.I.T.
Checked by: David Yarbray, E.I.T.
Reviewed by: Larry Simonson, P.E.

# SUBGRADE SETTLEMENT CALCULATIONS
# MAJOR MODIFICATION SUPPORT

ARROWHEAD LANDFILL
PERRY COUNTY, ALABAMA
BLE Project No. J24-4999-66

| **Settlement Point:** | **S-3B** | **Pre-Construction Grade (ft)** | **280.58** | **Groundwater Elev (ft)** | **127.5** | **Design Subgrade (ft)** | **263.71** |
|---|---|---|---|---|---|---|---|

| Subsurface Layer | Upper Elevation (feet) | Lower Elevation (feet) | Layer Thickness (feet) | SPT Blow Count (bpf) | Total Soil Unit Weight (pcf) | Effective Soil Unit Weight (pcf) | Net Surcharge Pressure (psf) | Overburden Pressure at Mid-Point of Layer [$\sigma'v_0$] (psf) | Final Vertical Pressure at Mid-Point of Layer [$\sigma'v_f$] (psf) | Consolidation Parameters | | | | Constrained Elastic Modulus, M | | | | Immediate Settlement (inches) | Recomp. Primary Consol. (inches) | Virgin Primary Consol. (inches) | Layer Settlement (inches) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | Pc (ksf) | e | $C_r$ | $C_c$ | Elastic Modulus [1] (ksf) | Poissons Ratio, μ | M (ksf) | Strain (%) | | | | |
| Sandy CLAY [CUT] | 280.6 | 263.7 | 17 | - | 120 | 120 | 20,284 | 0 | 20,284 | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | 0.0 |
| Sandy CLAY | 263.7 | 203.7 | 60 | - | 120 | 120 | 20,284 | 3,600 | 23,884 | 5.0 | 0.7 | 0.03 | 0.13 | --- | --- | --- | --- | --- | 1.6 | 36.5 | 38.1 |
| Total Compressible Subsurface | | | 60 | feet | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | **TOTAL SETTLEMENT (INCHES)** | | | | | | | **38.1** |
| | | | | | | | | | | | | | | **TOTAL SETTLEMENT (FEET)** | | | | | | | **3.2** |

Notes: 1) Settlement conservatively assumed to occur in the upper 60 feet of the eutaw formation below the landfill subgrade.

Prepared by: Tanner Whitesell, E.I.T.
Checked by: David Yarbray, E.I.T.
Reviewed by: Larry Simonson, P.E.

# SUBGRADE SETTLEMENT CALCULATIONS
# MAJOR MODIFICATION SUPPORT

ARROWHEAD LANDFILL
PERRY COUNTY, ALABAMA
BLE Project No. J24-4999-66

| **Settlement Point:** | S-3C | **Pre-Construction Grade (ft)** | **276.09** | **Groundwater Elev (ft)** | **127.5** | **Design Subgrade (ft)** | **253.79** |
|---|---|---|---|---|---|---|---|

| Subsurface Layer | Upper Elevation (feet) | Lower Elevation (feet) | Layer Thickness (feet) | SPT Blow Count (bpf) | Total Soil Unit Weight (pcf) | Effective Soil Unit Weight (pcf) | Net Surcharge Pressure (psf) | Overburden Pressure at Mid-Point of Layer [$\sigma'v_0$] (psf) | Final Vertical Pressure at Mid-Point of Layer [$\sigma'v_f$] (psf) | Consolidation Parameters | | | | Constrained Elastic Modulus, M | | | | Immediate Settlement (inches) | Recomp. Primary Consol. (inches) | Virgin Primary Consol. (inches) | Layer Settlement (inches) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | Pc (ksf) | e | $C_r$ | $C_c$ | Elastic Modulus [1] (ksf) | Poissons Ratio, μ | M (ksf) | Strain (%) | | | | |
| Sandy CLAY [CUT] | 276.1 | 253.8 | 22 | - | 120 | 120 | 21,056 | 0 | 21,056 | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | 0.0 |
| Sandy CLAY | 253.8 | 193.8 | 60 | - | 120 | 120 | 21,056 | 3,600 | 24,656 | 5.0 | 0.7 | 0.03 | 0.13 | --- | --- | --- | --- | --- | 1.6 | 37.3 | 38.9 |
| Total Compressible Subsurface | | | 60 | feet | | | | | | | | | | | | | | | | | |

| | |
|---|---|
| **TOTAL SETTLEMENT (INCHES)** | **38.9** |
| **TOTAL SETTLEMENT (FEET)** | **3.2** |

Notes: 1) Settlement conservatively assumed to occur in the upper 60 feet of the eutaw formation below the landfill subgrade.

Prepared by: Tanner Whitesell, E.I.T.
Checked by: David Yarbray, E.I.T.
Reviewed by: Larry Simonson, P.E.

# SUBGRADE SETTLEMENT CALCULATIONS
# MAJOR MODIFICATION SUPPORT

ARROWHEAD LANDFILL
PERRY COUNTY, ALABAMA
BLE Project No. J24-4999-66

| **Settlement Point:** | **S-3D** | **Pre-Construction Grade (ft)** | **279.2** | **Groundwater Elev (ft)** | **127.5** | **Design Subgrade (ft)** | **244** |
|---|---|---|---|---|---|---|---|

| Subsurface Layer | Upper Elevation (feet) | Lower Elevation (feet) | Layer Thickness (feet) | SPT Blow Count (bpf) | Total Soil Unit Weight (pcf) | Effective Soil Unit Weight (pcf) | Net Surcharge Pressure (psf) | Overburden Pressure at Mid-Point of Layer [$\sigma'v_0$] (psf) | Final Vertical Pressure at Mid-Point of Layer [$\sigma'v_f$] (psf) | Consolidation Parameters | | | | Constrained Elastic Modulus, M | | | | Immediate Settlement (inches) | Recomp. Primary Consol. (inches) | Virgin Primary Consol. (inches) | Layer Settlement (inches) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | Pc (ksf) | e | $C_r$ | $C_c$ | Elastic Modulus [1] (ksf) | Poissons Ratio, μ | M (ksf) | Strain (%) | | | | |
| Sandy CLAY [CUT] | 279.2 | 244.0 | 35 | - | 120 | 120 | 6,639 | 0 | 6,639 | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | 0.0 |
| Sandy CLAY | 244.0 | 184.0 | 60 | - | 120 | 120 | 6,639 | 3,600 | 10,239 | 5.0 | 0.7 | 0.03 | 0.13 | --- | --- | --- | --- | --- | 1.6 | 16.6 | 18.2 |
| Total Compressible Subsurface | | | 60 | feet | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | **TOTAL SETTLEMENT (INCHES)** | | | | | | | **18.2** |
| | | | | | | | | | | | | | | **TOTAL SETTLEMENT (FEET)** | | | | | | | **1.5** |

Notes: 1) Settlement conservatively assumed to occur in the upper 60 feet of the eutaw formation below the landfill subgrade.

Prepared by: Tanner Whitesell, E.I.T.
Checked by: David Yarbray, E.I.T.
Reviewed by: Larry Simonson, P.E.

# SUBGRADE SETTLEMENT CALCULATIONS
# MAJOR MODIFICATION SUPPORT

ARROWHEAD LANDFILL
PERRY COUNTY, ALABAMA
BLE Project No. J24-4999-66

**Settlement Point:** S-4A **Pre-Construction Grade (ft)** 256.86 **Groundwater Elev (ft)** 126.47 **Design Subgrade (ft)** 237.65

| Subsurface Layer | Upper Elevation (feet) | Lower Elevation (feet) | Layer Thickness (feet) | SPT Blow Count (bpf) | Total Soil Unit Weight (pcf) | Effective Soil Unit Weight (pcf) | Net Surcharge Pressure (psf) | Overburden Pressure at Mid-Point of Layer [$\sigma'v_0$] (psf) | Final Vertical Pressure at Mid-Point of Layer [$\sigma'v_f$] (psf) | Consolidation Parameters: Pc (ksf) | e | $C_r$ | $C_c$ | Constrained Elastic Modulus, M: Elastic Modulus [1] (ksf) | Poissons Ratio, μ | M (ksf) | Strain (%) | Immediate Settlement (inches) | Recomp. Primary Consol. (inches) | Virgin Primary Consol. (inches) | Layer Settlement (inches) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sandy CLAY [CUT] | 256.9 | 237.7 | 19 | - | 120 | 120 | 2,849 | 0 | 2,849 | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | 0.0 |
| Sandy CLAY | 237.7 | 177.7 | 60 | - | 120 | 120 | 2,849 | 3,600 | 6,449 | 5.0 | 0.7 | 0.03 | 0.13 | --- | --- | --- | --- | --- | 1.6 | 5.8 | 7.4 |
| Total Compressible Subsurface | | | 60 | feet | | | | | | | | | | | | | | | | | |

| | |
|---|---|
| **TOTAL SETTLEMENT (INCHES)** | **7.4** |
| **TOTAL SETTLEMENT (FEET)** | **0.6** |

Notes: 1) Settlement conservatively assumed to occur in the upper 60 feet of the eutaw formation below the landfill subgrade.

Prepared by: Tanner Whitesell, E.I.T.
Checked by: David Yarbray, E.I.T.
Reviewed by: Larry Simonson, P.E.

# SUBGRADE SETTLEMENT CALCULATIONS
# MAJOR MODIFICATION SUPPORT

ARROWHEAD LANDFILL
PERRY COUNTY, ALABAMA
BLE Project No. J24-4999-66

**Settlement Point:** S-4B **Pre-Construction Grade (ft)** 242.97 **Groundwater Elev (ft)** 126.58 **Design Subgrade (ft)** 224.21

| Subsurface Layer | Upper Elevation (feet) | Lower Elevation (feet) | Layer Thickness (feet) | SPT Blow Count (bpf) | Total Soil Unit Weight (pcf) | Effective Soil Unit Weight (pcf) | Net Surcharge Pressure (psf) | Overburden Pressure at Mid-Point of Layer [$\sigma'v_0$] (psf) | Final Vertical Pressure at Mid-Point of Layer [$\sigma'v_f$] (psf) | Consolidation Parameters | | | | Constrained Elastic Modulus, M | | | | Immediate Settlement (inches) | Recomp. Primary Consol. (inches) | Virgin Primary Consol. (inches) | Layer Settlement (inches) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | Pc (ksf) | e | $C_r$ | $C_c$ | Elastic Modulus [1] (ksf) | Poissons Ratio, μ | M (ksf) | Strain (%) | | | | |
| Sandy CLAY [CUT] | 243.0 | 224.2 | 19 | - | 120 | 120 | 19,484 | 0 | 19,484 | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | 0.0 |
| Sandy CLAY | 224.2 | 164.2 | 60 | - | 120 | 120 | 19,484 | 3,600 | 23,084 | 5.0 | 0.7 | 0.03 | 0.13 | --- | --- | --- | --- | --- | 1.6 | 35.7 | 37.3 |
| Total Compressible Subsurface | | | 60 | feet | | | | | | | | | | | | | | | | | |

**TOTAL SETTLEMENT (INCHES)** **37.3**
**TOTAL SETTLEMENT (FEET)** **3.1**

Notes: 1) Settlement conservatively assumed to occur in the upper 60 feet of the eutaw formation below the landfill subgrade.

Prepared by: Tanner Whitesell, E.I.T.
Checked by: David Yarbray, E.I.T.
Reviewed by: Larry Simonson, P.E.

# SUBGRADE SETTLEMENT CALCULATIONS
# MAJOR MODIFICATION SUPPORT

ARROWHEAD LANDFILL
PERRY COUNTY, ALABAMA
BLE Project No. J24-4999-66

**Settlement Point:** S-4C **Pre-Construction Grade (ft)** 229.38 **Groundwater Elev (ft)** 126.68 **Design Subgrade (ft)** 212.44

| Subsurface Layer | Upper Elevation (feet) | Lower Elevation (feet) | Layer Thickness (feet) | SPT Blow Count (bpf) | Total Soil Unit Weight (pcf) | Effective Soil Unit Weight (pcf) | Net Surcharge Pressure (psf) | Overburden Pressure at Mid-Point of Layer [$\sigma'v_0$] (psf) | Final Vertical Pressure at Mid-Point of Layer [$\sigma'v_f$] (psf) | Consolidation Parameters: Pc (ksf) | e | $C_r$ | $C_c$ | Constrained Elastic Modulus, M: Elastic Modulus [1] (ksf) | Poissons Ratio, μ | M (ksf) | Strain (%) | Immediate Settlement (inches) | Recomp. Primary Consol. (inches) | Virgin Primary Consol. (inches) | Layer Settlement (inches) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sandy CLAY [CUT] | 229.4 | 212.4 | 17 | - | 120 | 120 | 19,515 | 0 | 19,515 | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | 0.0 |
| Sandy CLAY | 212.4 | 152.4 | 60 | - | 120 | 120 | 19,515 | 3,600 | 23,115 | 5.0 | 0.7 | 0.03 | 0.13 | --- | --- | --- | --- | --- | 1.6 | 35.8 | 37.4 |
| Total Compressible Subsurface | | | 60 | feet | | | | | | | | | | | | | | | | | |

**TOTAL SETTLEMENT (INCHES)** **37.4**
**TOTAL SETTLEMENT (FEET)** **3.1**

Notes: 1) Settlement conservatively assumed to occur in the upper 60 feet of the eutaw formation below the landfill subgrade.

Prepared by: Tanner Whitesell, E.I.T.
Checked by: David Yarbray, E.I.T.
Reviewed by: Larry Simonson, P.E.

# SUBGRADE SETTLEMENT CALCULATIONS
# MAJOR MODIFICATION SUPPORT

ARROWHEAD LANDFILL
PERRY COUNTY, ALABAMA
BLE Project No. J24-4999-66

**Settlement Point:** S-4D **Pre-Construction Grade (ft)** 231.95 **Groundwater Elev (ft)** 126.78 **Design Subgrade (ft)** 200

| Subsurface Layer | Upper Elevation (feet) | Lower Elevation (feet) | Layer Thickness (feet) | SPT Blow Count (bpf) | Total Soil Unit Weight (pcf) | Effective Soil Unit Weight (pcf) | Net Surcharge Pressure (psf) | Overburden Pressure at Mid-Point of Layer [$\sigma'v_0$] (psf) | Final Vertical Pressure at Mid-Point of Layer [$\sigma'v_f$] (psf) | Consolidation Parameters: Pc (ksf) | e | $C_r$ | $C_c$ | Constrained Elastic Modulus, M: Elastic Modulus [1] (ksf) | Poissons Ratio, μ | M (ksf) | Strain (%) | Immediate Settlement (inches) | Recomp. Primary Consol. (inches) | Virgin Primary Consol. (inches) | Layer Settlement (inches) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sandy CLAY [CUT] | 232.0 | 200.0 | 32 | - | 120 | 120 | 5,472 | 0 | 5,472 | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | 0.0 |
| Sandy CLAY | 200.0 | 140.0 | 60 | - | 120 | 120 | 5,472 | 3,600 | 9,072 | 5.0 | 0.7 | 0.03 | 0.13 | --- | --- | --- | --- | --- | 1.6 | 13.8 | 15.4 |
| Total Compressible Subsurface | | | 60 | feet | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | **TOTAL SETTLEMENT (INCHES)** | | | | | | | **15.4** |
| | | | | | | | | | | | | | | **TOTAL SETTLEMENT (FEET)** | | | | | | | **1.3** |

Notes: 1) Settlement conservatively assumed to occur in the upper 60 feet of the eutaw formation below the landfill subgrade.

Prepared by: Tanner Whitesell, E.I.T.
Checked by: David Yarbray, E.I.T.
Reviewed by: Larry Simonson, P.E.

# SUBGRADE SETTLEMENT CALCULATIONS
# MAJOR MODIFICATION SUPPORT

ARROWHEAD LANDFILL
PERRY COUNTY, ALABAMA
BLE Project No. J24-4999-66

| **Settlement Point:** | **S-5A** | **Pre-Construction Grade (ft)** | **252.62** | **Groundwater Elev (ft)** | **127.35** | **Design Subgrade (ft)** | **240** |
|---|---|---|---|---|---|---|---|

| Subsurface Layer | Upper Elevation (feet) | Lower Elevation (feet) | Layer Thickness (feet) | SPT Blow Count (bpf) | Total Soil Unit Weight (pcf) | Effective Soil Unit Weight (pcf) | Net Surcharge Pressure (psf) | Overburden Pressure at Mid-Point of Layer [$\sigma'v_0$] (psf) | Final Vertical Pressure at Mid-Point of Layer [$\sigma'v_f$] (psf) | Consolidation Parameters | | | | Constrained Elastic Modulus, M | | | | Immediate Settlement (inches) | Recomp. Primary Consol. (inches) | Virgin Primary Consol. (inches) | Layer Settlement (inches) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | Pc (ksf) | e | $C_r$ | $C_c$ | Elastic Modulus [1] (ksf) | Poissons Ratio, μ | M (ksf) | Strain (%) | | | | |
| Sandy CLAY [CUT] | 252.6 | 240.0 | 13 | - | 120 | 120 | 1,411 | 0 | 1,411 | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | 0.0 |
| Sandy CLAY | 240.0 | 180.0 | 60 | - | 120 | 120 | 1,411 | 3,600 | 5,011 | 5.0 | 0.7 | 0.03 | 0.13 | --- | --- | --- | --- | --- | 1.6 | --- | 1.6 |
| Total Compressible Subsurface | | | 60 | feet | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | |

| | |
|---|---|
| **TOTAL SETTLEMENT (INCHES)** | **1.6** |
| **TOTAL SETTLEMENT (FEET)** | **0.1** |

Notes: 1) Settlement conservatively assumed to occur in the upper 60 feet of the eutaw formation below the landfill subgrade.

Prepared by: Tanner Whitesell, E.I.T.
Checked by: David Yarbray, E.I.T.
Reviewed by: Larry Simonson, P.E.

# SUBGRADE SETTLEMENT CALCULATIONS
# MAJOR MODIFICATION SUPPORT

ARROWHEAD LANDFILL
PERRY COUNTY, ALABAMA
BLE Project No. J24-4999-66

**Settlement Point:** S-5B **Pre-Construction Grade (ft)** 256.02 **Groundwater Elev (ft)** 127.53 **Design Subgrade (ft)** 234

| Subsurface Layer | Upper Elevation (feet) | Lower Elevation (feet) | Layer Thickness (feet) | SPT Blow Count (bpf) | Total Soil Unit Weight (pcf) | Effective Soil Unit Weight (pcf) | Net Surcharge Pressure (psf) | Overburden Pressure at Mid-Point of Layer [$\sigma'v_0$] (psf) | Final Vertical Pressure at Mid-Point of Layer [$\sigma'v_f$] (psf) | Consolidation Parameters Pc (ksf) | e | $C_r$ | $C_c$ | Constrained Elastic Modulus, M: Elastic Modulus [1] (ksf) | Poissons Ratio, μ | M (ksf) | Strain (%) | Immediate Settlement (inches) | Recomp. Primary Consol. (inches) | Virgin Primary Consol. (inches) | Layer Settlement (inches) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sandy CLAY [CUT] | 256.0 | 234.0 | 22 | - | 120 | 120 | 16,092 | 0 | 16,092 | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | 0.0 |
| Sandy CLAY | 234.0 | 174.0 | 60 | - | 120 | 120 | 16,092 | 3,600 | 19,692 | 5.0 | 0.7 | 0.03 | 0.13 | --- | --- | --- | --- | --- | 1.6 | 32.0 | 33.6 |
| Total Compressible Subsurface | | | 60 | feet | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | **TOTAL SETTLEMENT (INCHES)** | | | | | | | **33.6** |
| | | | | | | | | | | | | | | **TOTAL SETTLEMENT (FEET)** | | | | | | | **2.8** |

Notes: 1) Settlement conservatively assumed to occur in the upper 60 feet of the eutaw formation below the landfill subgrade.

Prepared by: Tanner Whitesell, E.I.T.
Checked by: David Yarbray, E.I.T.
Reviewed by: Larry Simonson, P.E.

# SUBGRADE SETTLEMENT CALCULATIONS
# MAJOR MODIFICATION SUPPORT

ARROWHEAD LANDFILL
PERRY COUNTY, ALABAMA
BLE Project No. J24-4999-66

**Settlement Point:** S-5C **Pre-Construction Grade (ft)** 255.88 **Groundwater Elev (ft)** 127.69 **Design Subgrade (ft)** 222.66

| Subsurface Layer | Upper Elevation (feet) | Lower Elevation (feet) | Layer Thickness (feet) | SPT Blow Count (bpf) | Total Soil Unit Weight (pcf) | Effective Soil Unit Weight (pcf) | Net Surcharge Pressure (psf) | Overburden Pressure at Mid-Point of Layer [$\sigma'v_0$] (psf) | Final Vertical Pressure at Mid-Point of Layer [$\sigma'v_f$] (psf) | Consolidation Parameters | | | | Constrained Elastic Modulus, M | | | | Immediate Settlement (inches) | Recomp. Primary Consol. (inches) | Virgin Primary Consol. (inches) | Layer Settlement (inches) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | Pc (ksf) | e | $C_r$ | $C_c$ | Elastic Modulus [1] (ksf) | Poissons Ratio, μ | M (ksf) | Strain (%) | | | | |
| Sandy CLAY [CUT] | 255.9 | 222.7 | 33 | - | 120 | 120 | 24,270 | 0 | 24,270 | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | 0.0 |
| Sandy CLAY | 222.7 | 162.7 | 60 | - | 120 | 120 | 24,270 | 3,600 | 27,870 | 5.0 | 0.7 | 0.03 | 0.13 | --- | --- | --- | --- | --- | 1.6 | 40.1 | 41.7 |
| Total Compressible Subsurface | | | 60 | feet | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | **TOTAL SETTLEMENT (INCHES)** | | | | | | | **41.7** |
| | | | | | | | | | | | | | | **TOTAL SETTLEMENT (FEET)** | | | | | | | **3.5** |

Notes: 1) Settlement conservatively assumed to occur in the upper 60 feet of the eutaw formation below the landfill subgrade.

Prepared by: Tanner Whitesell, E.I.T.
Checked by: David Yarbray, E.I.T.
Reviewed by: Larry Simonson, P.E.

# SUBGRADE SETTLEMENT CALCULATIONS
# MAJOR MODIFICATION SUPPORT

ARROWHEAD LANDFILL
PERRY COUNTY, ALABAMA
BLE Project No. J24-4999-66

| **Settlement Point:** | **S-5D** | **Pre-Construction Grade (ft)** | **245.55** | **Groundwater Elev (ft)** | **127.79** | **Design Subgrade (ft)** | **209.66** |
|---|---|---|---|---|---|---|---|

| Subsurface Layer | Upper Elevation (feet) | Lower Elevation (feet) | Layer Thickness (feet) | SPT Blow Count (bpf) | Total Soil Unit Weight (pcf) | Effective Soil Unit Weight (pcf) | Net Surcharge Pressure (psf) | Overburden Pressure at Mid-Point of Layer [$\sigma'v_0$] (psf) | Final Vertical Pressure at Mid-Point of Layer [$\sigma'v_f$] (psf) | Consolidation Parameters | | | | Constrained Elastic Modulus, M | | | | Immediate Settlement (inches) | Recomp. Primary Consol. (inches) | Virgin Primary Consol. (inches) | Layer Settlement (inches) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | Pc (ksf) | e | $C_r$ | $C_c$ | Elastic Modulus [1] (ksf) | Poissons Ratio, μ | M (ksf) | Strain (%) | | | | |
| Sandy CLAY [CUT] | 245.6 | 209.7 | 36 | - | 120 | 120 | 17,921 | 0 | 17,921 | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | 0.0 |
| Sandy CLAY | 209.7 | 149.7 | 60 | - | 120 | 120 | 17,921 | 3,600 | 21,521 | 5.0 | 0.7 | 0.03 | 0.13 | --- | --- | --- | --- | --- | 1.6 | 34.1 | 35.7 |
| Total Compressible Subsurface | | | 60 | feet | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | **TOTAL SETTLEMENT (INCHES)** | | | | | | | **35.7** |
| | | | | | | | | | | | | | | **TOTAL SETTLEMENT (FEET)** | | | | | | | **3.0** |

Notes: 1) Settlement conservatively assumed to occur in the upper 60 feet of the eutaw formation below the landfill subgrade.

Prepared by: Tanner Whitesell, E.I.T.
Checked by: David Yarbray, E.I.T.
Reviewed by: Larry Simonson, P.E.

# SUBGRADE SETTLEMENT CALCULATIONS
# MAJOR MODIFICATION SUPPORT

ARROWHEAD LANDFILL
PERRY COUNTY, ALABAMA
BLE Project No. J24-4999-66

| **Settlement Point:** | **S-5E** | **Pre-Construction Grade (ft)** | **207.9** | **Groundwater Elev (ft)** | **127.9** | **Design Subgrade (ft)** | **196.18** |
|---|---|---|---|---|---|---|---|

| Subsurface Layer | Upper Elevation (feet) | Lower Elevation (feet) | Layer Thickness (feet) | SPT Blow Count (bpf) | Total Soil Unit Weight (pcf) | Effective Soil Unit Weight (pcf) | Net Surcharge Pressure (psf) | Overburden Pressure at Mid-Point of Layer [$\sigma'v_0$] (psf) | Final Vertical Pressure at Mid-Point of Layer [$\sigma'v_f$] (psf) | Consolidation Parameters | | | | Constrained Elastic Modulus, M | | | | Immediate Settlement (inches) | Recomp. Primary Consol. (inches) | Virgin Primary Consol. (inches) | Layer Settlement (inches) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | Pc (ksf) | e | $C_r$ | $C_c$ | Elastic Modulus [1] (ksf) | Poissons Ratio, μ | M (ksf) | Strain (%) | | | | |
| Sandy CLAY [CUT] | 207.9 | 196.2 | 12 | - | 120 | 120 | 5,510 | 0 | 5,510 | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | 0.0 |
| Sandy CLAY | 196.2 | 136.2 | 60 | - | 120 | 120 | 5,510 | 3,600 | 9,110 | 5.0 | 0.7 | 0.03 | 0.13 | --- | --- | --- | --- | --- | 1.6 | 13.9 | 15.5 |
| Total Compressible Subsurface | | | 60 | feet | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | **TOTAL SETTLEMENT (INCHES)** | | | | | | | **15.5** |
| | | | | | | | | | | | | | | **TOTAL SETTLEMENT (FEET)** | | | | | | | **1.3** |

Notes: 1) Settlement conservatively assumed to occur in the upper 60 feet of the eutaw formation below the landfill subgrade.

Prepared by: Tanner Whitesell, E.I.T.
Checked by: David Yarbray, E.I.T.
Reviewed by: Larry Simonson, P.E.

# SUBGRADE SETTLEMENT CALCULATIONS
# MAJOR MODIFICATION SUPPORT

ARROWHEAD LANDFILL
PERRY COUNTY, ALABAMA
BLE Project No. J24-4999-66

| **Settlement Point:** | **S-6A** | **Pre-Construction Grade (ft)** | **244.06** | **Groundwater Elev (ft)** | **127.73** | **Design Subgrade (ft)** | **232.29** |
|---|---|---|---|---|---|---|---|

| Subsurface Layer | Upper Elevation (feet) | Lower Elevation (feet) | Layer Thickness (feet) | SPT Blow Count (bpf) | Total Soil Unit Weight (pcf) | Effective Soil Unit Weight (pcf) | Net Surcharge Pressure (psf) | Overburden Pressure at Mid-Point of Layer [$\sigma'v_0$] (psf) | Final Vertical Pressure at Mid-Point of Layer [$\sigma'v_f$] (psf) | Consolidation Parameters | | | | Constrained Elastic Modulus, M | | | | Immediate Settlement (inches) | Recomp. Primary Consol. (inches) | Virgin Primary Consol. (inches) | Layer Settlement (inches) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | Pc (ksf) | e | $C_r$ | $C_c$ | Elastic Modulus [1] (ksf) | Poissons Ratio, μ | M (ksf) | Strain (%) | | | | |
| Sandy CLAY [CUT] | 244.1 | 232.3 | 12 | - | 120 | 120 | 25,319 | 0 | 25,319 | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | 0.0 |
| Sandy CLAY | 232.3 | 172.3 | 60 | - | 120 | 120 | 25,319 | 3,600 | 28,919 | 5.0 | 0.7 | 0.03 | 0.13 | --- | --- | --- | --- | --- | 1.6 | 41.0 | 42.6 |
| Total Compressible Subsurface | | | 60 | feet | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | **TOTAL SETTLEMENT (INCHES)** | | | | | | | **42.6** |
| | | | | | | | | | | | | | | **TOTAL SETTLEMENT (FEET)** | | | | | | | **3.6** |

Notes: 1) Settlement conservatively assumed to occur in the upper 60 feet of the eutaw formation below the landfill subgrade.

Prepared by: Tanner Whitesell, E.I.T.
Checked by: David Yarbray, E.I.T.
Reviewed by: Larry Simonson, P.E.

# SUBGRADE SETTLEMENT CALCULATIONS
# MAJOR MODIFICATION SUPPORT

ARROWHEAD LANDFILL
PERRY COUNTY, ALABAMA
BLE Project No. J24-4999-66

**Settlement Point:** S-6B **Pre-Construction Grade (ft)** 237.23 **Groundwater Elev (ft)** 127.62 **Design Subgrade (ft)** 227.43

| Subsurface Layer | Upper Elevation (feet) | Lower Elevation (feet) | Layer Thickness (feet) | SPT Blow Count (bpf) | Total Soil Unit Weight (pcf) | Effective Soil Unit Weight (pcf) | Net Surcharge Pressure (psf) | Overburden Pressure at Mid-Point of Layer [$\sigma'v_0$] (psf) | Final Vertical Pressure at Mid-Point of Layer [$\sigma'v_f$] (psf) | Consolidation Parameters | | | | Constrained Elastic Modulus, M | | | | Immediate Settlement (inches) | Recomp. Primary Consol. (inches) | Virgin Primary Consol. (inches) | Layer Settlement (inches) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | Pc (ksf) | e | $C_r$ | $C_c$ | Elastic Modulus [1] (ksf) | Poissons Ratio, μ | M (ksf) | Strain (%) | | | | |
| Sandy CLAY [CUT] | 237.2 | 227.4 | 10 | - | 120 | 120 | 26,503 | 0 | 26,503 | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | 0.0 |
| Sandy CLAY | 227.4 | 167.4 | 60 | - | 120 | 120 | 26,503 | 3,600 | 30,103 | 5.0 | 0.7 | 0.03 | 0.13 | --- | --- | --- | --- | --- | 1.6 | 42.0 | 43.6 |
| Total Compressible Subsurface | | | 60 | feet | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | **TOTAL SETTLEMENT (INCHES)** | | | **43.6** |
| | | | | | | | | | | | | | | | | | | **TOTAL SETTLEMENT (FEET)** | | | **3.6** |

Notes: 1) Settlement conservatively assumed to occur in the upper 60 feet of the eutaw formation below the landfill subgrade.

Prepared by: Tanner Whitesell, E.I.T.
Checked by: David Yarbray, E.I.T.
Reviewed by: Larry Simonson, P.E.

# SUBGRADE SETTLEMENT CALCULATIONS
# MAJOR MODIFICATION SUPPORT

ARROWHEAD LANDFILL
PERRY COUNTY, ALABAMA
BLE Project No. J24-4999-66

| **Settlement Point:** | **S-6C** | **Pre-Construction Grade (ft)** | **248.95** | **Groundwater Elev (ft)** | **127.48** | **Design Subgrade (ft)** | **221.92** |
|---|---|---|---|---|---|---|---|

| Subsurface Layer | Upper Elevation (feet) | Lower Elevation (feet) | Layer Thickness (feet) | SPT Blow Count (bpf) | Total Soil Unit Weight (pcf) | Effective Soil Unit Weight (pcf) | Net Surcharge Pressure (psf) | Overburden Pressure at Mid-Point of Layer [$\sigma'v_0$] (psf) | Final Vertical Pressure at Mid-Point of Layer [$\sigma'v_f$] (psf) | Consolidation Parameters | | | | Constrained Elastic Modulus, M | | | | Immediate Settlement (inches) | Recomp. Primary Consol. (inches) | Virgin Primary Consol. (inches) | Layer Settlement (inches) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | Pc (ksf) | e | $C_r$ | $C_c$ | Elastic Modulus [1] (ksf) | Poissons Ratio, μ | M (ksf) | Strain (%) | | | | |
| Sandy CLAY [CUT] | 249.0 | 221.9 | 27 | - | 120 | 120 | 13,708 | 0 | 13,708 | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | 0.0 |
| Sandy CLAY | 221.9 | 161.9 | 60 | - | 120 | 120 | 13,708 | 3,600 | 17,308 | 5.0 | 0.7 | 0.03 | 0.13 | --- | --- | --- | --- | --- | 1.6 | 29.0 | 30.6 |
| Total Compressible Subsurface | | | 60 | feet | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | **TOTAL SETTLEMENT (INCHES)** | | | | | | | **30.6** |
| | | | | | | | | | | | | | | **TOTAL SETTLEMENT (FEET)** | | | | | | | **2.5** |

Notes: 1) Settlement conservatively assumed to occur in the upper 60 feet of the eutaw formation below the landfill subgrade.

Prepared by: Tanner Whitesell, E.I.T.
Checked by: David Yarbray, E.I.T.
Reviewed by: Larry Simonson, P.E.

# SUBGRADE SETTLEMENT CALCULATIONS
# MAJOR MODIFICATION SUPPORT

ARROWHEAD LANDFILL
PERRY COUNTY, ALABAMA
BLE Project No. J24-4999-66

| **Settlement Point:** | **S-6D** | **Pre-Construction Grade (ft)** | **252.37** | **Groundwater Elev (ft)** | **127.36** | **Design Subgrade (ft)** | **216.87** |
|---|---|---|---|---|---|---|---|

| Subsurface Layer | Upper Elevation (feet) | Lower Elevation (feet) | Layer Thickness (feet) | SPT Blow Count (bpf) | Total Soil Unit Weight (pcf) | Effective Soil Unit Weight (pcf) | Net Surcharge Pressure (psf) | Overburden Pressure at Mid-Point of Layer [$\sigma'v_0$] (psf) | Final Vertical Pressure at Mid-Point of Layer [$\sigma'v_f$] (psf) | Consolidation Parameters | | | | Constrained Elastic Modulus, M | | | | Immediate Settlement (inches) | Recomp. Primary Consol. (inches) | Virgin Primary Consol. (inches) | Layer Settlement (inches) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | Pc (ksf) | e | $C_r$ | $C_c$ | Elastic Modulus [1] (ksf) | Poissons Ratio, μ | M (ksf) | Strain (%) | | | | |
| Sandy CLAY [CUT] | 252.4 | 216.9 | 36 | - | 120 | 120 | 2,812 | 0 | 2,812 | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | 0.0 |
| Sandy CLAY | 216.9 | 156.9 | 60 | - | 120 | 120 | 2,812 | 3,600 | 6,412 | 5.0 | 0.7 | 0.03 | 0.13 | --- | --- | --- | --- | --- | 1.6 | 5.7 | 7.3 |
| Total Compressible Subsurface | | | 60 | feet | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | **TOTAL SETTLEMENT (INCHES)** | | | | | | | **7.3** |
| | | | | | | | | | | | | | | **TOTAL SETTLEMENT (FEET)** | | | | | | | **0.6** |

Notes: 1) Settlement conservatively assumed to occur in the upper 60 feet of the eutaw formation below the landfill subgrade.

Prepared by: Tanner Whitesell, E.I.T.
Checked by: David Yarbray, E.I.T.
Reviewed by: Larry Simonson, P.E.

# Referenced Historical Boring Logs – BLE, 2007

BLB INC.

**BUNNELL-LAMMONS ENGINEERING, INC.**

GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

# SOIL TEST BORING NO. B-1

PROJECT: Perry County Landfill — PROJECT NO.: J06-4999-01

CLIENT: G N Richardson — START: 12-5-06 END: 12-5-06

LOCATION: Uniontown, Alabama — ELEVATION: 272

DRILLER: TTL, J. Phillips — LOGGED BY: J. Helvey

DRILLING METHOD: CME 550X standard penetration

DEPTH TO - WATER> INITIAL: ▽ AFTER 24 HOURS: ▼ CAVING>

| ELEVATION/ DEPTH (FT) | SOIL DESCRIPTION | SOIL TYPE | SAMPLES | STANDARD PENETRATION RESULTS BLOWS/FOOT (2 5 10 20 30 40 50 70 90) |
|---|---|---|---|---|
| 270 / 2 | 2-inches of TOPSOIL<br>Firm, red and yellow, calcareous, silty CLAY | | 3<br>3<br>4 | |
| 4 | Stiff, yellow and gray, calcareous, silty CLAY - (selma chalk) | | 4<br>4<br>8 | |
| 265 / 6 | Very hard, greenish-gray, calcareous, silty CLAY - (selma chalk) | | | |
| 8 | UD sample collected with 13 inches of recovery | | | |
| 260 / 10 | | | | |
| 12 | | | | |
| 14 | | | 16<br>32<br>48 | |
| 255 / 16 | Hard to very hard, light gray, calcareous, silty CLAY - (selma chalk) | | | |
| 18 | | | | |
| 20 | | | 17<br>36<br>50/5" | 50/5" |
| 250 / 22 | | | | |
| 24 | | | 14<br>40<br>50/5" | 50/5" |
| 245 / 26 | | | | |
| 28 | UD sample collected with 6 inches of recovery | | | |
| 30 | | | | |
| 240 / 32 | | | | |
| 34 | Very hard, gray, calcareous, silty CLAY - (selma chalk) | | 22<br>50/1" | 50/1" |
| 235 / 36 | | | | |
| 38 | | | 25<br>50/5" | 50/5" |

BLB INC.

**BUNNELL-LAMMONS ENGINEERING, INC.**

GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

# SOIL TEST BORING NO. B-1

PROJECT: Perry County Landfill — PROJECT NO.: J06-4999-01

CLIENT: G N Richardson — START: 12-5-06 END: 12-5-06

LOCATION: Uniontown, Alabama — ELEVATION: 272

DRILLER: TTL, J. Phillips — LOGGED BY: J. Helvey

DRILLING METHOD: CME 550X standard penetration

DEPTH TO - WATER> INITIAL: ▽ _____ AFTER 24 HOURS: ▼ _____ CAVING> _____

| ELEVATION/ DEPTH (FT) | SOIL DESCRIPTION | SOIL TYPE | SAMPLES | STANDARD PENETRATION RESULTS BLOWS/FOOT (2 5 10 20 30 40 50 70 90) |
|---|---|---|---|---|
| 230 — 42 | Very hard, gray, calcareous, silty CLAY - (selma chalk) | | | |
| 44 | | | 21 32 50/5" | 50/5" |
| 46 | | | | |
| 225 — 48 | | | | |
| | UD sample collected with 14 inches of recovery | | | |
| 50 | | | | |
| 220 — 52 | | | | |
| 54 | | | 40 50/5" | 50/5" |
| 56 | | | | |
| 215 — 58 | | | | |
| 60 | | | 25 50/5" | 50/5" |
| | Boring terminated at 60.5 feet. No ground water encountered at time of drilling. | | | |
| 210 — 62 | | | | |
| 64 | | | | |
| 66 | | | | |
| 205 — 68 | | | | |
| 70 | | | | |
| 200 — 72 | | | | |
| 74 | | | | |
| 76 | | | | |
| 195 — 78 | | | | |

BLB INC.

**BUNNELL-LAMMONS ENGINEERING, INC.**

GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

# SOIL TEST BORING NO. B-2

PROJECT: Perry County Landfill — PROJECT NO.: J06-4999-01

CLIENT: G N Richardson — START: 12-5-06 END: 12-5-06

LOCATION: Uniontown, Alabama — ELEVATION: 267

DRILLER: TTL, J. Phillips — LOGGED BY: J. Helvey

DRILLING METHOD: CME 550X standard penetration

DEPTH TO - WATER> INITIAL ▽ AFTER 24 HOURS: ▼ CAVING>

| ELEVATION/ DEPTH (FT) | SOIL DESCRIPTION | SOIL TYPE | SAMPLES | STANDARD PENETRATION RESULTS BLOWS/FOOT (2 5 10 20 30 40 50 70 90) |
|---|---|---|---|---|
| 265 / 2 | 2-inches of TOPSOIL<br>Firm to very stiff, brown and gray, calcareous, silty CLAY | | 2<br>3<br>3 | |
| 4 | | | 5<br>8<br>9 | |
| 260 / 6 | | | | |
| 8 | UD sample collected with 5 inches of recovery<br>Very hard, light gray, calcareous, silty CLAY - (selma chalk) | | | |
| 255 / 10 | | | | |
| 12 | | | | |
| 14 | | | 14<br>34<br>50/5" | 50/5" |
| 250 / 16 | | | | |
| 18 | | | | |
| 20 | | | 14<br>32<br>49 | |
| 245 / 22 | | | | |
| 24 | | | 10<br>22<br>50/5" | 50/5" |
| 26 | | | | |
| 240 / 28 | UD sample collected with 6 inches of recovery | | | |
| 30 | | | | |
| 235 / 32 | | | | |
| 34 | Very hard, gray, calcareous, silty CLAY - (selma chalk) | | 14<br>22<br>50/3" | 50/3" |
| 36 | | | | |
| 230 / 38 | | | 22<br>34 | |

GEOT_NOWELL 4999-01.GPJ 12/13/06

# SOIL TEST BORING NO. B-2

**BUNNELL-LAMMONS ENGINEERING, INC.**
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

PROJECT: Perry County Landfill — PROJECT NO.: J06-4999-01
CLIENT: G N Richardson — START: 12-5-06 END: 12-5-06
LOCATION: Uniontown, Alabama — ELEVATION: 267
DRILLER: TTL, J. Phillips — LOGGED BY: J. Helvey
DRILLING METHOD: CME 550X standard penetration
DEPTH TO - WATER> INITIAL: ____ AFTER 24 HOURS: ____ CAVING> ____

| ELEVATION/ DEPTH (FT) | SOIL DESCRIPTION | SOIL TYPE | SAMPLES | STANDARD PENETRATION RESULTS BLOWS/FOOT (2 5 10 20 30 40 50 70 50/0) |
|---|---|---|---|---|
| 225 — 42 | Very hard, gray, calcareous, silty CLAY - (selma chalk) | | 50/5" | 50/5" |
| 44 | | | 22 48 50/2" | 50/2" |
| 46 | | | | |
| 220 — 48 | | | | |
| 50 | UD sample collected with 12 inches of recovery | | | |
| 215 — 52 | | | | |
| 54 | | | 26 34 50/3" | 50/3" |
| 56 | | | | |
| 210 — 58 | | | | |
| 60 | | | 14 32 50/5" | 50/5" |
| 205 — 62 | Boring terminated at 60.5 feet. No ground water encountered at time of drilling. | | | |
| 64 | | | | |
| 66 | | | | |
| 200 — 68 | | | | |
| 70 | | | | |
| 195 — 72 | | | | |
| 74 | | | | |
| 76 | | | | |
| 190 — 78 | | | | |

GEOT_NOWELL 4999-01.GPJ 12/13/06

BLB INC.

**BUNNELL-LAMMONS ENGINEERING, INC.**
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

# SOIL TEST BORING NO. B-3

PROJECT: Perry County Landfill — PROJECT NO.: J06-4999-01
CLIENT: G N Richardson — START: 12-6-06 END: 12-6-06
LOCATION: Uniontown, Alabama — ELEVATION: 272
DRILLER: TTL, J. Phillips — LOGGED BY: J. Helvey
DRILLING METHOD: CME 550X standard penetration
DEPTH TO - WATER> INITIAL ▽ AFTER 24 HOURS: ▼ CAVING>

| ELEVATION/ DEPTH (FT) | SOIL DESCRIPTION | SOIL TYPE | SAMPLES | STANDARD PENETRATION RESULTS BLOWS/FOOT (2 5 10 20 30 40 50 70 90) |
|---|---|---|---|---|
| 270 / 0 | 2-inches of TOPSOIL | | | |
| | Firm to very stiff, brown and gray, calcareous, silty CLAY | | 3<br>3<br>4 | 7 |
| 270 / 2 | | | | |
| 4 | | | 4<br>4<br>8 | 12 |
| 265 / 6 | | | | |
| 8 | UD sample collected with 3 inches of recovery | | | |
| | Very hard, light gray, calcareous, silty CLAY - (selma chalk) | | | |
| 260 / 10 | | | | |
| 12 | | | 16<br>32<br>48 | 80 |
| 255 / 14 | | | | |
| 16 | | | | |
| 18 | | | 17<br>36<br>50/5" | 50/5" |
| 250 / 20 | | | | |
| 22 | | | | |
| 24 | Very hard, gray, calcareous, silty CLAY | | 14<br>40<br>50/5" | 50/5" |
| 245 / 26 | | | | |
| 28 | UD sample collected with 15 inches of recovery | | | |
| 30 | | | | |
| 240 / 32 | | | | |
| 34 | | | 22<br>50/1" | 50/1" |
| 235 / 36 | | | | |
| 38 | | | 25<br>50/5" | 50/5" |



GEOT_NOWELL 4999-01.GPJ 12/13/06

BLB INC.

**BUNNELL-LAMMONS ENGINEERING, INC.**

GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

# SOIL TEST BORING NO. B-3

PROJECT: Perry County Landfill — PROJECT NO.: J06-4999-01

CLIENT: G N Richardson — START: 12-6-06 END: 12-6-06

LOCATION: Uniontown, Alabama — ELEVATION: 272

DRILLER: TTL, J. Phillips — LOGGED BY: J. Helvey

DRILLING METHOD: CME 550X standard penetration

DEPTH TO - WATER> INITIAL ▽ _____ AFTER 24 HOURS: ▼ _____ CAVING> ▨ _____

| ELEVATION/ DEPTH (FT) | SOIL DESCRIPTION | SOIL TYPE | SAMPLES | STANDARD PENETRATION RESULTS BLOWS/FOOT (2 5 10 20 30 40 50 70 90) |
|---|---|---|---|---|
| 230 — 42 | Very hard, gray, calcareous, silty CLAY | | | |
| 44 | | | 21 32 50/5" | 50/5" |
| 46 | | | | |
| 225 — 48 | | | | |
| 50 | UD sample collected with 12 inches of recovery | | | |
| 220 — 52 | | | | |
| 54 | | | 40 50/5" | 50/5" |
| 56 | | | | |
| 215 — 58 | | | | |
| 60 | | | 25 50/5" | 50/5" |
| 210 — 62 | Boring terminated at 60.5 feet. No ground water encountered at time of drilling. | | | |
| 64 | | | | |
| 66 | | | | |
| 205 — 68 | | | | |
| 70 | | | | |
| 200 — 72 | | | | |
| 74 | | | | |
| 76 | | | | |
| 195 — 78 | | | | |

GEOT_NOWELL 4999-01.GPJ 12/13/06

BLB INC.

**BUNNELL-LAMMONS ENGINEERING, INC.**

GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

# SOIL TEST BORING NO. B-4

PROJECT: Perry County Landfill — PROJECT NO.: J06-4999-01

CLIENT: G N Richardson — START: 12-6-06 END: 12-6-06

LOCATION: Uniontown, Alabama — ELEVATION: 282

DRILLER: TTL, J. Phillips — LOGGED BY: J. Helvey

DRILLING METHOD: CME 550X standard penetration

DEPTH TO - WATER> INITIAL: ▽ AFTER 24 HOURS: ▼ CAVING>

| ELEVATION/ DEPTH (FT) | SOIL DESCRIPTION | SOIL TYPE | SAMPLES | STANDARD PENETRATION RESULTS BLOWS/FOOT (2 5 10 20 30 40 50 70 90) |
|---|---|---|---|---|
| 280 — 0 | 2-inches of TOPSOIL | | | |
| | Firm to very stiff, light brown and gray, calcareous, silty CLAY | | | 2, 2, 5 |
| 2 | | | | |
| 4 | | | | 6, 9, 14 |
| 275 — 6 | | | | |
| 8 | UD sample collected with 11 inches of recovery | | | |
| 10 | Hard to very hard, light gray, calcareous, silty CLAY - (selma chalk) | | | |
| 270 — 12 | | | | |
| 14 | | | | 11, 22, 26 |
| 16 | | | | |
| 265 — 18 | | | | |
| 20 | | | | 9, 14, 29 |
| 260 — 22 | | | | |
| 24 | | | | 21, 27, 38 |
| 26 | | | | |
| 255 — 28 | | | | |
| 30 | | | | 15, 15, 35 |
| 250 — 32 | Boring terminated at 30.5 feet. No ground water encountered at time of drilling. | | | |
| 34 | | | | |
| 36 | | | | |
| 245 — 38 | | | | |

GEOT_NOWELL 4999-01.GPJ 12/13/06

# APPENDIX D

# BOTTOM LINER SYSTEM ANALSYIS

# Pipe Stress Analysis Calculations

# SUMMARY OF PIPE STRESS ANALYSIS RESULTS
# MAJOR MODIFICTION SUPPORT
# ARROWHEAD LANDFILL
## BLE PROJECT NO. J24-4999-66

| Settlement Analysis Point (S-#) | Tract No., Cell No. | Leachate Collection Pipe Installed | | | | Thickness of Stone | Maximum Waste Thickness | Factor of Safety | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Diameter (inches) | Material | Formula (for HDPE) | SDR or Schedule | | | Wall Crushing | Wall Buckling | Ring Deflection | |
| | | | | | | | | FS Target ≥ 1.5 | FS Target ≥ 1.8 | Max Strain < 7.5% | FS Target > 3.0 |
| **S-2B** | **Tract 1, Cell 5 West** | 8 | HDPE | PE3408 | 9 | 2 | 198 | **3.21** | **6.15** | **5.36** | **4.20** |
| **-** | **Tract 1, Cell 6A** | 4 | HDPE | PE3408 | 9 | - | 234 | **2.76** | **5.19** | **6.23** | **3.61** |
| **S-1B** | **Tract 1, Cell 8** | 8 | HDPE | PE4710 | 9 | 2 | 238 | **3.07** | **5.18** | **6.40** | **3.51** |
| **S-3C** | **Tract 2** | 8 | HDPE | PE4710 | 9 | 2 | 269 | **2.73** | **4.60** | **7.21** | **3.12** |
| **Max Waste Check** | **Tract 3** | 8 | HDPE | PE4710 | 9 | 2 | 280 | **2.62** | **4.43** | **7.49** | **3.00** |
| **Max Waste Check** | **Tract 3** | 8 | HDPE | PE4710 | 7 | 2 | 330 | **2.86** | **5.10** | **7.47** | **3.01** |

Note (1): Unit weight of waste assumed to be 85 pcf
Note (2): Drainage stone assumed to be 2 feet above bottom liner, base on historical CQA documentation. The secondary 4-inch LCS pipe within Cell No. 6A was constructed without drainage stone.
Note (3): Maximum waste height approximated using HHNT provided intial and final grades, dated September 2024.
Note (4): Maximum waste height determined by subtracting the proposed final closure cap grades by the proposed stone and closure cap thickness and then subtracted by the proposed top of clay liner grades.
Note (5): From Final Cover Detail, final cover consists of (top to bottom): 6-inch top soil, 18-inches protective cover soil, 12-inches compacted soil liner, and 12-inches intermediate cover
Note (6): Pipe characteristics for the existing cells were obtained from historical CQA documentation.

Prepared by: Tanner Whitesell, EIT
Checked by: David Yarbray, EIT
Reviewed by: Larry Simonson, PE

# Tract 1

**Project Number:** J24-4999-66
**Project Name:** Arrowhead Landfill Major Modification Support
**Calc Task:** HDPE Pipe Stress Analysis
**Calc Num:** Tract 1, Existing Cell No. 5 West
**Date:** October 24, 2024

**Objective:** Analysis of the pipe stress due to load from solid waste, cap layers, and leachate stone. Determine the suitability of HDPE pipe against crushing, buckling, and ring deflection

**References:**
Performance Pipe, Iron Pipe Size (IPS) and Dimension Data, DriscoPlex Pipe for Municipal and Industrial Application, Chevron Phillips Chemical Company LP, 2015.

Assessment and Recommendations for Improving the Performance of Waste Containment Systems, US EPA, by Bonaparte, Daniel & Koerner, 2002, pages 2-13 to 2-25.

Design of Polyethylene Piping Systems, Chapters 3 & 6 Handbook of Polyethylene Pipe, Second Edition, 2012.

Finite Element Analysis of Plastic Pipe Behavior in Leachate Collection and Removal Systems, Wilson-Fahmy & Koerner, 1994.

Plastic Pipe Design Manual, Vylon Pipe

**Design Basis:** Pipe wall crushing occurs when external vertical pressure causes the compressive stress in the pipe wall to exceed the long-term compressive strength of the pipe material. Pipe wall buckling is a longitudinal wrinkling of the pipe wall. Buckling can occur in the non-pressurized pipe if the total external soil pressure exceeds the critical buckling pressure (Pcb) of the pipe-soil system

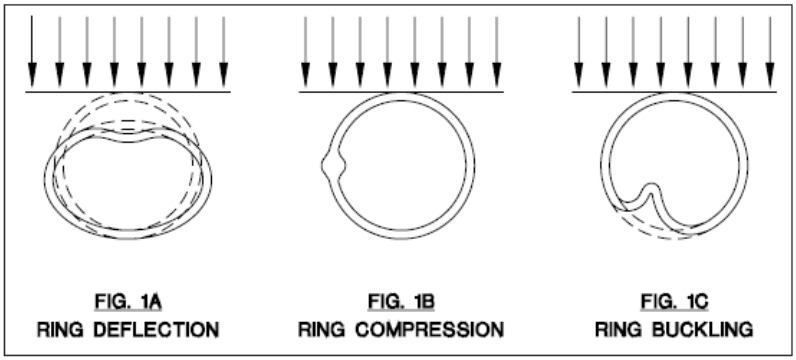


Figure: Example of typical failure modes for buried pipe

**Given:** Analyze pipe stress at settlement analysis location designated S-2B on BLE Figure No. 2C.

Minimum Factor of Safety = 1.5 for Crushing, 1.8 for Buckling, and 3.0 for Ring Deflection (maximum deflection of 7.5%)

Leachate Pipe is a 8-inch diameter HDPE $SDR - 9$ with Material Desgination PE3408.

The closure cap will consist of the following layers: Erosion Layer & Vegetative Cover, Infiltration Layer Thickness, and Intermediate Cover Thickness

Assumed Variables of Materials and Geometry of Cap

$\gamma_sw := 85 \frac{lb}{ft^3}$ (Assumed Unit Weight of Solid Waste)

$\gamma_cspc := 110 \frac{lb}{ft^3}$ (Assumed Unit Weight of Cap Soil and Protective Cover)

$\gamma_ds := 115 \frac{lb}{ft^3}$ (Assumed Unit Weight of Drainage Stone)

$T_elt := 2\ ft$ (Erosion Layer & Vegetative Cover)

$T_il := 1.5\ ft$ (Infiltration Layer Thickness)

$T_ic := 0.5\ ft$ (Intermediate Cover Thickness)

$H_lc := T_elt + T_il + T_ic$ (Landfill Cover Height)

$H_ds := 2\ ft$ (Thickness of Drainage Stone)

$Ec := 470\ ft$ (Cap Elevation)

$E_tcl := 266\ ft$ (Top of Clay Liner Elevation)

**PIPE AND STONE PROPERTIES**

$SDR := 9$ (Standard Dimension Ratio: Pipe Diameter / Wall Thickness)

$ID_P := 6.59\ in$ (Inner Diameter of the Pipe, Nominal)

$ODP := 8.625\ in$ (Outer Diameter of the Pipe)

$E_PM := 27000 \frac{lb}{in^2}$ (Pipe Material Apparent Elastic Modulus for PE3XXX - Reference Table B.1.1 in App B of Handbook of Polyethylene Pipe)

$E_red := 1$ (Pipe Modulus Reduction Factor - Reference Table B.1.2 in App B Handbook of Polyethylene Pipe)

$M_s := 3000 \frac{lb}{in^2}$ (Stone Modulus Around Pipe, PPI Table 3-7, Ch. 3)

$Y_s := 1000 \frac{lb}{in^2}$ (Allowable Compressive Stress for PE3XXX Material Designation (With FS 1.5) PPI Table C.1, Ch. 3)

$A_P := 0.958\ in$ (Minimum Wall Thickness)

$r_CENT := \frac{ODP}{2} - \frac{A_P}{2} = 3.8335\ in$ (Radius to Centroidal Axis of Pipe)

$P_d := \frac{3}{8}\ in$ (Perforation Dimimiameter)

$p_Circ := 2 \cdot 3.1415 \cdot r_CENT = 24.0859\ in$ (Pipe Circumimeference)

$perf_num := 4$ (Number of perforations)

**Calculation:**

## Total Pressure at the Top of the Leachate Pipe

$H_waste := Ec - E_tcl = 204\ ft$ (Difference between cap elevation and top of clay liner elevation at a given location)

$T_dc := H_lc + H_ds = 6\ ft$ (Thickness of Drainage Stone and Landfill Cover)

$P_de$ (Static Load Pressure of Waste and Cap Soils and Drainage Stone - Varies with waste height. The waste height is defined as the difference between the cap elevation and the top of the clay liner elevation. A vertical arching factor is applied to the prism load above the pipe)

$$P_de := (H_waste - T_dc)\cdot \gamma_sw + H_ds \cdot \gamma_ds + H_lc \cdot \gamma_cspc = 121.5278\ \frac{lb}{in^2}$$

$P_we := 0$ (Static Load Pressure of Wet, Saturated soil below water table - Assume top of the pipe is above the leachate)

$P_b := 0$ (Static Load Pressure due to Stationary Structures - Assume no structures)

$P_s$ (Total Static Pressure)

$$P_s := P_de + P_we + P_b = 121.5278\ \frac{lb}{in^2}$$

$P_l := 0\ \frac{lb}{in^2}$ (Total Live Pressure - No Equipment Load for final condition)

$P_i := 0\ \frac{lb}{in^2}$ (Total Internal Pressure - Gravity Flow Pipe, No Internal Pressure)

$$S_A := \frac{(1.43 \cdot M_s \cdot r_CENT)}{E_PM \cdot E_red \cdot A_P} = 0.6358$$ (Hoop Thrust Stiffness Ratio)

$$VAF := 0.88 - 0.71 \cdot \left(\frac{S_A - 1}{S_A + 2.5}\right) = 0.9625$$ (Vertical Arching Factor)

$$P_t := VAF \cdot (P_s + P_l + P_i) = 116.9656\ \frac{lb}{in^2}$$ **(Total Pressure Long Term Condition)**

## Factor of Safety against Wall Crushing

Wall Crushing occurs when the total pressure (P_t) exceeds actual compressive pressure (S_a).

$$S_a := \left( \frac{(SDR - 1)}{2} \right) \cdot P_t = 467.8626 \ \frac{lb}{in^2}$$

Factor of Safety (FS) against wall crushing equals the allowable compressive stress of HDPE pipe (Ys) divided by the actual compressive pressure (Sa).

$$FS_WC := \frac{Y_s \cdot 1.5}{S_a} = 3.2061$$

FS_WC is greater than or equal to 1.5

The FS_WC is greater than 1.5(minimum FS for wall crushing); therefore the pipe is acceptable aganist crushing failure mode

## Factor of Safety Against Wall Buckling

Contrained buckling in deep fill without groundwater present can be determine from the Moore-Selig equation for the critical bucking pressure

$\varphi := 0.55$ (Calibration Factor - for granular materials)

$R_H := 1.0$ (Geometry Factor for deep fill)

$$I := \frac{A_P^3}{12 \ in^3} \cdot \frac{(p_Circ - (perf_num \cdot P_d))}{(p_Circ)} = 0.0687$$ (Moment of Inertia of Perforated Pipe Wall)

$\mu := 0.4$ (Poisson's Ratio of drainage stone)

$$M_P := \frac{M_s}{(1 - \mu)} = 5000 \ \frac{lb}{in^2}$$ (Modified Modulus of Drainage Stone)

$D_m := ODP - A_P$ (Mean Diameter of Pipe (OD-wall thickness), inches)

$P_CR$ **(Critical Buckling Soil Pressure)**

$$P_CR := \left( \frac{2.4 \ in \cdot \varphi \cdot R_H}{ID_P} \right) \cdot (E_PM \cdot E_red \cdot I)^{\frac{1}{3}} \cdot M_P^{\frac{2}{3}} = 719.6473 \ \frac{lb}{in^2}$$

FS against wall buckling equals the Critical Buckling Soil Pressure (Pcr) divided by the total earth pressure (Pt) reduced by the vertical arching factor for the long term condtions

$$FS_WB := \frac{P_CR}{P_t} = 6.1526$$

**FS_WB is greater than the 1.8 for (minimum FS for Wall Buckling); therefore the pipe is acceptable against buckling failure.**

## Factor of Safety Against Ring Deflection

Ring deflection of flexible pipe under prism loading is derived by the modified Iowa Formula.

$k_BED := 0.1$ (Bedding Factor - for 90 central angle)

$L_DL := 1$ (Deflection Lag Factor, assumed)

$F_S := 1$ (Soil Support Value)

$\Delta_X$ (Horizontal Deflection, inches)

$P_t' := P_t \cdot 144$ (Total Pressure including VAF, psf)

$P_l' := P_l \cdot 144$ (Live Load, psf)

$D_m$ (Mean Diameter of Pipe (OD-wall thickness), inches)

$D_R := \frac{\Delta_X}{D_m}$ (Ring Deflection)

$$D_R := \frac{1}{144} \cdot \left( \frac{\left(k_BED \cdot L_DL \cdot P_t'\right) + \left(k_BED \cdot P_l'\right)}{\frac{\left(2 \cdot E_PM \cdot E_red\right)}{3} \cdot \left(\frac{1}{SDR - 1}\right)^3 + \left(0.061 \cdot F_S \cdot M_s\right)} \right) \cdot 100 = 5.3616$$

Determine the factor of safety against a ring deflection failure.

For non-pressurized pipe, a ring deflection of 7.5 % yields a factor of safety of 3 (Handbook of Polyethylene Pipe, Ch. 6)

$$FS_RD := \frac{7.5}{D_R} \cdot 3 = 4.1965$$

**FS_RD is greater than 3 (minimum FS for Ring Deflection); therefore the pipe is acceptable against excessive ring deflection.**

**Conclusions:** Based upon the calculations above, the HDPE pipe is suitable against crushing, buckling, and ring deflection.

**Project Number:** J24-4999-66
**Project Name:** Arrowhead Landfill Major Modification Support
**Calc Task:** HDPE Pipe Stress Analysis
**Calc Num:** Tract 1, Existing Cell No. 6A
**Date:** October 24, 2024

**Objective:** Analysis of the pipe stress due to load from solid waste, cap layers, and leachate stone. Determine the suitability of HDPE pipe against crushing, buckling, and ring deflection

**References:**
Performance Pipe, Iron Pipe Size (IPS) and Dimension Data, DriscoPlex Pipe for Municipal and Industrial Application, Chevron Phillips Chemical Company LP, 2015.

Assessment and Recommendations for Improving the Performance of Waste Containment Systems, US EPA, by Bonaparte, Daniel & Koerner, 2002, pages 2-13 to 2-25.

Design of Polyethylene Piping Systems, Chapters 3 & 6 Handbook of Polyethylene Pipe, Second Edition, 2012.

Finite Element Analysis of Plastic Pipe Behavior in Leachate Collection and Removal Systems, Wilson-Fahmy & Koerner, 1994.

Plastic Pipe Design Manual, Vylon Pipe

**Design Basis:** Pipe wall crushing occurs when external vertical pressure causes the compressive stress in the pipe wall to exceed the long-term compressive strength of the pipe material. Pipe wall buckling is a longitudinal wrinkling of the pipe wall. Buckling can occur in the non-pressurized pipe if the total external soil pressure exceeds the critical buckling pressure (Pcb) of the pipe-soil system

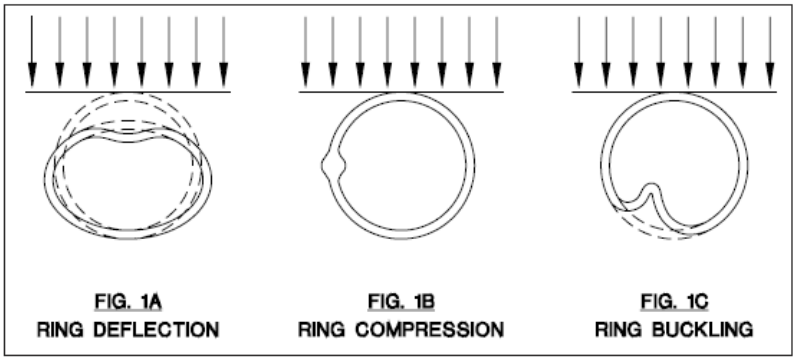


Figure: Example of typical failure modes for buried pipe

**Given:** Analyze pipe stress for secondary 4inch HDPE leachate collection pipe

Minimum Factor of Safety = 1.5 for Crushing, 1.8 for Buckling, and 3.0 for Ring Deflection (maximum deflection of 7.5%)

Leachate Pipe is a 4-inch diameter HDPE $SDR - 9$ with Material Desgination PE3408.

The closure cap will consist of the following layers: Erosion Layer & Vegetative Cover, Infiltration Layer Thickness, and Intermediate Cover Thickness

Assumed Variables of Materials and Geometry of Cap

$\gamma_sw := 85 \frac{lb}{ft^3}$ (Assumed Unit Weight of Solid Waste)

$\gamma_cspc := 110 \frac{lb}{ft^3}$ (Assumed Unit Weight of Cap Soil and Protective Cover)

$\gamma_ds := 115 \frac{lb}{ft^3}$ (Assumed Unit Weight of Drainage Stone)

$T_elt := 2\ ft$ (Erosion Layer & Vegetative Cover)

$T_il := 1.5\ ft$ (Infiltration Layer Thickness)

$T_ic := 0.5\ ft$ (Intermediate Cover Thickness)

$H_lc := T_elt + T_il + T_ic$ (Landfill Cover Height)

$H_ds := 0\ ft$ (Thickness of Drainage Stone)

$Ec := 484\ ft$ (Cap Elevation)

$E_tcl := 246\ ft$ (Top of Clay Liner Elevation)

**PIPE AND STONE PROPERTIES**

$SDR := 9$ (Standard Dimension Ratio: Pipe Diameter / Wall Thickness)

$ID_P := 3.44\ in$ (Inner Diameter of the Pipe, Nominal)

$ODP := 4.500\ in$ (Outer Diameter of the Pipe)

$E_PM := 27000 \frac{lb}{in^2}$ (Pipe Material Apparent Elastic Modulus for PE3XXX - Reference Table B.1.1 in App B of Handbook of Polyethylene Pipe)

$E_red := 1$ (Pipe Modulus Reduction Factor - Reference Table B.1.2 in App B Handbook of Polyethylene Pipe)

$M_s := 3000 \frac{lb}{in^2}$ (Stone Modulus Around Pipe, PPI Table 3-7, Ch. 3))

$Y_s := 1000 \frac{lb}{in^2}$ (Allowable Compressive Stress for PE3XXX Material Designation (With FS 1.5) PPI Table C.1, Ch. 3)

$A_P := 0.50\ in$ (Minimum Wall Thickness)

$P_d := \frac{3}{8}\ in$ (Perforation Diameter)

$r_CENT := \frac{ODP}{2} - \frac{A_P}{2} = 2\ in$ (Radius to Centroidal Axis of Pipe)

$p_Circ := 2 \cdot 3.1415 \cdot r_CENT = 12.566\ in$ (Pipe Circumference)

$perf_num := 4$ (Number of perforations)

**Calculation:**

## Total Pressure at the Top of the Leachate Pipe

$H_waste := Ec - E_tcl = 238\ ft$ (Difference between cap elevation and top of clay liner elevation at a given location)

$T_dc := H_lc + H_ds = 4\ ft$ (Thickness of Drainage Stone and Landfill Cover)

$P_de$ (Static Load Pressure of Waste and Cap Soils and Drainage Stone - Varies with waste height. The waste height is defined as the difference between the cap elevation and the top of the clay liner elevation. A vertical arching factor is applied to the prism load above the pipe)

$$P_de := (H_waste - T_dc)\cdot \gamma_sw + H_ds \cdot \gamma_ds + H_lc \cdot \gamma_cspc = 141.1806\ \frac{lb}{in^2}$$

$P_we := 0$ (Static Load Pressure of Wet, Saturated soil below water table - Assume top of the pipe is above the leachate)

$P_b := 0$ (Static Load Pressure due to Stationary Structures - Assume no structures)

$P_s$ (Total Static Pressure)

$$P_s := P_de + P_we + P_b = 141.1806\ \frac{lb}{in^2}$$

$P_l := 0\ \frac{lb}{in^2}$ (Total Live Pressure - No Equipment Load for final condition)

$P_i := 0\ \frac{lb}{in^2}$ (Total Internal Pressure - Gravity Flow Pipe, No Internal Pressure)

$$S_A := \frac{(1.43 \cdot M_s \cdot r_CENT)}{E_PM \cdot E_red \cdot A_P} = 0.6356$$ (Hoop Thrust Stiffness Ratio)

$$VAF := 0.88 - 0.71 \cdot \left(\frac{S_A - 1}{S_A + 2.5}\right) = 0.9625$$ (Vertical Arching Factor)

$$P_t := VAF \cdot (P_s + P_l + P_i) = 135.8895\ \frac{lb}{in^2}$$ **(Total Pressure Long Term Condition)**

## Factor of Safety against Wall Crushing

Wall Crushing occurs when the total pressure (P_t) exceeds actual compressive pressure (S_a).

$$S_a := \left( \frac{(SDR - 1)}{2} \right) \cdot P_t = 543.5581 \ \frac{lb}{in^2}$$

Factor of Safety (FS) against wall crushing equals the allowable compressive stress of HDPE pipe (Ys) divided by the actual compressive pressure (Sa).

$$FS_WC := \frac{Y_s \cdot 1.5}{S_a} = 2.7596$$

FS_WC is greater than or equal to 1.5

The FS_WC is greater than 1.5(minimum FS for wall crushing); therefore the pipe is acceptable aganist crushing failure mode

## Factor of Safety Against Wall Buckling

Contrained buckling in deep fill without groundwater present can be determine from the Moore-Selig equation for the critical bucking pressure

$\varphi := 0.55$ (Calibration Factor - for granular materials)

$R_H := 1.0$ (Geometry Factor for deep fill)

$$I := \frac{A_P^3}{12 \ in^3} \cdot \frac{(p_Circ - (perf_num \cdot P_d))}{(p_Circ)} = 0.0092$$ (Moment of Inertia of Perforated Pipe Wall)

$\mu := 0.4$ (Poisson's Ratio of drainage stone)

$$M_P := \frac{M_s}{(1 - \mu)} = 5000 \ \frac{lb}{in^2}$$ (Modified Modulus of Drainage Stone)

$D_m := ODP - A_P$ (Mean Diameter of Pipe (OD-wall thickness), inches)

$P_CR$ **(Critical Buckling Soil Pressure)**

$$P_CR := \left( \frac{2.4 \ in \cdot \varphi \cdot R_H}{ID_P} \right) \cdot (E_PM \cdot E_red \cdot I)^{\frac{1}{3}} \cdot M_P^{\frac{2}{3}} = 704.6242 \ \frac{lb}{in^2}$$

FS against wall buckling equals the Critical Buckling Soil Pressure (Pcr) divided by the total earth pressure (Pt) reduced by the vertical arching factor for the long term condtions

$$FS_WB := \frac{P_CR}{P_t} = 5.1853$$

**FS_WB is greater than the 1.8 for (minimum FS for Wall Buckling); therefore the pipe is acceptable against buckling failure.**

## Factor of Safety Against Ring Deflection

Ring deflection of flexible pipe under prism loading is derived by the modified Iowa Formula.

$k_BED := 0.1$ (Bedding Factor - for 90 central angle)

$L_DL := 1$ (Deflection Lag Factor, assumed)

$F_S := 1$ (Soil Support Value)

$\Delta_X$ (Horizontal Deflection, inches)

$P_t' := P_t \cdot 144$ (Total Pressure including VAF, psf)

$P_l' := P_l \cdot 144$ (Live Load, psf)

$D_m$ (Mean Diameter of Pipe (OD-wall thickness), inches)

$D_R := \frac{\Delta_X}{D_m}$ (Ring Deflection)

$$D_R := \frac{1}{144} \cdot \left( \frac{(k_BED \cdot L_DL \cdot P_t') + (k_BED \cdot P_l')}{\frac{(2 \cdot E_PM \cdot E_red)}{3} \cdot \left( \frac{1}{SDR - 1} \right)^3 + (0.061 \cdot F_S \cdot M_s)} \right) \cdot 100 = 6.229$$

Determine the factor of safety against a ring deflection failure.

For non-pressurized pipe, a ring deflection of 7.5 % yields a factor of safety of 3 (Handbook of Polyethylene Pipe, Ch. 6)

$$FS_RD := \frac{7.5}{D_R} \cdot 3 = 3.6121$$

**FS_RD is greater than 3 (minimum FS for Ring Deflection); therefore the pipe is acceptable against excessive ring deflection.**

**Conclusions:** Based upon the calculations above, the HDPE pipe is suitable against crushing, buckling, and ring deflection.

**Project Number:** J24-4999-66
**Project Name:** Arrowhead Landfill Major Modification Support
**Calc Task:** HDPE Pipe Stress Analysis
**Calc Num:** Tract 1, Existing Cell No. 8
**Date:** October 24, 2024

**Objective:** Analysis of the pipe stress due to load from solid waste, cap layers, and leachate stone. Determine the suitability of HDPE pipe against crushing, buckling, and ring deflection

**References:**
Performance Pipe, Iron Pipe Size (IPS) and Dimension Data, DriscoPlex Pipe for Municipal and Industrial Application, Chevron Phillips Chemical Company LP, 2015.

Assessment and Recommendations for Improving the Performance of Waste Containment Systems, US EPA, by Bonaparte, Daniel & Koerner, 2002, pages 2-13 to 2-25.

Design of Polyethylene Piping Systems, Chapters 3 & 6 Handbook of Polyethylene Pipe, Second Edition, 2012.

Finite Element Analysis of Plastic Pipe Behavior in Leachate Collection and Removal Systems, Wilson-Fahmy & Koerner, 1994.

Plastic Pipe Design Manual, Vylon Pipe

**Design Basis:** Pipe wall crushing occurs when external vertical pressure causes the compressive stress in the pipe wall to exceed the long-term compressive strength of the pipe material. Pipe wall buckling is a longitudinal wrinkling of the pipe wall. Buckling can occur in the non-pressurized pipe if the total external soil pressure exceeds the critical buckling pressure (Pcb) of the pipe-soil system

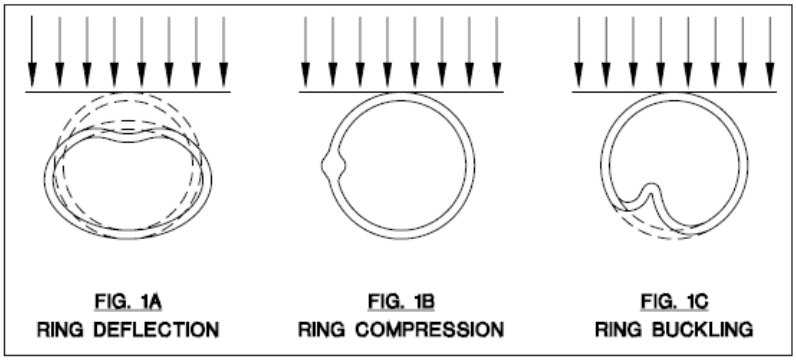


Figure: Example of typical failure modes for buried pipe

**Given:** Analyze pipe stress at settlement analysis location designated S-1B on BLE Figure No. 2C.

Minimum Factor of Safety = 1.5 for Crushing, 1.8 for Buckling, and 3.0 for Ring Deflection (maximum deflection of 7.5%)

Leachate Pipe is a 8-inch diameter HDPE $SDR - 9$ with Material Desgination PE4710.

The closure cap will consist of the following layers: Erosion Layer & Vegetative Cover, Infiltration Layer Thickness, and Intermediate Cover Thickness

Assumed Variables of Materials and Geometry of Cap

$\gamma_{sw} := 85 \frac{lb}{ft^3}$ (Assumed Unit Weight of Solid Waste)

$\gamma_{cspc} := 110 \frac{lb}{ft^3}$ (Assumed Unit Weight of Cap Soil and Protective Cover)

$\gamma_{ds} := 115 \frac{lb}{ft^3}$ (Assumed Unit Weight of Drainage Stone)

$T_{elt} := 2\ ft$ (Erosion Layer & Vegetative Cover)

$T_{il} := 1.5\ ft$ (Infiltration Layer Thickness)

$T_{ic} := 0.5\ ft$ (Intermediate Cover Thickness)

$H_{lc} := T_{elt} + T_{il} + T_{ic}$ (Landfill Cover Height)

$H_{ds} := 2\ ft$ (Thickness of Drainage Stone)

$Ec := 486\ ft$ (Cap Elevation)

$E_{tcl} := 242\ ft$ (Top of Clay Liner Elevation)

**PIPE AND STONE PROPERTIES**

$SDR := 9$ (Standard Dimension Ratio: Pipe Diameter / Wall Thickness)

$ID_P := 6.59\ in$ (Inner Diameter of the Pipe, Nominal)

$ODP := 8.625\ in$ (Outer Diameter of the Pipe)

$E_{PM} := 28000 \frac{lb}{in^2}$ (Pipe Material Apparent Elastic Modulus for PE4XXX - Reference Table B.1.1 in App B of Handbook of Polyethylene Pipe)

$E_{red} := 1$ (Pipe Modulus Reduction Factor - Reference Table B.1.2 in App B Handbook of Polyethylene Pipe)

$M_s := 3000 \frac{lb}{in^2}$ (Stone Modulus Around Pipe, PPI Table 3-7, Ch. 3)

$Y_s := 1150 \frac{lb}{in^2}$ (Allowable Compressive Stress for PE4XXX Material Designation (With FS 1.5) PPI Table C.1, Ch. 3)

$A_P := 0.958\ in$ (Minimum Wall Thickness)

$r_{CENT} := \frac{ODP}{2} - \frac{A_P}{2} = 3.8335\ in$ (Radius to Centroidal Axis of Pipe)

$P_d := \frac{3}{8}\ in$ (Perforation Diameter)

$p_{Circ} := 2 \cdot 3.1415 \cdot r_{CENT} = 24.0859\ in$ (Pipe Circumference)

$perf_{num} := 4$ (Number of perforations)

**Calculation:**

## Total Pressure at the Top of the Leachate Pipe

$H_waste := Ec - E_tcl = 244\ ft$ (Difference between cap elevation and top of clay liner elevation at a given location)

$T_dc := H_lc + H_ds = 6\ ft$ (Thickness of Drainage Stone and Landfill Cover)

$P_de$ (Static Load Pressure of Waste and Cap Soils and Drainage Stone - Varies with waste height. The waste height is defined as the difference between the cap elevation and the top of the clay liner elevation. A vertical arching factor is applied to the prism load above the pipe)

$$P_de := (H_waste - T_dc)\cdot \gamma_sw + H_ds \cdot \gamma_ds + H_lc \cdot \gamma_cspc = 145.1389\ \frac{lb}{in^2}$$

$P_we := 0$ (Static Load Pressure of Wet, Saturated soil below water table - Assume top of the pipe is above the leachate)

$P_b := 0$ (Static Load Pressure due to Stationary Structures - Assume no structures)

$P_s$ (Total Static Pressure)

$$P_s := P_de + P_we + P_b = 145.1389\ \frac{lb}{in^2}$$

$P_l := 0\ \frac{lb}{in^2}$ (Total Live Pressure - No Equipment Load for final condition)

$P_i := 0\ \frac{lb}{in^2}$ (Total Internal Pressure - Gravity Flow Pipe, No Internal Pressure)

$$S_A := \frac{(1.43 \cdot M_s \cdot r_CENT)}{E_PM \cdot E_red \cdot A_P} = 0.6131$$ (Hoop Thrust Stiffness Ratio)

$$VAF := 0.88 - 0.71 \cdot \left(\frac{S_A - 1}{S_A + 2.5}\right) = 0.9682$$ (Vertical Arching Factor)

$$P_t := VAF \cdot (P_s + P_l + P_i) = 140.5293\ \frac{lb}{in^2}$$ **(Total Pressure Long Term Condition)**

## Factor of Safety against Wall Crushing

Wall Crushing occurs when the total pressure (P_t) exceeds actual compressive pressure (S_a).

$$S_a := \left[\frac{(SDR - 1)}{2}\right] \cdot P_t = 562.1174 \ \frac{lb}{in^2}$$

Factor of Safety (FS) against wall crushing equals the allowable compressive stress of HDPE pipe (Ys) divided by the actual compressive pressure (Sa).

$$FS_WC := \frac{Y_s \cdot 1.5}{S_a} = 3.0688$$

FS_WC is greater than or equal to 1.5

The FS_WC is greater than 1.5(minimum FS for wall crushing); therefore the pipe is acceptable aganist crushing failure mode

## Factor of Safety Against Wall Buckling

Contrained buckling in deep fill without groundwater present can be determine from the Moore-Selig equation for the critical bucking pressure

$\varphi := 0.55$ (Calibration Factor - for granular materials)

$R_H := 1.0$ (Geometry Factor for deep fill)

$$I := \frac{A_P^3}{12 \ in^3} \cdot \frac{(p_Circ - (perf_num \cdot P_d))}{(p_Circ)} = 0.0687$$ (Moment of Inertia of Perforated Pipe Wall)

$\mu := 0.4$ (Poisson's Ratio of drainage stone)

$$M_P := \frac{M_s}{(1 - \mu)} = 5000 \ \frac{lb}{in^2}$$ (Modified Modulus of Drainage Stone)

$D_m := ODP - A_P$ (Mean Diameter of Pipe (OD-wall thickness), inches)

$P_CR$ **(Critical Buckling Soil Pressure)**

$$P_CR := \left[\frac{2.4 \ in \cdot \varphi \cdot R_H}{ID_P}\right] \cdot (E_PM \cdot E_red \cdot I)^{\frac{1}{3}} \cdot M_P^{\frac{2}{3}} = 728.4244 \ \frac{lb}{in^2}$$

FS against wall buckling equals the Critical Buckling Soil Pressure (Pcr) divided by the total earth pressure (Pt) reduced by the vertical arching factor for the long term condtions

$$FS_WB := \frac{P_CR}{P_t} = 5.1834$$

**FS_WB is greater than the 1.8 for (minimum FS for Wall Buckling); therefore the pipe is acceptable against buckling failure.**

## Factor of Safety Against Ring Deflection

Ring deflection of flexible pipe under prism loading is derived by the modified Iowa Formula.

$k_BED := 0.1$ (Bedding Factor - for 90 central angle)

$L_DL := 1$ (Deflection Lag Factor, assumed)

$F_S := 1$ (Soil Support Value)

$\Delta_X$ (Horizontal Deflection, inches)

$P_t' := P_t \cdot 144$ (Total Pressure including VAF, psf)

$P_l' := P_l \cdot 144$ (Live Load, psf)

$D_m$ (Mean Diameter of Pipe (OD-wall thickness), inches)

$D_R := \frac{\Delta_X}{D_m}$ (Ring Deflection)

$$D_R := \frac{1}{144} \cdot \left( \frac{(k_BED \cdot L_DL \cdot P_t') + (k_BED \cdot P_l')}{\frac{(2 \cdot E_PM \cdot E_red)}{3} \cdot \left( \frac{1}{SDR - 1} \right)^3 + (0.061 \cdot F_S \cdot M_s)} \right) \cdot 100 = 6.4035$$

Determine the factor of safety against a ring deflection failure.

For non-pressurized pipe, a ring deflection of 7.5 % yields a factor of safety of 3 (Handbook of Polyethylene Pipe, Ch. 6)

$$FS_RD := \frac{7.5}{D_R} \cdot 3 = 3.5137$$

**FS_RD is greater than 3 (minimum FS for Ring Deflection); therefore the pipe is acceptable against excessive ring deflection.**

**Conclusions:** Based upon the calculations above, the HDPE pipe is suitable against crushing, buckling, and ring deflection.

| | | | |
|---|---|---|---|
| Calc By: | Tanner Whitesell, E.I.T. | Tanner Whitesell | 01/30/2025 |
| | Print Name | Signature | Date |
| Checked By: | David Yarbray, E.I.T. | William David Yarbray | 01/30/2025 |
| | Print Name | Signature | Date |
| Reviewed By: | Larry Simonson, P.E. | Lawrence J Simonson | 01/30/2025 |
| | Print Name | Signature | Date |

# Appendix B
# Apparent Elastic Modulus

## B.1 – Apparent Elastic Modulus for the Condition of Either a Sustained Constant Load or a Sustained Constant Deformation

### B.1.1 – Design Values for the Base Temperature of 73°F (23°C)

**TABLE B.1.1**
**Apparent Elastic Modulus for 73°F (23°C)**

| Duration of Sustained Loading | Design Values For 73°F (23°C) [1,2,3] | | | | | |
|---|---|---|---|---|---|---|
| | PE 2XXX | | PE3XXX | | PE4XXX | |
| | psi | MPa | psi | MPa | psi | MPa |
| 0.5hr | 62,000 | 428 | 78,000 | 538 | 82,000 | 565 |
| 1hr | 59,000 | 407 | 74,000 | 510 | 78,000 | 538 |
| 2hr | 57,000 | 393 | 71,000 | 490 | 74,000 | 510 |
| 10hr | 50,000 | 345 | 62,000 | 428 | 65,000 | 448 |
| 12hr | 48,000 | 331 | 60,000 | 414 | 63,000 | 434 |
| 24hr | 46,000 | 317 | 57,000 | 393 | 60,000 | 414 |
| 100hr | 42,000 | 290 | 52,000 | 359 | 55,000 | 379 |
| 1,000hr | 35,000 | 241 | 44,000 | 303 | 46,000 | 317 |
| 1 year | 30,000 | 207 | 38,000 | 262 | 40,000 | 276 |
| 10 years | 26,000 | 179 | 32,000 | 221 | 34,000 | 234 |
| 50 years | 22,000 | 152 | 28,000 | 193 | 29,000 | 200 |
| 100 years | 21,000 | 145 | 27,000 | 186 | 28,000 | 193 |

(1) Although there are various factors that determine the exact apparent modulus response of a PE, a major factor is its ratio of crystalline to amorphous content – a parameter that is reflected by a PE's density. Hence, the major headings PE2XXX, PE3XXX and, PE4XXX, which are based on PE's Standard Designation Code. The first numeral of this code denotes the PE's density category in accordance with ASTM D3350 (An explanation of this code is presented in Chapter 5).

(2) The values in this table are applicable to both the condition of sustained and constant loading (under which the resultant strain increases with increased duration of loading) and that of constant strain (under which an initially generated stress gradually relaxes with increased time).

(3) The design values in this table are based on results obtained under uni-axial loading, such as occurs in a test bar that is being subjected to a pulling load. When a PE is subjected to multi-axial stressing its strain response is inhibited, which results in a somewhat higher apparent modulus. For example, the apparent modulus of a PE pipe that is subjected to internal hydrostatic pressure – a condition that induces bi-axial stressing – is about 25% greater than that reported by this table. Thus, the Uni-axial condition represents a conservative estimate of the value that is achieved in most applications.

It should also be kept in mind that these values are for the condition of continually sustained loading. If there is an interruption or a decrease in the loading this, effectively, results in a somewhat larger modulus.

In addition, the values in this table apply to a stress intensity ranging up to about 400psi, a value that is seldom exceeded under normal service conditions.

## B.1.2 – Values for Other Temperatures

The multipliers listed in Table B.1.2 when applied to the base temperature value (Table B.1.1) yield the value for another temperature.

**TABLE B.1.2**

**Temperature Compensating Multipliers for Determination of the Apparent Modulus of Elasticity at Temperatures Other than at 73°F (23°C)**

**Equally Applicable to All Stress-Rated PE's (e.g., All PE2xxx's, All PE3xxx's and All PE4xxx's)**

| Maximum Sustained Temperature of the Pipe °F (°C) | Compensating Multiplier |
|---|---|
| -20 (-29) | 2.54 |
| -10 (-23) | 2.36 |
| 0 (-18) | 2.18 |
| 10 (-12) | 2.00 |
| 20 (-7) | 1.81 |
| 30 (-1) | 1.65 |
| 40 (4) | 1.49 |
| 50 (10) | 1.32 |
| 60 (16) | 1.18 |
| 73.4 (23) | 1.00 |
| 80 (27) | 0.93 |
| 90 (32) | 0.82 |
| 100 (38) | 0.73 |
| 110 (43) | 0.64 |
| 120 (49) | 0.58 |
| 130 (54) | 0.50 |
| 140 (60) | 0.43 |

| OD | | | Pipe inside diameter (d) | Minimum Wall Thickness (t) | Weight (w) |
|---|---|---|---|---|---|
| Nominal in. | Actual in. | DR | in. | in. | lb. per foot |
| | | 7 | 3.14 | 0.643 | 3.384 |
| | | 7.3 | 3.19 | 0.616 | 3.269 |
| | | 9 | 3.44 | 0.500 | 2.737 |
| | | 9.3 | 3.47 | 0.484 | 2.660 |
| | | 11 | 3.63 | 0.409 | 2.294 |
| 4 | 4.500 | 11.5 | 3.67 | 0.391 | 2.204 |
| | | 13.5 | 3.79 | 0.333 | 1.906 |
| | | 15.5 | 3.88 | 0.290 | 1.678 |
| | | 17 | 3.94 | 0.265 | 1.540 |
| | | 21 | 4.05 | 0.214 | 1.262 |
| | | 26 | 4.13 | 0.173 | 1.030 |
| | | 32.5 | 4.21 | 0.138 | 0.831 |

| OD | | | Pipe inside diameter (d) | Minimum Wall Thickness (t) | Weight (w) |
|---|---|---|---|---|---|
| Nominal in. | Actual in. | DR | in. | in. | lb. per foot |
| | | 7 | 6.01 | 1.232 | 12.433 |
| | | 7.3 | 6.12 | 1.182 | 12.010 |
| | | 9 | 6.59 | 0.958 | 10.054 |
| | | 9.3 | 6.66 | 0.927 | 9.771 |
| | | 11 | 6.96 | 0.784 | 8.425 |
| 8 | 8.625 | 11.5 | 7.04 | 0.750 | 8.096 |
| | | 13.5 | 7.27 | 0.639 | 7.001 |
| | | 15.5 | 7.45 | 0.556 | 6.164 |
| | | 17 | 7.55 | 0.507 | 5.657 |
| | | 21 | 7.75 | 0.411 | 4.637 |
| | | 26 | 7.92 | 0.332 | 3.784 |

# Tract 2

**Project Number:** J24-4999-66
**Project Name:** Arrowhead Landfill Major Modification Support
**Calc Task:** HDPE Pipe Stress Analysis
**Calc Num:** Tract 2
**Date:** November 11, 2024

**Objective:** Analysis of the pipe stress due to load from solid waste, cap layers, and leachate stone. Determine the suitability of HDPE pipe against crushing, buckling, and ring deflection

**References:**
Performance Pipe, Iron Pipe Size (IPS) and Dimension Data, DriscoPlex Pipe for Municipal and Industrial Application, Chevron Phillips Chemical Company LP, 2015.

Assessment and Recommendations for Improving the Performance of Waste Containment Systems, US EPA, by Bonaparte, Daniel & Koerner, 2002, pages 2-13 to 2-25.

Design of Polyethylene Piping Systems, Chapters 3 & 6 Handbook of Polyethylene Pipe, Second Edition, 2012.

Finite Element Analysis of Plastic Pipe Behavior in Leachate Collection and Removal Systems, Wilson-Fahmy & Koerner, 1994.

Plastic Pipe Design Manual, Vylon Pipe

**Design Basis:** Pipe wall crushing occurs when external vertical pressure causes the compressive stress in the pipe wall to exceed the long-term compressive strength of the pipe material. Pipe wall buckling is a longitudinal wrinkling of the pipe wall. Buckling can occur in the non-pressurized pipe if the total external soil pressure exceeds the critical buckling pressure (Pcb) of the pipe-soil system

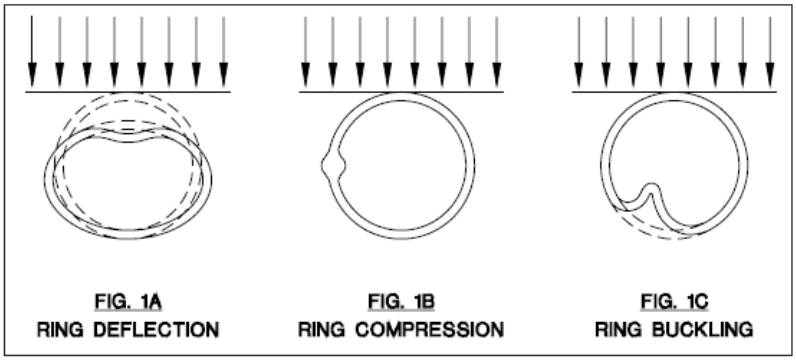


Figure: Example of typical failure modes for buried pipe

**Given:** Analyze pipe stress at settlement analysis location designated S-3C on BLE Figure No.3C.

Minimum Factor of Safety = 1.5 for Crushing, 1.8 for Buckling, and 3.0 for Ring Deflection (maximum deflection of 7.5%)

Leachate Pipe is a 8-inch diameter HDPE $SDR - 9$ with Material Desgination PE4710.

The closure cap will consist of the following layers: Erosion Layer & Vegetative Cover, Infiltration Layer Thickness, and Intermediate Cover Thickness

Assumed Variables of Materials and Geometry of Cap

$\gamma_sw := 85 \frac{lb}{ft^3}$ (Assumed Unit Weight of Solid Waste)

$\gamma_cspc := 110 \frac{lb}{ft^3}$ (Assumed Unit Weight of Cap Soil and Protective Cover)

$\gamma_ds := 115 \frac{lb}{ft^3}$ (Assumed Unit Weight of Drainage Stone)

$T_elt := 2\ ft$ (Erosion Layer & Vegetative Cover)

$T_il := 1.5\ ft$ (Infiltration Layer Thickness)

$T_ic := 0.5\ ft$ (Intermediate Cover Thickness)

$H_lc := T_elt + T_il + T_ic$ (Landfill Cover Height)

$H_ds := 2\ ft$ (Thickness of Drainage Stone)

$Ec := 530\ ft$ (Cap Elevation)

$E_tcl := 255\ ft$ (Top of Clay Liner Elevation)

**PIPE AND STONE PROPERTIES**

$SDR := 9$ (Standard Dimension Ratio: Pipe Diameter / Wall Thickness)

$ID_P := 6.59\ in$ (Inner Diameter of the Pipe, Nominal)

$ODP := 8.625\ in$ (Outer Diameter of the Pipe)

$E_PM := 28000 \frac{lb}{in^2}$ (Pipe Material Apparent Elastic Modulus for PE4XXX - Reference Table B.1.1 in App B of Handbook of Polyethylene Pipe)

$E_red := 1$ (Pipe Modulus Reduction Factor - Reference Table B.1.2 in App B Handbook of Polyethylene Pipe)

$M_s := 3000 \frac{lb}{in^2}$ (Stone Modulus Around Pipe, PPI Table 3-7, Ch. 3)

$Y_s := 1150 \frac{lb}{in^2}$ (Allowable Compressive Stress for PE4XXX Material Designation (With FS 1.5) PPI Table C.1, Ch. 3)

$A_P := 0.958\ in$ (Minimum Wall Thickness)

$r_CENT := \frac{ODP}{2} - \frac{A_P}{2} = 3.8335\ in$ (Radius to Centroidal Axis of Pipe)

$P_d := \frac{3}{8}\ in$ (Perforation Diameter)

$p_Circ := 2 \cdot 3.1415 \cdot r_CENT = 24.0859\ in$ (Pipe Circumference)

$perf_num := 4$ (Number of perforations)

**Calculation:**

## Total Pressure at the Top of the Leachate Pipe

$H_waste := Ec - E_tcl = 275\ ft$ (Difference between cap elevation and top of clay liner elevation at a given location)

$T_dc := H_lc + H_ds = 6\ ft$ (Thickness of Drainage Stone and Landfill Cover)

$P_de$ (Static Load Pressure of Waste and Cap Soils and Drainage Stone - Varies with waste height. The waste height is defined as the difference between the cap elevation and the top of the clay liner elevation. A vertical arching factor is applied to the prism load above the pipe)

$$P_de := (H_waste - T_dc)\cdot \gamma_sw + H_ds \cdot \gamma_ds + H_lc \cdot \gamma_cspc = 163.4375\ \frac{lb}{in^2}$$

$P_we := 0$ (Static Load Pressure of Wet, Saturated soil below water table - Assume top of the pipe is above the leachate)

$P_b := 0$ (Static Load Pressure due to Stationary Structures - Assume no structures)

$P_s$ (Total Static Pressure)

$$P_s := P_de + P_we + P_b = 163.4375\ \frac{lb}{in^2}$$

$P_l := 0\ \frac{lb}{in^2}$ (Total Live Pressure - No Equipment Load for final condition)

$P_i := 0\ \frac{lb}{in^2}$ (Total Internal Pressure - Gravity Flow Pipe, No Internal Pressure)

$$S_A := \frac{(1.43 \cdot M_s \cdot r_CENT)}{E_PM \cdot E_red \cdot A_P} = 0.6131$$ (Hoop Thrust Stiffness Ratio)

$$VAF := 0.88 - 0.71 \cdot \left(\frac{S_A - 1}{S_A + 2.5}\right) = 0.9682$$ (Vertical Arching Factor)

$$P_t := VAF \cdot (P_s + P_l + P_i) = 158.2468\ \frac{lb}{in^2}$$ **(Total Pressure Long Term Condition)**

## Factor of Safety against Wall Crushing

Wall Crushing occurs when the total pressure (P_t) exceeds actual compressive pressure (S_a).

$$S_a := \left(\frac{(SDR - 1)}{2}\right) \cdot P_t = 632.9872 \ \frac{lb}{in^2}$$

Factor of Safety (FS) against wall crushing equals the allowable compressive stress of HDPE pipe (Ys) divided by the actual compressive pressure (Sa).

$$FS_WC := \frac{Y_s \cdot 1.5}{S_a} = 2.7252$$

FS_WC is greater than or equal to 1.5

The FS_WC is greater than 1.5(minimum FS for wall crushing); therefore the pipe is acceptable aganist crushing failure mode

## Factor of Safety Against Wall Buckling

Contrained buckling in deep fill without groundwater present can be determine from the Moore-Selig equation for the critical bucking pressure

$\varphi := 0.55$ (Calibration Factor - for granular materials)

$R_H := 1.0$ (Geometry Factor for deep fill)

$$I := \frac{A_P^3}{12 \ in^3} \cdot \frac{(p_Circ - (perf_num \cdot P_d))}{(p_Circ)} = 0.0687$$ (Moment of Inertia of Perforated Pipe Wall)

$\mu := 0.4$ (Poisson's Ratio of drainage stone)

$$M_P := \frac{M_s}{(1 - \mu)} = 5000 \ \frac{lb}{in^2}$$ (Modified Modulus of Drainage Stone)

$D_m := ODP - A_P$ (Mean Diameter of Pipe (OD-wall thickness), inches)

$P_CR$ **(Critical Buckling Soil Pressure)**

$$P_CR := \left(\frac{2.4 \ in \cdot \varphi \cdot R_H}{ID_P}\right) \cdot (E_PM \cdot E_red \cdot I)^{\frac{1}{3}} \cdot M_P^{\frac{2}{3}} = 728.4244 \ \frac{lb}{in^2}$$

FS against wall buckling equals the Critical Buckling Soil Pressure (Pcr) divided by the total earth pressure (Pt) reduced by the vertical arching factor for the long term condtions

$$FS_WB := \frac{P_CR}{P_t} = 4.6031$$

**FS_WB is greater than the 1.8 for (minimum FS for Wall Buckling); therefore the pipe is acceptable against buckling failure.**

## Factor of Safety Against Ring Deflection

Ring deflection of flexible pipe under prism loading is derived by the modified Iowa Formula.

$k_BED := 0.1$ (Bedding Factor - for 90 central angle)

$L_DL := 1$ (Deflection Lag Factor, assumed)

$F_S := 1$ (Soil Support Value)

$\Delta_X$ (Horizontal Deflection, inches)

$P_t' := P_t \cdot 144$ (Total Pressure including VAF, psf)

$P_l' := P_l \cdot 144$ (Live Load, psf)

$D_m$ (Mean Diameter of Pipe (OD-wall thickness), inches)

$D_R := \frac{\Delta_X}{D_m}$ (Ring Deflection)

$$D_R := \frac{1}{144} \cdot \left( \frac{(k_BED \cdot L_DL \cdot P_t') + (k_BED \cdot P_l')}{\frac{(2 \cdot E_PM \cdot E_red)}{3} \cdot \left( \frac{1}{SDR - 1} \right)^3 + (0.061 \cdot F_S \cdot M_s)} \right) \cdot 100 = 7.2108$$

Determine the factor of safety against a ring deflection failure.

For non-pressurized pipe, a ring deflection of 7.5 % yields a factor of safety of 3 (Handbook of Polyethylene Pipe, Ch. 6)

$$FS_RD := \frac{7.5}{D_R} \cdot 3 = 3.1203$$

**FS_RD is greater than 3 (minimum FS for Ring Deflection); therefore the pipe is acceptable against excessive ring deflection.**

**Conclusions:** Based upon the calculations above, the HDPE pipe is suitable against crushing, buckling, ring deflection.

| | | | |
|---|---|---|---|
| Calc By: | Tanner Whitesell, E.I.T. | Tanner Whitesell | 01/30/2025 |
| | Print Name | Signature | Date |
| Checked By: | David Yarbray, E.I.T. | William David Yarbray | 01/30/2025 |
| | Print Name | Signature | Date |
| Reviewed By: | Larry Simonson, P.E. | Lawrence J Simonson | 01/30/2025 |
| | Print Name | Signature | Date |

# Appendix B
# Apparent Elastic Modulus

## B.1 – Apparent Elastic Modulus for the Condition of Either a Sustained Constant Load or a Sustained Constant Deformation

### B.1.1 – Design Values for the Base Temperature of 73°F (23°C)

**TABLE B.1.1**
**Apparent Elastic Modulus for 73°F (23°C)**

| Duration of Sustained Loading | Design Values For 73°F (23°C) [1,2,3] | | | | | |
|---|---|---|---|---|---|---|
| | PE 2XXX | | PE3XXX | | PE4XXX | |
| | psi | MPa | psi | MPa | psi | MPa |
| 0.5hr | 62,000 | 428 | 78,000 | 538 | 82,000 | 565 |
| 1hr | 59,000 | 407 | 74,000 | 510 | 78,000 | 538 |
| 2hr | 57,000 | 393 | 71,000 | 490 | 74,000 | 510 |
| 10hr | 50,000 | 345 | 62,000 | 428 | 65,000 | 448 |
| 12hr | 48,000 | 331 | 60,000 | 414 | 63,000 | 434 |
| 24hr | 46,000 | 317 | 57,000 | 393 | 60,000 | 414 |
| 100hr | 42,000 | 290 | 52,000 | 359 | 55,000 | 379 |
| 1,000hr | 35,000 | 241 | 44,000 | 303 | 46,000 | 317 |
| 1 year | 30,000 | 207 | 38,000 | 262 | 40,000 | 276 |
| 10 years | 26,000 | 179 | 32,000 | 221 | 34,000 | 234 |
| 50 years | 22,000 | 152 | 28,000 | 193 | 29,000 | 200 |
| 100 years | 21,000 | 145 | 27,000 | 186 | 28,000 | 193 |

(1) Although there are various factors that determine the exact apparent modulus response of a PE, a major factor is its ratio of crystalline to amorphous content – a parameter that is reflected by a PE's density. Hence, the major headings PE2XXX, PE3XXX and, PE4XXX, which are based on PE's Standard Designation Code. The first numeral of this code denotes the PE's density category in accordance with ASTM D3350 (An explanation of this code is presented in Chapter 5).

(2) The values in this table are applicable to both the condition of sustained and constant loading (under which the resultant strain increases with increased duration of loading) and that of constant strain (under which an initially generated stress gradually relaxes with increased time).

(3) The design values in this table are based on results obtained under uni-axial loading, such as occurs in a test bar that is being subjected to a pulling load. When a PE is subjected to multi-axial stressing its strain response is inhibited, which results in a somewhat higher apparent modulus. For example, the apparent modulus of a PE pipe that is subjected to internal hydrostatic pressure – a condition that induces bi-axial stressing – is about 25% greater than that reported by this table. Thus, the Uni-axial condition represents a conservative estimate of the value that is achieved in most applications.

It should also be kept in mind that these values are for the condition of continually sustained loading. If there is an interruption or a decrease in the loading this, effectively, results in a somewhat larger modulus.

In addition, the values in this table apply to a stress intensity ranging up to about 400psi, a value that is seldom exceeded under normal service conditions.

## B.1.2 – Values for Other Temperatures

The multipliers listed in Table B.1.2 when applied to the base temperature value (Table B.1.1) yield the value for another temperature.

**TABLE B.1.2**

**Temperature Compensating Multipliers for Determination of the Apparent Modulus of Elasticity at Temperatures Other than at 73°F (23°C)**

**Equally Applicable to All Stress-Rated PE's (e.g., All PE2xxx's, All PE3xxx's and All PE4xxx's)**

| Maximum Sustained Temperature of the Pipe °F (°C) | Compensating Multiplier |
|---|---|
| -20 (-29) | 2.54 |
| -10 (-23) | 2.36 |
| 0 (-18) | 2.18 |
| 10 (-12) | 2.00 |
| 20 (-7) | 1.81 |
| 30 (-1) | 1.65 |
| 40 (4) | 1.49 |
| 50 (10) | 1.32 |
| 60 (16) | 1.18 |
| 73.4 (23) | 1.00 |
| 80 (27) | 0.93 |
| 90 (32) | 0.82 |
| 100 (38) | 0.73 |
| 110 (43) | 0.64 |
| 120 (49) | 0.58 |
| 130 (54) | 0.50 |
| 140 (60) | 0.43 |

| OD | | | Pipe inside diameter (d) | Minimum Wall Thickness (t) | Weight (w) |
|---|---|---|---|---|---|
| Nominal in. | Actual in. | DR | in. | in. | lb. per foot |
| | | 7 | 3.14 | 0.643 | 3.384 |
| | | 7.3 | 3.19 | 0.616 | 3.269 |
| | | 9 | 3.44 | 0.500 | 2.737 |
| | | 9.3 | 3.47 | 0.484 | 2.660 |
| | | 11 | 3.63 | 0.409 | 2.294 |
| 4 | 4.500 | 11.5 | 3.67 | 0.391 | 2.204 |
| | | 13.5 | 3.79 | 0.333 | 1.906 |
| | | 15.5 | 3.88 | 0.290 | 1.678 |
| | | 17 | 3.94 | 0.265 | 1.540 |
| | | 21 | 4.05 | 0.214 | 1.262 |
| | | 26 | 4.13 | 0.173 | 1.030 |
| | | 32.5 | 4.21 | 0.138 | 0.831 |

| OD | | | Pipe inside diameter (d) | Minimum Wall Thickness (t) | Weight (w) |
|---|---|---|---|---|---|
| Nominal in. | Actual in. | DR | in. | in. | lb. per foot |
| | | 7 | 6.01 | 1.232 | 12.433 |
| | | 7.3 | 6.12 | 1.182 | 12.010 |
| | | 9 | 6.59 | 0.958 | 10.054 |
| | | 9.3 | 6.66 | 0.927 | 9.771 |
| | | 11 | 6.96 | 0.784 | 8.425 |
| 8 | 8.625 | 11.5 | 7.04 | 0.750 | 8.096 |
| | | 13.5 | 7.27 | 0.639 | 7.001 |
| | | 15.5 | 7.45 | 0.556 | 6.164 |
| | | 17 | 7.55 | 0.507 | 5.657 |
| | | 21 | 7.75 | 0.411 | 4.637 |
| | | 26 | 7.92 | 0.332 | 3.784 |

# Tract 3

**Project Number:** J24-4999-66
**Project Name:** Arrowhead Landfill Major Modification Support
**Calc Task:** HDPE Pipe Stress Analysis
**Calc Num:** Tract 3
**Date:** October 24, 2024

**Objective:** Analysis of the pipe stress due to load from solid waste, cap layers, and leachate stone. Determine the suitability of HDPE pipe against crushing, buckling, and ring deflection

**References:**
Performance Pipe, Iron Pipe Size (IPS) and Dimension Data, DriscoPlex Pipe for Municipal and Industrial Application, Chevron Phillips Chemical Company LP, 2015.

Assessment and Recommendations for Improving the Performance of Waste Containment Systems, US EPA, by Bonaparte, Daniel & Koerner, 2002, pages 2-13 to 2-25.

Design of Polyethylene Piping Systems, Chapters 3 & 6 Handbook of Polyethylene Pipe, Second Edition, 2012.

Finite Element Analysis of Plastic Pipe Behavior in Leachate Collection and Removal Systems, Wilson-Fahmy & Koerner, 1994.

Plastic Pipe Design Manual, Vylon Pipe

**Design Basis:** Pipe wall crushing occurs when external vertical pressure causes the compressive stress in the pipe wall to exceed the long-term compressive strength of the pipe material. Pipe wall buckling is a longitudinal wrinkling of the pipe wall. Buckling can occur in the non-pressurized pipe if the total external soil pressure exceeds the critical buckling pressure (Pcb) of the pipe-soil system

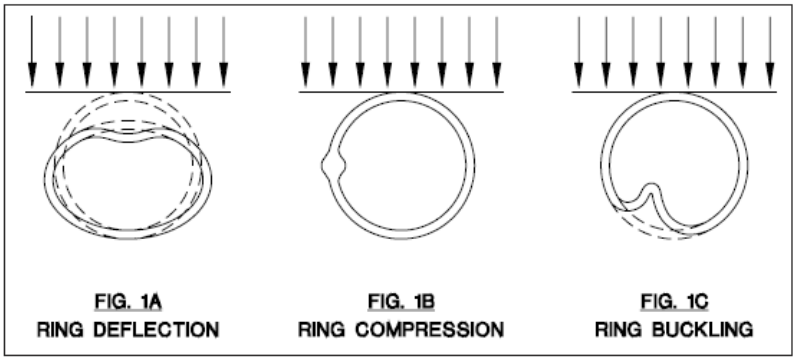


Figure: Example of typical failure modes for buried pipe

**Given:** Analyze pipe stress at settlement analysis location designated S-5C on BLE Figure No.4C.

Minimum Factor of Safety = 1.5 for Crushing, 1.8 for Buckling, and 3.0 for Ring Deflection (maximum deflection of 7.5%)

Leachate Pipe is a 8-inch diameter HDPE $SDR - 9$ with Material Desgination PE4710.

The closure cap will consist of the following layers: Erosion Layer & Vegetative Cover, Infiltration Layer Thickness, and Intermediate Cover Thickness

Assumed Variables of Materials and Geometry of Cap

$\gamma_{sw} := 85 \frac{lb}{ft^3}$ (Assumed Unit Weight of Solid Waste)

$\gamma_{cspc} := 110 \frac{lb}{ft^3}$ (Assumed Unit Weight of Cap Soil and Protective Cover)

$\gamma_{ds} := 115 \frac{lb}{ft^3}$ (Assumed Unit Weight of Drainage Stone)

$T_{elt} := 2\ ft$ (Erosion Layer & Vegetative Cover)

$T_{il} := 1.5\ ft$ (Infiltration Layer Thickness)

$T_{ic} := 0.5\ ft$ (Intermediate Cover Thickness)

$H_{lc} := T_{elt} + T_{il} + T_{ic}$ (Landfill Cover Height)

$H_{ds} := 2\ ft$ (Thickness of Drainage Stone)

$Ec := 510\ ft$ (Cap Elevation)

$E_{tcl} := 224\ ft$ (Top of Clay Liner Elevation)

**PIPE AND STONE PROPERTIES**

$SDR := 9$ (Standard Dimension Ratio: Pipe Diameter / Wall Thickness)

$ID_P := 6.59\ in$ (Inner Diameter of the Pipe, Nominal)

$ODP := 8.625\ in$ (Outer Diameter of the Pipe)

$E_{PM} := 28000 \frac{lb}{in^2}$ (Pipe Material Apparent Elastic Modulus for PE4XXX - Reference Table B.1.1 in App B of Handbook of Polyethylene Pipe)

$E_{red} := 1$ (Pipe Modulus Reduction Factor - Reference Table B.1.2 in App B Handbook of Polyethylene Pipe)

$M_s := 3000 \frac{lb}{in^2}$ (Stone Modulus Around Pipe, PPI Table 3-7, Ch. 3)

$Y_s := 1150 \frac{lb}{in^2}$ (Allowable Compressive Stress for PE4XXX Material Designation (With FS 1.5) PPI Table C.1, Ch. 3)

$A_P := 0.958\ in$ (Minimum Wall Thickness)

$r_{CENT} := \frac{ODP}{2} - \frac{A_P}{2} = 3.8335\ in$ (Radius to Centroidal Axis of Pipe)

$P_d := \frac{3}{8}\ in$ (Perforation Diameter)

$p_{Circ} := 2 \cdot 3.1415 \cdot r_{CENT} = 24.0859\ in$ (Pipe Circumference)

$perf_{num} := 4$ (Number of perforations)

**Calculation:**

## Total Pressure at the Top of the Leachate Pipe

$H_waste := Ec - E_tcl = 286\ ft$ (Difference between cap elevation and top of clay liner elevation at a given location)

$T_dc := H_lc + H_ds = 6\ ft$ (Thickness of Drainage Stone and Landfill Cover)

$P_de$ (Static Load Pressure of Waste and Cap Soils and Drainage Stone - Varies with waste height. The waste height is defined as the difference between the cap elevation and the top of the clay liner elevation. A vertical arching factor is applied to the prism load above the pipe)

$$P_de := (H_waste - T_dc)\cdot \gamma_sw + H_ds \cdot \gamma_ds + H_lc \cdot \gamma_cspc = 169.9306\ \frac{lb}{in^2}$$

$P_we := 0$ (Static Load Pressure of Wet, Saturated soil below water table - Assume top of the pipe is above the leachate)

$P_b := 0$ (Static Load Pressure due to Stationary Structures - Assume no structures)

$P_s$ (Total Static Pressure)

$$P_s := P_de + P_we + P_b = 169.9306\ \frac{lb}{in^2}$$

$P_l := 0\ \frac{lb}{in^2}$ (Total Live Pressure - No Equipment Load for final condition)

$P_i := 0\ \frac{lb}{in^2}$ (Total Internal Pressure - Gravity Flow Pipe, No Internal Pressure)

$$S_A := \frac{(1.43 \cdot M_s \cdot r_CENT)}{E_PM \cdot E_red \cdot A_P} = 0.6131$$ (Hoop Thrust Stiffness Ratio)

$$VAF := 0.88 - 0.71 \cdot \left(\frac{S_A - 1}{S_A + 2.5}\right) = 0.9682$$ (Vertical Arching Factor)

$$P_t := VAF \cdot (P_s + P_l + P_i) = 164.5336\ \frac{lb}{in^2}$$ **(Total Pressure Long Term Condition)**

## Factor of Safety against Wall Crushing

Wall Crushing occurs when the total pressure (P_t) exceeds actual compressive pressure (S_a).

$$S_a := \left[\frac{(SDR - 1)}{2}\right] \cdot P_t = 658.1346 \ \frac{lb}{in^2}$$

Factor of Safety (FS) against wall crushing equals the allowable compressive stress of HDPE pipe (Ys) divided by the actual compressive pressure (Sa).

$$FS_WC := \frac{Y_s \cdot 1.5}{S_a} = 2.621$$

FS_WC is greater than or equal to 1.5

The FS_WC is greater than 1.5(minimum FS for wall crushing); therefore the pipe is acceptable aganist crushing failure mode

## Factor of Safety Against Wall Buckling

Contrained buckling in deep fill without groundwater present can be determine from the Moore-Selig equation for the critical bucking pressure

$\varphi := 0.55$ (Calibration Factor - for granular materials)

$R_H := 1.0$ (Geometry Factor for deep fill)

$$I := \frac{A_P^3}{12 \ in^3} \cdot \frac{(p_Circ - (perf_num \cdot P_d))}{(p_Circ)} = 0.0687$$ (Moment of Inertia of Perforated Pipe Wall)

$\mu := 0.4$ (Poisson's Ratio of drainage stone)

$$M_P := \frac{M_s}{(1 - \mu)} = 5000 \ \frac{lb}{in^2}$$ (Modified Modulus of Drainage Stone)

$D_m := ODP - A_P$ (Mean Diameter of Pipe (OD-wall thickness), inches)

$P_CR$ **(Critical Buckling Soil Pressure)**

$$P_CR := \left[\frac{2.4 \ in \cdot \varphi \cdot R_H}{ID_P}\right] \cdot (E_PM \cdot E_red \cdot I)^{\frac{1}{3}} \cdot M_P^{\frac{2}{3}} = 728.4244 \ \frac{lb}{in^2}$$

FS against wall buckling equals the Critical Buckling Soil Pressure (Pcr) divided by the total earth pressure (Pt) reduced by the vertical arching factor for the long term condtions

$$FS_WB := \frac{P_CR}{P_t} = 4.4272$$

**FS_WB is greater than the 1.8 for (minimum FS for Wall Buckling); therefore the pipe is acceptable against buckling failure.**

## Factor of Safety Against Ring Deflection

Ring deflection of flexible pipe under prism loading is derived by the modified Iowa Formula.

$k_BED := 0.1$ (Bedding Factor - for 90 central angle)

$L_DL := 1$ (Deflection Lag Factor, assumed)

$F_S := 1$ (Soil Support Value)

$\Delta_X$ (Horizontal Deflection, inches)

$P_t' := P_t \cdot 144$ (Total Pressure including VAF, psf)

$P_l' := P_l \cdot 144$ (Live Load, psf)

$D_m$ (Mean Diameter of Pipe (OD-wall thickness), inches)

$D_R := \frac{\Delta_X}{D_m}$ (Ring Deflection)

$$D_R := \frac{1}{144} \cdot \left( \frac{\left(k_BED \cdot L_DL \cdot P_t'\right) + \left(k_BED \cdot P_l'\right)}{\frac{\left(2 \cdot E_PM \cdot E_red\right)}{3} \cdot \left(\frac{1}{SDR - 1}\right)^3 + \left(0.061 \cdot F_S \cdot M_s\right)} \right) \cdot 100 = 7.4973$$

Determine the factor of safety against a ring deflection failure.

For non-pressurized pipe, a ring deflection of 7.5 % yields a factor of safety of 3 (Handbook of Polyethylene Pipe, Ch. 6)

$$FS_RD := \frac{7.5}{D_R} \cdot 3 = 3.0011$$

**FS_RD is greater than 3 (minimum FS for Ring Deflection); therefore the pipe is acceptable against excessive ring deflection.**

**Conclusions:** Based upon the calculations above, the HDPE pipe is suitable against crushing, buckling, and ring deflection.

**Project Number:** J24-4999-66
**Project Name:** Arrowhead Landfill Major Modification Support
**Calc Task:** HDPE Pipe Stress Analysis
**Calc Num:** Tract 3
**Date:** October 24, 2024

**Objective:** Analysis of the pipe stress due to load from solid waste, cap layers, and leachate stone. Determine the suitability of HDPE pipe against crushing, buckling, and ring deflection

**References:**
Performance Pipe, Iron Pipe Size (IPS) and Dimension Data, DriscoPlex Pipe for Municipal and Industrial Application, Chevron Phillips Chemical Company LP, 2015.

Assessment and Recommendations for Improving the Performance of Waste Containment Systems, US EPA, by Bonaparte, Daniel & Koerner, 2002, pages 2-13 to 2-25.

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Finite Element Analysis of Plastic Pipe Behavior in Leachate Collection and Removal Systems, Wilson-Fahmy & Koerner, 1994.

Plastic Pipe Design Manual, Vylon Pipe

**Design Basis:** Pipe wall crushing occurs when external vertical pressure causes the compressive stress in the pipe wall to exceed the long-term compressive strength of the pipe material. Pipe wall buckling is a longitudinal wrinkling of the pipe wall. Buckling can occur in the non-pressurized pipe if the total external soil pressure exceeds the critical buckling pressure (Pcb) of the pipe-soil system

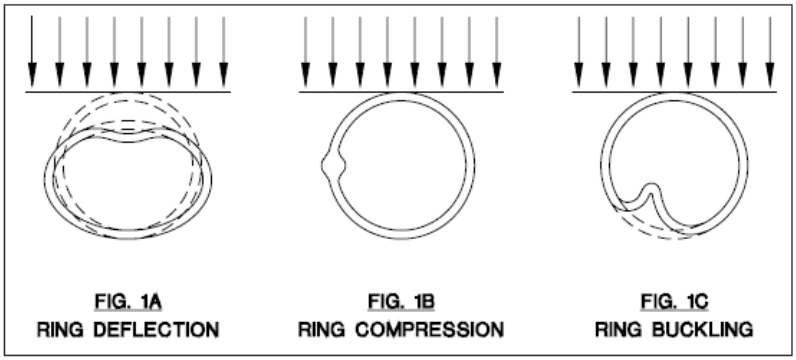


Figure: Example of typical failure modes for buried pipe

**Given:** Analyze pipe stress at settlement analysis location designated S-5C on BLE Figure No. 8.

Minimum Factor of Safety = 1.5 for Crushing, 1.8 for Buckling, and 3.0 for Ring Deflection (maximum deflection of 7.5%)

Leachate Pipe is a 8-inch diameter HDPE $SDR - 7$ with Material Desgination PE4710.

The closure cap will consist of the following layers: Erosion Layer & Vegetative Cover, Infiltration Layer Thickness, and Intermediate Cover Thickness

Assumed Variables of Materials and Geometry of Cap

$\gamma_sw := 85 \frac{lb}{ft^3}$ (Assumed Unit Weight of Solid Waste)

$\gamma_cspc := 110 \frac{lb}{ft^3}$ (Assumed Unit Weight of Cap Soil and Protective Cover)

$\gamma_ds := 115 \frac{lb}{ft^3}$ (Assumed Unit Weight of Drainage Stone)

$T_elt := 2\ ft$ (Erosion Layer & Vegetative Cover)

$T_il := 1.5\ ft$ (Infiltration Layer Thickness)

$T_ic := 0.5\ ft$ (Intermediate Cover Thickness)

$H_lc := T_elt + T_il + T_ic$ (Landfill Cover Height)

$H_ds := 2\ ft$ (Thickness of Drainage Stone)

$Ec := 560\ ft$ (Cap Elevation)

$E_tcl := 224\ ft$ (Top of Clay Liner Elevation)

**PIPE AND STONE PROPERTIES**

$SDR := 7$ (Standard Dimension Ratio: Pipe Diameter / Wall Thickness)

$ID_P := 6.01\ in$ (Inner Diameter of the Pipe, Nominal)

$ODP := 8.625\ in$ (Outer Diameter of the Pipe)

$E_PM := 28000 \frac{lb}{in^2}$ (Pipe Material Apparent Elastic Modulus for PE4XXX - Reference Table B.1.1 in App B of Handbook of Polyethylene Pipe)

$E_red := 1$ (Pipe Modulus Reduction Factor - Reference Table B.1.2 in App B Handbook of Polyethylene Pipe)

$M_s := 3000 \frac{lb}{in^2}$ (Stone Modulus Around Pipe, PPI Table 3-7, Ch. 3)

$Y_s := 1150 \frac{lb}{in^2}$ (Allowable Compressive Stress for PE4XXX Material Designation (With FS 1.5) PPI Table C.1, Ch. 3)

$A_P := 1.232\ in$ (Minimum Wall Thickness)

$r_CENT := \frac{ODP}{2} - \frac{A_P}{2} = 3.6965\ in$ (Radius to Centroidal Axis of Pipe)

$P_d := \frac{3}{8}\ in$ (Perforation Diameter)

$p_Circ := 2 \cdot 3.1415 \cdot r_CENT = 23.2251\ in$ (Pipe Circumference)

$perf_num := 4$ (Number of perforations)

**Calculation:**

## Total Pressure at the Top of the Leachate Pipe

$H_waste := Ec - E_tcl = 336\ ft$ (Difference between cap elevation and top of clay liner elevation at a given location)

$T_dc := H_lc + H_ds = 6\ ft$ (Thickness of Drainage Stone and Landfill Cover)

$P_de$ (Static Load Pressure of Waste and Cap Soils and Drainage Stone - Varies with waste height. The waste height is defined as the difference between the cap elevation and the top of the clay liner elevation. A vertical arching factor is applied to the prism load above the pipe)

$$P_de := (H_waste - T_dc)\cdot \gamma_sw + H_ds \cdot \gamma_ds + H_lc \cdot \gamma_cspc = 199.4444\ \frac{lb}{in^2}$$

$P_we := 0$ (Static Load Pressure of Wet, Saturated soil below water table - Assume top of the pipe is above the leachate)

$P_b := 0$ (Static Load Pressure due to Stationary Structures - Assume no structures)

$P_s$ (Total Static Pressure)

$$P_s := P_de + P_we + P_b = 199.4444\ \frac{lb}{in^2}$$

$P_l := 0\ \frac{lb}{in^2}$ (Total Live Pressure - No Equipment Load for final condition)

$P_i := 0\ \frac{lb}{in^2}$ (Total Internal Pressure - Gravity Flow Pipe, No Internal Pressure)

$$S_A := \frac{(1.43 \cdot M_s \cdot r_CENT)}{E_PM \cdot E_red \cdot A_P} = 0.4597$$ (Hoop Thrust Stiffness Ratio)

$$VAF := 0.88 - 0.71 \cdot \left(\frac{S_A - 1}{S_A + 2.5}\right) = 1.0096$$ (Vertical Arching Factor)

$$P_t := VAF \cdot (P_s + P_l + P_i) = 201.3612\ \frac{lb}{in^2}$$ **(Total Pressure Long Term Condition)**

## Factor of Safety against Wall Crushing

Wall Crushing occurs when the total pressure (P_t) exceeds actual compressive pressure (S_a).

$$S_a := \left[\frac{(SDR - 1)}{2}\right] \cdot P_t = 604.0837 \ \frac{lb}{in^2}$$

Factor of Safety (FS) against wall crushing equals the allowable compressive stress of HDPE pipe (Ys) divided by the actual compressive pressure (Sa).

$$FS_WC := \frac{Y_s \cdot 1.5}{S_a} = 2.8556$$

FS_WC is greater than or equal to 1.5

The FS_WC is greater than 1.5(minimum FS for wall crushing); therefore the pipe is acceptable aganist crushing failure mode

## Factor of Safety Against Wall Buckling

Contrained buckling in deep fill without groundwater present can be determine from the Moore-Selig equation for the critical bucking pressure

$\varphi := 0.55$ (Calibration Factor - for granular materials)

$R_H := 1.0$ (Geometry Factor for deep fill)

$$I := \frac{A_P^3}{12 \ in^3} \cdot \frac{(p_Circ - (perf_num \cdot P_d))}{(p_Circ)} = 0.1458$$ (Moment of Inertia of Perforated Pipe Wall)

$\mu := 0.4$ (Poisson's Ratio of drainage stone)

$$M_P := \frac{M_s}{(1 - \mu)} = 5000 \ \frac{lb}{in^2}$$ (Modified Modulus of Drainage Stone)

$D_m := ODP - A_P$ (Mean Diameter of Pipe (OD-wall thickness), inches)

$P_CR$ **(Critical Buckling Soil Pressure)**

$$P_CR := \left[\frac{2.4 \ in \cdot \varphi \cdot R_H}{ID_P}\right] \cdot (E_PM \cdot E_red \cdot I)^{\frac{1}{3}} \cdot M_P^{\frac{2}{3}} = 1026.3225 \ \frac{lb}{in^2}$$

FS against wall buckling equals the Critical Buckling Soil Pressure (Pcr) divided by the total earth pressure (Pt) reduced by the vertical arching factor for the long term condtions

$$FS_WB := \frac{P_CR}{P_t} = 5.0969$$

**FS_WB is greater than the 1.8 for (minimum FS for Wall Buckling); therefore the pipe is acceptable against buckling failure.**

## Factor of Safety Against Ring Deflection

Ring deflection of flexible pipe under prism loading is derived by the modified Iowa Formula.

$k_BED := 0.1$ (Bedding Factor - for 90 central angle)

$L_DL := 1$ (Deflection Lag Factor, assumed)

$F_S := 1$ (Soil Support Value)

$\Delta_X$ (Horizontal Deflection, inches)

$P_t' := P_t \cdot 144$ (Total Pressure including VAF, psf)

$P_l' := P_l \cdot 144$ (Live Load, psf)

$D_m$ (Mean Diameter of Pipe (OD-wall thickness), inches)

$D_R := \frac{\Delta_X}{D_m}$ (Ring Deflection)

$$D_R := \frac{1}{144} \cdot \left( \frac{(k_BED \cdot L_DL \cdot P_t') + (k_BED \cdot P_l')}{\frac{(2 \cdot E_PM \cdot E_red)}{3} \cdot \left( \frac{1}{SDR - 1} \right)^3 + (0.061 \cdot F_S \cdot M_s)} \right) \cdot 100 = 7.4739$$

Determine the factor of safety against a ring deflection failure.

For non-pressurized pipe, a ring deflection of 7.5 % yields a factor of safety of 3 (Handbook of Polyethylene Pipe, Ch. 6)

$$FS_RD := \frac{7.5}{D_R} \cdot 3 = 3.0105$$

**FS_RD is greater than 3 (minimum FS for Ring Deflection); therefore the pipe is acceptable against excessive ring deflection.**

**Conclusions:** Based upon the calculations above, the HDPE pipe is suitable against crushing, buckling, and ring deflection.

| | | | |
|---|---|---|---|
| Calc By: | Tanner Whitesell, E.I.T. | Tanner Whitesell | 01/30/2025 |
| | Print Name | Signature | Date |
| Checked By: | David Yarbray, E.I.T. | William David Yarbray | 01/30/2025 |
| | Print Name | Signature | Date |
| Reviewed By: | Larry Simonson, P.E. | Lawrence J Simonson | 01/30/2025 |
| | Print Name | Signature | Date |

# Appendix B
# Apparent Elastic Modulus

## B.1 – Apparent Elastic Modulus for the Condition of Either a Sustained Constant Load or a Sustained Constant Deformation

### B.1.1 – Design Values for the Base Temperature of 73°F (23°C)

**TABLE B.1.1**
**Apparent Elastic Modulus for 73°F (23°C)**

| Duration of Sustained Loading | Design Values For 73°F (23°C) [1,2,3] | | | | | |
|---|---|---|---|---|---|---|
| | PE 2XXX | | PE3XXX | | PE4XXX | |
| | psi | MPa | psi | MPa | psi | MPa |
| 0.5hr | 62,000 | 428 | 78,000 | 538 | 82,000 | 565 |
| 1hr | 59,000 | 407 | 74,000 | 510 | 78,000 | 538 |
| 2hr | 57,000 | 393 | 71,000 | 490 | 74,000 | 510 |
| 10hr | 50,000 | 345 | 62,000 | 428 | 65,000 | 448 |
| 12hr | 48,000 | 331 | 60,000 | 414 | 63,000 | 434 |
| 24hr | 46,000 | 317 | 57,000 | 393 | 60,000 | 414 |
| 100hr | 42,000 | 290 | 52,000 | 359 | 55,000 | 379 |
| 1,000hr | 35,000 | 241 | 44,000 | 303 | 46,000 | 317 |
| 1 year | 30,000 | 207 | 38,000 | 262 | 40,000 | 276 |
| 10 years | 26,000 | 179 | 32,000 | 221 | 34,000 | 234 |
| 50 years | 22,000 | 152 | 28,000 | 193 | 29,000 | 200 |
| 100 years | 21,000 | 145 | 27,000 | 186 | 28,000 | 193 |

(1) Although there are various factors that determine the exact apparent modulus response of a PE, a major factor is its ratio of crystalline to amorphous content – a parameter that is reflected by a PE's density. Hence, the major headings PE2XXX, PE3XXX and, PE4XXX, which are based on PE's Standard Designation Code. The first numeral of this code denotes the PE's density category in accordance with ASTM D3350 (An explanation of this code is presented in Chapter 5).

(2) The values in this table are applicable to both the condition of sustained and constant loading (under which the resultant strain increases with increased duration of loading) and that of constant strain (under which an initially generated stress gradually relaxes with increased time).

(3) The design values in this table are based on results obtained under uni-axial loading, such as occurs in a test bar that is being subjected to a pulling load. When a PE is subjected to multi-axial stressing its strain response is inhibited, which results in a somewhat higher apparent modulus. For example, the apparent modulus of a PE pipe that is subjected to internal hydrostatic pressure – a condition that induces bi-axial stressing – is about 25% greater than that reported by this table. Thus, the Uni-axial condition represents a conservative estimate of the value that is achieved in most applications.

It should also be kept in mind that these values are for the condition of continually sustained loading. If there is an interruption or a decrease in the loading this, effectively, results in a somewhat larger modulus.

In addition, the values in this table apply to a stress intensity ranging up to about 400psi, a value that is seldom exceeded under normal service conditions.

## B.1.2 – Values for Other Temperatures

The multipliers listed in Table B.1.2 when applied to the base temperature value (Table B.1.1) yield the value for another temperature.

**TABLE B.1.2**

**Temperature Compensating Multipliers for Determination of the Apparent Modulus of Elasticity at Temperatures Other than at 73°F (23°C)**

**Equally Applicable to All Stress-Rated PE's (e.g., All PE2xxx's, All PE3xxx's and All PE4xxx's)**

| Maximum Sustained Temperature of the Pipe °F (°C) | Compensating Multiplier |
|---|---|
| -20 (-29) | 2.54 |
| -10 (-23) | 2.36 |
| 0 (-18) | 2.18 |
| 10 (-12) | 2.00 |
| 20 (-7) | 1.81 |
| 30 (-1) | 1.65 |
| 40 (4) | 1.49 |
| 50 (10) | 1.32 |
| 60 (16) | 1.18 |
| 73.4 (23) | 1.00 |
| 80 (27) | 0.93 |
| 90 (32) | 0.82 |
| 100 (38) | 0.73 |
| 110 (43) | 0.64 |
| 120 (49) | 0.58 |
| 130 (54) | 0.50 |
| 140 (60) | 0.43 |

| OD | | | Pipe inside diameter (d) | Minimum Wall Thickness (t) | Weight (w) |
|---|---|---|---|---|---|
| Nominal in. | Actual in. | DR | in. | in. | lb. per foot |
| | | 7 | 3.14 | 0.643 | 3.384 |
| | | 7.3 | 3.19 | 0.616 | 3.269 |
| | | 9 | 3.44 | 0.500 | 2.737 |
| | | 9.3 | 3.47 | 0.484 | 2.660 |
| | | 11 | 3.63 | 0.409 | 2.294 |
| 4 | 4.500 | 11.5 | 3.67 | 0.391 | 2.204 |
| | | 13.5 | 3.79 | 0.333 | 1.906 |
| | | 15.5 | 3.88 | 0.290 | 1.678 |
| | | 17 | 3.94 | 0.265 | 1.540 |
| | | 21 | 4.05 | 0.214 | 1.262 |
| | | 26 | 4.13 | 0.173 | 1.030 |
| | | 32.5 | 4.21 | 0.138 | 0.831 |

| OD | | | Pipe inside diameter (d) | Minimum Wall Thickness (t) | Weight (w) |
|---|---|---|---|---|---|
| Nominal in. | Actual in. | DR | in. | in. | lb. per foot |
| | | 7 | 6.01 | 1.232 | 12.433 |
| | | 7.3 | 6.12 | 1.182 | 12.010 |
| | | 9 | 6.59 | 0.958 | 10.054 |
| | | 9.3 | 6.66 | 0.927 | 9.771 |
| | | 11 | 6.96 | 0.784 | 8.425 |
| 8 | 8.625 | 11.5 | 7.04 | 0.750 | 8.096 |
| | | 13.5 | 7.27 | 0.639 | 7.001 |
| | | 15.5 | 7.45 | 0.556 | 6.164 |
| | | 17 | 7.55 | 0.507 | 5.657 |
| | | 21 | 7.75 | 0.411 | 4.637 |
| | | 26 | 7.92 | 0.332 | 3.784 |

# Geomembrane Puncture Resistance Analysis

# GEOMEMBRANE PUNCTURE RESISTANCE (CUSHION) GEOTEXTILE ANALYSIS
## GEOMEMBRANE PROTECTION DESIGN USING NONWOVEN NEEDLE-PUNCHED GEOTEXTILES
## 60 mil HDPE GEOMEMBRANE
## Arrowhead Landfill, Perry County Alabama
### BLE Project Number J24-4999-66

| Analysis Point No. | Conditions | | Geotextile | Effective Diameter ($d_{50}$) | Modification Factors | | | Reduction Factors | | Allowable Bearing Pressure | Planned Max | Factor of Safety |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Geomembrane Thickness & Type | Drainage Stone Type | Mass/Area osy | Leachate Stone or Protective Cover mm | MFs | MFpd | Mfa | RFcbd | RFcr | psf | Waste Thickness | For Est Max Waste Thickness FS Target ≥ 5.0 |
| **Tract 1, Existing Cell No. 8** | 60 mil HDPE | No. 57 Stone, Subrounded | 24 | 17 | 0.5 | 0.57 | 0.5 | 1.3 | 1.26 | 117,570 | 238 | **5.8** |
| **Tract 1, max waste** | 60 mil HDPE | No. 57 Stone, Subrounded | 24 | 17 | 0.5 | 0.57 | 0.5 | 1.3 | 1.26 | 117,570 | 275 | **5.0** |
| **Tract 2** | 60 mil HDPE | No. 57 Stone, Subrounded | 24 | 17 | 0.5 | 0.57 | 0.5 | 1.3 | 1.26 | 117,570 | 269 | **5.1** |
| **Tract 3** | 60 mil HDPE | No. 57 Stone, Subrounded | 30 | 17 | 0.5 | 0.57 | 0.5 | 1.3 | 1.17 | 157,065 | 330 | **5.6** |

Note (1): Unit weight of MSW assumed to be 85 pcf  Unit Wt. of Waste **85 pcf**
Note (2): Maximum waste height conservatively estimated based on Landfill initial and final grading plans provided by Hodges, Harbin, Newberry & Tribble, Inc. (HHNT) September, 2024.
Note (3): Recommended FS ≥ 5.0
Note (4): Geotextile mass/area includes all geotextile layers below the leachate collection stone, including filter geotextiles
Note (5): Average Particle Size (D50) based on median stone gradation.
Note (6): Red text indicates user input values

Definition of Terms

MFs: Modification Factor for Protective Cover particle shape.
MFpd: Modification Factor for Protective Cover packing density.
Mfa: Modification Factor for arching in the Protective Cover.
RFcr: Reduction Factor for long-term creep.
RFcbd: Reduction Factor for long-term chemical/biological degradation.

Based on a large number of ASTM 5514 experiments, an empirical relationship for $p_{allow}$ has been obtained, as shown in equation (5.33). It requires the use of modification factors and reduction factors as given in Table 5.18. Note that in Table 5.18 all MF values ≤1.0 and all RF values ≥1.0.

$$p_{allow} = \left(50 + 0.00045\frac{M}{H^2}\right)\left[\frac{1}{MF_S \times MF_{PD} \times MF_A}\right]\left[\frac{1}{RF_{CR} \times RF_{CBD}}\right] \quad (5.33)$$

| Parameter | Unit | Conversion | | | |
|---|---|---|---|---|---|
| M | g/m2 | 1 oz | 1.0933 yd | 101.5 | kPa |
| H | m | 28.35 g | 1 m | 2116 | psf |
| p | kPa | | | | |
| | | 0.00045 | | | |

Performed by: Tanner Whitesell, EIT
Checked by: David Yarbray, EIT
Reviewed by: Larry Simonson, PE

# GEOMEMBRANE PUNCTURE RESISTANCE (CUSHION) GEOTEXTILE ANALYSIS
## GEOMEMBRANE PROTECTION DESIGN USING NONWOVEN NEEDLE-PUNCHED GEOTEXTILES
## 60 mil HDPE GEOMEMBRANE
## Arrowhead Landfill, Perry County Alabama
### BLE Project Number J24-4999-66

## MODIFICATION FACTORS AND REDUCTION FACTORS FOR GEOMEMBRANE PROTECTION DESIGN USING NONWOVEN NEEDLE-PUNCHED GEOTEXTILES

### Modification Factors

| MFs | |
|---|---|
| Angular | 1.00 |
| Subangular | 0.75 |
| Subrounded | 0.50 |
| Rounded | 0.25 |

| MFpd | |
|---|---|
| Isolated Particle | 1.00 |
| Dense, 38 mm Particle | 0.83 |
| Dense, 25 mm Particle | 0.67 |
| Dense, 12mm Particle | 0.50 |
| Dense, 6mm Particle | 0.33 |
| Dense, 4mm Particle | 0.25 |

| Mfa | |
|---|---|
| Hydrostatic | 1 |
| Geostatic, Shallow | 0.75 |
| Geostatic, mod. | 0.5 |
| Geostatic, deep | 0.25 |

### Reduction Factors

| RFcbd | |
|---|---|
| Mild Leachate | 1.00 |
| Moderate Leachate | 1.30 |
| Harsh Leachate | 1.50 |

| RFcr | | | | | |
|---|---|---|---|---|---|
| Geotextile Mass/Area | Maximum Particle Size | | | | |
| (osy) | 38 mm | 25mm | 12mm | 6mm | 4mm |
| 0 | N/R | N/R | N/R | N/D | N/D |
| 8 | N/R | N/R | >1.5 | 1.5 | 1.5 |
| 16 | N/R | 1.5 | 1.3 | 1.3 | 1.3 |
| 32 | 1.3 | 1.2 | 1.1 | 1.1 | 1.1 |
| >32 | 1.2 | 1.1 | 1 | 1 | 1 |

N/R: Not Recommended by Koerner.
N/D: No data provided by Koerner.

Reference:

*Designing With Geosynthetics* , Fourth Addition, July 1999, Robert M. Koerner
Chapter 5 Designing with Geomembranes. Section 5.6 Solid-Material Landfill Liners
pp 535 - 548. Table 5.18 and Formula Number 5.33

*Geosynthetics 2003: Design of Waste Containment Liner & Final Closure Systems*
Robert Mackey, P. E. and Richard Thiel, P. E.
Puncture Protection Formulas

# CALCULATION DOCUMENTATION
# SLOPE STABILITY ANALYSIS

## MAJOR MODIFICATION SUPPORT
## ARROWHEAD LANDFILL
## PERRY COUNTY, ALABAMA

BLE Project No. J24-4999-66

Prepared By: _____

Tanner Whitesell, E.I.T.

Date: January 30, 2025

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Date: January 30, 2025

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## PURPOSE

Analyze the slope stability of representative cross sections of the proposed maximum operational 3H:1V interim and final slope conditions at Arrowhead Landfill. The following cross-sections were analyzed:

- A-A′ (Tract 1 east and west slopes, through existing Cell No. 8)
- B-B′ (Tract 2 south slope, through proposed Cell No. 3)
- C-C' (Tract 3 north west slope, through proposed Cell Nos. 3, 4, and 5)
- D-D' (Tract 3 south slope, through proposed Cell Nos. 3, 4, and 6)
- E-E' (Tract 1 interim north slope, through existing Cell No. 8 and proposed Cell No. 9)
- F-F' (Tract 2 interim northeast slope, through proposed Cell Nos. 7, 8, and 9)
- G-G' (Tract 3 interim east slope, through proposed Cell Nos. 3, 4, 5, 7, and 9)

Potential slip surfaces were modeled to consider subgrade, interface sliding, and waste-only modes of mass landfill slope displacement. The interface sliding mode of displacement considers peak and large displacement interface friction strength parameters of the bottom liner system interfaces. Static interim short-term slope conditions are modeled, as well as long-term static and pseudo-static (seismic) final grade conditions. The following represents the recommended minimum target factors of safety (FS) for each analysis condition:

- Final Slopes:
  i. For long-term, static conditions, FS $\geq$ 1.5
  ii. For interface sliding failure modes where large displacement (residual) strength of the base liner system is modeled, FS $\geq$ 1.1 is considered acceptable (Geotechnical Resource Group, 2004) (Bonaparte, Othman, Rad, Swan, & Vander Linde, 1996).
  iii. Seismic F.S. > 1.0, or an acceptable seismic-induced deformation.
- Interim Slopes – for short-term, static conditions, FS $\geq$ 1.3

## DESCRIPTION OF ANALYSIS

### General Conditions

1. Tract 1, 2, and 3 existing ground surface topography, proposed initial grades (top of clay liner), and final grades were obtained from drawings titled "Vertical Expansion Arrowhead Landfill", provided September 13, 2024 by Hodges, Harbin, Newberry, & Tribble, Inc. (HHNT).
   a. The as-built top of clay liner grades of existing cells within Tract 1 were obtained from electronic drawing files provided September 27, 2024 by HHNT.
   b. Revised Tract 3 final grades were obtained the electronic drawing file titled "EMAIL – TRACT 3 – R", provided by HHNT on January 28, 2025.

c. The modeled final grade conditions in Tract 3 are based on prior design grades provided by HHNT. The revised Tract 3 final grades provided by HHNT on January 28, 2025 reduced the proposed waste height on the order of 10 vertical feet. Therefore, the modeled cross sections in Tract 3 are considered to be conservative.

2. Groundwater contour elevations were obtained from the drawing titled "Groundwater Elevation Contour Map (Eutaw Formation) – September 12, 2023" by BLE, dated April 2024.
3. Information of the subsurface soil conditions has been obtained from the *Report of Geotechnical Exploration and Laboratory Testing – Perry Uniontown Landfill*, by BLE dated January 16, 2007. The subsurface profile consists of soft limestone (chalk) and clayey sediments. The soils are dominantly clay materials.
4. The constructed base liner system of the existing cells (Cell Nos. 1-8) within Tract 1 were reported in CQA documentation by BLE (Cell Nos. 1-6B, and recently constructed Cell No. 8) and Atlantic Coast Consulting, Inc. (Cell No. 7). The bottom liner system consists of (from top to bottom):
    - 12 to 24-inches of soil protective cover ($k \geq 1 \times 10^{-2}$ cm/s)
    - 24-osy cushion geotextile
    - 60-mil textured HDPE geomembrane layer
    - 24-inches of compacted clay liner ($k \leq 1 \times 10^{-7}$ cm/s)
5. The base liner system in the proposed cells is assumed to consist of the following components, as designed by the "Bottom Liner and Protective Cover Systems" (Detail 19) in the Permit Renewal dated March 2016, (from top to bottom):
    - 12-inches of soil protective cover ($k \geq 1 \times 10^{-2}$ cm/s)
    - 24-osy cushion geotextile
    - 60-mil textured high density polyethylene (HDPE) geomembrane layer
    - 24-inches of compacted clay liner ($k \leq 1 \times 10^{-7}$ cm/s)
6. It is our understanding that the bottom liner leachate collection system is maintaining less than 30 cm of head on the liner. Therefore, the proposed waste mound was assumed to be free draining. Therefore, no piezometric surface was applied to the modeled waste.
7. Estimated shear strength and unit weight properties for the modeled material types are presented in **Table 2**. Shear strength parameters for the subgrade soils were estimated based on standard penetration test data from available on-site soil test boring records, laboratory testing results, and our experience with similar soils. The shear strength of the municipal solid waste (MSW) was modeled having a non-linear relationship with increasing overburden stress, as commonly cited in literature for typical MSW (Bray, et al., 2009).
8. The USGS Unified Hazard Tool and the American Society of Civil Engineers (ASCE) ASCE 7 Hazard Tool were used to develop the seismic spectral response. Given the site location and subsurface conditions, a seismic Site Class "C" was calculated for the site. The peak ground acceleration (PGA) for the site was determined to be 0.24g based on the 2018 USGS National Seismic Map.

a. Bray and Travasarou's (Bray J. a., 2009) method was used for calculation of the seismic coefficient ($k_s$) as a function of the median allowable seismic displacement and seismic hazard at the project site given the following design criteria

**Table 1: Seismic Coefficient Input Parameters**

| Input Criteria | Value | Source |
|---|---|---|
| Median Displacement ($D_a$) | 15 cm | Bray and Travasarou (2009) |
| Shear Wave Velocity ($V_s$) | 541 m/s | Table 20.3-1 (ASCE 7-22) |
| Fundamental Period ($T_s$) | 0.54 sec | Calculated |
| Spectral Acceleration ($S_a$) [Not PGA] | 0.16g | Calculated (Chap. 11 Eq. 11.4-5, ASCE 7-22) |
| Moment Magnitude ($M_w$) | 6.16 | USGS Hazard Tool, 2018 |
| Probability of Exceeding Displacement | 50% | Bray and Travasarou (2009) |
| Random Variable Factor (ε) | 0 | Bray and Travasarou (2009) for 50% probability |

b. The Bray and Travasarou's (2009) site-specific and allowable displacement - dependent value of the seismic coefficient ($k_s$) is:

$$k_s = \exp\left[\frac{-a + \sqrt{b}}{0.665}\right]$$

Where:

$$a = 2.83 - 0.566 \ln(S_a)$$

$$b = a^2 - 1.33 * \{\ln(D_a) + 1.10 - 3.04 \ln(S_a) + 0.244[\ln(S_a)]^2 - 1.5T_s - 0.278(M - 7) - \varepsilon\}$$

$$k_s = \exp\left[\frac{-3.866+\sqrt{2.153}}{0.665}\right] = 0.03$$

Therefore, the seismic coefficient used for the seismic pseudo-static analysis is **$k_s$ = 0.03.**

## Assumptions

The results of our analysis are contingent on the following general assumptions which pertain to landfill operations. It is our understanding that the site is to continue little to no acceptance of HMCW. The total waste disposal tonnage ranges from 6,500 tons per day (tpd) to 8,000 tpd in the past year. The site intends to take a tonnage rate as high as 10,000 tpd. If the anticipated tonnage acceptance rate is to exceed 10,000 tpd, we request to be informed of the changes to revise our analysis.

1. Storm water will be controlled to prevent long-term saturation of constructed waste slopes.
2. The leachate collection system will reduce the liquid head on the geomembrane liner to less than 30 cm.

3. Proper grassing and erosion control will be provided for the long-term performance of the exterior landfill slopes.
4. Excess pore pressure due to excess landfill gas and leachate conditions within the MSW was not considered in the analysis.
5. Assumed no sludge waste is present within 50 feet of the outside landfill slopes.

The waste stream has been assumed to consist primarily of MSW or industrial waste that meets the EPA and state criteria for paint filter tests. All sludges present within the waste are assumed to have been thoroughly mixed with the MSW at the time of placement. The MSW stream should be such that it retains the shear strength used in this analysis. Otherwise, additional analysis should be performed.

The waste stability analysis is contingent upon proper waste placement practices including the following:

1. When beginning new waste lifts over previous waste lifts, cover soils are removed to provide waste to waste contact.
2. Placement of sludges in lifts or in excavations within the waste are to be prohibited.
3. Storm water is to be managed to prevent prolonged ponding over the landfill surface.
4. Leachate and landfill gas are to be properly controlled as the waste placement progresses in order to prevent excess pore pressures from gas and liquids.
5. Waste is placed and compacted in horizontal lifts and not pushed downhill.
6. Waste is placed starting from the lowest elevation of each cell and working upward in horizontal lifts.
7. Each lift is to be keyed into an existing slope from prior lifts, i.e., sliver fills are properly benched to provide waste to waste contact.
8. Intermediate landfill slopes should not terminate in the cell floor, but rather the toe of the waste slope should be at the edge of the landfill cell/section.

Failure to properly place, compact, and maintain the waste mound could result in lower factors of safety than those calculated in this analysis and therefore lead to instability.

## ANALYSIS METHODOLOGY

The analysis was performed using the modeling software Slide2 of the Rocscience software package (2023 Release, Version 9.031). The analysis used the Morgenstern-Price method of slices for limit equilibrium, using an Entry/Exit (circular failure) or a block specified (block failure) slip surface search criteria. The Morgenstern-Price method of analysis satisfies force and moment equilibrium equations and permits assumed side force inclinations to be iteratively varied. The results of limit equilibrium methods that satisfy all conditions of equilibrium are considered accurate for engineering practice (Duncan J. M., 1996). An iterative optimization search procedure was then performed, which provided an optimized composite failure surface. In general, the program calculates the factor of safety for potential slip surfaces from the ratio of available shear resistance and the shear resistance required to provide equilibrium.

Slip surface constraints were assigned to identify three potential displacement modes: *Global shear* planes which may intercept the cell liner, subgrade, and structural fill perimeter berm; *interface sliding* shear planes which follow the geosynthetic liner system interfaces; and *waste-only* shear

planes limited to the waste mass above the base liner system. These displacement modes were modeled for the 3H:1V planned interim and final perimeter waste slopes.

Analysis was performed for the proposed structural fill berm located at northwest perimeter of proposed Tract 3 as represented by cross section C-C'. This is representative of the tallest structural fill slope associated with the final grading plan and infrastructure. Global stability analysis was performed to consider the slope stability factor of safety for deep-seated shearing through the structural fill considering a static surcharge of 250 psf applied to the perimeter access roadway representative of a typical traffic load condition. The structural fill is expected to consist of the on-site clay which is the predominant soil type encountered in the historical boring logs made available for use in this analysis.

## Shear Strength Parameters

The shear strength parameters for the in-situ subsurface soil and fill soil, liner interface system, and MSW were estimated based on available shear strength testing data and our experience with similar materials. A summary of the modeled interface shear strengths is reported in **Table 2** below.

For the modeled interface sliding slope deformation condition in an existing cell as represented by cross section A-A', the base liner was modeled having a shear strength representative of the lowest strength geosynthetic interface present in the cell's liner system profile. Strength parameters were obtained from available interface friction testing data from historical construction quality assurance (CQA) documentation. The lowest tested interface friction peak and corresponding large displacement strength parameters for the liner system components in Cell No. 8 were used in this analysis. For the proposed cells where interface friction testing data has not yet been performed, interface friction shear strengths were estimated based on our experience with interface friction testing. For base liner side slopes greater than 4H:1V in inclination, the base liner system is modeled as exhibiting large displacement interface shear strength for static slope conditions based on the assumption that shear strain developed along the liner system interfaces will exceed strains typically associated with peak strengths as a results of waste filling operations and waste settlement along the slope.

**Table 2: Geotechnical Material Parameters**

| Material | Total Unit Weight (pcf) | Effective, Drained | | Total, Undrained | | Pseudostatic Seismic[2] | |
|---|---|---|---|---|---|---|---|
| | | Friction Angle, Φ' (degrees) | Cohesion, c' (psf) | Friction Angle, Φ (degrees) | Cohesion, c (psf) | Friction Angle, Φ (degrees | Cohesion, c (psf) |
| Structural Fill | 125 | 30 | 50 | --- | --- | --- | --- |
| Subgrade Soil[1] | 120 | 36 | 195 | 20 | 172 | 16 | 137 |
| Min. Cell No. 8 Geosynthetic Interface – Peak[3] | 125 | σn = 250 psf at τ = 170 psf; σn = 1000 psf at τ = 437 psf; σn = 3000 psf at τ = 1004 psf; | | | | --- | --- |
| Min. Cell No. 8 Geosynthetic Interface – Large Displacement[3] | 125 | σn = 250 psf at τ = 168 psf; σn = 1000 psf at τ = 255 psf; σn = 3000 psf at τ = 889 psf; | | | | --- | --- |
| Future Cells Geosynthetic Interface – Peak [Recommended][4] | 125 | $\phi_1$ = 20°, $\phi_2$ = 15°; $\sigma_n$ = 1,000 psf | | | | --- | --- |
| Future Cells Geosynthetic Interface – Large Displacement [Recommended][4] | 125 | $\phi_1$ = 15°, $\phi_2$ = 10°; $\sigma_n$ = 1,000 psf | | | | --- | --- |
| MSW[5] | 85 | See Note 5 | | | | --- | --- |

**Table 2 Notes:**

1) Shear strength parameters taken from BLE conducted Consolidated Undrained Triaxial laboratory testing (BLE, 2007).
2) Accounts for a recommended total shear strength reduction of 20% in pseudostatic analysis (summarized by Duncan et al, 2015, Table 10.1, pp 183). Where a reduced pseudostatic strength is not used, a total undrained shear strength is assumed for the analysis.
3) Direct shear testing of each component of the liner system interface was performed at normal loads, 250, 1000, and 3000 psf, the minimum peak and corresponding large displacement shear strength was plotted, and a decaying power function trendline developed to model the interface friction for the peak and large displacement shear strengths.

$$\tau = a * {\sigma_n}^b$$

a = slope of envelope
b = curvature of envelope
$\sigma_n$ = normal load

Figure 1 displays the composite envelope for peak and large displacement interface shear strength based on the average of the minimum peak values from CQA testing of Cell No. 8. Table 3 displays the shear strength envelopes for peak and large displacement interface shear strength.

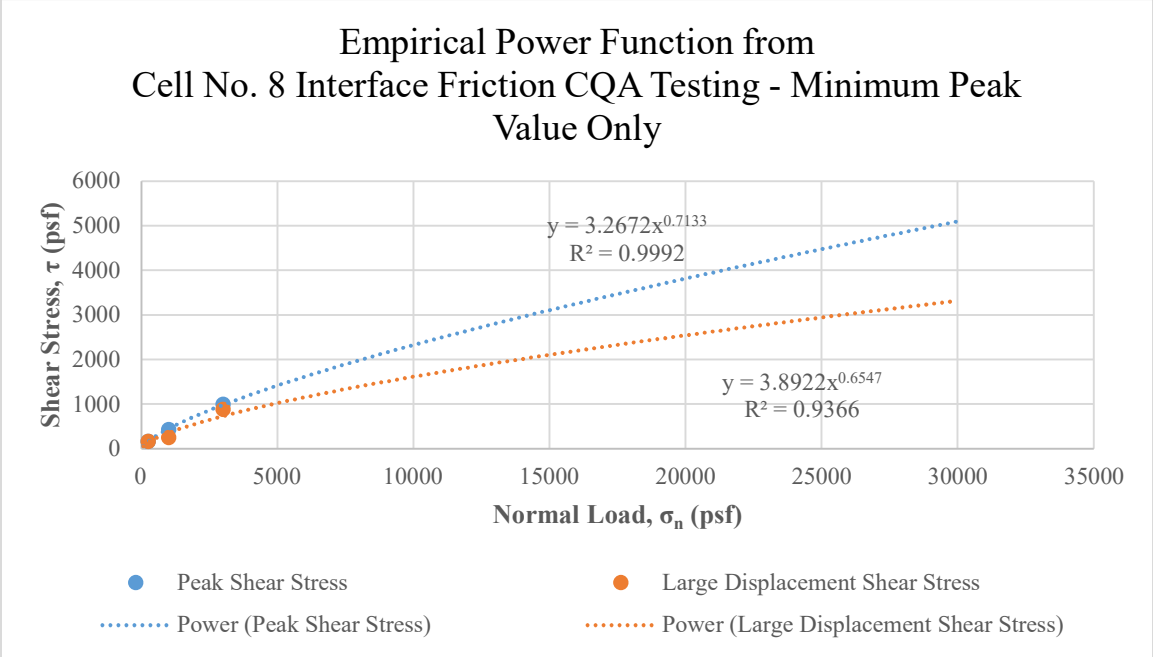


**Figure 1 – Estimated Peak and Large Displacement Interface Shear Strength Envelopes Using Average of Minimum Peak Interface Shear Strength Values for Liner System of Cell No. 8**

**Table 3: Calculated Composite Peak and Large Displacement Interface Friction Shear Strength from Figure 1 Empirical Power Functions**

| Normal Load (psf) | Peak Shear Stress (psf) | Peak Secant Angle (deg) | Large Displacement Shear Stress (psf) | Large Displacement Secant Angle (deg) |
|---|---|---|---|---|
| 0 | 0 | - | 0 | 0 |
| 250 | 170.0 | 34.2 | 168.0 | 33.9 |
| 1000 | 437.0 | 23.6 | 255.0 | 14.3 |
| 3000 | 1004.0 | 18.5 | 889.0 | 16.5 |
| 6000 | 1618.6 | 15.1 | 1158.1 | 10.9 |
| 9000 | 2161.4 | 13.5 | 1510.2 | 9.5 |
| 12000 | 2653.7 | 12.5 | 1823.2 | 8.6 |
| 15000 | 3111.6 | 11.7 | 2110.0 | 8.0 |
| 18000 | 3543.7 | 11.1 | 2377.5 | 7.5 |
| 21000 | 3955.6 | 10.7 | 2630.0 | 7.1 |
| 24000 | 4350.9 | 10.3 | 2870.2 | 6.8 |
| 27000 | 4732.3 | 9.9 | 3100.3 | 6.6 |
| 30000 | 5101.6 | 9.7 | 3321.7 | 6.3 |

4) The recommended minimum peak and large displacement interface shear strength functions for future landfill cells were established to correspond to acceptable factors of safety for the condition of base liner sliding modes of deformation. The recommended peak and large displacement interface shear strengths are presented in Table 10.
5) The estimated MSW shear strength is based on the non-linear strength function as published by Bray et al. (2009). The function is defined as follows and is depicted in **Figure 2:**

$$\tau = c + \sigma_n * \tan(\phi_\sigma)$$
$$\phi_\sigma = \phi_0 - \Delta\phi * \log_{10}\left(\frac{\sigma_n}{p_a}\right)$$

where

$\tau$ = shear strength
$c$ = cohesion intercept, 313 psf
$\sigma_n$ = total normal stress
$\phi_\sigma$ = normal stress dependent friction angle
$\phi_0$ = friction angle measured at a normal stress of 1 atm = 36º
$\Delta\phi$ = change of friction angle over 1 log-cycle change of normal stress = 5º
$p_a$ = atmospheric pressure = 1 atm

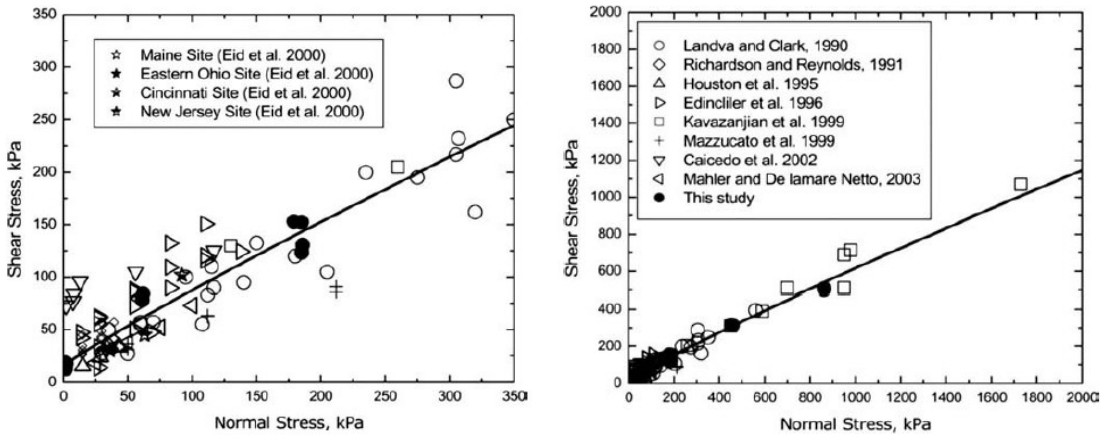


**Figure 2**: Municipal Solid Waste (MSW) Curvilinear Shear Strength Envelope (Bray et al., 2009).

## ANALYSIS RESULTS

The analysis considers modeled potential slip surfaces for multiple shearing modes for the waste mound in static conditions. A *Global (Subgrade)* shearing mode denotes a composite slip plane through the waste, intercepting the protective cover and liner system, and exiting the ground surface through the compacted fill or in-situ soil. An *Interface Sliding* shearing mode represents a slip surface that is forced to slide along the base liner system interface. A *Waste-Only* shearing mode represents a potential slip plane limited to the waste mass and is primarily governed by the slope inclination and the pore pressure conditions. A *Localized Fill and Subgrade* shearing mode is evaluated for the planned structural fill slope at the northwest perimeter of Tract 3. This considers the shearing of the structural fill soils.

Each of these shearing modes are evaluated against a minimum factor of safety of 1.5 for static long-term conditions, 1.1 where large displacement interface strengths are modelled for the entire length of the base liner system, 1.3 for short-term interim slope conditions, and 1.0 for long-term seismic conditions. The minimum factor of safety (FS) value from all shearing modes analyzed is reported in the following **Tables 4 - 9** as the critical slip surface FS for each condition.

**Table 4: Slope Stability Analysis Results: Section A-A', Tract 1 East Slope**

| Loading Conditions | Run No. | Minimum FS | Target FS | FS Target Met |
|---|---|---|---|---|
| **Final Static Loading Conditions – Tract 1, East Slope** | | | | |
| Waste Only | A.1.E | 2.5 | 1.5 | YES |
| Global - Subgrade | A.2.E | 2.4 | 1.5 | YES |
| Interface Sliding - Peak | A.3.E | 1.6 | 1.5 | YES |
| Interface Sliding – Large Displacement | A.4.E | 1.3 | 1.1 | YES |
| **Final Seismic Loading Conditions – Tract 1, East Slope** | | | | |
| Waste Only | A.5.E | 2.7 | 1.0 | YES |
| Global - Subgrade | A.6.E | 1.7 | 1.0 | YES |
| Interface Sliding - Peak | A.7.E | 1.5 | 1.0 | YES |

As shown in **Table 4**, acceptable factors of safety are achieved under long-term static and seismic 3H:1V final grade conditions for interface sliding, global, and waste-only modes of slope deformation for the east slope of Tract 1, as represented by cross section A-A'.

**Table 5: Slope Stability Analysis Results: Section A-A', Tract 1 West Slope**

| Loading Conditions | Run No. | Minimum FS | Target FS | FS Target Met |
|---|---|---|---|---|
| **Final Static Loading Conditions – Tract 1, West Slope** | | | | |
| Waste Only | A.1.W | 2.5 | 1.5 | YES |
| Global - Subgrade | A.2.W | 2.4 | 1.5 | YES |
| Interface Sliding - Peak | A.3.W | 1.5 | 1.5 | YES |
| Interface Sliding – Large Displacement | A.4.W | 1.3 | 1.1 | YES |
| **Final Seismic Loading Conditions – Tract 1, West Slope** | | | | |
| Waste Only | A.5.W | 2.7 | 1.0 | YES |
| Global - Subgrade | A.6.W | 1.7 | 1.0 | YES |
| Interface Sliding - Peak | A.7.W | 1.5 | 1.0 | YES |

As shown in **Table 5**, acceptable factors of safety are achieved under long-term static and seismic 3H:1V final grade conditions for interface sliding, global, and waste-only modes of slope deformation for the west slope of Tract 1, as represented by cross section A-A'.

**Table 6: Slope Stability Analysis Results: Section B-B', Tract 2 South Slope**

| Loading Conditions | Run No. | Minimum FS | Target FS | FS Target Met |
|---|---|---|---|---|
| **Final Static Loading Conditions – Tract 2, South Slope** | | | | |
| Waste Only | B.1 | 2.4 | 1.5 | YES |
| Global - Subgrade | B.2 | 2.4 | 1.5 | YES |
| Interface Sliding - Peak | B.3 | 1.5 | 1.5 | YES |
| Interface Sliding – Large Displacement | B.4 | 1.1 | 1.1 | YES |
| **Final Seismic Loading Conditions – Tract 2, South Slope** | | | | |
| Waste Only | B.5 | 2.6 | 1.0 | YES |
| Global - Subgrade | B.6 | 1.7 | 1.0 | YES |
| Interface Sliding - Peak | B.7 | 1.4 | 1.0 | YES |

As shown in **Table 6**, acceptable factors of safety are achieved under long-term static and seismic 3H:1V final grade conditions for interface sliding, global, and waste-only modes of slope deformation for the south slope of Tract 2, as represented by cross section B-B'.

**Table 7: Slope Stability Analysis Results: Section C-C', Tract 3 Northwest Slope**

| Loading Conditions | Run No. | Minimum FS | Target FS | FS Target Met |
|---|---|---|---|---|
| **Final Static Loading Conditions – Tract 3, Northwest Slope** | | | | |
| Waste Only | C.1 | 2.3 | 1.5 | YES |
| Global - Subgrade | C.2 | 2.3 | 1.5 | YES |
| Interface Sliding - Peak | C.3 | 1.5 | 1.5 | YES |
| Interface Sliding – Large Displacement | C.4 | 1.1 | 1.1 | YES |
| **Final Static Loading Conditions – 3H:1V Fill Slope** | | | | |
| Global Subgrade (traffic loading, 250 psf) | C.2.1 | 2.1 | 1.5 | YES |
| **Final Seismic Loading Conditions – Tract 3, Northwest Slope** | | | | |
| Waste Only | C.5 | 2.5 | 1.0 | YES |
| Global - Subgrade | C.6 | 1.6 | 1.0 | YES |
| Interface Sliding - Peak | C.7 | 1.5 | 1.0 | YES |
| **Final Seismic Loading Conditions – 3H:1V Fill Slope** | | | | |
| Global Subgrade (traffic loading, 250 psf) | C.6.1 | 1.5 | 1.0 | YES |

As shown in **Table 7**, acceptable factors of safety are achieved under long-term static and seismic 3H:1V final grade conditions for interface sliding, global, and waste-only modes of slope deformation for the northwest slope of Tract 3, as represented by cross section C-C'. Acceptable factors of safety are achieved for the proposed approximate 3H:1V northwestern fill slope under static and seismic loading conditions.

**Table 8: Slope Stability Analysis Results: Section D-D', Tract 3 South Slope**

| Loading Conditions | Run No. | Minimum FS | Target FS | FS Target Met |
|---|---|---|---|---|
| **Final Static Loading Conditions – Tract 3, South Slope** | | | | |
| Waste Only | D.1 | 2.3 | 1.5 | YES |
| Global - Subgrade | D.2 | 2.3 | 1.5 | YES |
| Interface Sliding - Peak | D.3 | 1.5 | 1.5 | YES |
| Interface Sliding – Large Displacement | D.4 | 1.1 | 1.1 | YES |
| **Final Seismic Loading Conditions – Tract 3, South Slope** | | | | |
| Waste Only | D.5 | 2.5 | 1.0 | YES |
| Global - Subgrade | D.6 | 1.6 | 1.0 | YES |
| Interface Sliding - Peak | D.7 | 1.5 | 1.0 | YES |

As shown in **Table 8**, acceptable factors of safety are achieved under long-term static and seismic 3H:1V final grade conditions for interface sliding, global, and waste-only modes of slope deformation for the south slope of Tract 3, as represented by cross section D-D'.

**Table 9: Interim Slope Conditions – Slope Stability Analysis Results:**

| Loading Conditions | Run No. | Minimum FS | Target FS | FS Target Met? |
|---|---|---|---|---|
| **Interim Static Loading Conditions – 3H:1V Tract 1 Operational Slope, Section E-E'** | | | | |
| Waste Only | E.1 | 2.4 | 1.3 | YES |
| Global - Subgrade | E.2 | 2.4 | 1.3 | YES |
| Interface Sliding – Peak Strength | E.3 | 1.5 | 1.3 | YES |
| **Interim Static Loading Conditions – 3H:1V Tract 2 Operational Slope, Section F-F'** | | | | |
| Waste Only | F.1 | 2.4 | 1.3 | YES |
| Global - Subgrade | F.2 | 2.4 | 1.3 | YES |
| Interface Sliding – Peak Strength | F.3 | 1.5 | 1.3 | YES |
| **Interim Static Loading Conditions – 3H:1V Tract 3 Operational Slope, Section G-G'** | | | | |
| Waste Only | G.1 | 2.3 | 1.3 | YES |
| Global – Subgrade | G.2 | 2.3 | 1.3 | YES |
| Interface Sliding – Peak Strength | G.3 | 1.4 | 1.3 | YES |

As shown in **Table 9**, acceptable factors of safety are achieved under short-term static 3H:1V interim grade conditions for interface sliding, global, and waste-only modes of slope deformation for the expected interim slope conditions for Tract 1, 2, and 3, as represented by cross section E-E', F-F', and G-G', respectively.

**Table 10: Recommended Minimum Interface Shear Strengths for Base Liner Systems**

| Normal Load (psf) | Peak Shear Strength [psf] (Secant Friction Angle) | Large Displacement Shear Strength [psf] (Secant Friction Angle)[(2)] |
|---|---|---|
| 1,000 | 510 (27.0°) | 250 (14.0°) |
| 8,000 | 2069 (14.5°) | 1125 (8.0°) |
| 15,000 | 3188 (12.0°) | 1842 (7.0°) |
| 20,000 | 4069 (11.5°) | 2279 (6.5°) |

Note (1): For each landfill waste cell construction project, a minimum of 2 tests should be performed for each interface, including the soil liner to the lowermost geosynthetic liner, and should cover the normal loads in **Table 10**. Test results should be reviewed by a geotechnical engineer specializing in solid waste landfills and experienced in interface friction testing. The average of the 2 tests should exceed the values in **Table 10** with none of the test being less than 80% of the listed value.
Note (2): The large-displacement values should be obtained from the interface with the lowest peak shear strength.
Note (3): The shear strength may be considered a combination of cohesion and friction angle at each normal load.
Note (4): Peak shear strength at 1,000 psf required to achieve an acceptable factor of safety for veneer stability of the base liner system.

Pre-construction interface friction testing of the liner system components should be assigned and reviewed by a design engineer with experience in interface friction testing to confirm that the minimum peak and residual strength values of the tested interfaces meet or exceed those identified in this evaluation.

## CONCLUSION

The results of our stability analysis are contingent upon the stated conditions and assumptions. If existing or proposed slope conditions in Tract 1, 2, and 3 are understood to deviate from the conditions modeled in this analysis, we request to be informed of the changes to revise our analysis. Examples of the significant items to be reviewed include, but are not limited to, increases in high moisture content waste or low shear strength waste intake to greater than 20%, change in fill sequence, increase of liquid level or gas pressure (pore pressure) within the waste mound, and an increase in waste tonnage acceptance to an average value greater than 10,000 tons per day.

The analysis results of the interim and final waste slopes in Tracts 1, 2, and 3 have been modeled to result in acceptable factors of safety considering the stated conditions, notably the interface friction shear strength values assigned to the bottom liner system. These conditions should be achieved during cell construction and landfill operation for our analysis to remain valid.

**Attachments:**

*Seismic Hazard Design Parameters*

Unified Hazard Tool 2018, U.S. Geological Survey
ASCE Hazard Tool 2018, U.S. Geological Survey (PGA Value) for Lithified Earth
Seismic Site Classification Calculation
ASCE Hazard Tool 2018, U.S. Geological Survey (PGAm Value) for Site Class C
Bray & Travasarou (2009) Seismic Coefficient Calculation ($k_s$ Value)
Boring B-1 (BLE, 2007)

*Historical CQA Interface Friction Laboratory Test Results*

Tract 1, Cell No. 8 Interface Friction Result Summary Table
Tract 1, Cell No. 8 Test Results

*Slope Stability Analysis*

Slope Stability Analysis Interface Shear Strength Functions
Stability Analysis Model Results
Table 4 Runs – A-A', Tract 1 East Slope
Table 5 Runs – A-A', Tract 1 West Slope
Table 6 Runs – B-B', Tract 2 South Slope
Table 7 Runs – C-C, Tract 3 Northwest Slope
Table 8 Runs – D-D, Tract 3 South Slope
Table 9 Runs – Interim Slope Conditions

## REFERENCES

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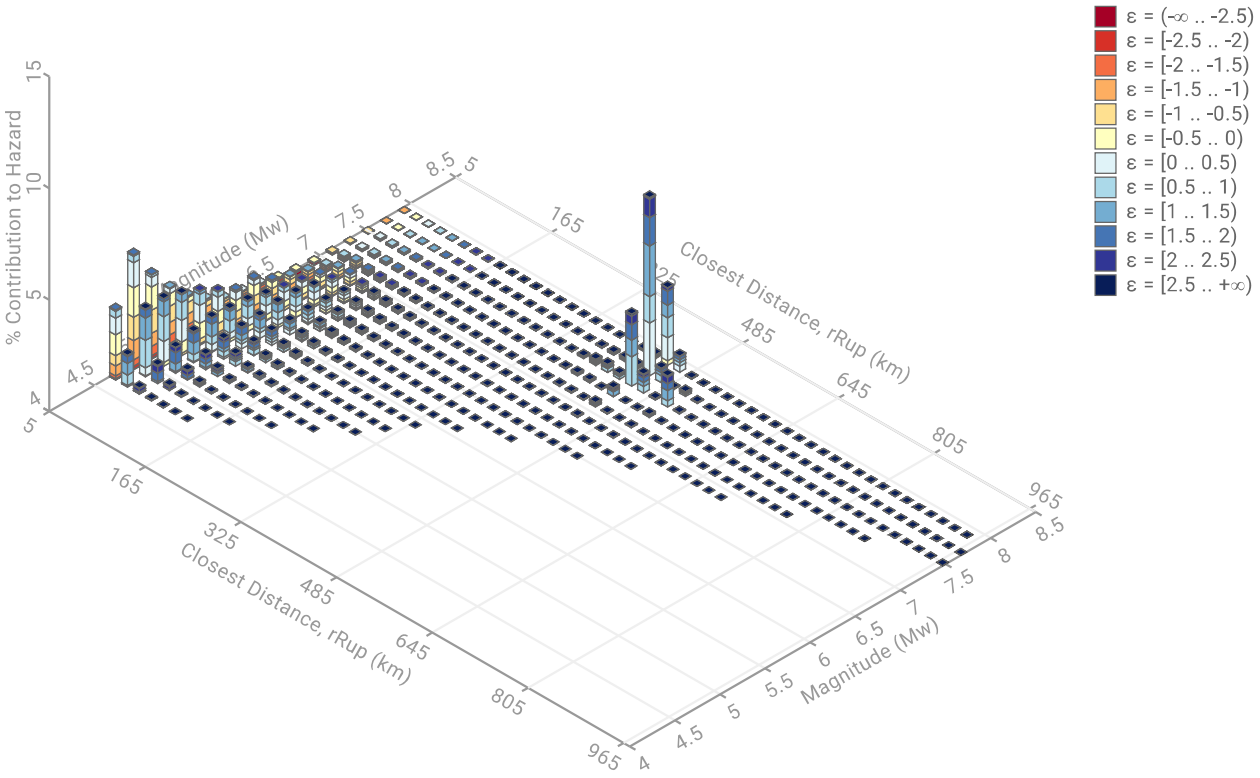
# SEISMIC DESIGN HAZARD PARAMETERS

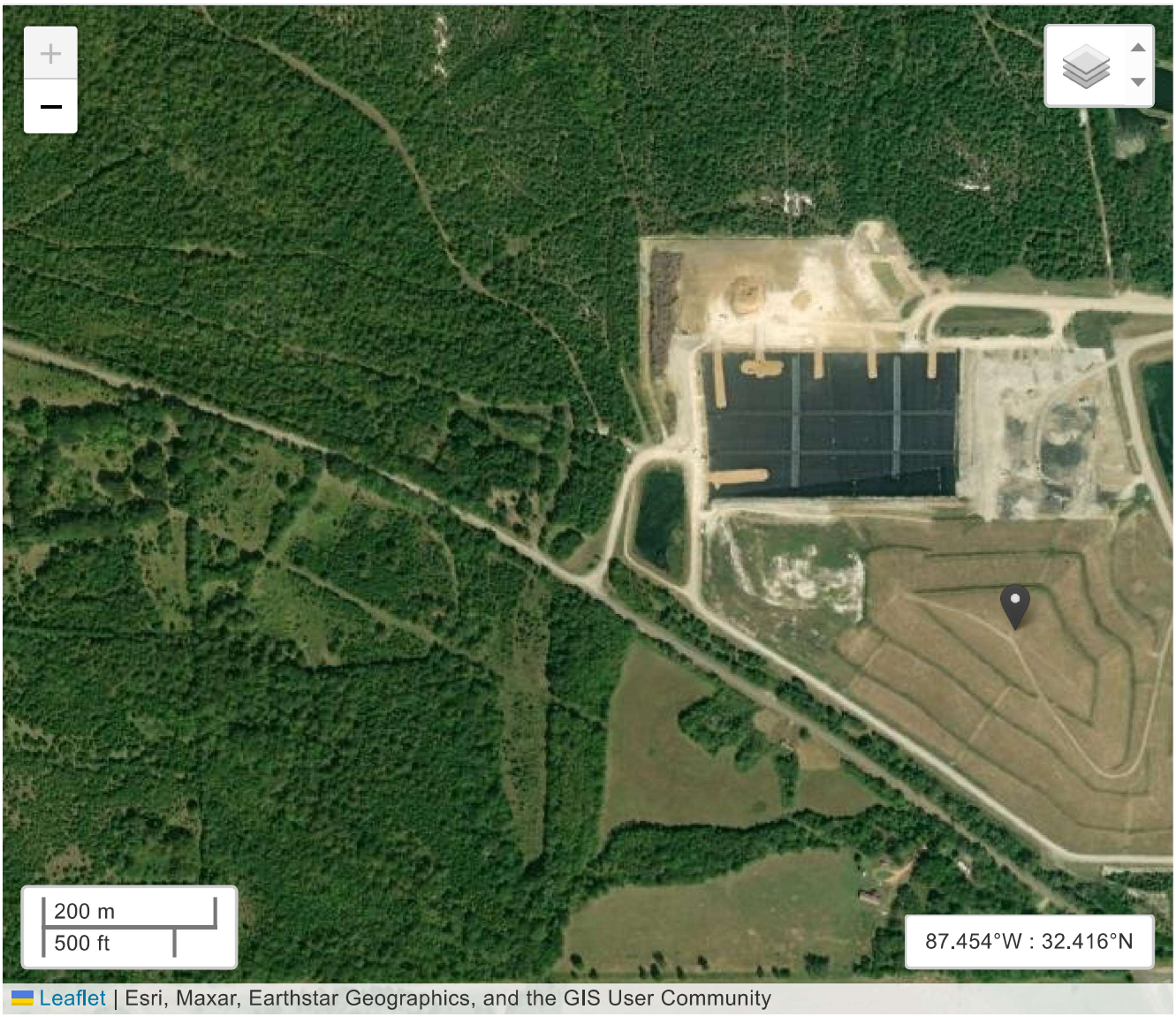
# Unified Hazard Tool 2018, U.S. Geological Survey

# Disaggregation Report

## Disaggregation



## Geographical Disaggregation




## Parameter Summary

**Model**: NSHM Conterminous U.S. 2018

**Latitude**: 32.412798 °

**Longitude**: -87.468398 °

**Site Class**: BC (Vs30 760)

**Intensity Measure Type**: PGA

**Return Period**: 2475 (2% in 50)

**Component**: Total

## Disaggregation Summary: Total

## Disaggregation targets

**Return period** : 2475 yrs

**Exceedance rate** : 4.040e-4 $yr^{-1}$

**PGA ground motion** : 1.221e-1 g

## Recovered targets

**Return period** : 2478.0968 yrs

**Exceedance rate** : 4.035e-4 $yr^{-1}$

## Totals

**Binned** : 100 %

**Residual** : 0 %

**Trace** : 2.94 %

## Mean (over all sources)

**m** : 6.16

**r** : 139.02 km

**$\varepsilon_0$** : 0.38 σ

## Mode (largest m-r bin)

**m** : 7.77

**r** : 448.71 km

**$\varepsilon_0$** : 1.08 σ

**Contribution** : 7.98 %

## Mode (largest m-r-$\varepsilon_0$ bin)

**m** : 7.78

**r** : 446.84 km

**$\varepsilon_0$** : 0.36 σ

**Contribution** : 2.36 %

## Discretization

**r** : min = 0.0, max = 1000.0, Δ = 20.0 km

**m** : min = 4.4, max = 9.4, Δ = 0.2

**ε** : min = -3.0, max = 3.0, Δ = 0.5 σ

## Epsilon keys

**ε0** : [-∞ .. -2.5)

**ε1** : [-2.5 .. -2.0)

**ε2** : [-2.0 .. -1.5)

**ε3** : [-1.5 .. -1.0)

**ε4** : [-1.0 .. -0.5)

**ε5** : [-0.5 .. 0.0)

**ε6** : [0.0 .. 0.5)

**ε7** : [0.5 .. 1.0)

**ε8** : [1.0 .. 1.5)

**ε9** : [1.5 .. 2.0)

**ε10** : [2.0 .. 2.5)

**ε11** : [2.5 .. +∞]

## Disaggregation Contributions: Total

| Source Set ↳ Source | Type | r | m | $\varepsilon_0$ | lon | lat | az | % |
|---|---|---|---|---|---|---|---|---|
| USGS Extended Margin [2] (fixed) (opt) | Grid | | | | | | | 20.21 |
| PointSourceFinite: -87.468, 32.525 | | 13.23 | 5.22 | -0.83 | 87.468°W | 32.525°N | 0.00 | 2.1 |
| PointSourceFinite: -87.468, 32.570 | | 17.84 | 5.28 | -0.41 | 87.468°W | 32.570°N | 0.00 | 1.99 |
| PointSourceFinite: -87.468, 32.615 | | 22.52 | 5.37 | -0.09 | 87.468°W | 32.615°N | 0.00 | 1.95 |
| PointSourceFinite: -87.468, 32.660 | | 27.19 | 5.46 | 0.13 | 87.468°W | 32.660°N | 0.00 | 1.71 |
| PointSourceFinite: -87.468, 32.480 | | 8.89 | 5.17 | -1.36 | 87.468°W | 32.480°N | 0.00 | 1.56 |
| PointSourceFinite: -87.468, 32.705 | | 31.85 | 5.56 | 0.29 | 87.468°W | 32.705°N | 0.00 | 1.47 |
| PointSourceFinite: -87.468, 32.795 | | 41.12 | 5.75 | 0.49 | 87.468°W | 32.795°N | 0.00 | 1.36 |
| SSCn Paleozoic [7] (fixed) (opt) | Grid | | | | | | | 19.72 |
| PointSourceFinite: -87.468, 32.525 | | 13.23 | 5.21 | -0.83 | 87.468°W | 32.525°N | 0.00 | 2.1 |
| PointSourceFinite: -87.468, 32.570 | | 17.85 | 5.28 | -0.40 | 87.468°W | 32.570°N | 0.00 | 1.99 |
| PointSourceFinite: -87.468, 32.615 | | 22.53 | 5.37 | -0.09 | 87.468°W | 32.615°N | 0.00 | 1.94 |
| PointSourceFinite: -87.468, 32.660 | | 27.21 | 5.46 | 0.14 | 87.468°W | 32.660°N | 0.00 | 1.71 |
| PointSourceFinite: -87.468, 32.480 | | 8.89 | 5.17 | -1.36 | 87.468°W | 32.480°N | 0.00 | 1.56 |
| PointSourceFinite: -87.468, 32.705 | | 31.88 | 5.55 | 0.30 | 87.468°W | 32.705°N | 0.00 | 1.47 |
| PointSourceFinite: -87.468, 32.795 | | 41.17 | 5.74 | 0.51 | 87.468°W | 32.795°N | 0.00 | 1.35 |
| USGS Extended Margin [2] (adaptive) (opt) | Grid | | | | | | | 13.45 |
| PointSourceFinite: -87.468, 32.525 | | 13.23 | 5.22 | -0.83 | 87.468°W | 32.525°N | 0.00 | 1.38 |
| PointSourceFinite: -87.468, 32.570 | | 17.84 | 5.28 | -0.41 | 87.468°W | 32.570°N | 0.00 | 1.29 |
| PointSourceFinite: -87.468, 32.615 | | 22.52 | 5.37 | -0.09 | 87.468°W | 32.615°N | 0.00 | 1.25 |
| PointSourceFinite: -87.468, 32.660 | | 27.19 | 5.46 | 0.13 | 87.468°W | 32.660°N | 0.00 | 1.1 |
| PointSourceFinite: -87.468, 32.480 | | 8.89 | 5.17 | -1.36 | 87.468°W | 32.480°N | 0.00 | 1.03 |
| SSCn Paleozoic [7] (adaptive) (opt) | Grid | | | | | | | 13.11 |
| PointSourceFinite: -87.468, 32.525 | | 13.23 | 5.21 | -0.83 | 87.468°W | 32.525°N | 0.00 | 1.38 |
| PointSourceFinite: -87.468, 32.570 | | 17.85 | 5.28 | -0.40 | 87.468°W | 32.570°N | 0.00 | 1.29 |
| PointSourceFinite: -87.468, 32.615 | | 22.53 | 5.37 | -0.09 | 87.468°W | 32.615°N | 0.00 | 1.25 |
| PointSourceFinite: -87.468, 32.660 | | 27.21 | 5.46 | 0.14 | 87.468°W | 32.660°N | 0.00 | 1.1 |
| PointSourceFinite: -87.468, 32.480 | | 8.89 | 5.17 | -1.36 | 87.468°W | 32.480°N | 0.00 | 1.03 |
| USGS Craton [1,3,4] (adaptive) (opt) | Grid | | | | | | | 3.2 |
| SSCn Craton [1,9,10] (adaptive) (opt) | Grid | | | | | | | 3.02 |
| USGS Craton [1,3,4] (fixed) (opt) | Grid | | | | | | | 2.53 |
| SSCn Craton [1,9,10] (fixed) (opt) | Grid | | | | | | | 2.32 |
| New Madrid - USGS (center, all) : R1-500-yr | FaultCluster | | | | | | | 2.25 |
| New Madrid - USGS (center, all) : R1-500-yr | | 458.55 | 7.70 | 1.21 | 90.614°W | 35.419°N | 319.90 | 2.25 |
| New Madrid - USGS (center, all) : R2-750-yr | FaultCluster | | | | | | | 1.5 |
| New Madrid - USGS (center, all) : R2-750-yr | | 458.55 | 7.70 | 1.21 | 90.614°W | 35.419°N | 319.90 | 1.5 |
| New Madrid - SSCn (BA-BL : RFT-S : NMN-S) : R2-270-yr | FaultCluster | | | | | | | 1.23 |
| New Madrid - SSCn (BA-BL : RFT-S : NMN-S) : R2-270-yr | | 453.99 | 7.73 | 1.16 | 90.374°W | 35.555°N | 323.33 | 1.23 |
| New Madrid - SSCn (BA-BL : RFT-S : NMN-S) : R3-417-yr | FaultCluster | | | | | | | 1.01 |
| New Madrid - SSCn (BA-BL : RFT-S : NMN-S) : R3-417-yr | | 453.99 | 7.73 | 1.16 | 90.374°W | 35.555°N | 323.33 | 1.01 |

Application Metadata

**Application**: Disaggregation
**URL**: https://earthquake.usgs.gov/nshmp/hazard/disagg

**Repository**: nshmp-apps
**Version**: 4.5.1
**URL**: https://code.usgs.gov/ghsc/nshmp/nshmp-apps

**Repository** : nshmp-haz
**Version**: 2.4.15
**URL**: https://code.usgs.gov/ghsc/nshmp/nshmp-haz

**Repository** : nshmp-lib
**Version**: 1.4.27
**URL**: https://code.usgs.gov/ghsc/nshmp/nshmp-lib

**Repository** : nshmp-utils-java
**Version**: 0.4.0
**URL**: https://code.usgs.gov/ghsc/nshmp/nshmp-utils-java

**Repository** : nshm-conus
**Version**: 5.2.2
**URL**: https://code.usgs.gov/ghsc/nshmp/nshms/nshm-conus

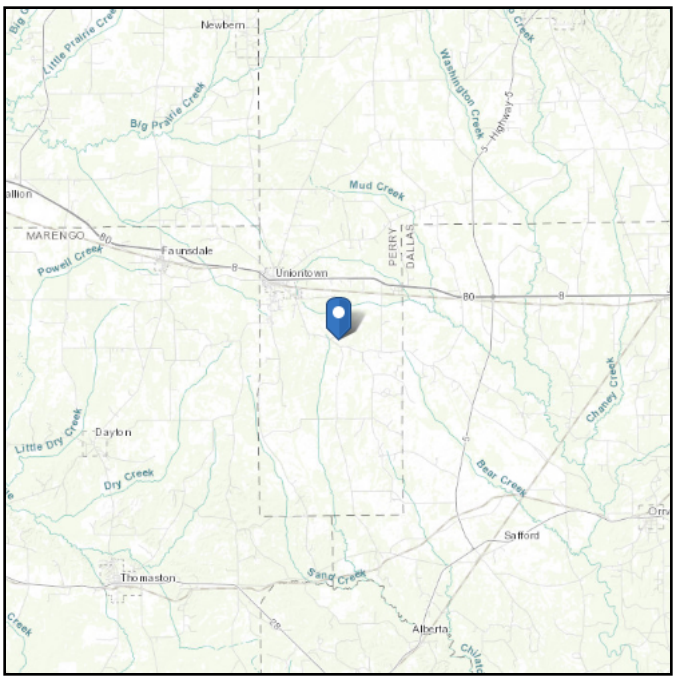
October 16, 2024, 04:52 PM

# ASCE Hazard Tool 2018, U.S. Geological Survey (PGA Value) for Lithified Earth

# ASCE Hazards Report

**Address:**
No Address at This Location

| | | | |
|---|---|---|---|
| **Standard:** | ASCE/SEI 7-22 | **Latitude:** | 32.412798 |
| **Risk Category:** | II | **Longitude:** | -87.468398 |
| **Soil Class:** | BC | **Elevation:** | 387.68426628712973 ft (NAVD 88) |



# Seismic

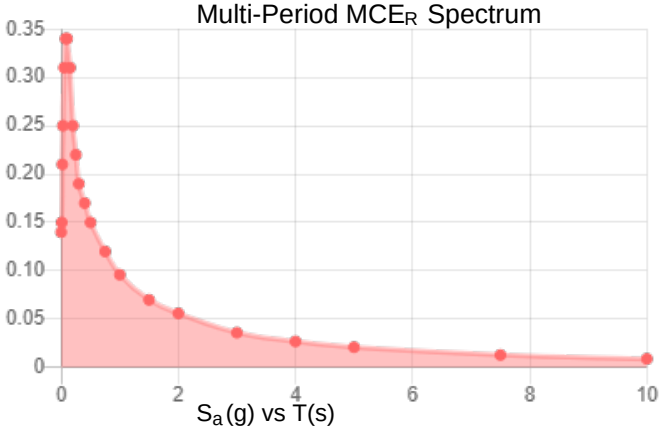
**Site Soil Class:** BC

**Results:**

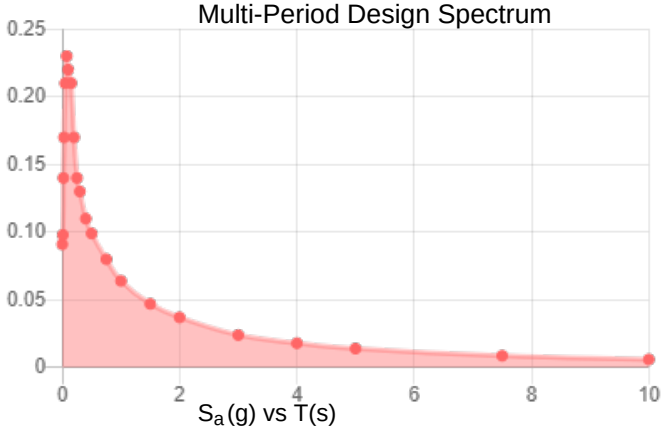
| | | | |
|---|---|---|---|
| $PGA_M$ : | 0.12 | $T_L$ : | 12 |
| $S_{MS}$ : | 0.22 | $S_S$ : | 0.25 |
| $S_{M1}$ : | 0.1 | $S_1$ : | 0.096 |
| $S_{DS}$ : | 0.15 | $V_{S30}$ : | 760 |
| $S_{D1}$ : | 0.067 | | |

**Seismic Design Category: B**

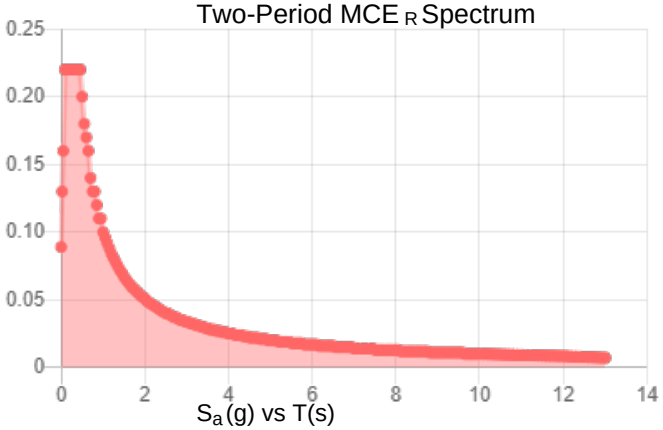
Multi-Period $MCE_R$ Spectrum



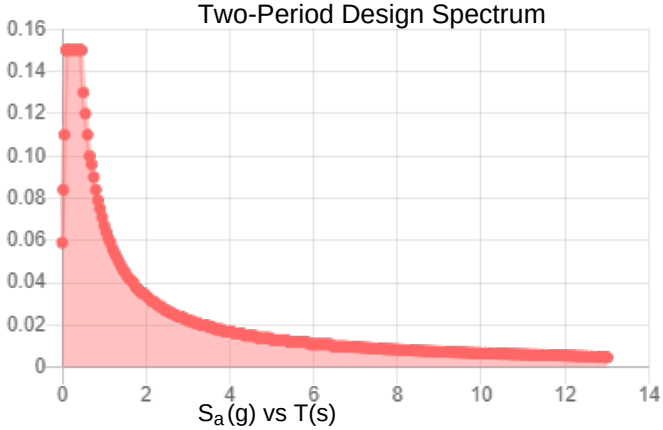

Multi-Period Design Spectrum




Two-Period $MCE_R$ Spectrum




Two-Period Design Spectrum




$MCE_R$ Vertical Response Spectrum

Vertical ground motion data has not yet been made available by USGS.

Design Vertical Response Spectrum

Vertical ground motion data has not yet been made available by USGS.

**Data Accessed:** Thu Sep 19 2024

**Date Source:**
**USGS Seismic Design Maps based on ASCE/SEI 7-22 and ASCE/SEI 7-22 Table 1.5-2. Additional data for site-specific ground motion procedures in accordance with ASCE/SEI 7-22 Ch. 21 are available from USGS.**

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# Seismic Site Class Calculation

# SEISMIC SITE CLASS CALCULATION

## SEISMIC STABILITY EVALUATION
## MAJOR MODIFICATION SUPPORT
## ARROWHEAD LANDFILL

**BLE Project No. J24-4999-66**

| **Boring No:** | **B-1 (Reference BLE Project No. J06-4999-01; Boring completed 12-05-2006)** | | | |
|---|---|---|---|---|
| **Layer Number (i)** | **Depth Range (ft)** | **N-value (Ni)** | **Layer Thickness (di)** | **di/Ni** |
| 0 | 0 | --- | --- | --- |
| 1 | 1.5 | 7 | 1.5 | 0.2143 |
| 2 | 5.5 | 12 | 4 | 0.3333 |
| 3 | 15.5 | 80 | 10 | 0.1250 |
| 4 | 20.5 | 100 | 5 | 0.0500 |
| 5 | 25.5 | 100 | 5 | 0.0500 |
| 6 | 34.5 | 100 | 9 | 0.0900 |
| 7 | 39.5 | 100 | 5 | 0.0500 |
| 8 | 45.5 | 100 | 6 | 0.0600 |
| 9 | 55 | 100 | 9.5 | 0.0950 |
| 10 | 60.5 | 100 | 5.5 | 0.0550 |
| 11 | 65 | 100 | 4.5 | 0.0450 |
| 12 | 70 | 100 | 5 | 0.0500 |
| 13 | 75 | 100 | 5 | 0.0500 |
| 14 | 80 | 100 | 5 | 0.0500 |
| 15 | 85 | 100 | 5 | 0.0500 |
| 16 | 90 | 100 | 5 | 0.0500 |
| 17 | 95 | 100 | 5 | 0.0500 |
| 18 | 100 | 100 | 5 | 0.0500 |
| | | **Sum** | **100** | **1.5176** |

*Comments:*
*Table shows weighted average N-Value over 100-ft depth based on standard sampling*

| | | |
|---|---|---|
| | **IBC 2000 Seismic Site Class Navg value:** | **65.9** |
| | **Site Class:** | **C** |

**Reference: IBC 2000 Table 1615.1.1 p.350**

| **Site Class** | **Classification** | **SPTavg (N)** | **Vavg (of top 30 m or 100 ft))** |
|---|---|---|---|
| A | Hard Rock | NA | >5,000 ft/s |
| B | Rock | NA | 2,500 to 5,000 ft/s |
| C | V. Dense Soil/Soft Rock | N>50 | 1,200 to 2,500 ft/s |
| D | Stiff Soil | 15≤N≤50 | 600 to 1,200 ft/s |
| E | Soft Soil | N<15 | <600 ft/s |
| F | See Special Provisions | See Special Provisions | See Special Provisions |

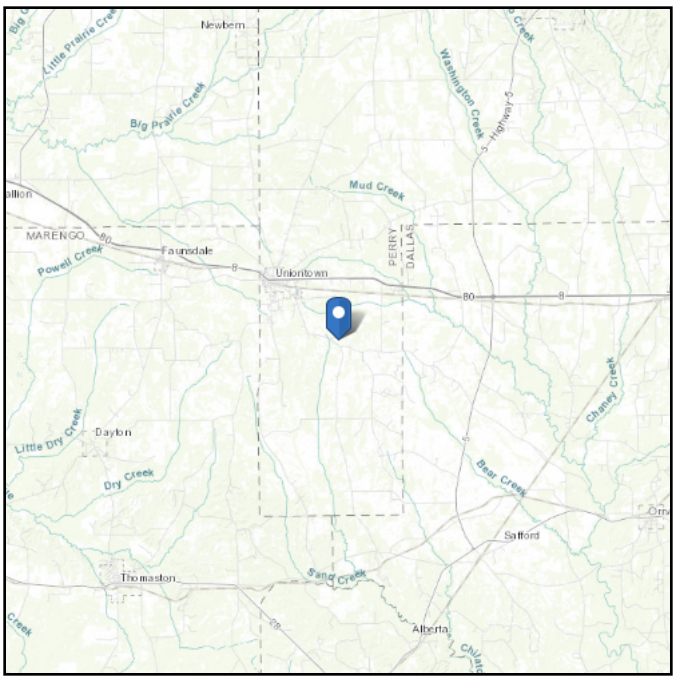
| | | |
|---|---|---|
| **Calculated by:** | David Yarbray, EIT | 10/16/2024 |
| **Checked by:** | Tanner, EIT | 10/24/2024 |
| **Reviewed by:** | Larry Simonson, PE | 11/20/2024 |

# ASCE Hazard Tool 2018, U.S. Geological Survey (PGAm Value) for Site Class C

# ASCE Hazards Report

**Address:**
No Address at This Location

| | | | |
|---|---|---|---|
| **Standard:** | ASCE/SEI 7-22 | **Latitude:** | 32.412798 |
| **Risk Category:** | II | **Longitude:** | -87.468398 |
| **Soil Class:** | C - Very Dense Soil and Soft Rock | **Elevation:** | 387.68426628712973 ft (NAVD 88) |



# Seismic

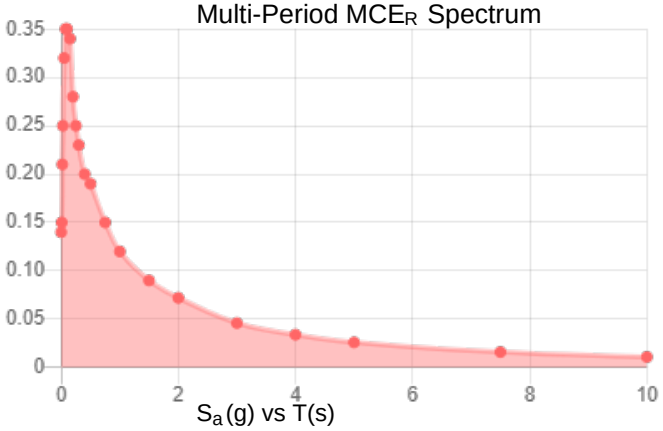
**Site Soil Class:** C - Very Dense Soil and Soft Rock

**Results:**

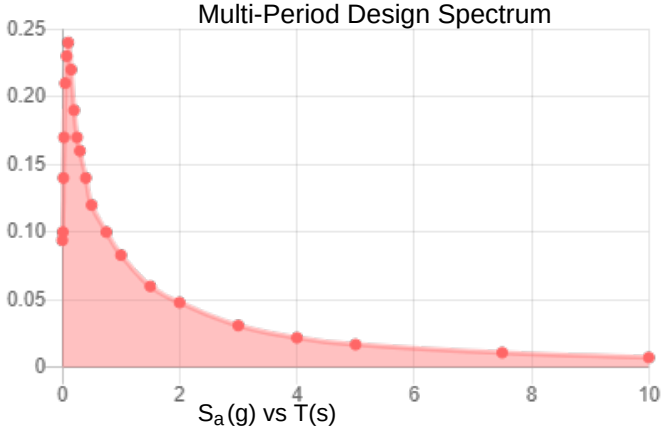
| | | | |
|---|---|---|---|
| $PGA_M$ : | 0.13 | $T_L$ : | 12 |
| $S_{MS}$ : | 0.25 | $S_S$ : | 0.25 |
| $S_{M1}$ : | 0.13 | $S_1$ : | 0.096 |
| $S_{DS}$ : | 0.17 | $V_{S30}$ : | 530 |
| $S_{D1}$ : | 0.086 | | |

**Seismic Design Category: B**

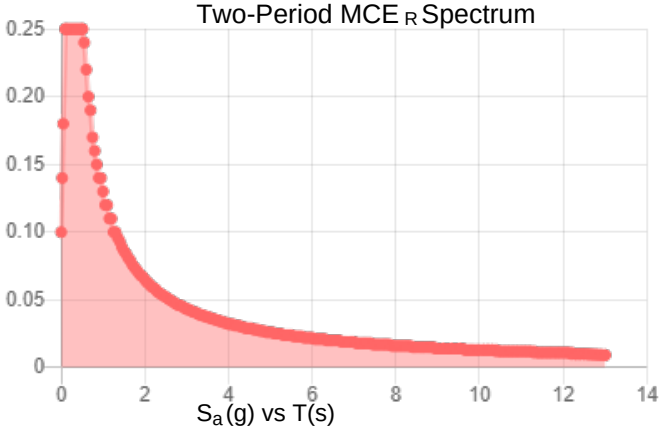
Multi-Period $MCE_R$ Spectrum



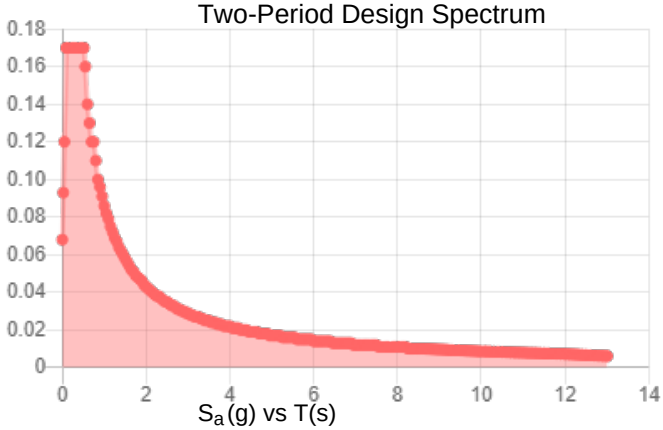

Multi-Period Design Spectrum




Two-Period $MCE_R$ Spectrum




Two-Period Design Spectrum




$MCE_R$ Vertical Response Spectrum

Vertical ground motion data has not yet been made available by USGS.

Design Vertical Response Spectrum

Vertical ground motion data has not yet been made available by USGS.

**Data Accessed:** **Wed Oct 16 2024**

**Date Source:**
**USGS Seismic Design Maps based on ASCE/SEI 7-22 and ASCE/SEI 7-22 Table 1.5-2. Additional data for site-specific ground motion procedures in accordance with ASCE/SEI 7-22 Ch. 21 are available from USGS.**

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# Bray and Travasarou (2009) Seismic Coefficient Calcualtion ($k_s$ value)

# PSEUDOSTATIC COEFFICIENT DETERMINATION

## MAJOR MODIFICATION SUPPORT

### ARROWHEAD LANDFILL

### PERRY COUNTY, ALABAMA

BLE JOB NO.: J24-4999-66

References:

*Bray, J.D. and Travasarou, T. (2009) "Pseudostatic Coefficient for Use in Simplified Seismic Slope Stability Evaluation," J. of Geotechnical and Geoenv. Engineering, ASCE, 135(9), 1336-1340.*

*Bray, J.D. and Macedo, J. (2021) "Closure to Procedure for Estimating Shear-Induced Seismic Slope Displacement for Shallow Crustal Earthquakes," J. of Geotechnical and Geoenv. Engineering, ASCE, 147(5), 1-3.*

Initial Fundamental Period of Slide Mass

$T_s = 2.6H/V_s$ For a 2D Traingular Shaped Potential Sliding Mass (Bray & Macedo, 2021)

H (m) = 111.54856 Final Grades Thickness = 340 ft

$V_s\ (\frac{ft}{s}) =$ 1775 Site Class C, Table 20.2-1 (ASCE 7-22)

$V_s\ (\frac{m}{s}) =$ 541

$T_s =$ 0.536

1.5 x Ts = 0.8041488

Allowable Seismic Displacement Threshold

$D_a =$ 15 cm

Spectral Acceleration

$S_{DS} =$ 0.17 from ASCE 7-22 Hazard Report

$S_{D1} =$ 0.086 from ASCE 7-22 Hazard Report

$T_0 =$ 0.101 Calculated from definitions herein

$T_S =$ 0.536 Calculated from Above

$S_a =$ 0.160 calculated using ASCE 7-22, Chap. 11 Eq. 11.4-5

Moment Magnitude

$M_w =$ 6.16 Unified Hazard Tool, U.S. Geological Survey - Earthquake Hazards Program 2018 Update; Mean Moment Magnitude

$\epsilon =$ 0 Normally distributed random variable (ϵ = 0 for 50% probability of exceedance)

Seismic Coefficient (Pseudostatic)

$k = exp\left(\frac{-a + \sqrt{b}}{0.665}\right)$

a = 3.865764129 where -> $a = 2.83 - 0.566ln(S_a)$

b = 2.152667528 where -> $b = a^2 - 1.33[ln(D_a) + 1.10 - 3.04ln(S_a) + 0.244(ln(S_a))^2 - 1.5T_s - 0.278(M - 7) - \varepsilon]$

**k = 0.03**

Calculated by: David Yarbray, EIT 10/16/2024

Check by: Tanner Whitesell, EIT 10/24/2024

Reviewed by: Larry Simonson, PE 11/20/2024

From 2020 NEHRP Provision (Implemented in ASCE-7-22)

**Table 20.2-1 Site classification**

| Site Class | $\bar{v}_s$ Calculated Using Measured or Estimated Shear Wave Velocity Profile |
|---|---|
| A. Hard rock | > 5,000 ft/s |
| B. Medium hard rock | > 3,000 to 5,000 ft/s |
| BC. Soft rock | >2,100 to 3,000 ft/s |
| C. Very dense sand or hard clay | >1,450 to 2,100 ft/s |
| CD. Dense sand or very stiff clay | >1,000 to 1,450 ft/s |
| D. Medium dense sand or stiff clay | >700 to 1,000 ft/s |
| DE. Loose sand or medium stiff clay | >500 to 700 ft/s |
| E. Very loose sand or soft clay | < 500 ft/s |
| F. Soils requiring site response analysis in accordance with Section 21.1 | See Section 20.2.1 |

*Note*: For SI: 1 ft = 0.3048 m; 1 ft/s = 0.3048 m/s

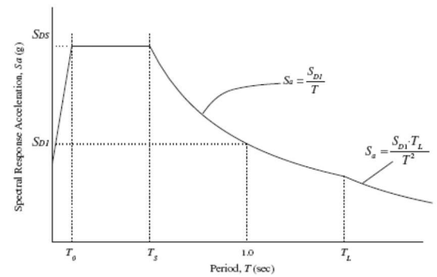


**FIGURE 11.4-1 Two-Period Design Response Spectrum**

where

$S_{DS}$ = the design spectral response acceleration parameter at short periods

$S_{D1}$ = the design spectral response acceleration parameter at 1-s period

$T$ = the fundamental period of the structure, $s$

$T_0 = 0.2\frac{S_{D1}}{S_{DS}}$

$T_S = \frac{S_{D1}}{S_{DS}}$ and

$T_L$ = long-period transition period (s) shown in Figs. 22-12 through 22-16.

3. For periods greater than $T_s$ and less than or equal to $T_L$, the design spectral response acceleration, $S_a$, shall be taken as given in Eq. (11.4-4):

$$S_a = \frac{S_{D1}}{T} \quad (11.4\text{-}4)$$

# Historical Reference Boring B-1 (BLE, 2007)

BLB INC.

**BUNNELL-LAMMONS ENGINEERING, INC.**

GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

# SOIL TEST BORING NO. B-1

PROJECT: Perry County Landfill — PROJECT NO.: J06-4999-01

CLIENT: G N Richardson — START: 12-5-06 END: 12-5-06

LOCATION: Uniontown, Alabama — ELEVATION: 272

DRILLER: TTL, J. Phillips — LOGGED BY: J. Helvey

DRILLING METHOD: CME 550X standard penetration

DEPTH TO - WATER> INITIAL: ▽ AFTER 24 HOURS: ▼ CAVING>

| ELEVATION/ DEPTH (FT) | SOIL DESCRIPTION | SOIL TYPE | SAMPLES | STANDARD PENETRATION RESULTS BLOWS/FOOT (2 5 10 20 30 40 50 70 90) |
|---|---|---|---|---|
| 270 / 2 | 2-inches of TOPSOIL<br>Firm, red and yellow, calcareous, silty CLAY | | 3<br>3<br>4 | |
| 4 | Stiff, yellow and gray, calcareous, silty CLAY - (selma chalk) | | 4<br>4<br>8 | |
| 265 / 6 | Very hard, greenish-gray, calcareous, silty CLAY - (selma chalk) | | | |
| 8 | UD sample collected with 13 inches of recovery | | | |
| 260 / 10 | | | | |
| 12 | | | | |
| 14 | | | 16<br>32<br>48 | |
| 255 / 16 | Hard to very hard, light gray, calcareous, silty CLAY - (selma chalk) | | | |
| 18 | | | | |
| 20 | | | 17<br>36<br>50/5" | 50/5" |
| 250 / 22 | | | | |
| 24 | | | 14<br>40<br>50/5" | 50/5" |
| 245 / 26 | | | | |
| 28 | UD sample collected with 6 inches of recovery | | | |
| 30 | | | | |
| 240 / 32 | | | | |
| 34 | Very hard, gray, calcareous, silty CLAY - (selma chalk) | | 22<br>50/1" | 50/1" |
| 235 / 36 | | | | |
| 38 | | | 25<br>50/5" | 50/5" |

BLB INC.

**BUNNELL-LAMMONS ENGINEERING, INC.**

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DRILLER: TTL, J. Phillips — LOGGED BY: J. Helvey

DRILLING METHOD: CME 550X standard penetration

DEPTH TO - WATER> INITIAL: ▽ _____ AFTER 24 HOURS: ▼ _____ CAVING> _____

| ELEVATION/ DEPTH (FT) | SOIL DESCRIPTION | SOIL TYPE | SAMPLES | STANDARD PENETRATION RESULTS BLOWS/FOOT (2 5 10 20 30 40 50 70 90) |
|---|---|---|---|---|
| 230 — 42 | Very hard, gray, calcareous, silty CLAY - (selma chalk) | | | |
| 44 | | | 21 32 50/5" | 50/5" |
| 46 | | | | |
| 225 — 48 | | | | |
| | UD sample collected with 14 inches of recovery | | | |
| 50 | | | | |
| 220 — 52 | | | | |
| 54 | | | 40 50/5" | 50/5" |
| 56 | | | | |
| 215 — 58 | | | | |
| 60 | | | 25 50/5" | 50/5" |
| | Boring terminated at 60.5 feet. No ground water encountered at time of drilling. | | | |
| 210 — 62 | | | | |
| 64 | | | | |
| 66 | | | | |
| 205 — 68 | | | | |
| 70 | | | | |
| 200 — 72 | | | | |
| 74 | | | | |
| 76 | | | | |
| 195 — 78 | | | | |

# HISTORICAL CQA INTERFACE FRICTION LABORATORY TEST RESULTS

# Tract 1, Cell No. 8 Interface Friction Result Summary Table

**SUMMARY OF INTERFACE FRICTION TESTING - GEOSYNTHETIC INTERFACES**
**HISTORIC TEST RESULTS**
**MAJOR MODIFICATION SUPPORT**
**ARROWHEAD LANDFILL**
**PERRY COUNTY, ALABAMA**

**Bunnell-Lammons Engineering, Inc. Project No. J24-4999-66**

| CELL NO. | TEST CONFIGURATION | NORMAL LOAD | CLAY LINER VS. FML | | | | FML VS. GDM | | | | GDM VS. PC | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | PEAK SHEAR STRESS (PSF) | PEAK SECANT ANGLE (DEGREES) | LARGE DISPLACEMENT SHEAR STRESS (PSF) | LARGE DISPLACEMENT SECANT ANGLE (DEGREES) | PEAK SHEAR STRESS (PSF) | PEAK SECANT ANGLE (DEGREES) | LARGE DISPLACEMENT SHEAR STRESS (PSF) | LARGE DISPLACEMENT SECANT ANGLE (DEGREES) | PEAK SHEAR STRESS (PSF) | PEAK SECANT ANGLE (DEGREES) | LARGE DISPLACEMENT SHEAR STRESS (PSF) | LARGE DISPLACEMENT SECANT ANGLE (DEGREES) | MIN PEAK SHEAR STRESS (PSF) | MIN PEAK SECANT ANGLE (DEGREES) |
| TRACT 1, CELL NO. 8 | A | 250 | 210 | 40.0 | 124 | 26.4 | 233 | 43.0 | 141 | 29.4 | 208 | 39.8 | 207 | 39.6 | 208.0 | 39.8 |
| | A | 1000 | 451 | 24.3 | 309 | 17.2 | 437 | 23.6 | 255 | 14.3 | 629 | 32.2 | 614 | 31.5 | 437.0 | 23.6 |
| | A | 3000 | 1004 | 18.5 | 889 | 16.5 | 1324 | 23.8 | 708 | 13.3 | 1790 | 30.8 | 1790 | 30.8 | 1004.0 | 18.5 |
| | B | 250 | 205 | 39.4 | 129 | 27.3 | 246 | 44.5 | 174 | 34.8 | 170 | 34.2 | 168 | 33.9 | 170.0 | 34.2 |
| | B | 1000 | 449 | 24.2 | 348 | 19.2 | 520 | 27.5 | 290 | 16.2 | 654 | 33.2 | 654 | 33.2 | 449.0 | 24.2 |
| | B | 3000 | 1062 | 19.5 | 945 | 17.5 | 1356 | 24.3 | 764 | 14.3 | 1718 | 29.8 | 1718 | 29.8 | 1062.0 | 19.5 |

Notes: The minimum peak shear strength for each normal load, along with the corresponding large displacement shear strength were used in the stability analysis.

**Prepared by:** David Yarbray, EIT 11/7/2024
**Checked by:** Tanner Whitesell, EIT 11/7/2024

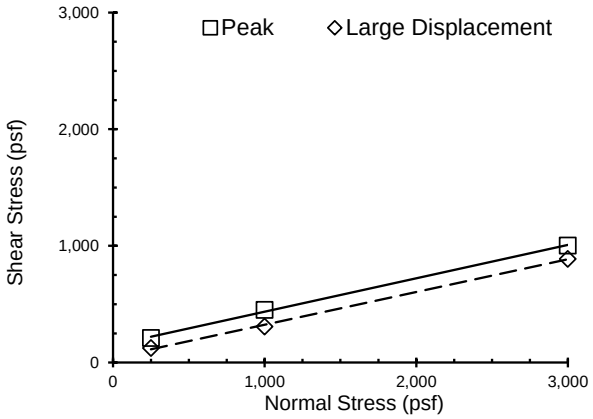
# Tract 1, Cell No. 8 Interface Friction Test Results

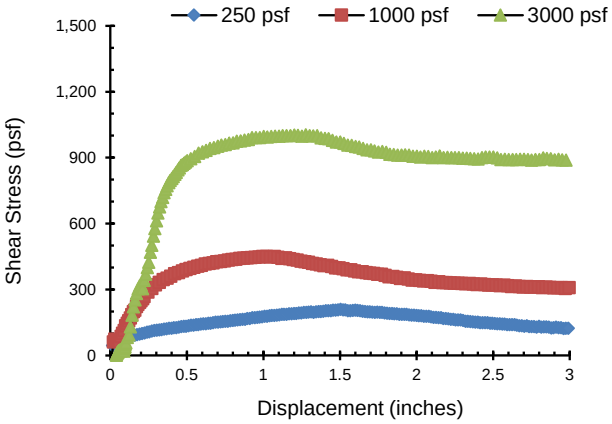
# Shear Strength of Soil-Geosynthetic Interface by Direct Shear (ASTM D5321)

Client: Bunnell-Lammons Engineering, Inc.
Project: Arrowhead Landfill Cell No. 8

TRI Log #: IF24016-1A
Richard S. Lacey, P.E. 6/21/2024
Analysis & Quality Review/Date

## Compacted Clay CLBW-14 vs. SKAPS 60mil DS Textured HDPE




| Test Results, Linear Regression | | | |
|---|---|---|---|
| Mohr-Coulomb Parameters | | Peak | Large Displacement |
| Friction Angle | Degrees | 16.0 | 15.7 |
| Y-intercept or Adhesion | psf | 149 | 43 |
| Minimum Secant Angle | Degrees | 18.5 | 16.5 |

Note - Large Displacement Values Reported for 3.0 inches of Displacement

| Test Conditions | | |
|---|---|---|
| Upper Box | Compacted Clay CLBW-14<br>$\omega$ = 30.9%, $\gamma_d$ = 87.2 pcf | |
| Lower Box | SKAPS 60mil DS Textured HDPE<br>Roll # 3111023026 | |
| Conditioning | Wet/drained: Loading applied, interface flooded after 1 hour and held at test load for 24 hours then drained for 12 hours prior to shear. | |
| Shearing Rate | inches/minute | 0.004 |

**Test Notes**

Shearing occurred at the interface at all stresses.

| Specimen No. | | - | 1 | 2 | 3 |
|---|---|---|---|---|---|
| Normal Stress | | psf | 250 | 1,000 | 3,000 |
| Box Edge Dimension | | in | 12 | 12 | 12 |
| Equivalent Bearing Slide Resist. Correction | | psf | 10 | 18 | 37 |
| Peak | Shear Stress | psf | 210 | 451 | 1,004 |
| | Secant Angle | deg. | 40.0 | 24.3 | 18.5 |
| Large Displacement | Shear Stress | psf | 124 | 309 | 889 |
| | Secant Angle | deg. | 26.3 | 17.2 | 16.5 |
| Asperity Height, Avg. of 5 Meas. | | mils | 28 | 28 | 28 |

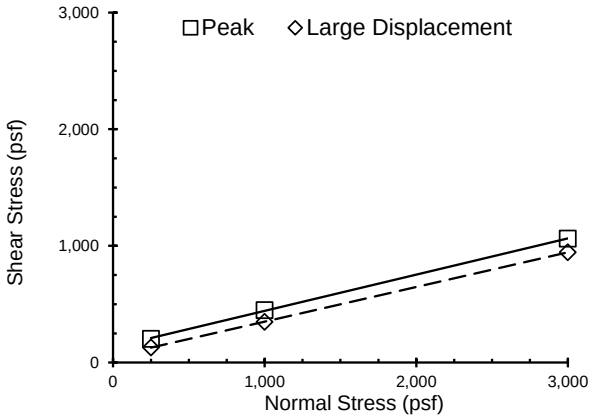
The testing herein is based upon accepted industry practice as well as the test method listed. Test results reported herein do not apply to samples other than those tested. TRI neither accepts responsibility for nor makes claim as to the final use and purpose of the material. TRI observes and maintains client confidentiality. TRI limits reproduction of this report, except in full, without prior app

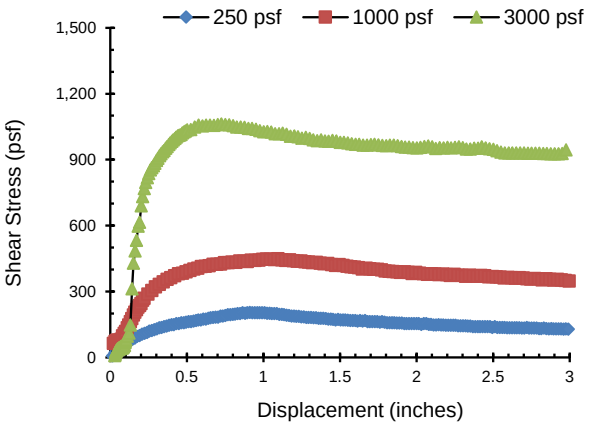
# Shear Strength of Soil-Geosynthetic Interface by Direct Shear (ASTM D5321)

Client: Bunnell-Lammons Engineering, Inc.
Project: Arrowhead Landfill Cell No. 8

TRI Log #: IF24016-1B
Richard S. Lacey, P.E. 6/21/2024
Analysis & Quality Review/Date

## Compacted Clay CLBW-14 vs. SKAPS 60mil DS Textured HDPE




| Test Results, Linear Regression | | | |
|---|---|---|---|
| Mohr-Coulomb Parameters | | Peak | Large Displacement |
| Friction Angle | Degrees | 17.3 | 16.6 |
| Y-intercept or Adhesion | psf | 132 | 53 |
| Minimum Secant Angle | Degrees | 19.5 | 17.5 |

Note - Large Displacement Values Reported for 3.0 inches of Displacement

| Test Conditions | | |
|---|---|---|
| Upper Box | Compacted Clay CLBW-14<br>$\omega$ = 30.9%, $\gamma_d$ = 87.2 pcf | |
| Lower Box | SKAPS 60mil DS Textured HDPE<br>Roll # 3111023024 | |
| Conditioning | Wet/drained: Loading applied, interface flooded after 1 hour and held at test load for 24 hours then drained for 12 hours prior to shear. | |
| Shearing Rate | inches/minute | 0.004 |

**Test Notes**

Shearing occurred at the interface at all stresses.

| Specimen No. | | - | 1 | 2 | 3 |
|---|---|---|---|---|---|
| Normal Stress | | psf | 250 | 1,000 | 3,000 |
| Box Edge Dimension | | in | 12 | 12 | 12 |
| Equivalent Bearing Slide Resist. Correction | | psf | 10 | 18 | 37 |
| Peak | Shear Stress | psf | 205 | 449 | 1,062 |
| | Secant Angle | deg. | 39.3 | 24.2 | 19.5 |
| Large Displacement | Shear Stress | psf | 129 | 348 | 945 |
| | Secant Angle | deg. | 27.2 | 19.2 | 17.5 |
| Asperity Height, Avg. of 5 Meas. | | mils | 28 | 28 | 29 |

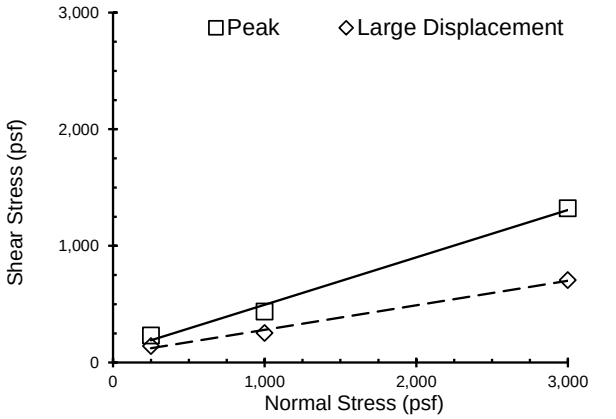
The testing herein is based upon accepted industry practice as well as the test method listed. Test results reported herein do not apply to samples other than those tested. TRI neither accepts responsibility for nor makes claim as to the final use and purpose of the material. TRI observes and maintains client confidentiality. TRI limits reproduction of this report, except in full, without prior app

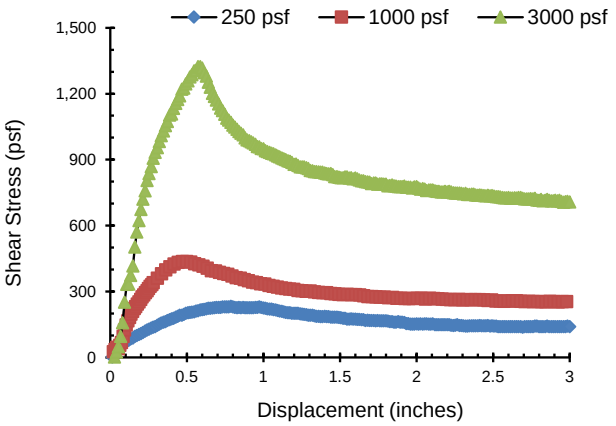
# Shear Strength of Geosynthetic-Geosynthetic Interface by Direct Shear (ASTM D5321)

Client: Bunnell-Lammons Engineering, Inc.
Project: Arrowhead LF Cell No. 8

TRI Log #: IF24016-2A
Richard S. Lacey, P.E. 5/21/2024
Analysis & Quality Review/Date

## SKAPS 8oz NW Geotextile vs. SKAPS 60mil DS Textured HDPE




| Test Results, Linear Regression | | | |
|---|---|---|---|
| Mohr-Coulomb Parameters | | Peak | Large Displacement |
| Friction Angle | Degrees | 22.1 | 11.9 |
| Y-intercept or Adhesion | psf | 89 | 70 |
| Minimum Secant Angle | Degrees | 23.6 | 13.3 |

Note - Large Displacement Values Reported for 3.0 inches of Displacement

| Test Conditions | | |
|---|---|---|
| Upper Box | SKAPS 8oz NW Geotextile Roll # 80550.26 | |
| Lower Box | SKAPS 60mil DS Textured HDPE Roll # 3111023026 | |
| Conditioning | Wet/Drained: Loading applied, interface flooded after 1 hour and held at test load for 1 hour then drained prior to shear. | |
| Shearing Rate | inches/minute | 0.2 |

**Test Notes**

Shearing occurred at the interface at all stresses.

| Specimen No. | | - | 1 | 2 | 3 |
|---|---|---|---|---|---|
| Normal Stress | | psf | 250 | 1,000 | 3,000 |
| Box Edge Dimension | | in | 12 | 12 | 12 |
| Equivalent Bearing Slide Resist. Correction | | psf | 10 | 18 | 37 |
| Peak | Shear Stress | psf | 233 | 437 | 1,324 |
| | Secant Angle | deg. | 42.9 | 23.6 | 23.8 |
| Large Displacement | Shear Stress | psf | 141 | 255 | 708 |
| | Secant Angle | deg. | 29.4 | 14.3 | 13.3 |
| Asperity Height, Avg. of 5 Meas. | | mils | 28 | 28 | 28 |

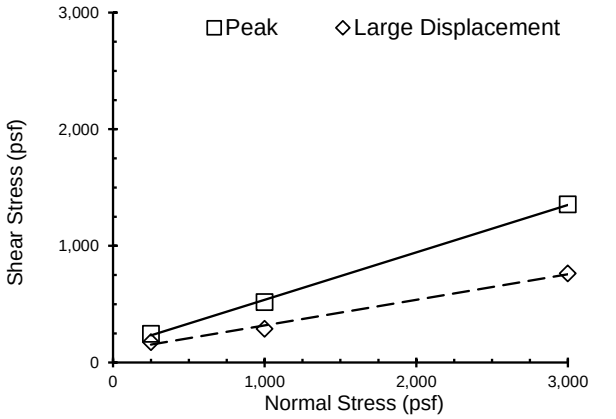
The testing herein is based upon accepted industry practice as well as the test method listed. Test results reported herein do not apply to samples other than those tested. TRI neither accepts responsibility for nor makes claim as to the final use and purpose of the material. TRI observes and maintains client confidentiality. TRI limits reproduction of this report, except in full, without prior app

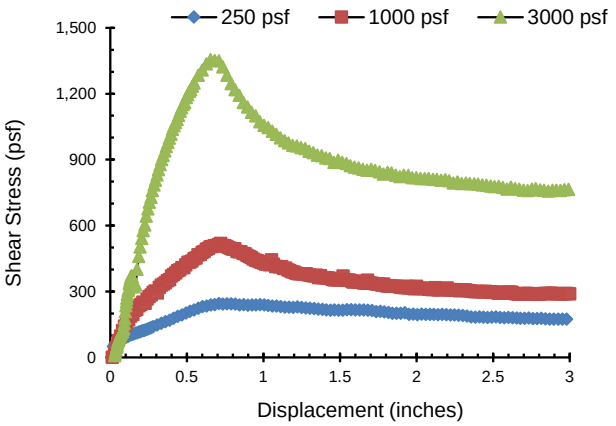
# Shear Strength of Geosynthetic-Geosynthetic Interface by Direct Shear (ASTM D5321)

Client: Bunnell-Lammons Engineering, Inc.
Project: Arrowhead LF Cell No. 8

TRI Log #: IF24016-2B
Richard S. Lacey, P.E. 5/21/2024
Analysis & Quality Review/Date

## SKAPS 8oz NW Geotextile vs. SKAPS 60mil DS Textured HDPE




| Test Results, Linear Regression | | | |
|---|---|---|---|
| Mohr-Coulomb Parameters | | Peak | Large Displacement |
| Friction Angle | Degrees | 22.1 | 12.4 |
| Y-intercept or Adhesion | psf | 131 | 99 |
| Minimum Secant Angle | Degrees | 24.3 | 14.3 |

Note - Large Displacement Values Reported for 3.0 inches of Displacement

| Test Conditions | | |
|---|---|---|
| Upper Box | SKAPS 8oz NW Geotextile Roll # 80550.53 | |
| Lower Box | SKAPS 60mil DS Textured HDPE Roll # 3111023024 | |
| Conditioning | Wet/Drained: Loading applied, interface flooded after 1 hour and held at test load for 1 hour then drained prior to shear. | |
| Shearing Rate | inches/minute | 0.2 |

**Test Notes**

Shearing occurred at the interface at all stresses.

| Specimen No. | | - | 1 | 2 | 3 |
|---|---|---|---|---|---|
| Normal Stress | | psf | 250 | 1,000 | 3,000 |
| Box Edge Dimension | | in | 12 | 12 | 12 |
| Equivalent Bearing Slide Resist. Correction | | psf | 10 | 18 | 37 |
| Peak | Shear Stress | psf | 246 | 520 | 1,356 |
| | Secant Angle | deg. | 44.5 | 27.5 | 24.3 |
| Large Displacement | Shear Stress | psf | 174 | 290 | 764 |
| | Secant Angle | deg. | 34.9 | 16.1 | 14.3 |
| Asperity Height, Avg. of 5 Meas. | | mils | 29 | 28 | 28 |

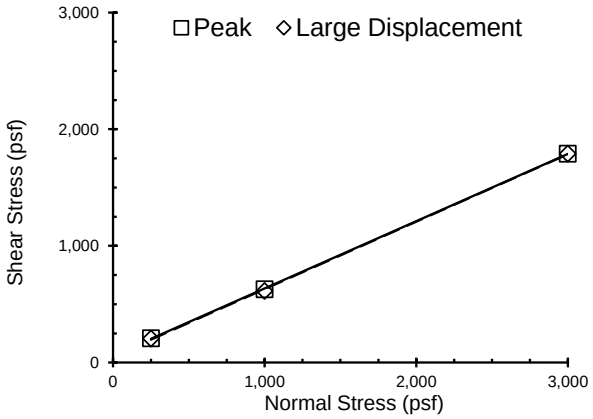
The testing herein is based upon accepted industry practice as well as the test method listed. Test results reported herein do not apply to samples other than those tested. TRI neither accepts responsibility for nor makes claim as to the final use and purpose of the material. TRI observes and maintains client confidentiality. TRI limits reproduction of this report, except in full, without prior app

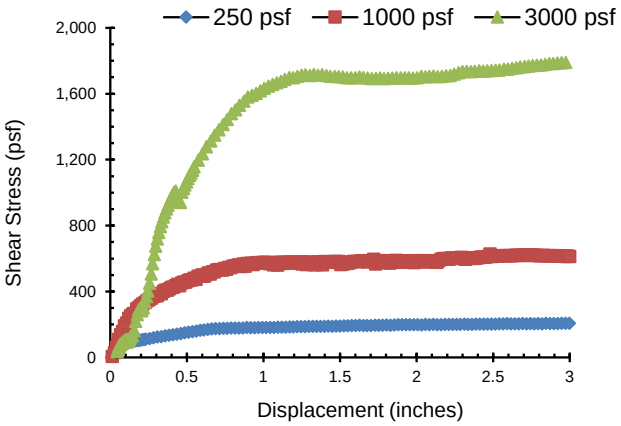
# Shear Strength of Soil-Geosynthetic Interface by Direct Shear (ASTM D5321)

Client: Bunnell-Lammons
Project: Arrowhead LF Cell No. 8

TRI Log #: IF24016-3A
Richard S. Lacey, P.E. 6/14/2024
Analysis & Quality Review/Date

## Protective Cover Sand PCBW-17 vs. SKAPS 8oz NW Geotextile




| Test Results, Linear Regression | | | |
|---|---|---|---|
| Mohr-Coulomb Parameters | | Peak | Large Displacement |
| Friction Angle | Degrees | 30.0 | 30.0 |
| Y-intercept or Adhesion | psf | 59 | 51 |
| Minimum Secant Angle | Degrees | 30.8 | 30.8 |

Note - Large Displacement Values Reported for 3.0 inches of Displacement

| Test Conditions | | |
|---|---|---|
| Upper Box | Protective Cover Sand PCBW-17 (tamped in place) | |
| Lower Box | SKAPS 8oz NW Geotextile Roll # 80550.26 | |
| Conditioning | Wet/drained: Loading applied, interface flooded after 1 hour and held at test load for 24 hours then drained for 12 hours prior to shear. | |
| Shearing Rate | inches/minute | 0.04 |

**Test Notes**

Shearing occurred at the interface at all stresses.

| Specimen No. | | - | 1 | 2 | 3 |
|---|---|---|---|---|---|
| Normal Stress | | psf | 250 | 1,000 | 3,000 |
| Box Edge Dimension | | in | 12 | 12 | 12 |
| Equivalent Bearing Slide Resist. Correction | | psf | 10 | 18 | 37 |
| Peak | Shear Stress | psf | 208 | 629 | 1,790 |
| | Secant Angle | deg. | 39.7 | 32.1 | 30.8 |
| Large Displacement | Shear Stress | psf | 207 | 614 | 1,790 |
| | Secant Angle | deg. | 39.6 | 31.5 | 30.8 |

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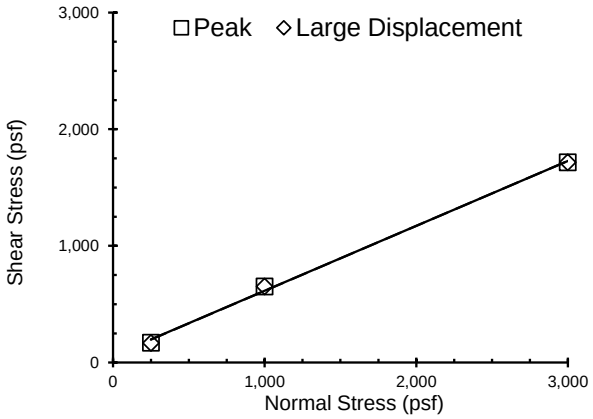
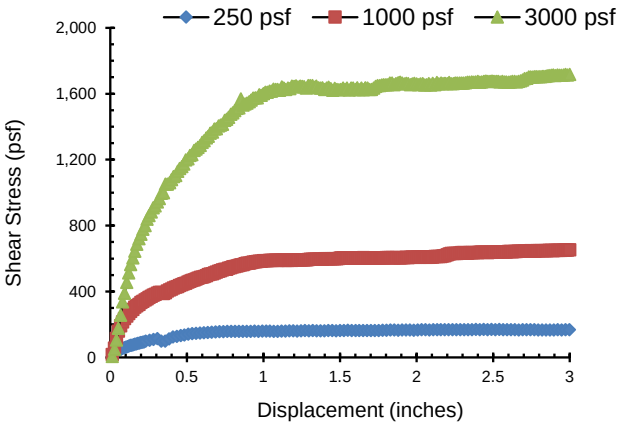
# Shear Strength of Soil-Geosynthetic Interface by Direct Shear (ASTM D5321)

Client: Bunnell-Lammons Engineering, Inc.
Project: Arrowhead LF Cell No. 8

TRI Log #: IF24016-3B
Richard S. Lacey, P.E. 6/14/2024
Analysis & Quality Review/Date

## Protective Cover Sand PCBW-17 vs. SKAPS 8oz NW Geotextile




| Test Results, Linear Regression | | | |
|---|---|---|---|
| Mohr-Coulomb Parameters | | Peak | Large Displacement |
| Friction Angle | Degrees | 29.1 | 29.1 |
| Y-intercept or Adhesion | psf | 59 | 57 |
| Minimum Secant Angle | Degrees | 29.8 | 29.8 |

Note - Large Displacement Values Reported for 3.0 inches of Displacement

| Test Conditions | | |
|---|---|---|
| Upper Box | Protective Cover Sand PCBW-17 (tamped in place) | |
| Lower Box | SKAPS 8oz NW Geotextile Roll # 80550.53 | |
| Conditioning | Wet/drained: Loading applied, interface flooded after 1 hour and held at test load for 24 hours then drained for 12 hours prior to shear. | |
| Shearing Rate | inches/minute | 0.04 |

**Test Notes**

Shearing occurred at the interface at all stresses.

| Specimen No. | | - | 1 | 2 | 3 |
|---|---|---|---|---|---|
| Normal Stress | | psf | 250 | 1,000 | 3,000 |
| Box Edge Dimension | | in | 12 | 12 | 12 |
| Equivalent Bearing Slide Resist. Correction | | psf | 10 | 18 | 37 |
| Peak | Shear Stress | psf | 170 | 654 | 1,718 |
| | Secant Angle | deg. | 34.2 | 33.2 | 29.8 |
| Large Displacement | Shear Stress | psf | 168 | 654 | 1,718 |
| | Secant Angle | deg. | 33.9 | 33.2 | 29.8 |

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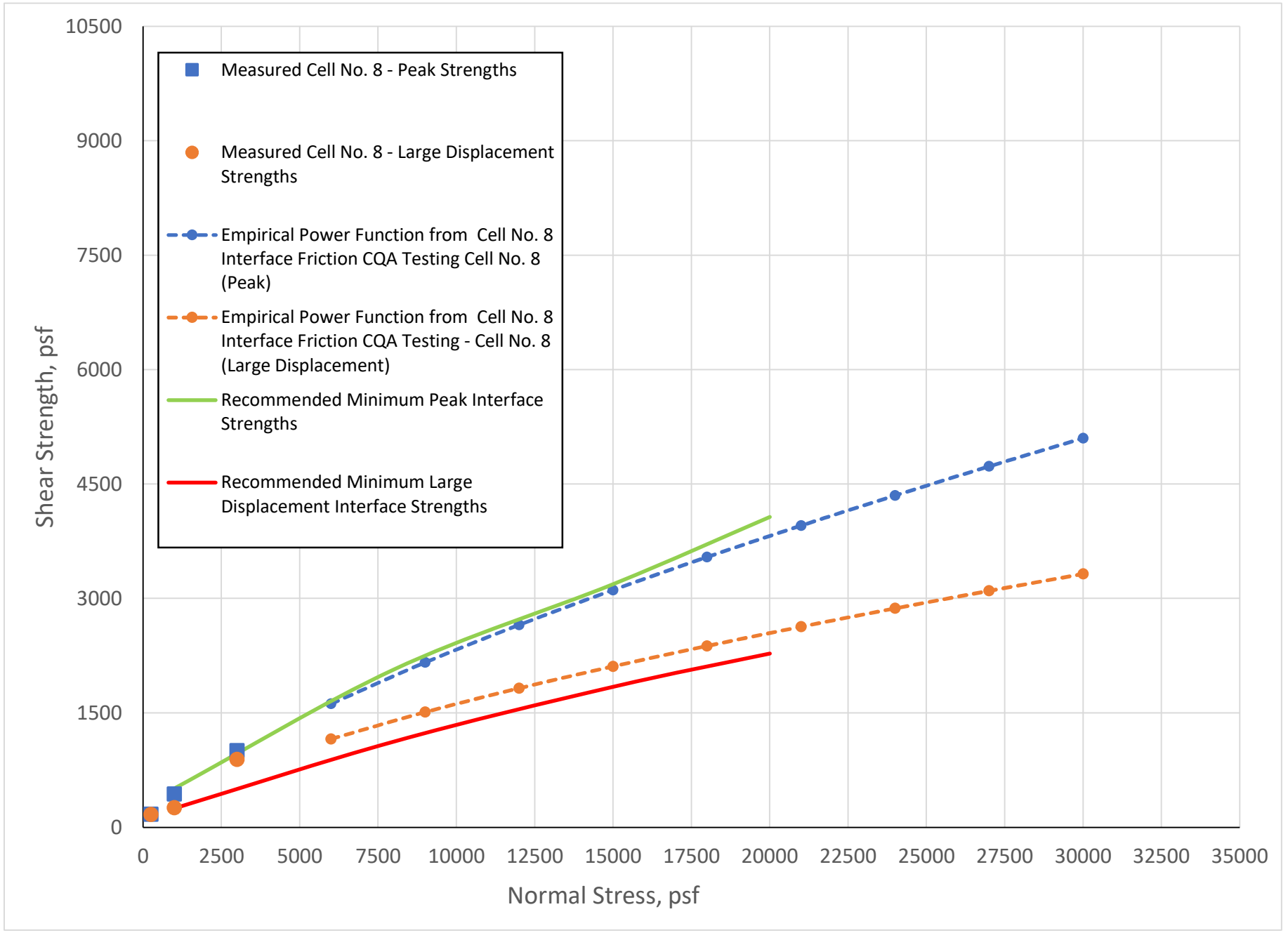
# SLOPE STABILITY ANALYSIS

# Slope Stability Analysis Interface Shear Strength Functions

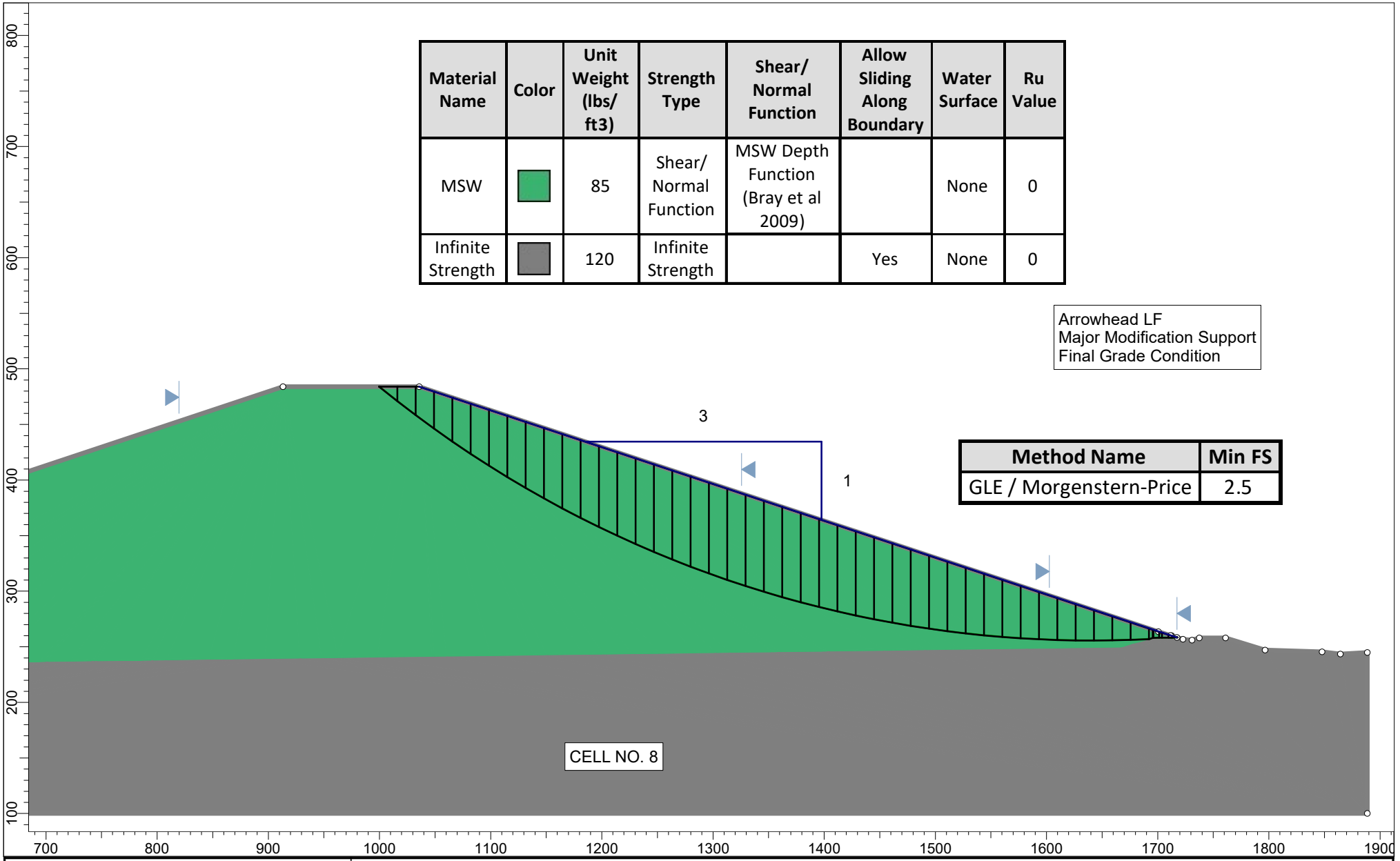

Measured Cell No. 8 - Peak Strengths
Measured Cell No. 8 - Large Displacement Strengths
Empirical Power Function from Cell No. 8 Interface Friction CQA Testing Cell No. 8 (Peak)
Empirical Power Function from Cell No. 8 Interface Friction CQA Testing - Cell No. 8 (Large Displacement)
Recommended Minimum Peak Interface Strengths
Recommended Minimum Large Displacement Interface Strengths
Shear Strength, psf
Normal Stress, psf
0
1500
3000
4500
6000
7500
9000
10500
0
2500
5000
7500
10000
12500
15000
17500
20000
22500
25000
27500
30000
32500
35000

# Stability Analysis Model Results

# Table 4 Runs – A-A', Tract 1 East Slope

| Material Name | Color | Unit Weight (lbs/ ft3) | Strength Type | Shear/ Normal Function | Allow Sliding Along Boundary | Water Surface | Ru Value |
|---|---|---|---|---|---|---|---|
| MSW | | 85 | Shear/ Normal Function | MSW Depth Function (Bray et al 2009) | | None | 0 |
| Infinite Strength | | 120 | Infinite Strength | | Yes | None | 0 |

Arrowhead LF
Major Modification Support
Final Grade Condition



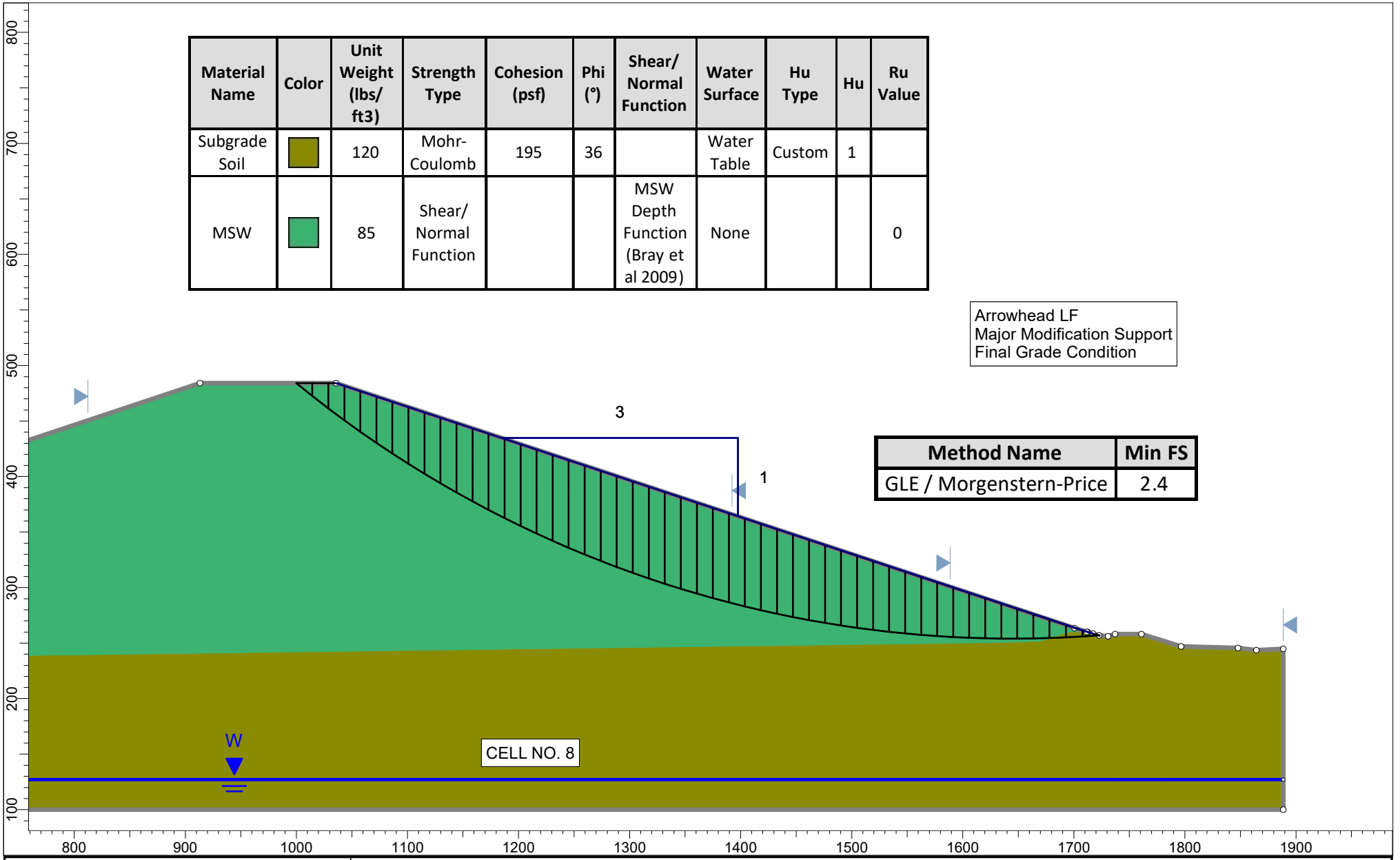

| Method Name | Min FS |
|---|---|
| GLE / Morgenstern-Price | 2.5 |

SLIDEINTERPRET 9.031

| | | | |
|---|---|---|---|
| Project | MAJOR MODIFICATION SUPPORT | | |
| Group | A-A - East slope - Static | Scenario | A.1 .E - Waste Only |
| Drawn | T. Whitesell, E.I.T. | Company | Bunnell-Lammons Engineering, Inc. |
| Date | 11/8/2024 | File Name | AHLF A-A'.slmd |

| Material Name | Color | Unit Weight (lbs/ ft3) | Strength Type | Cohesion (psf) | Phi (°) | Shear/ Normal Function | Water Surface | Hu Type | Hu | Ru Value |
|---|---|---|---|---|---|---|---|---|---|---|
| Subgrade Soil | | 120 | Mohr-Coulomb | 195 | 36 | | Water Table | Custom | 1 | |
| MSW | | 85 | Shear/ Normal Function | | | MSW Depth Function (Bray et al 2009) | None | | | 0 |

Arrowhead LF
Major Modification Support
Final Grade Condition



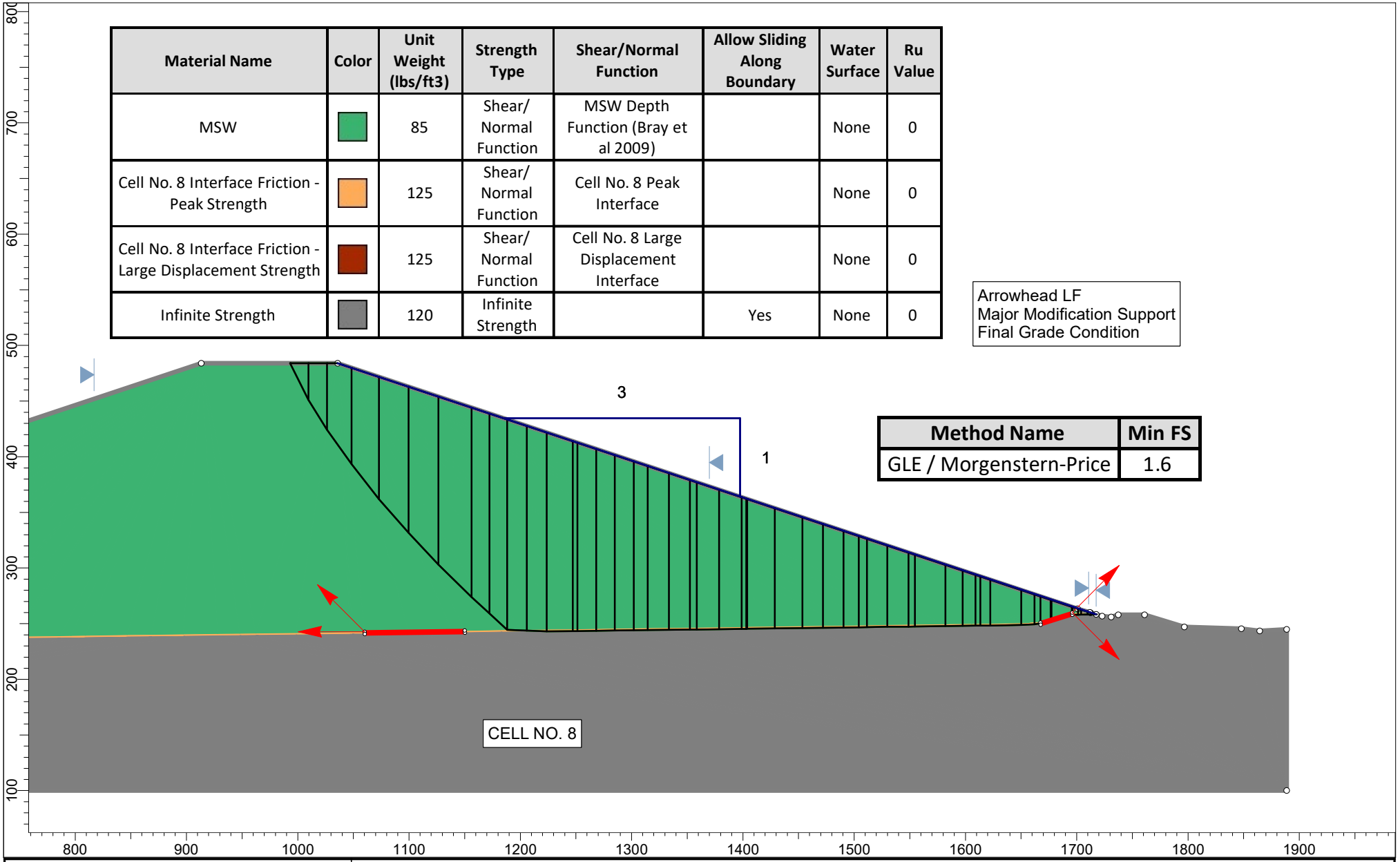

| Method Name | Min FS |
|---|---|
| GLE / Morgenstern-Price | 2.4 |

SLIDEINTERPRET 9.031

| | | | |
|---|---|---|---|
| Project | MAJOR MODIFICATION SUPPORT | | |
| Group | A-A - East slope - Static | Scenario | A.2.E - Subgrade - Global |
| Drawn | T. Whitesell, E.I.T. | Company | Bunnell-Lammons Engineering, Inc. |
| Date | 11/8/2024 | File Name | AHLF A-A'.slmd |

| Material Name | Color | Unit Weight (lbs/ft3) | Strength Type | Shear/Normal Function | Allow Sliding Along Boundary | Water Surface | Ru Value |
|---|---|---|---|---|---|---|---|
| MSW | | 85 | Shear/ Normal Function | MSW Depth Function (Bray et al 2009) | | None | 0 |
| Cell No. 8 Interface Friction - Peak Strength | | 125 | Shear/ Normal Function | Cell No. 8 Peak Interface | | None | 0 |
| Cell No. 8 Interface Friction - Large Displacement Strength | | 125 | Shear/ Normal Function | Cell No. 8 Large Displacement Interface | | None | 0 |
| Infinite Strength | | 120 | Infinite Strength | | Yes | None | 0 |

Arrowhead LF
Major Modification Support
Final Grade Condition



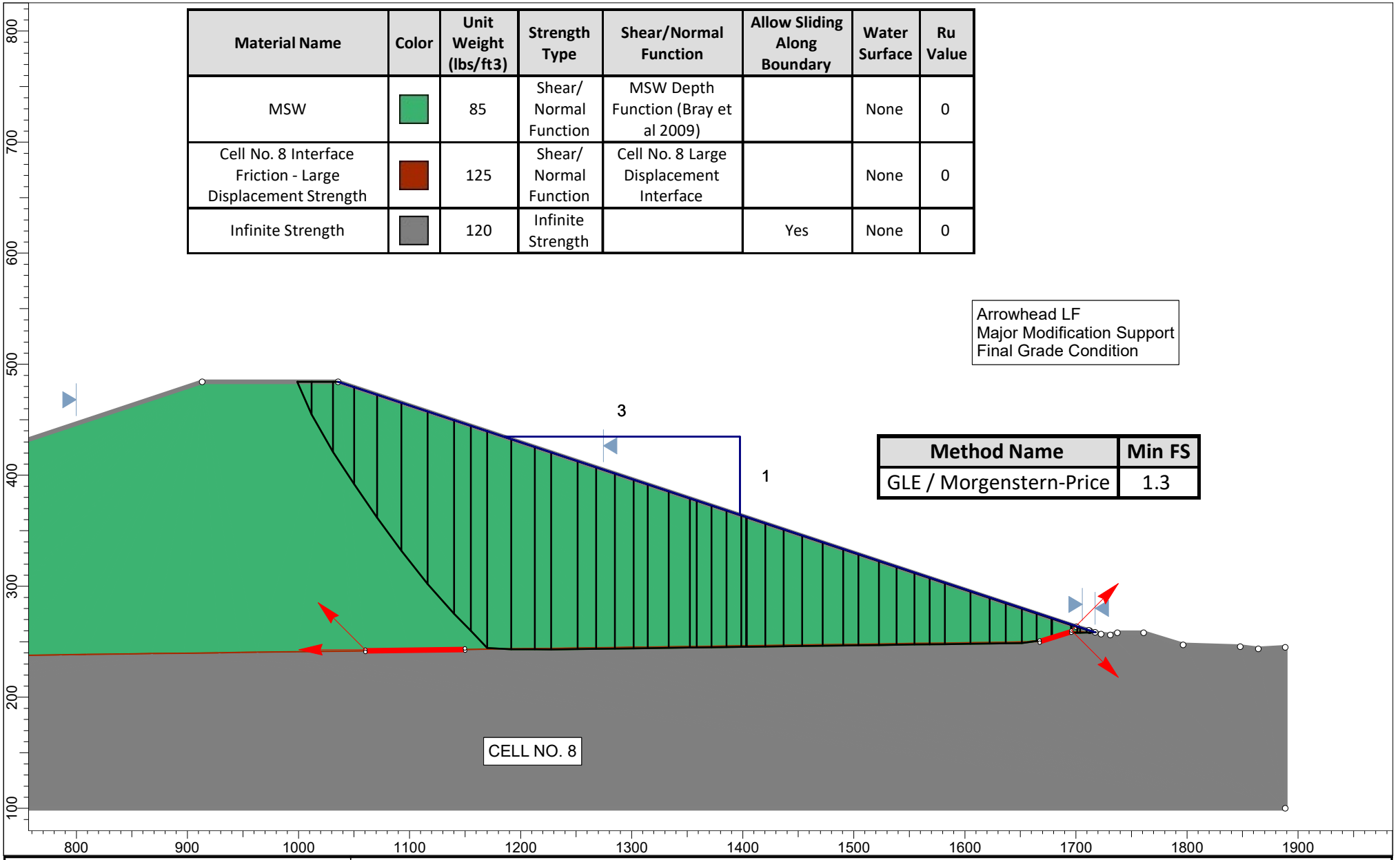

| Method Name | Min FS |
|---|---|
| GLE / Morgenstern-Price | 1.6 |

SLIDEINTERPRET 9.031

| | | | |
|---|---|---|---|
| Project | MAJOR MODIFICATION SUPPORT | | |
| Group | A-A - East slope - Static | Scenario | A.3.E - IS - Peak - Block |
| Drawn | T. Whitesell, E.I.T. | Company | Bunnell-Lammons Engineering, Inc. |
| Date | 11/22/2024 | File Name | AHLF A-A'.slmd |

| Material Name | Color | Unit Weight (lbs/ft3) | Strength Type | Shear/Normal Function | Allow Sliding Along Boundary | Water Surface | Ru Value |
|---|---|---|---|---|---|---|---|
| MSW | | 85 | Shear/ Normal Function | MSW Depth Function (Bray et al 2009) | | None | 0 |
| Cell No. 8 Interface Friction - Large Displacement Strength | | 125 | Shear/ Normal Function | Cell No. 8 Large Displacement Interface | | None | 0 |
| Infinite Strength | | 120 | Infinite Strength | | Yes | None | 0 |

Arrowhead LF
Major Modification Support
Final Grade Condition

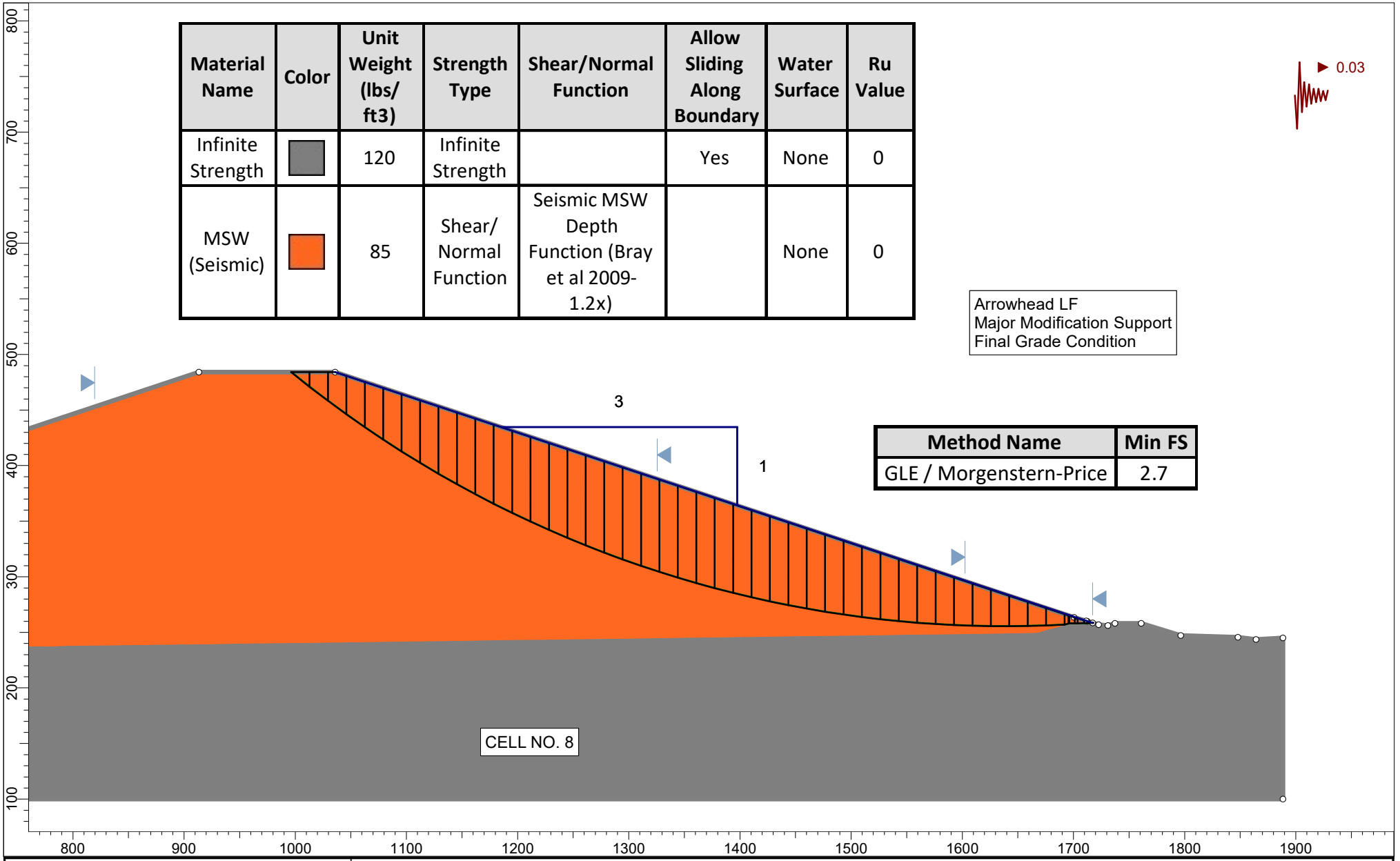



| Method Name | Min FS |
|---|---|
| GLE / Morgenstern-Price | 1.3 |

SLIDEINTERPRET 9.031

| | | | |
|---|---|---|---|
| Project | MAJOR MODIFICATION SUPPORT | | |
| Group | A-A - East slope - Static | Scenario | A.4.E - IS - Large Displacement - Block |
| Drawn | T. Whitesell, E.I.T. | Company | Bunnell-Lammons Engineering, Inc. |
| Date | 11/22/2024 | File Name | AHLF A-A'.slmd |

| Material Name | Color | Unit Weight (lbs/ ft3) | Strength Type | Shear/Normal Function | Allow Sliding Along Boundary | Water Surface | Ru Value |
|---|---|---|---|---|---|---|---|
| Infinite Strength | | 120 | Infinite Strength | | Yes | None | 0 |
| MSW (Seismic) | | 85 | Shear/ Normal Function | Seismic MSW Depth Function (Bray et al 2009-1.2x) | | None | 0 |




| Method Name | Min FS |
|---|---|
| GLE / Morgenstern-Price | 2.7 |

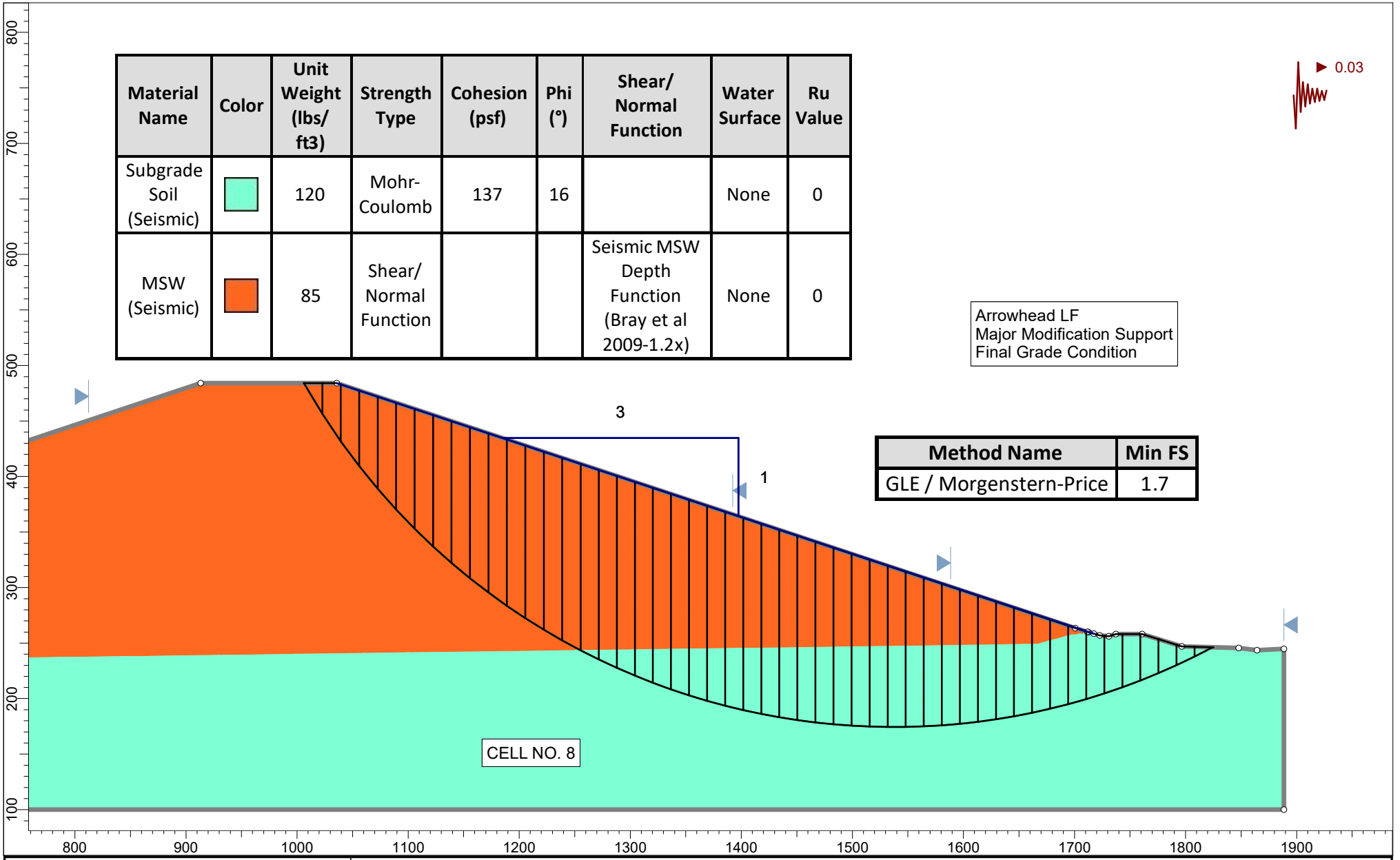
SLIDEINTERPRET 9.031

| | | | |
|---|---|---|---|
| Project | MAJOR MODIFICATION SUPPORT | | |
| Group | A-A - East slope - Seismic | Scenario | A.5 .E - Waste Only |
| Drawn | T. Whitesell, E.I.T. | Company | Bunnell-Lammons Engineering, Inc. |
| Date | 11/8/2024 | File Name | AHLF A-A'.slmd |

| Material Name | Color | Unit Weight (lbs/ ft3) | Strength Type | Cohesion (psf) | Phi (°) | Shear/ Normal Function | Water Surface | Ru Value |
|---|---|---|---|---|---|---|---|---|
| Subgrade Soil (Seismic) | | 120 | Mohr-Coulomb | 137 | 16 | | None | 0 |
| MSW (Seismic) | | 85 | Shear/ Normal Function | | | Seismic MSW Depth Function (Bray et al 2009-1.2x) | None | 0 |

0.03

Arrowhead LF
Major Modification Support
Final Grade Condition




| Method Name | Min FS |
|---|---|
| GLE / Morgenstern-Price | 1.7 |

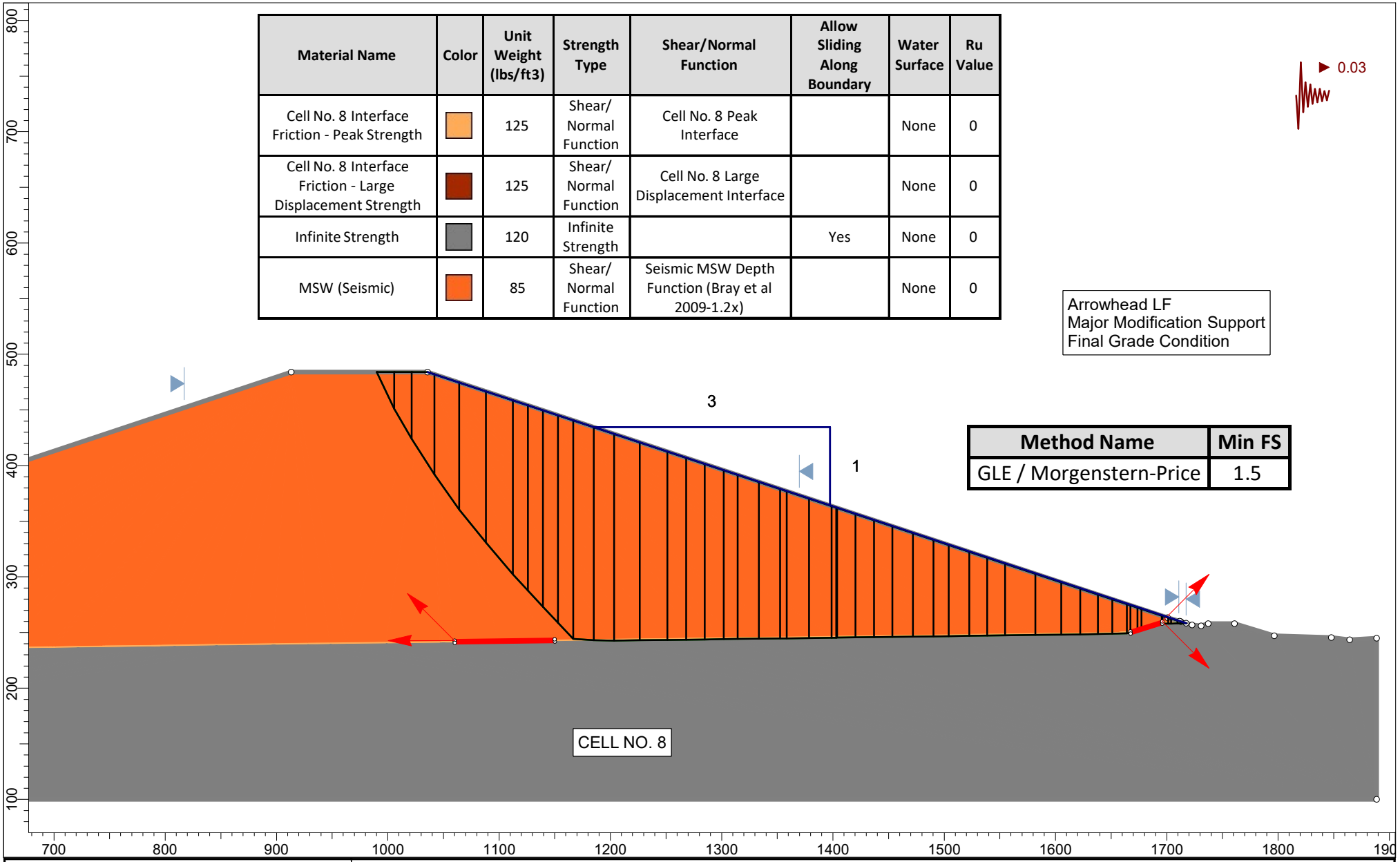
SLIDEINTERPRET 9.031

| | | | |
|---|---|---|---|
| Project | MAJOR MODIFICATION SUPPORT | | |
| Group | A-A - East slope - Seismic | Scenario | A.6.E - Subgrade - Global |
| Drawn | T. Whitesell, E.I.T. | Company | Bunnell-Lammons Engineering, Inc. |
| Date | 11/8/2024 | File Name | AHLF A-A'.slmd |

| Material Name | Color | Unit Weight (lbs/ft3) | Strength Type | Shear/Normal Function | Allow Sliding Along Boundary | Water Surface | Ru Value |
|---|---|---|---|---|---|---|---|
| Cell No. 8 Interface Friction - Peak Strength | | 125 | Shear/ Normal Function | Cell No. 8 Peak Interface | | None | 0 |
| Cell No. 8 Interface Friction - Large Displacement Strength | | 125 | Shear/ Normal Function | Cell No. 8 Large Displacement Interface | | None | 0 |
| Infinite Strength | | 120 | Infinite Strength | | Yes | None | 0 |
| MSW (Seismic) | | 85 | Shear/ Normal Function | Seismic MSW Depth Function (Bray et al 2009-1.2x) | | None | 0 |

0.03

Arrowhead LF
Major Modification Support
Final Grade Condition




| Method Name | Min FS |
|---|---|
| GLE / Morgenstern-Price | 1.5 |

SLIDEINTERPRET 9.031

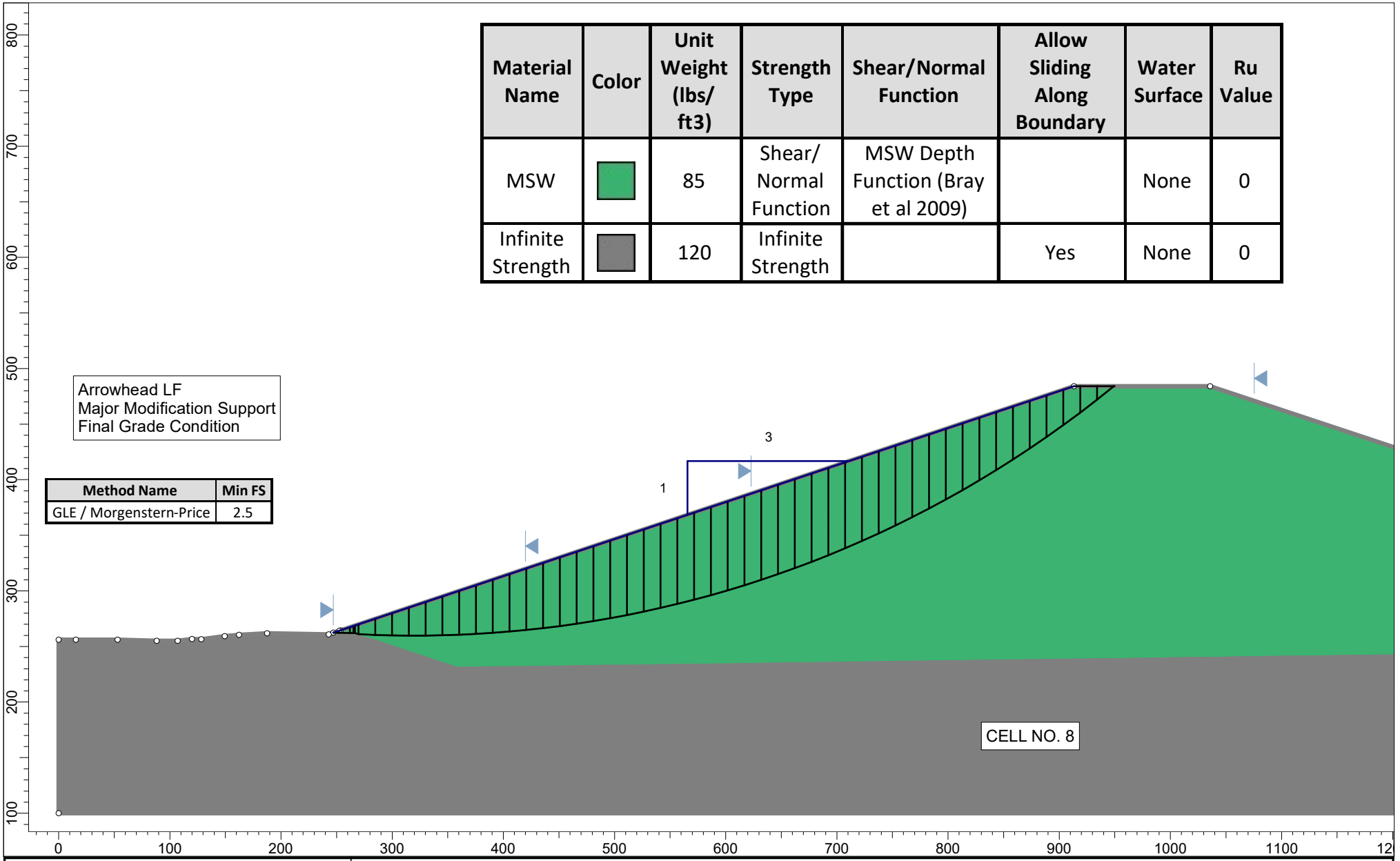
| | | | |
|---|---|---|---|
| Project | MAJOR MODIFICATION SUPPORT | | |
| Group | A-A - East slope - Seismic | Scenario | A.7.E - IS - Peak - Block |
| Drawn | T. Whitesell, E.I.T. | Company | Bunnell-Lammons Engineering, Inc. |
| Date | 11/22/2024 | File Name | AHLF A-A'.slmd |

# Table 5 Runs – A-A', Tract 1 West Slope

| Material Name | Color | Unit Weight (lbs/ ft3) | Strength Type | Shear/Normal Function | Allow Sliding Along Boundary | Water Surface | Ru Value |
|---|---|---|---|---|---|---|---|
| MSW | | 85 | Shear/ Normal Function | MSW Depth Function (Bray et al 2009) | | None | 0 |
| Infinite Strength | | 120 | Infinite Strength | | Yes | None | 0 |

Arrowhead LF
Major Modification Support
Final Grade Condition

| Method Name | Min FS |
|---|---|
| GLE / Morgenstern-Price | 2.5 |



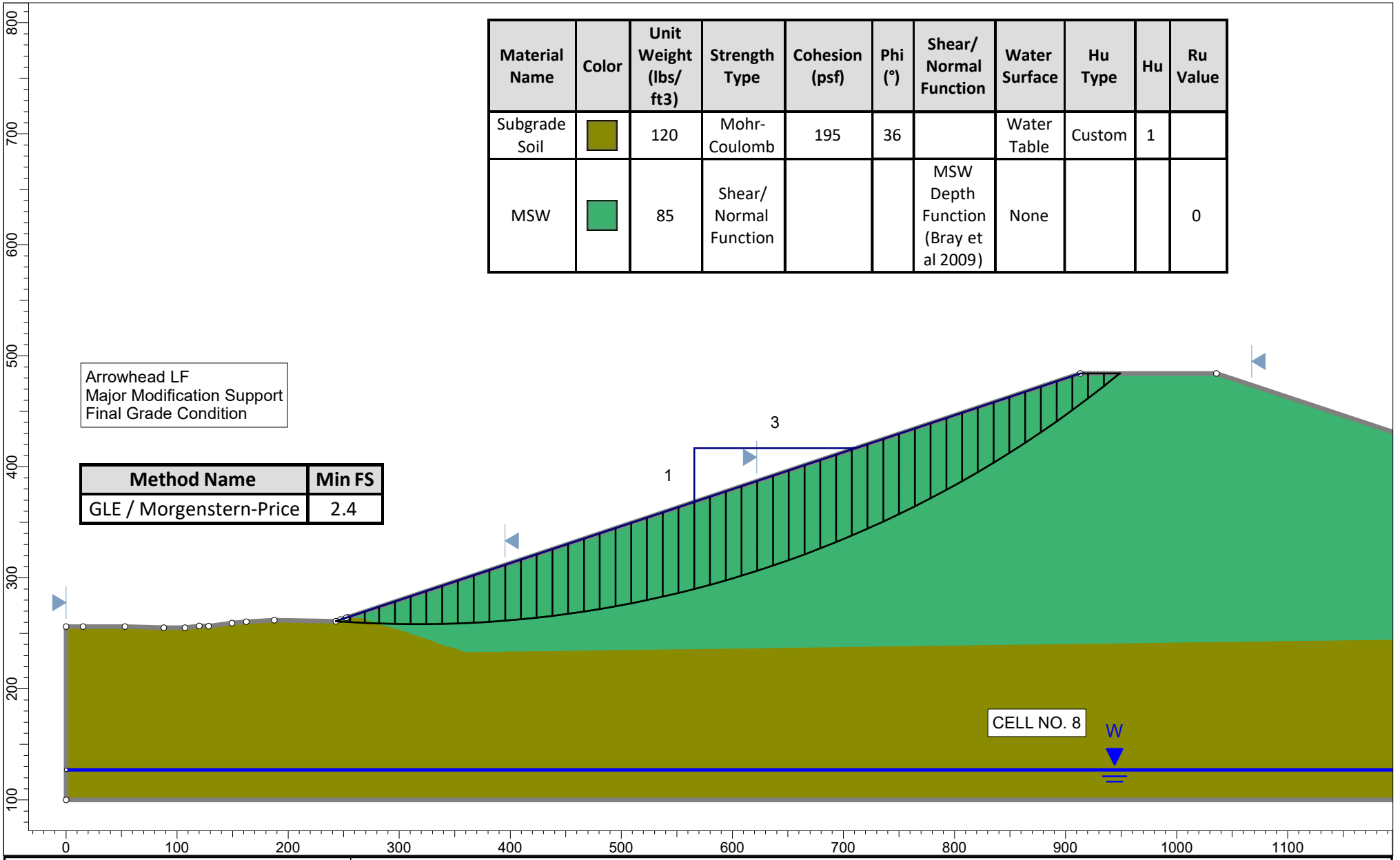

SLIDEINTERPRET 9.031

| | | | |
|---|---|---|---|
| Project | MAJOR MODIFICATION SUPPORT | | |
| Group | A-A - West slope - Static | Scenario | A.1.W - Waste Only |
| Drawn | T. Whitesell, E.I.T. | Company | Bunnell-Lammons Engineering, Inc. |
| Date | 11/8/2024 | File Name | AHLF A-A'.slmd |

| Material Name | Color | Unit Weight (lbs/ ft3) | Strength Type | Cohesion (psf) | Phi (°) | Shear/ Normal Function | Water Surface | Hu Type | Hu | Ru Value |
|---|---|---|---|---|---|---|---|---|---|---|
| Subgrade Soil | | 120 | Mohr-Coulomb | 195 | 36 | | Water Table | Custom | 1 | |
| MSW | | 85 | Shear/ Normal Function | | | MSW Depth Function (Bray et al 2009) | None | | | 0 |

Arrowhead LF
Major Modification Support
Final Grade Condition

| Method Name | Min FS |
|---|---|
| GLE / Morgenstern-Price | 2.4 |



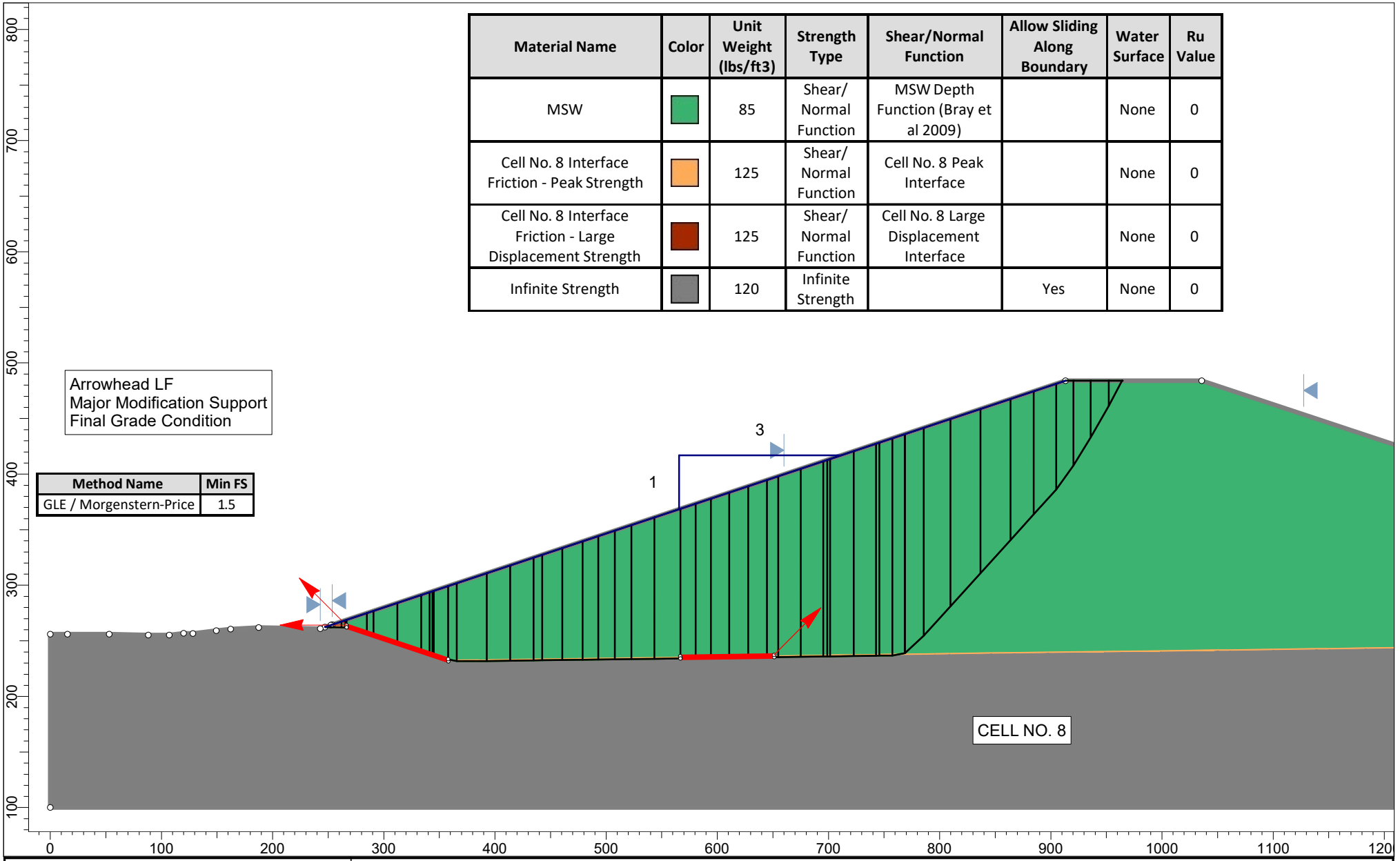

SLIDEINTERPRET 9.031

| | | | |
|---|---|---|---|
| Project | MAJOR MODIFICATION SUPPORT | | |
| Group | A-A - West slope - Static | Scenario | A.2.W - Subgrade - Global |
| Drawn | T. Whitesell, E.I.T. | Company | Bunnell-Lammons Engineering, Inc. |
| Date | 11/8/2024 | File Name | AHLF A-A'.slmd |

| Material Name | Color | Unit Weight (lbs/ft3) | Strength Type | Shear/Normal Function | Allow Sliding Along Boundary | Water Surface | Ru Value |
|---|---|---|---|---|---|---|---|
| MSW | | 85 | Shear/ Normal Function | MSW Depth Function (Bray et al 2009) | | None | 0 |
| Cell No. 8 Interface Friction - Peak Strength | | 125 | Shear/ Normal Function | Cell No. 8 Peak Interface | | None | 0 |
| Cell No. 8 Interface Friction - Large Displacement Strength | | 125 | Shear/ Normal Function | Cell No. 8 Large Displacement Interface | | None | 0 |
| Infinite Strength | | 120 | Infinite Strength | | Yes | None | 0 |

Arrowhead LF
Major Modification Support
Final Grade Condition

| Method Name | Min FS |
|---|---|
| GLE / Morgenstern-Price | 1.5 |



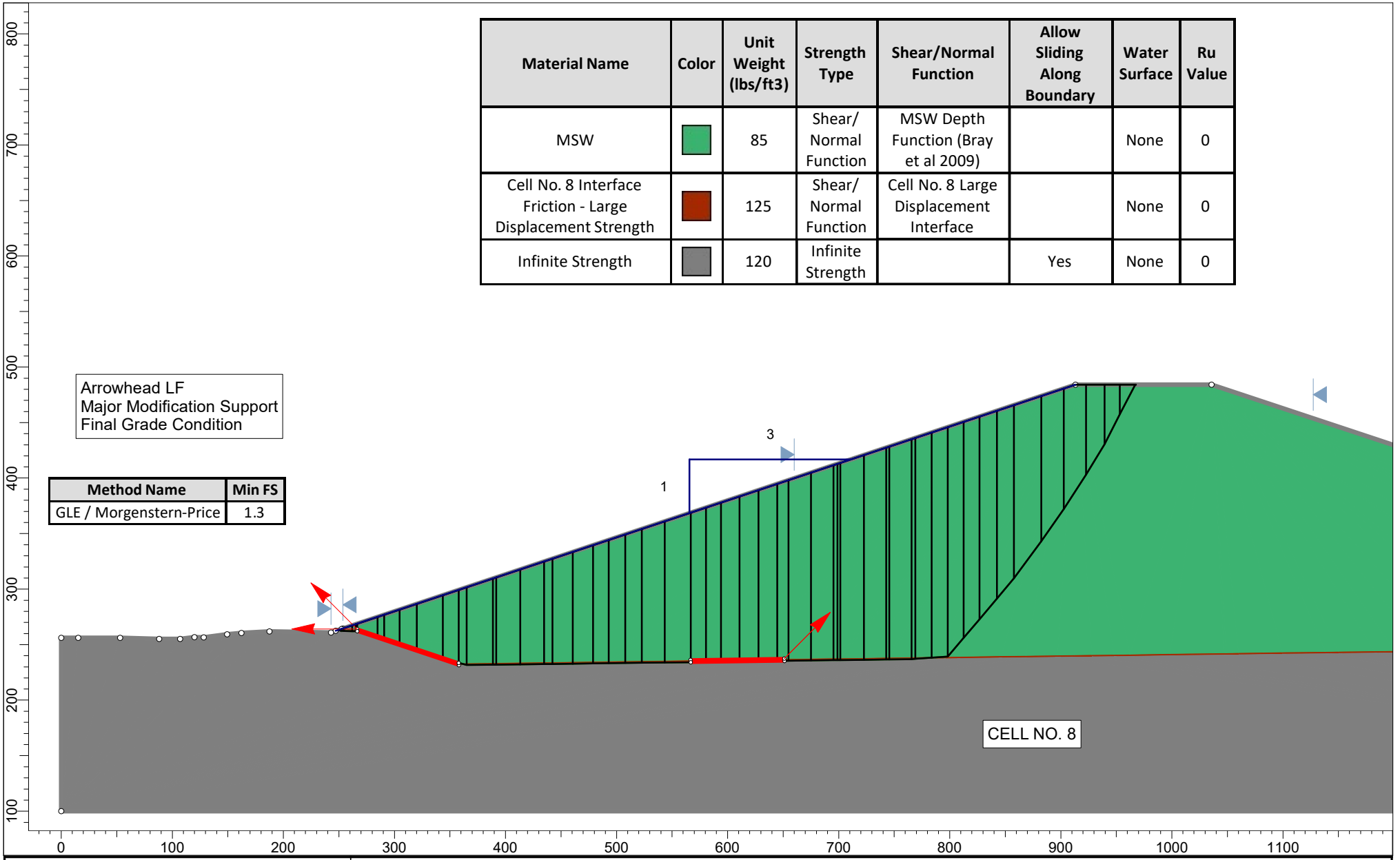

SLIDEINTERPRET 9.031

| | | | |
|---|---|---|---|
| *Project* | MAJOR MODIFICATION SUPPORT | | |
| *Group* | A-A - West slope - Static | *Scenario* | A.3.W - IS - Peak - Block |
| Drawn | T. Whitesell, E.I.T. | *Company* | Bunnell-Lammons Engineering, Inc. |
| *Date* | 11/22/2024 | *File Name* | AHLF A-A'.slmd |

| Material Name | Color | Unit Weight (lbs/ft3) | Strength Type | Shear/Normal Function | Allow Sliding Along Boundary | Water Surface | Ru Value |
|---|---|---|---|---|---|---|---|
| MSW | | 85 | Shear/ Normal Function | MSW Depth Function (Bray et al 2009) | | None | 0 |
| Cell No. 8 Interface Friction - Large Displacement Strength | | 125 | Shear/ Normal Function | Cell No. 8 Large Displacement Interface | | None | 0 |
| Infinite Strength | | 120 | Infinite Strength | | Yes | None | 0 |

Arrowhead LF
Major Modification Support
Final Grade Condition

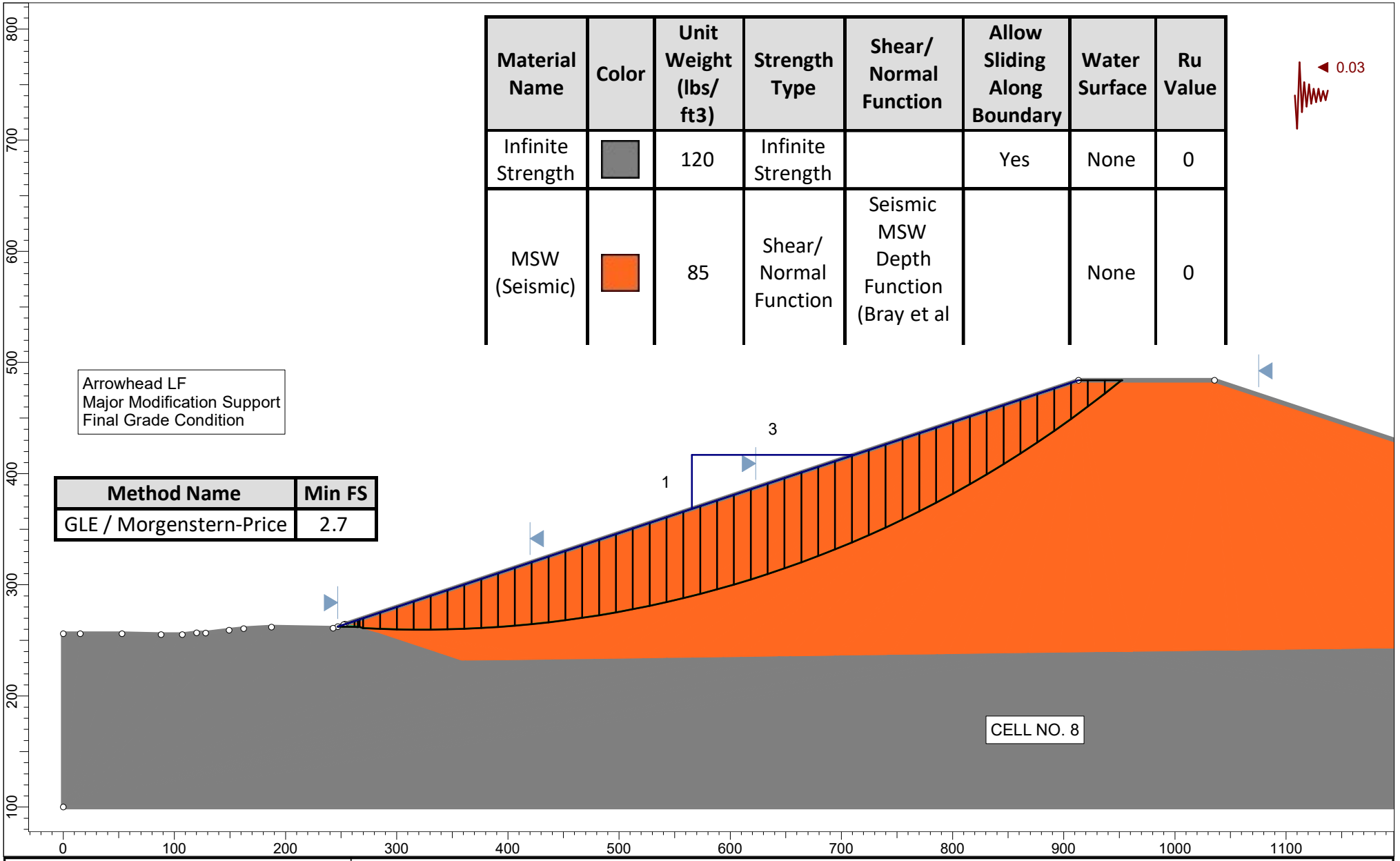
| Method Name | Min FS |
|---|---|
| GLE / Morgenstern-Price | 1.3 |




SLIDEINTERPRET 9.031

| | | | |
|---|---|---|---|
| Project | MAJOR MODIFICATION SUPPORT | | |
| Group | A-A - West slope - Static | Scenario | A.4.W - IS - Large Displacement - Block |
| Drawn | T. Whitesell, E.I.T. | Company | Bunnell-Lammons Engineering, Inc. |
| Date | 11/22/2024 | File Name | AHLF A-A'.slmd |

| Material Name | Color | Unit Weight (lbs/ ft3) | Strength Type | Shear/ Normal Function | Allow Sliding Along Boundary | Water Surface | Ru Value |
|---|---|---|---|---|---|---|---|
| Infinite Strength | | 120 | Infinite Strength | | Yes | None | 0 |
| MSW (Seismic) | | 85 | Shear/ Normal Function | Seismic MSW Depth Function (Bray et al | | None | 0 |

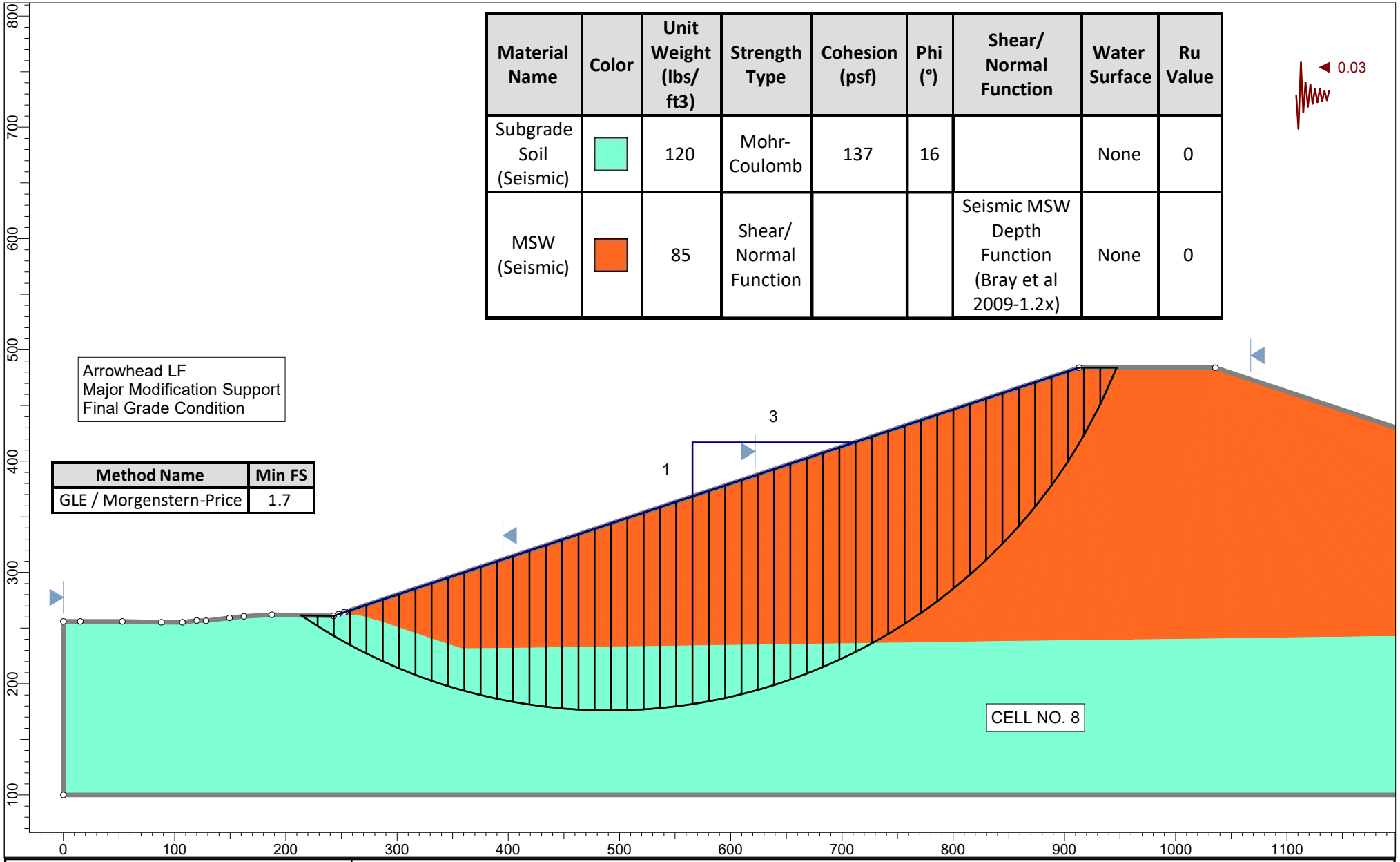



| Method Name | Min FS |
|---|---|
| GLE / Morgenstern-Price | 2.7 |

SLIDEINTERPRET 9.031

| | | | |
|---|---|---|---|
| Project | MAJOR MODIFICATION SUPPORT | | |
| Group | A-A - West slope - Seismic | Scenario | A.5.W - Waste Only - Seismic |
| Drawn | T. Whitesell, E.I.T. | Company | Bunnell-Lammons Engineering, Inc. |
| Date | 11/8/2024 | File Name | AHLF A-A'.slmd |

| Material Name | Color | Unit Weight (lbs/ ft3) | Strength Type | Cohesion (psf) | Phi (°) | Shear/ Normal Function | Water Surface | Ru Value |
|---|---|---|---|---|---|---|---|---|
| Subgrade Soil (Seismic) | | 120 | Mohr-Coulomb | 137 | 16 | | None | 0 |
| MSW (Seismic) | | 85 | Shear/ Normal Function | | | Seismic MSW Depth Function (Bray et al 2009-1.2x) | None | 0 |




SLIDEINTERPRET 9.031

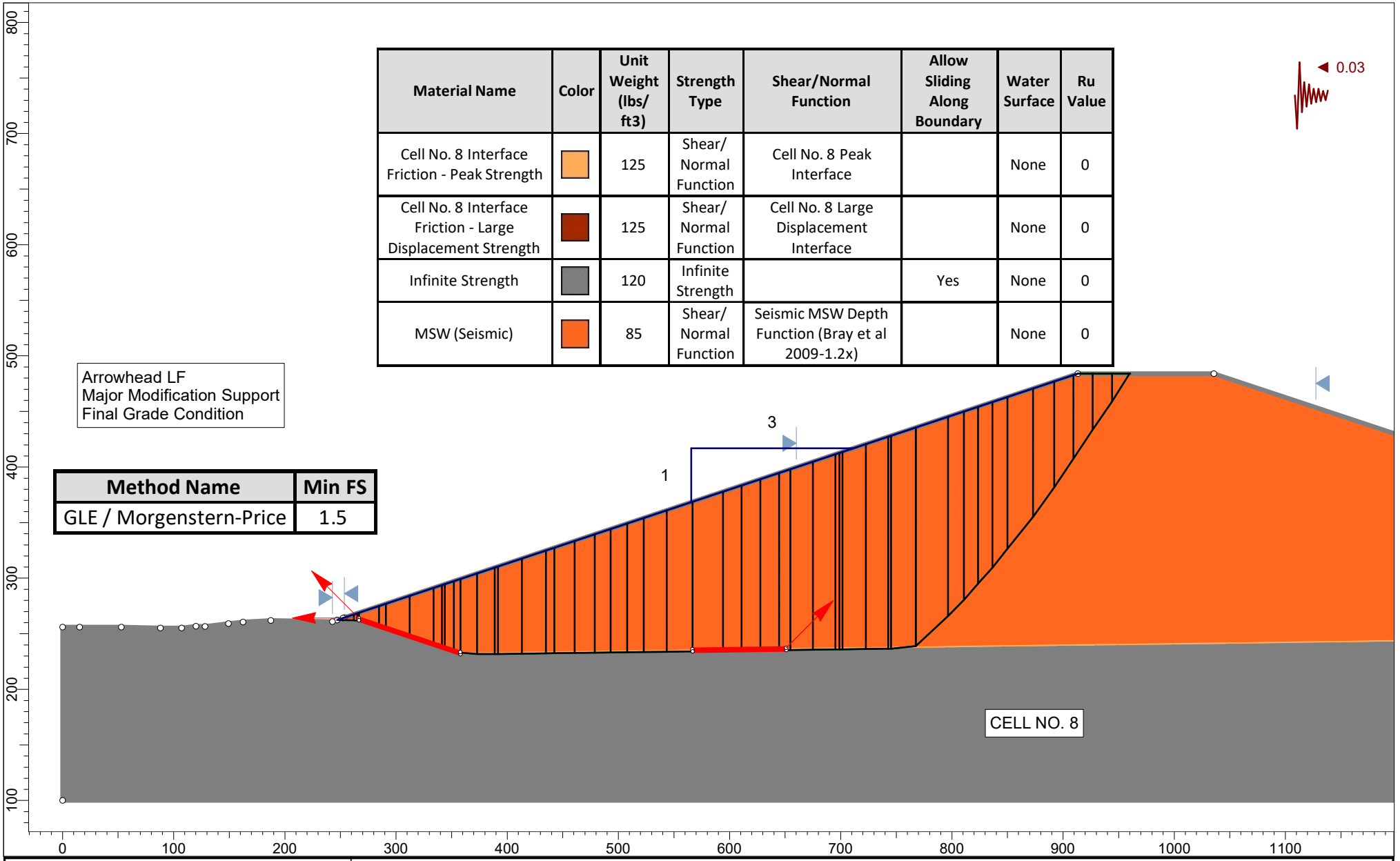
| | | | |
|---|---|---|---|
| Project | MAJOR MODIFICATION SUPPORT | | |
| Group | A-A - West slope - Seismic | Scenario | A.6.W - Subgrade - Global - Seismic |
| Drawn | T. Whitesell, E.I.T. | Company | Bunnell-Lammons Engineering, Inc. |
| Date | 11/8/2024 | File Name | AHLF A-A'.slmd |

| Material Name | Color | Unit Weight (lbs/ ft3) | Strength Type | Shear/Normal Function | Allow Sliding Along Boundary | Water Surface | Ru Value |
|---|---|---|---|---|---|---|---|
| Cell No. 8 Interface Friction - Peak Strength | | 125 | Shear/ Normal Function | Cell No. 8 Peak Interface | | None | 0 |
| Cell No. 8 Interface Friction - Large Displacement Strength | | 125 | Shear/ Normal Function | Cell No. 8 Large Displacement Interface | | None | 0 |
| Infinite Strength | | 120 | Infinite Strength | | Yes | None | 0 |
| MSW (Seismic) | | 85 | Shear/ Normal Function | Seismic MSW Depth Function (Bray et al 2009-1.2x) | | None | 0 |

0.03

Arrowhead LF
Major Modification Support
Final Grade Condition

| Method Name | Min FS |
|---|---|
| GLE / Morgenstern-Price | 1.5 |




SLIDEINTERPRET 9.031

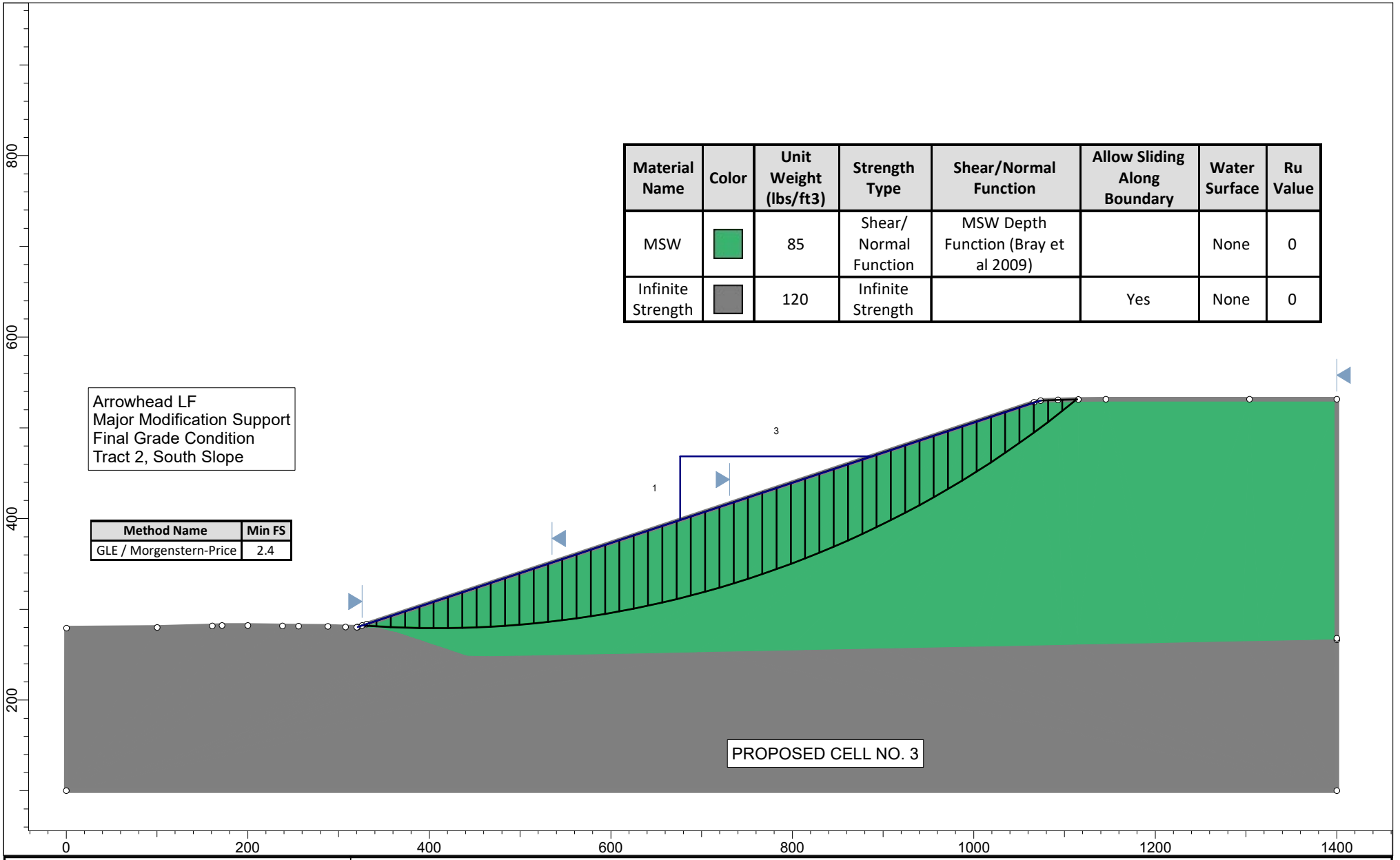
| | | | |
|---|---|---|---|
| Project | MAJOR MODIFICATION SUPPORT | | |
| Group | A-A - West slope - Seismic | Scenario | A.7.W - IS - Peak - Block |
| Drawn | T. Whitesell, E.I.T. | Company | Bunnell-Lammons Engineering, Inc. |
| Date | 11/22/2024 | File Name | AHLF A-A'.slmd |

# Table 6 Runs – B-B', Tract 2 South Slope

| Material Name | Color | Unit Weight (lbs/ft3) | Strength Type | Shear/Normal Function | Allow Sliding Along Boundary | Water Surface | Ru Value |
|---|---|---|---|---|---|---|---|
| MSW | | 85 | Shear/ Normal Function | MSW Depth Function (Bray et al 2009) | | None | 0 |
| Infinite Strength | | 120 | Infinite Strength | | Yes | None | 0 |

Arrowhead LF
Major Modification Support
Final Grade Condition
Tract 2, South Slope

| Method Name | Min FS |
|---|---|
| GLE / Morgenstern-Price | 2.4 |



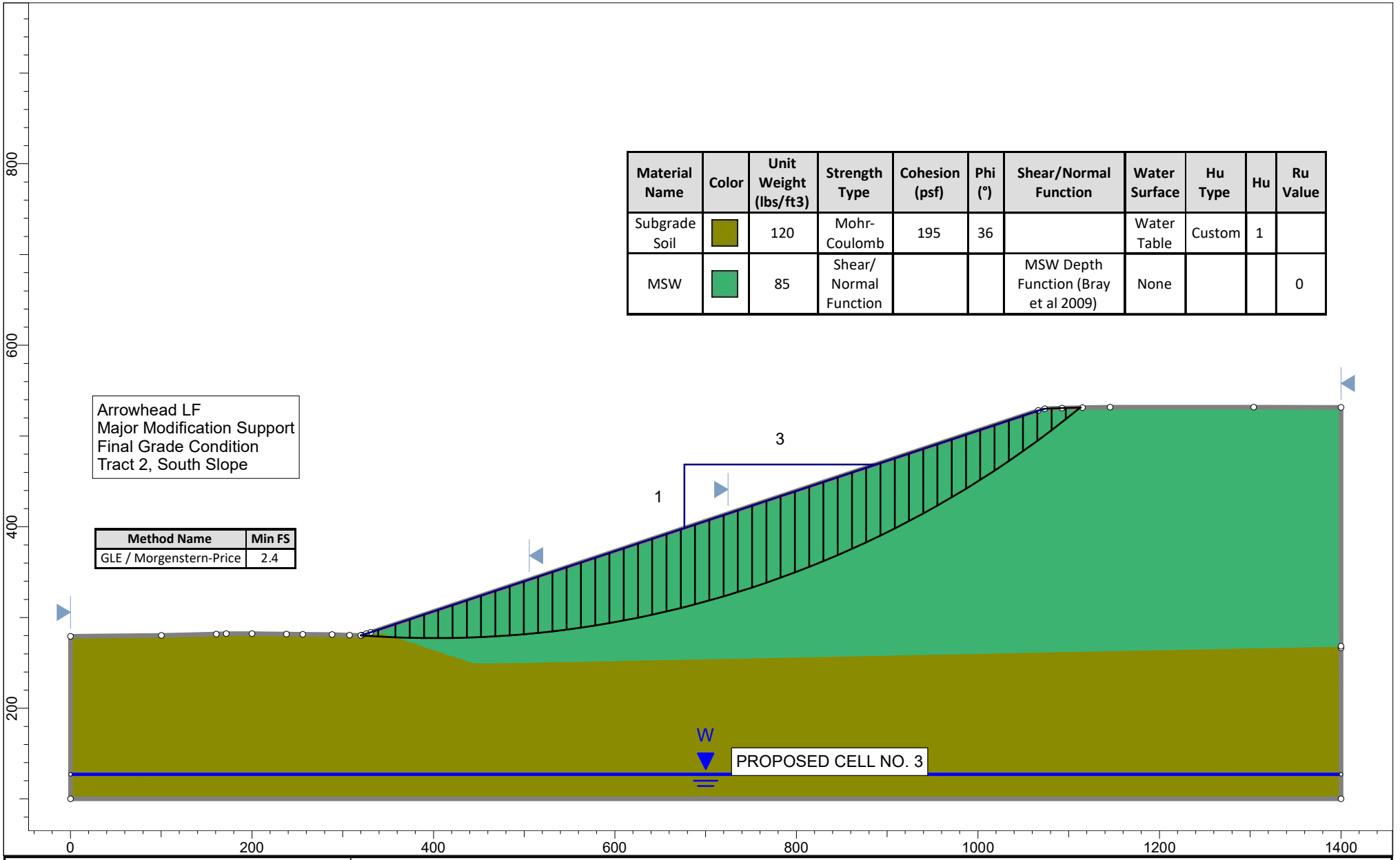

SLIDEINTERPRET 9.031

| | | | |
|---|---|---|---|
| Project | MAJOR MODIFICATION SUPPORT | | |
| Group | B-B - Static | Scenario | B.1 - Waste Only |
| Drawn | T. Whitesell, E.I.T. | Company | Bunnell-Lammons Engineering, Inc. |
| Date | 11/8/2024 | File Name | AHLF_B-B'.slmd |

| Material Name | Color | Unit Weight (lbs/ft3) | Strength Type | Cohesion (psf) | Phi (°) | Shear/Normal Function | Water Surface | Hu Type | Hu | Ru Value |
|---|---|---|---|---|---|---|---|---|---|---|
| Subgrade Soil | | 120 | Mohr-Coulomb | 195 | 36 | | Water Table | Custom | 1 | |
| MSW | | 85 | Shear/ Normal Function | | | MSW Depth Function (Bray et al 2009) | None | | | 0 |

Arrowhead LF
Major Modification Support
Final Grade Condition
Tract 2, South Slope

| Method Name | Min FS |
|---|---|
| GLE / Morgenstern-Price | 2.4 |

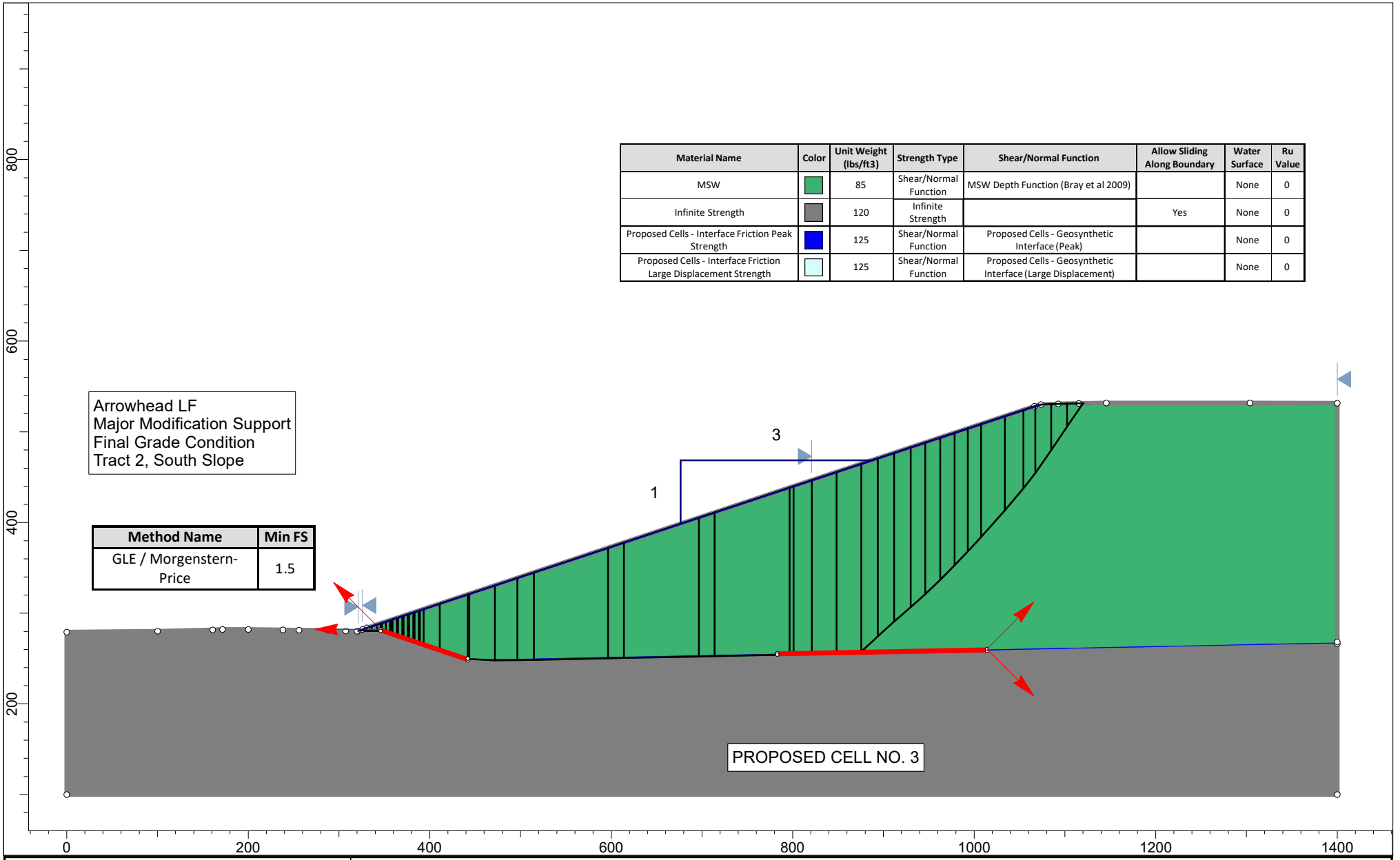



| | | | |
|---|---|---|---|
| | Project: MAJOR MODIFICATION SUPPORT | | |
| | Group: B-B - Static | Scenario: B.2 - Subgrade - Global | |
| | Drawn: T. Whitesell, E.I.T. | Company: Bunnell-Lammons Engineering, Inc. | |
| SLIDEINTERPRET 9.031 | Date: 11/8/2024 | File Name: AHLF_B-B'.slmd | |

| Material Name | Color | Unit Weight (lbs/ft3) | Strength Type | Shear/Normal Function | Allow Sliding Along Boundary | Water Surface | Ru Value |
|---|---|---|---|---|---|---|---|
| MSW | | 85 | Shear/Normal Function | MSW Depth Function (Bray et al 2009) | | None | 0 |
| Infinite Strength | | 120 | Infinite Strength | | Yes | None | 0 |
| Proposed Cells - Interface Friction Peak Strength | | 125 | Shear/Normal Function | Proposed Cells - Geosynthetic Interface (Peak) | | None | 0 |
| Proposed Cells - Interface Friction Large Displacement Strength | | 125 | Shear/Normal Function | Proposed Cells - Geosynthetic Interface (Large Displacement) | | None | 0 |

Arrowhead LF
Major Modification Support
Final Grade Condition
Tract 2, South Slope

| Method Name | Min FS |
|---|---|
| GLE / Morgenstern-Price | 1.5 |



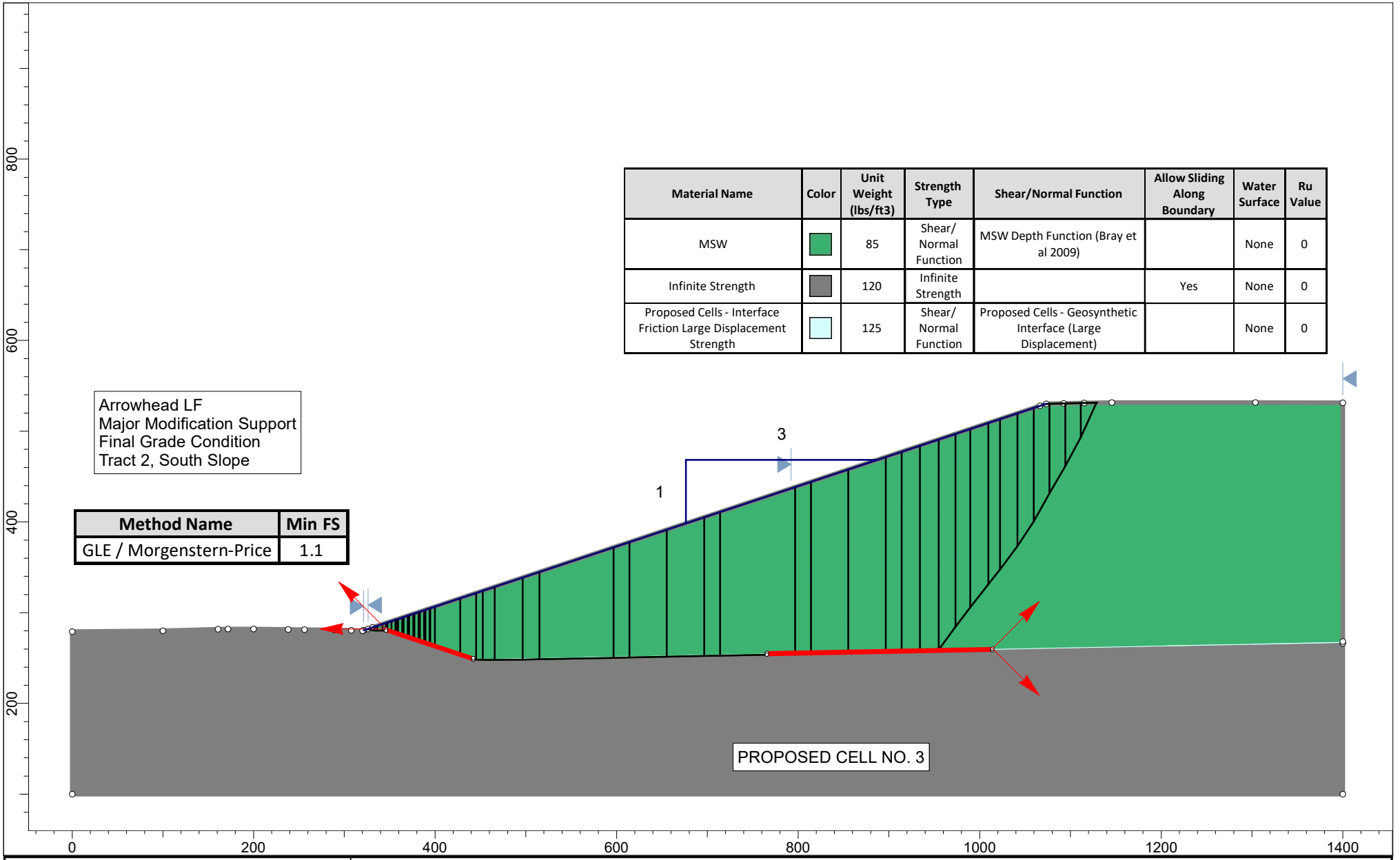

SLIDEINTERPRET 9.031

| | | | |
|---|---|---|---|
| Project | MAJOR MODIFICATION SUPPORT | | |
| Group | B-B - Static | Scenario | B.3 - IS - Peak - Block |
| Drawn | T. Whitesell, E.I.T. | Company | Bunnell-Lammons Engineering, Inc. |
| Date | 11/21/2024 | File Name | AHLF_B-B'.slmd |

| Material Name | Color | Unit Weight (lbs/ft3) | Strength Type | Shear/Normal Function | Allow Sliding Along Boundary | Water Surface | Ru Value |
|---|---|---|---|---|---|---|---|
| MSW | | 85 | Shear/ Normal Function | MSW Depth Function (Bray et al 2009) | | None | 0 |
| Infinite Strength | | 120 | Infinite Strength | | Yes | None | 0 |
| Proposed Cells - Interface Friction Large Displacement Strength | | 125 | Shear/ Normal Function | Proposed Cells - Geosynthetic Interface (Large Displacement) | | None | 0 |

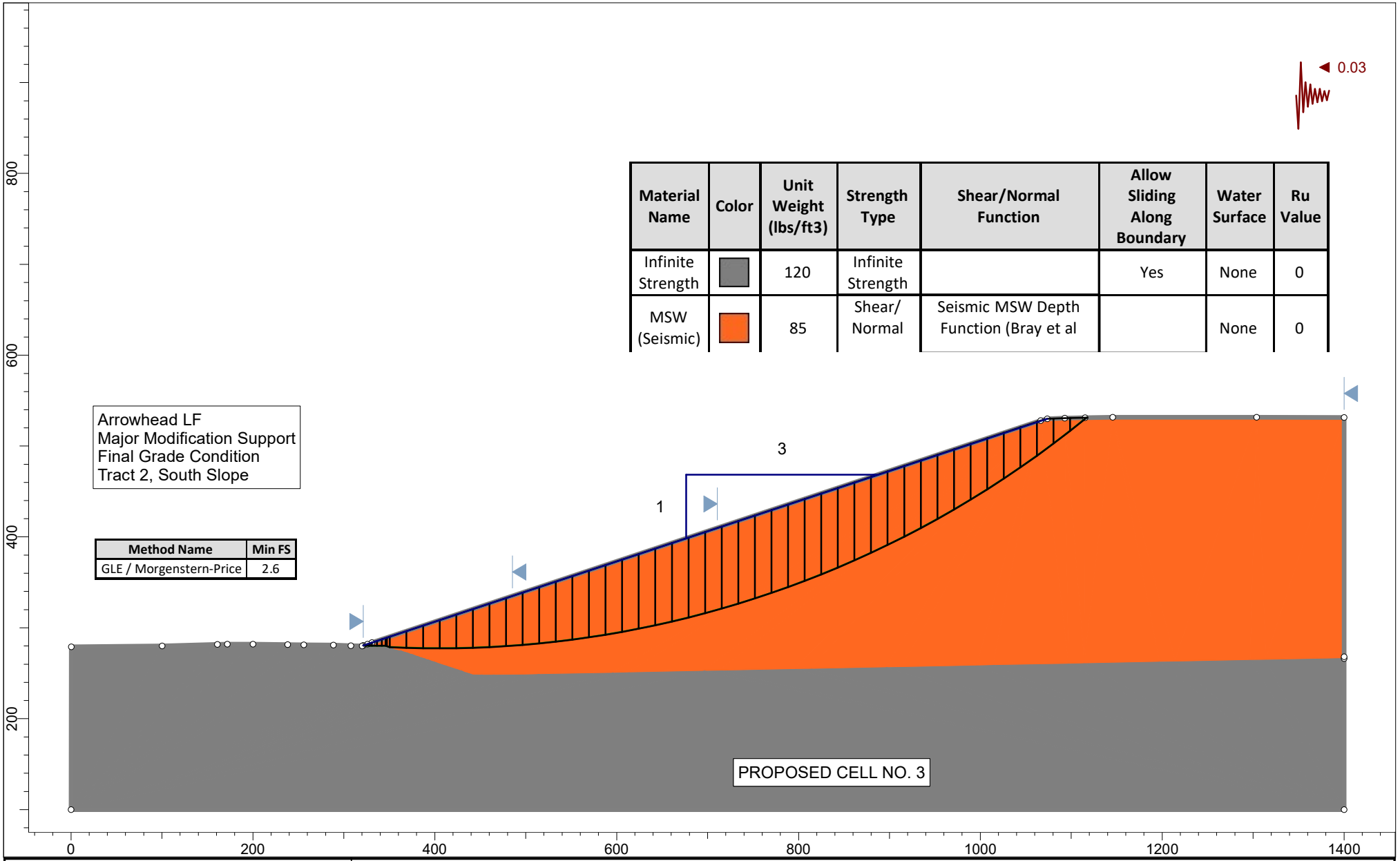
Arrowhead LF
Major Modification Support
Final Grade Condition
Tract 2, South Slope

| Method Name | Min FS |
|---|---|
| GLE / Morgenstern-Price | 1.1 |




SLIDEINTERPRET 9.031

| | | | |
|---|---|---|---|
| Project | MAJOR MODIFICATION SUPPORT | | |
| Group | B-B - Static | Scenario | B.4 - IS - Large Displacement - Block |
| Drawn | T. Whitesell, E.I.T. | Company | Bunnell-Lammons Engineering, Inc. |
| Date | 11/21/2024 | File Name | AHLF_B-B'.slmd |

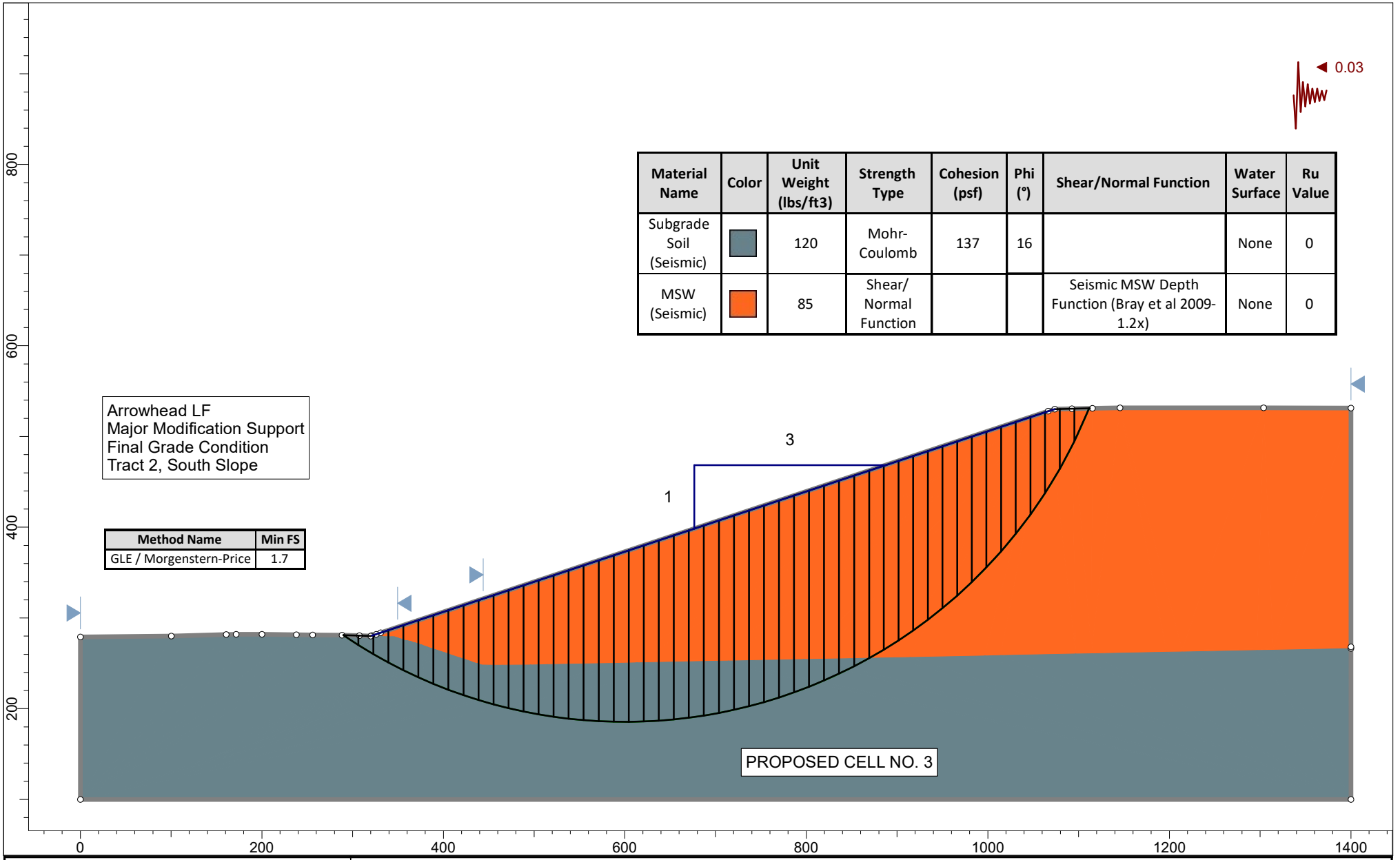



| Material Name | Color | Unit Weight (lbs/ft3) | Strength Type | Shear/Normal Function | Allow Sliding Along Boundary | Water Surface | Ru Value |
|---|---|---|---|---|---|---|---|
| Infinite Strength | | 120 | Infinite Strength | | Yes | None | 0 |
| MSW (Seismic) | | 85 | Shear/ Normal | Seismic MSW Depth Function (Bray et al | | None | 0 |

| Method Name | Min FS |
|---|---|
| GLE / Morgenstern-Price | 2.6 |

SLIDEINTERPRET 9.031

| | | | |
|---|---|---|---|
| *Project* | MAJOR MODIFICATION SUPPORT | | |
| *Group* | B-B' Seismic | *Scenario* | B.5 - Waste Only - Seismic |
| Drawn | T. Whitesell, E.I.T. | *Company* | Bunnell-Lammons Engineering, Inc. |
| *Date* | 11/8/2024 | *File Name* | AHLF_B-B'.slmd |




SLIDEINTERPRET 9.031

| | | | |
|---|---|---|---|
| *Project* | MAJOR MODIFICATION SUPPORT | | |
| *Group* | B-B' Seismic | *Scenario* | B.6 - Subgrade - Seismic |
| Drawn | T. Whitesell, E.I.T. | *Company* | Bunnell-Lammons Engineering, Inc. |
| *Date* | 11/8/2024 | *File Name* | AHLF_B-B'.slmd |

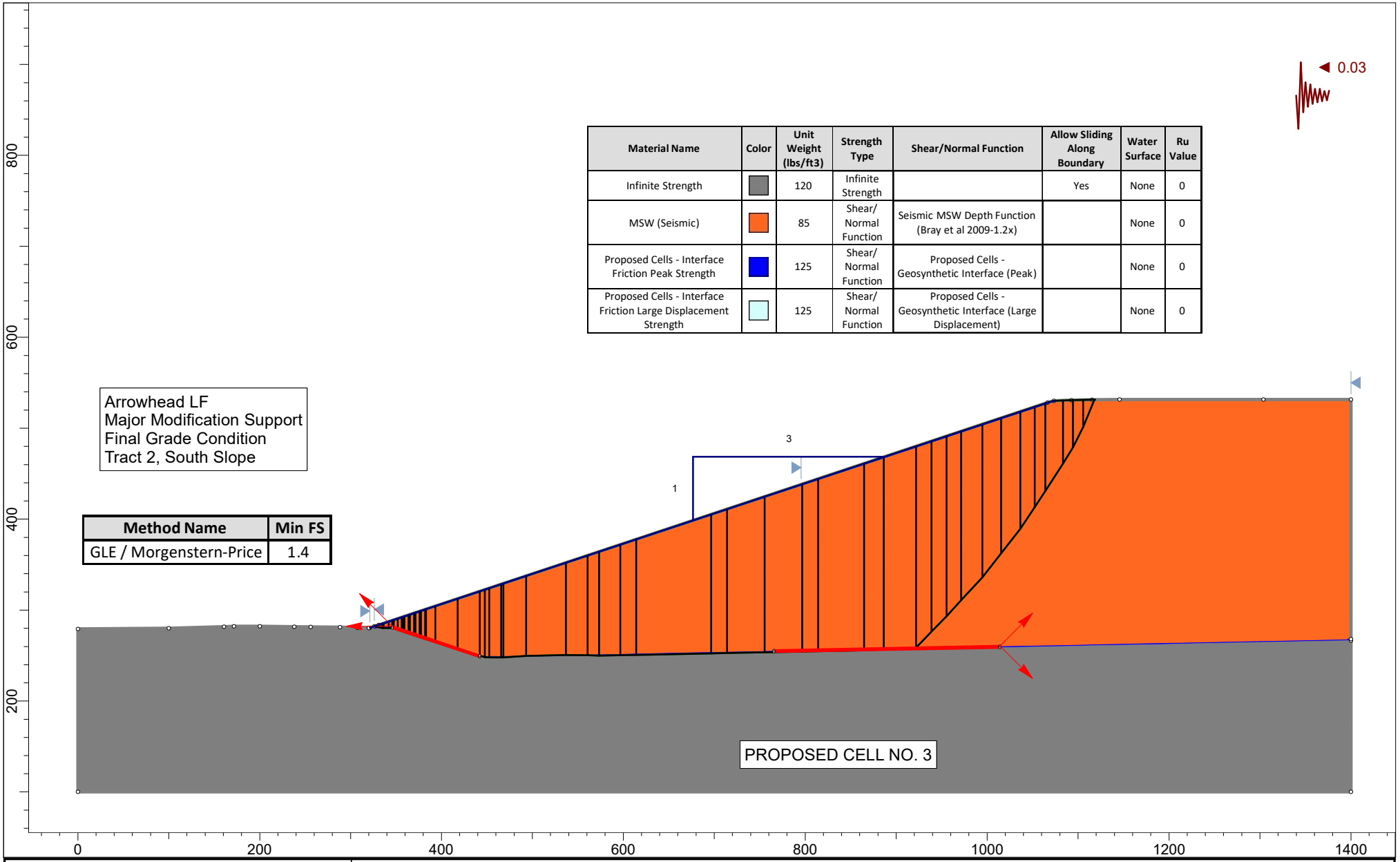
| Material Name | Color | Unit Weight (lbs/ft3) | Strength Type | Shear/Normal Function | Allow Sliding Along Boundary | Water Surface | Ru Value |
|---|---|---|---|---|---|---|---|
| Infinite Strength | | 120 | Infinite Strength | | Yes | None | 0 |
| MSW (Seismic) | | 85 | Shear/ Normal Function | Seismic MSW Depth Function (Bray et al 2009-1.2x) | | None | 0 |
| Proposed Cells - Interface Friction Peak Strength | | 125 | Shear/ Normal Function | Proposed Cells - Geosynthetic Interface (Peak) | | None | 0 |
| Proposed Cells - Interface Friction Large Displacement Strength | | 125 | Shear/ Normal Function | Proposed Cells - Geosynthetic Interface (Large Displacement) | | None | 0 |

0.03

Arrowhead LF
Major Modification Support
Final Grade Condition
Tract 2, South Slope

| Method Name | Min FS |
|---|---|
| GLE / Morgenstern-Price | 1.4 |




SLIDEINTERPRET 9.031

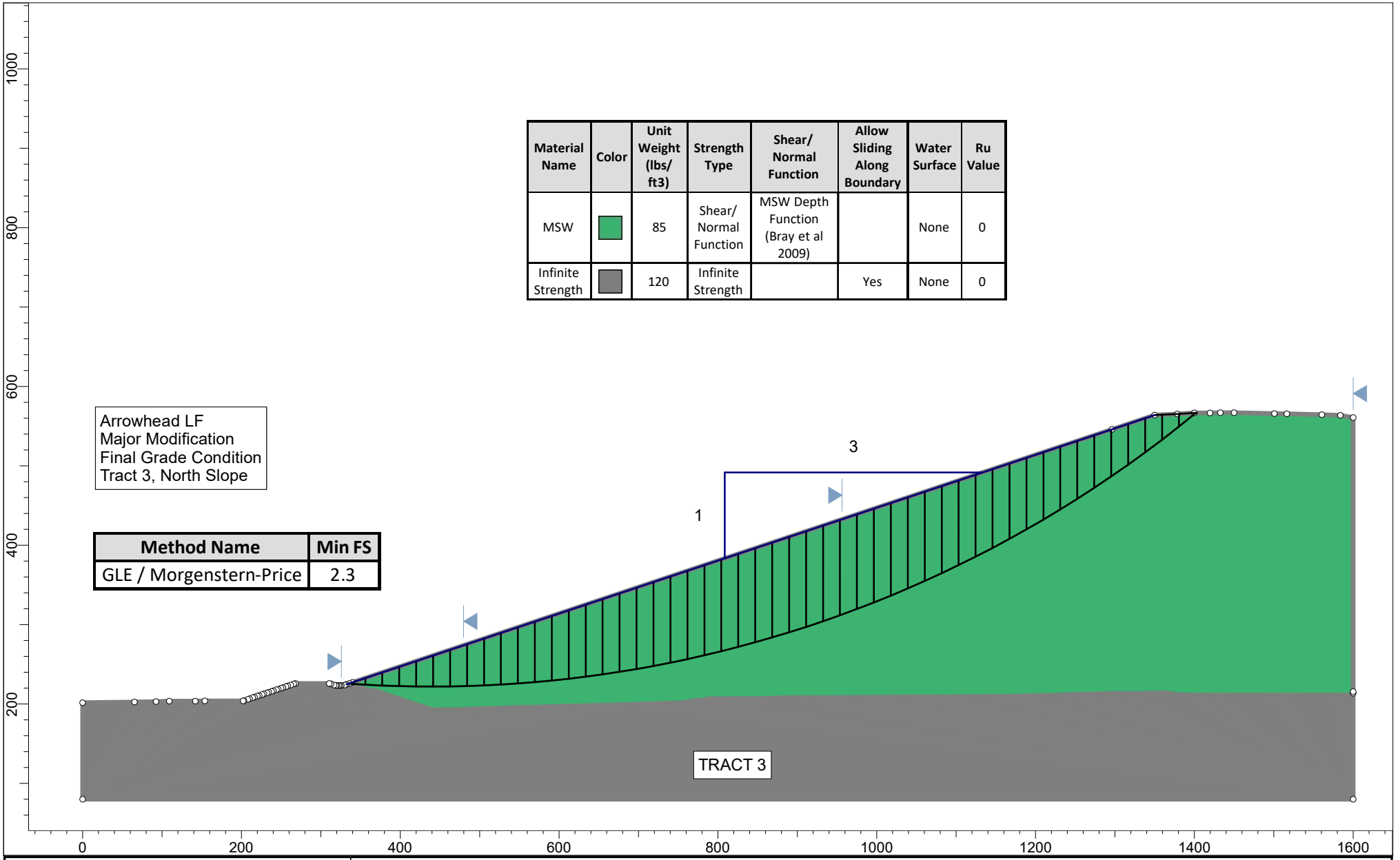
| | | | |
|---|---|---|---|
| Project | MAJOR MODIFICATION SUPPORT | | |
| Group | B-B' Seismic | Scenario | B.7 - IS - Peak - Block - Seismic |
| Drawn | T. Whitesell, E.I.T. | Company | Bunnell-Lammons Engineering, Inc. |
| Date | 11/21/2024 | File Name | AHLF_B-B'.slmd |

# Table 7 Runs – C-C', Tract 3 Northwest Slope

| Material Name | Color | Unit Weight (lbs/ ft3) | Strength Type | Shear/ Normal Function | Allow Sliding Along Boundary | Water Surface | Ru Value |
|---|---|---|---|---|---|---|---|
| MSW | | 85 | Shear/ Normal Function | MSW Depth Function (Bray et al 2009) | | None | 0 |
| Infinite Strength | | 120 | Infinite Strength | | Yes | None | 0 |

Arrowhead LF
Major Modification
Final Grade Condition
Tract 3, North Slope

| Method Name | Min FS |
|---|---|
| GLE / Morgenstern-Price | 2.3 |




SLIDEINTERPRET 9.031

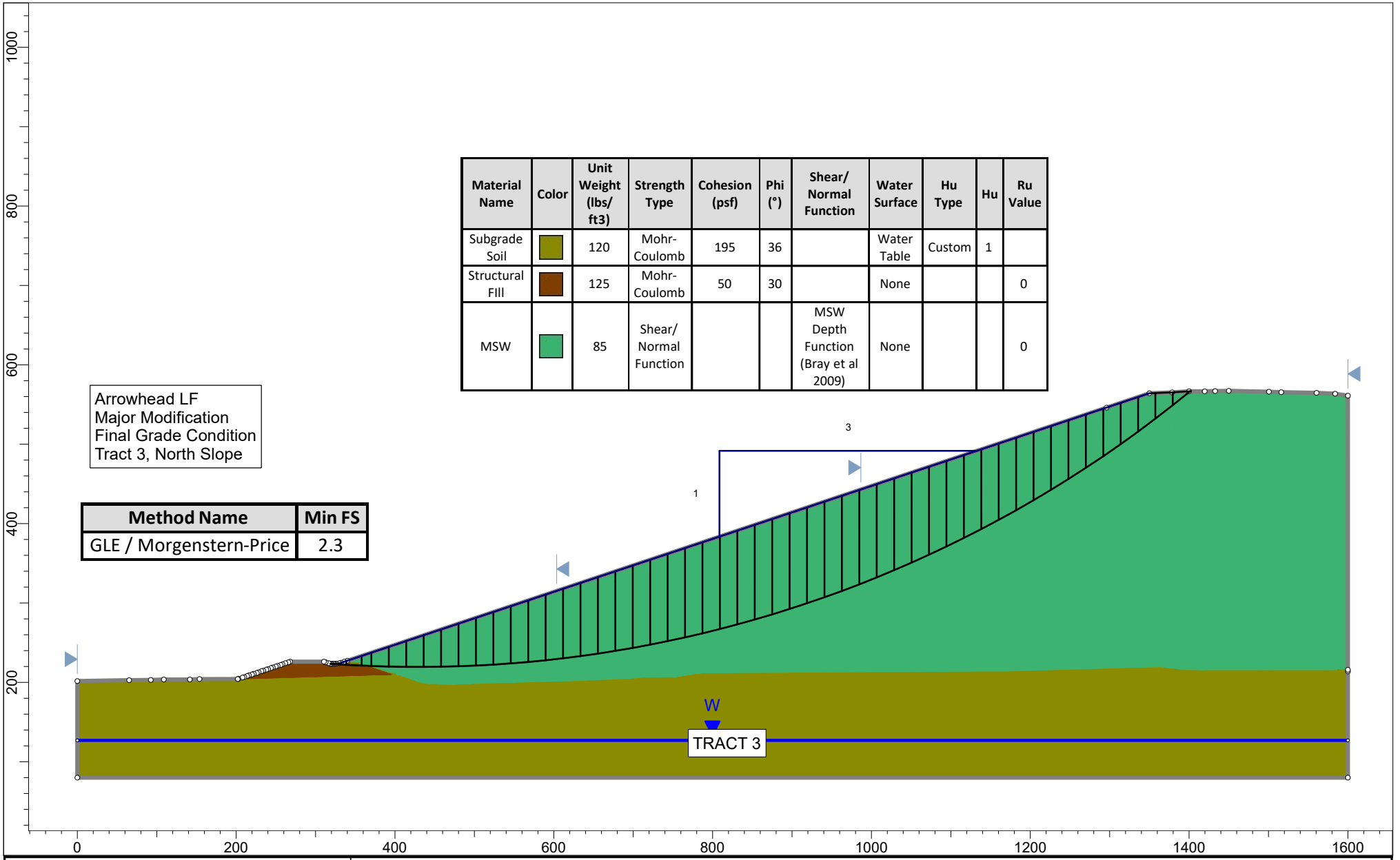
| | | | |
|---|---|---|---|
| Project | MAJOR MODIFICATION SUPPORT | | |
| Group | C-C - Static' | Scenario | C.1 - Waste Only - Global |
| Drawn | T. Whitesell, E.I.T. | Company | Bunnell-Lammons Engineering, Inc. |
| Date | 11/8/2024 | File Name | AHLF C-C'.slmd |

| Material Name | Color | Unit Weight (lbs/ ft3) | Strength Type | Cohesion (psf) | Phi (°) | Shear/ Normal Function | Water Surface | Hu Type | Hu | Ru Value |
|---|---|---|---|---|---|---|---|---|---|---|
| Subgrade Soil | | 120 | Mohr-Coulomb | 195 | 36 | | Water Table | Custom | 1 | |
| Structural FIll | | 125 | Mohr-Coulomb | 50 | 30 | | None | | | 0 |
| MSW | | 85 | Shear/ Normal Function | | | MSW Depth Function (Bray et al 2009) | None | | | 0 |

Arrowhead LF
Major Modification
Final Grade Condition
Tract 3, North Slope

| Method Name | Min FS |
|---|---|
| GLE / Morgenstern-Price | 2.3 |



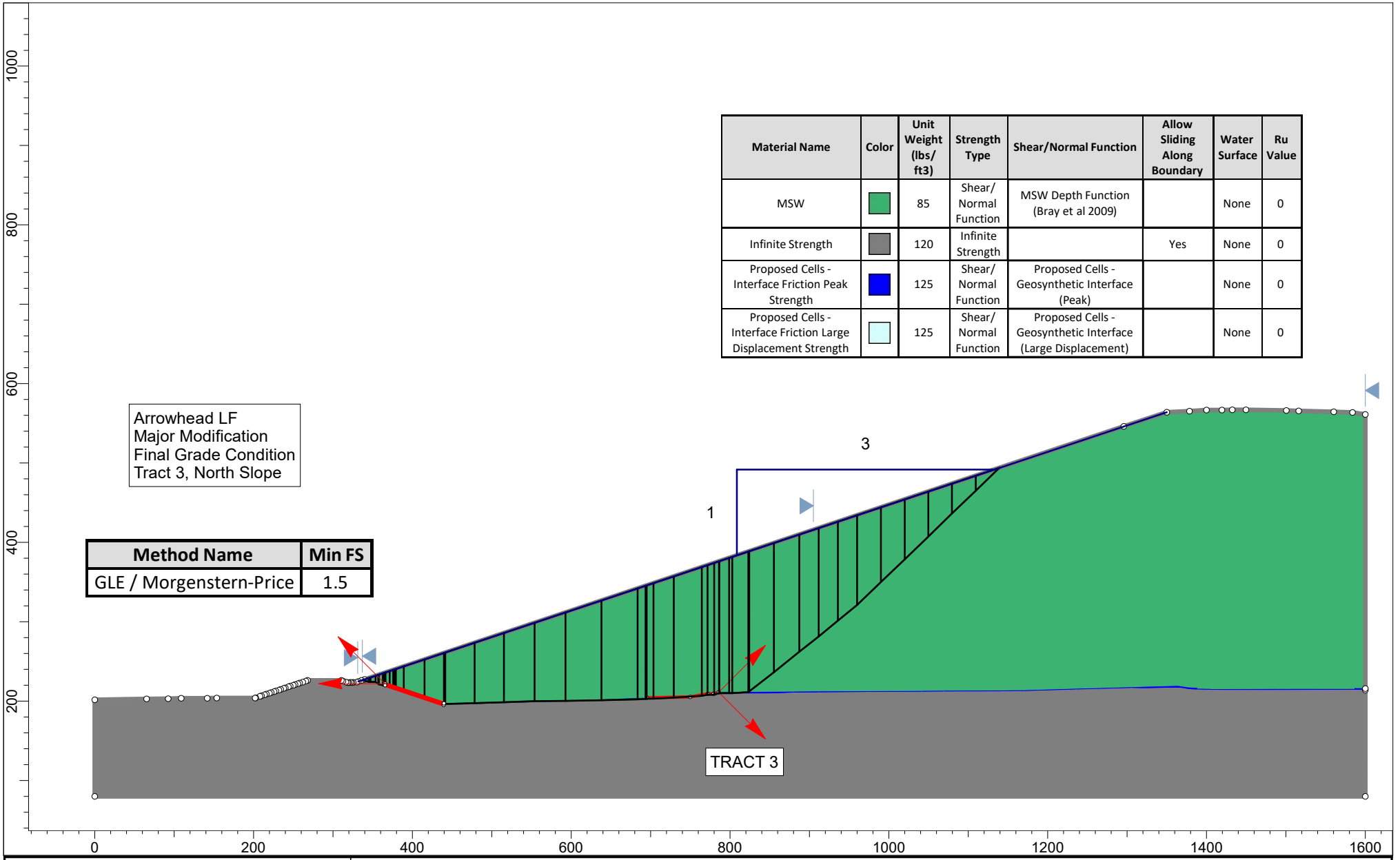

SLIDEINTERPRET 9.031

| | | | |
|---|---|---|---|
| Project | MAJOR MODIFICATION SUPPORT | | |
| Group | C-C - Static' | Scenario | C.2 - Subgrade - Global |
| Drawn | T. Whitesell, E.I.T. | Company | Bunnell-Lammons Engineering, Inc. |
| Date | 11/22/2024 | File Name | AHLF C-C'.slmd |

| Material Name | Color | Unit Weight (lbs/ ft3) | Strength Type | Shear/Normal Function | Allow Sliding Along Boundary | Water Surface | Ru Value |
|---|---|---|---|---|---|---|---|
| MSW | | 85 | Shear/ Normal Function | MSW Depth Function (Bray et al 2009) | | None | 0 |
| Infinite Strength | | 120 | Infinite Strength | | Yes | None | 0 |
| Proposed Cells - Interface Friction Peak Strength | | 125 | Shear/ Normal Function | Proposed Cells - Geosynthetic Interface (Peak) | | None | 0 |
| Proposed Cells - Interface Friction Large Displacement Strength | | 125 | Shear/ Normal Function | Proposed Cells - Geosynthetic Interface (Large Displacement) | | None | 0 |

Arrowhead LF
Major Modification
Final Grade Condition
Tract 3, North Slope

| Method Name | Min FS |
|---|---|
| GLE / Morgenstern-Price | 1.5 |



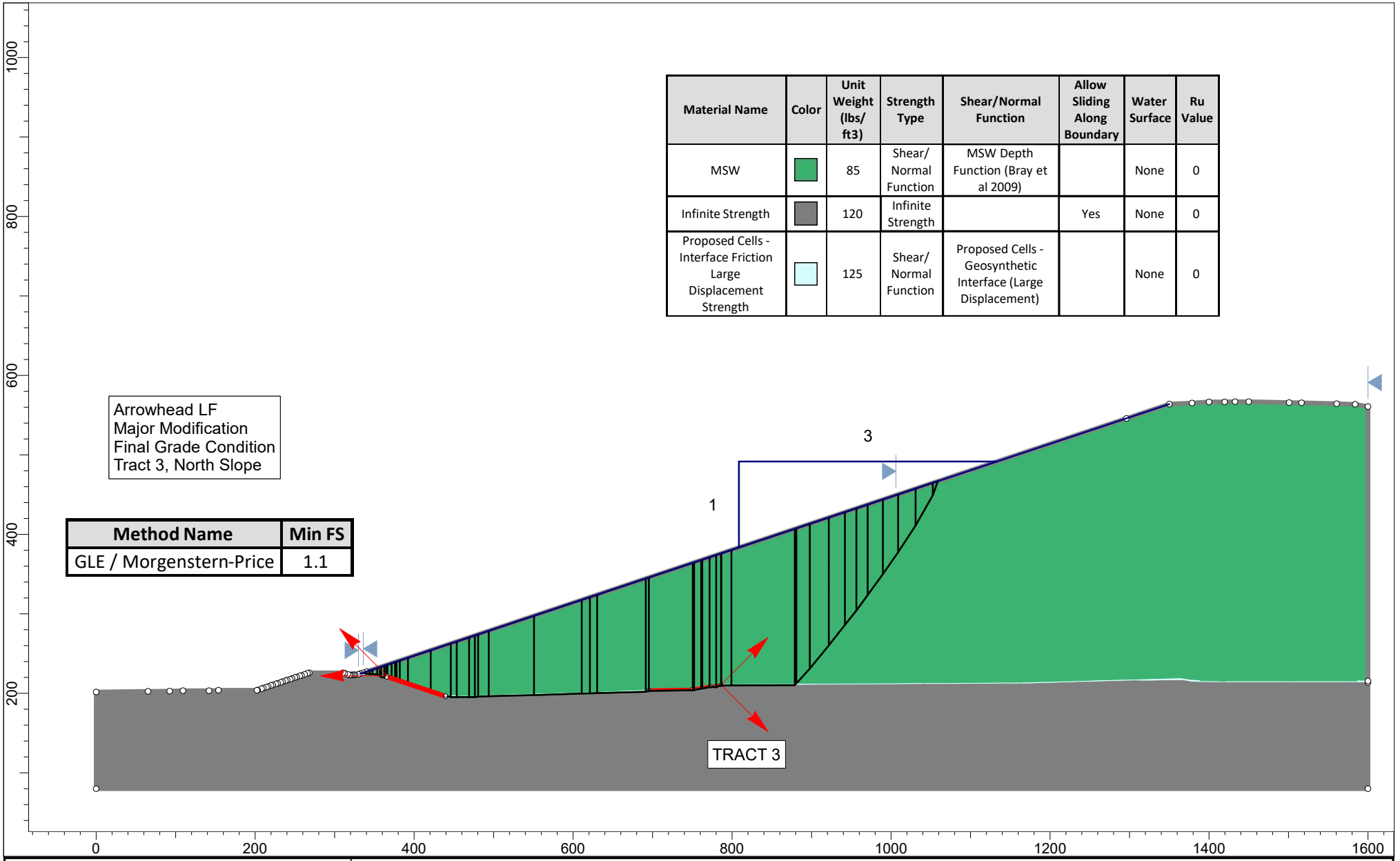

SLIDEINTERPRET 9.031

| | | | |
|---|---|---|---|
| Project | MAJOR MODIFICATION SUPPORT | | |
| Group | C-C - Static' | Scenario | C.3 - IS - Peak - Block |
| Drawn | T. Whitesell, E.I.T. | Company | Bunnell-Lammons Engineering, Inc. |
| Date | 11/21/2024 | File Name | AHLF C-C'.slmd |

| Material Name | Color | Unit Weight (lbs/ ft3) | Strength Type | Shear/Normal Function | Allow Sliding Along Boundary | Water Surface | Ru Value |
|---|---|---|---|---|---|---|---|
| MSW | | 85 | Shear/ Normal Function | MSW Depth Function (Bray et al 2009) | | None | 0 |
| Infinite Strength | | 120 | Infinite Strength | | Yes | None | 0 |
| Proposed Cells - Interface Friction Large Displacement Strength | | 125 | Shear/ Normal Function | Proposed Cells - Geosynthetic Interface (Large Displacement) | | None | 0 |

Arrowhead LF
Major Modification
Final Grade Condition
Tract 3, North Slope

| Method Name | Min FS |
|---|---|
| GLE / Morgenstern-Price | 1.1 |



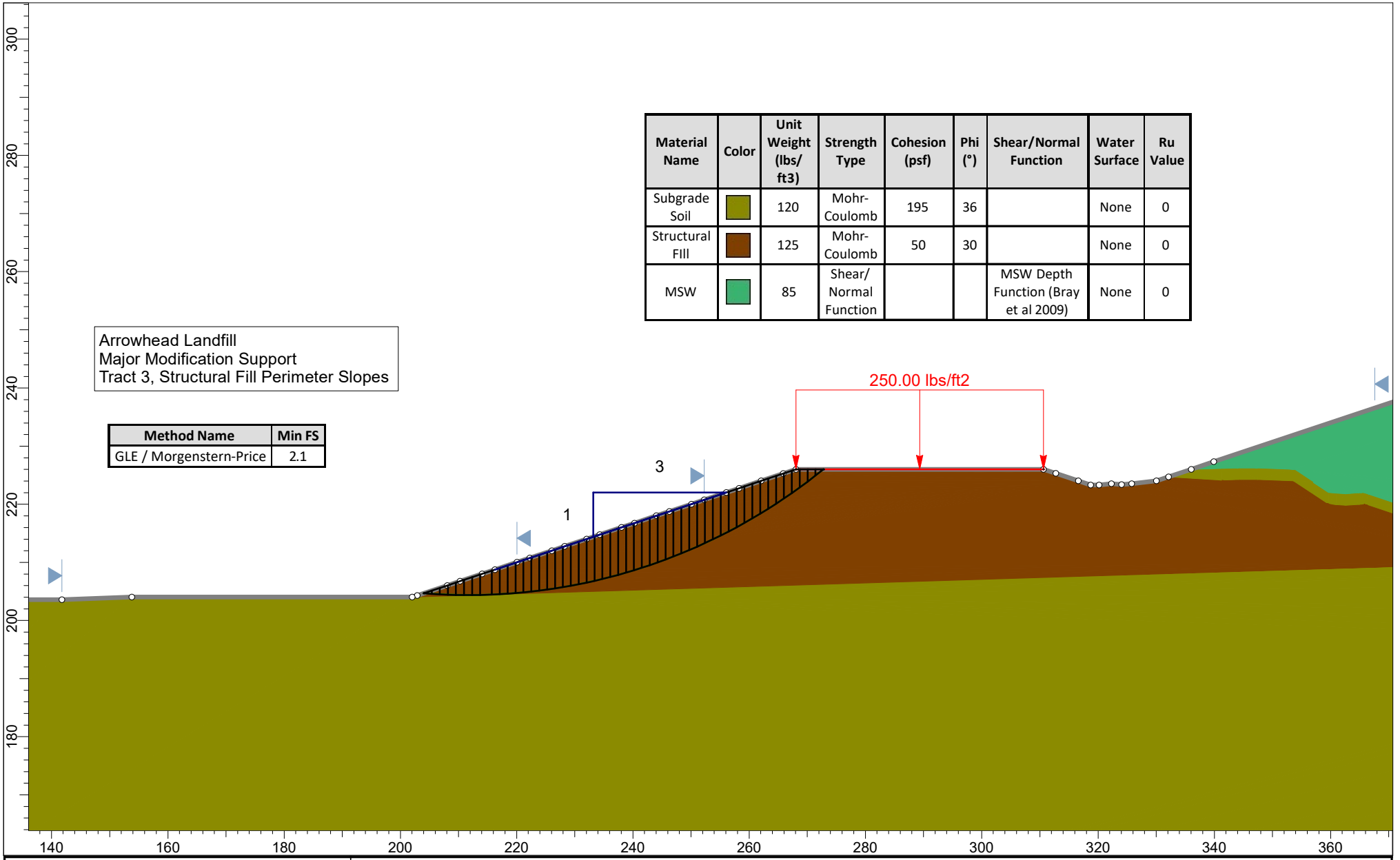

SLIDEINTERPRET 9.031

| | | | |
|---|---|---|---|
| Project | MAJOR MODIFICATION SUPPORT | | |
| Group | C-C - Static' | Scenario | C.4 - IS - Large Displacement - Block |
| Drawn | T. Whitesell, E.I.T. | Company | Bunnell-Lammons Engineering, Inc. |
| Date | 11/21/2024 | File Name | AHLF C-C'.slmd |

| Material Name | Color | Unit Weight (lbs/ ft3) | Strength Type | Cohesion (psf) | Phi (°) | Shear/Normal Function | Water Surface | Ru Value |
|---|---|---|---|---|---|---|---|---|
| Subgrade Soil | | 120 | Mohr-Coulomb | 195 | 36 | | None | 0 |
| Structural FIll | | 125 | Mohr-Coulomb | 50 | 30 | | None | 0 |
| MSW | | 85 | Shear/ Normal Function | | | MSW Depth Function (Bray et al 2009) | None | 0 |

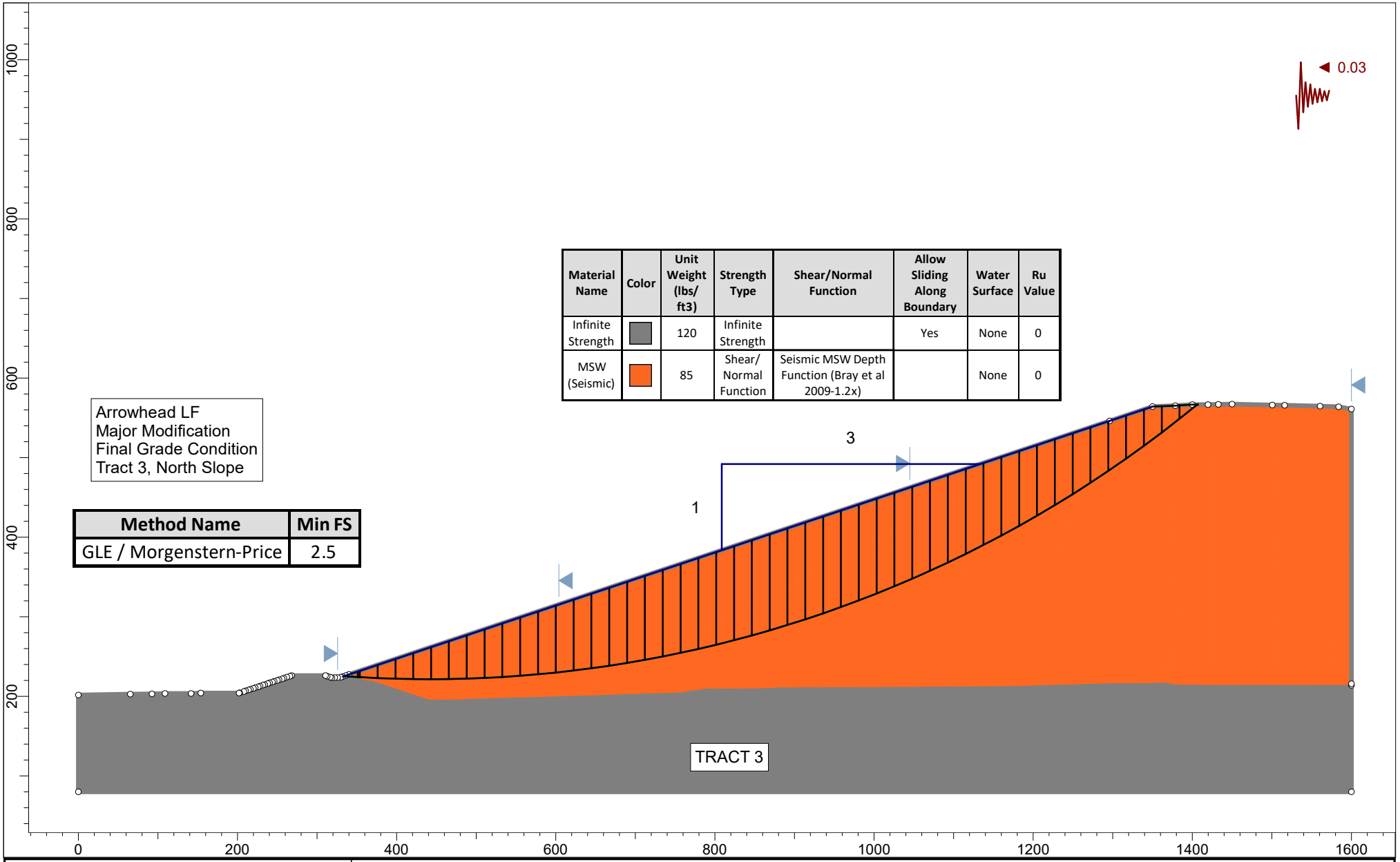
Arrowhead Landfill
Major Modification Support
Tract 3, Structural Fill Perimeter Slopes

| Method Name | Min FS |
|---|---|
| GLE / Morgenstern-Price | 2.1 |




| | | | |
|---|---|---|---|
| | Project | MAJOR MODIFICATION SUPPORT | |
| | Group | C-C - Static' | Scenario C.2.1 - Structural Fill |
| | Drawn | T. Whitesell, E.I.T. | Company Bunnell-Lammons Engineering, Inc. |
| | Date | 11/8/2024 | File Name AHLF C-C'.slmd |

SLIDEINTERPRET 9.031




| Material Name | Color | Unit Weight (lbs/ ft3) | Strength Type | Shear/Normal Function | Allow Sliding Along Boundary | Water Surface | Ru Value |
|---|---|---|---|---|---|---|---|
| Infinite Strength | | 120 | Infinite Strength | | Yes | None | 0 |
| MSW (Seismic) | | 85 | Shear/ Normal Function | Seismic MSW Depth Function (Bray et al 2009-1.2x) | | None | 0 |

Arrowhead LF
Major Modification
Final Grade Condition
Tract 3, North Slope

| Method Name | Min FS |
|---|---|
| GLE / Morgenstern-Price | 2.5 |

SLIDEINTERPRET 9.031

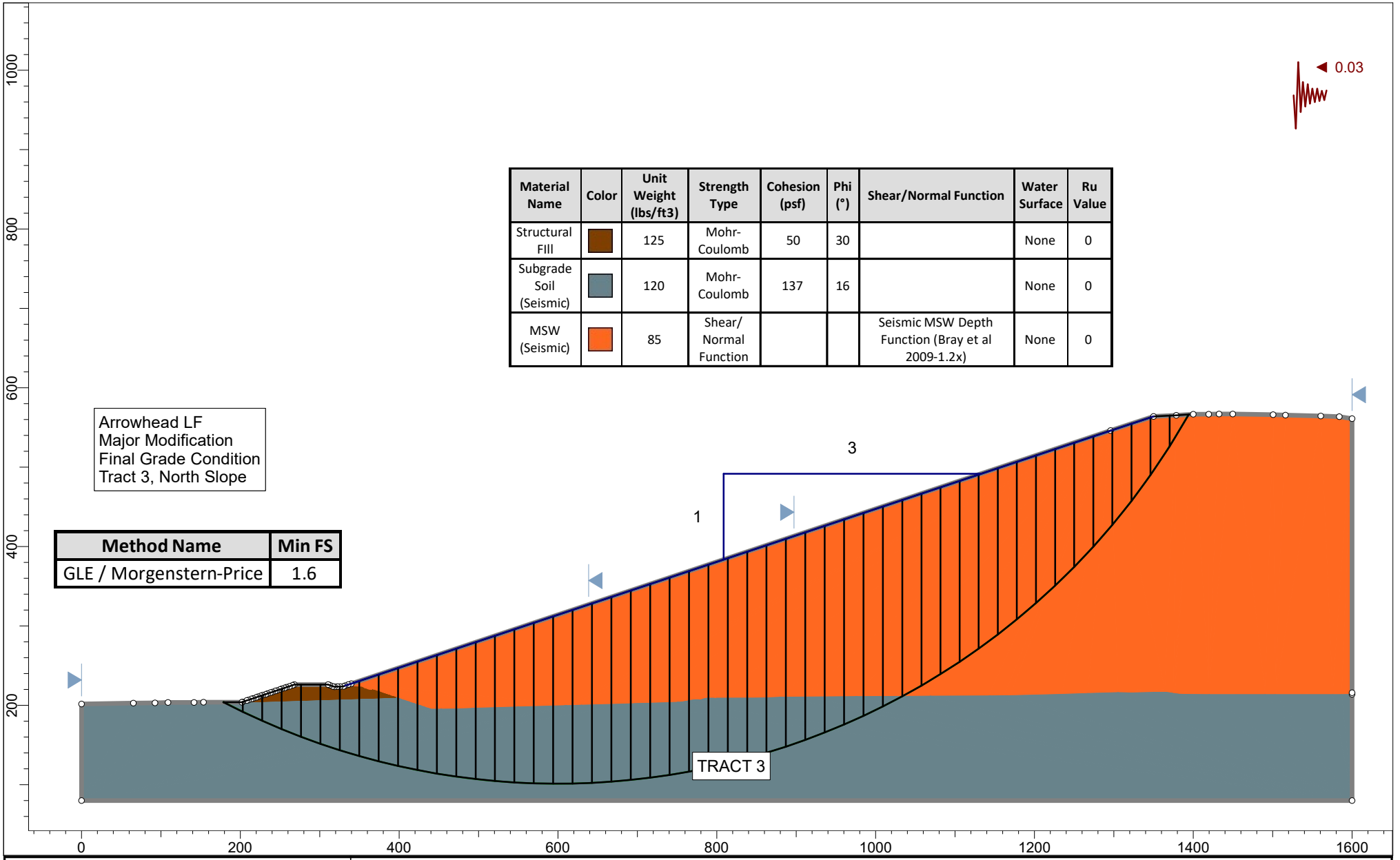
| | | | |
|---|---|---|---|
| Project | MAJOR MODIFICATION SUPPORT | | |
| Group | C-C' Seismic | Scenario | C.5 - Waste Only - Global |
| Drawn | T. Whitesell, E.I.T. | Company | Bunnell-Lammons Engineering, Inc. |
| Date | 11/8/2024 | File Name | AHLF C-C'.slmd |

| Material Name | Color | Unit Weight (lbs/ft3) | Strength Type | Cohesion (psf) | Phi (°) | Shear/Normal Function | Water Surface | Ru Value |
|---|---|---|---|---|---|---|---|---|
| Structural FIll | | 125 | Mohr-Coulomb | 50 | 30 | | None | 0 |
| Subgrade Soil (Seismic) | | 120 | Mohr-Coulomb | 137 | 16 | | None | 0 |
| MSW (Seismic) | | 85 | Shear/ Normal Function | | | Seismic MSW Depth Function (Bray et al 2009-1.2x) | None | 0 |

0.03

Arrowhead LF
Major Modification
Final Grade Condition
Tract 3, North Slope

| Method Name | Min FS |
|---|---|
| GLE / Morgenstern-Price | 1.6 |




SLIDEINTERPRET 9.031

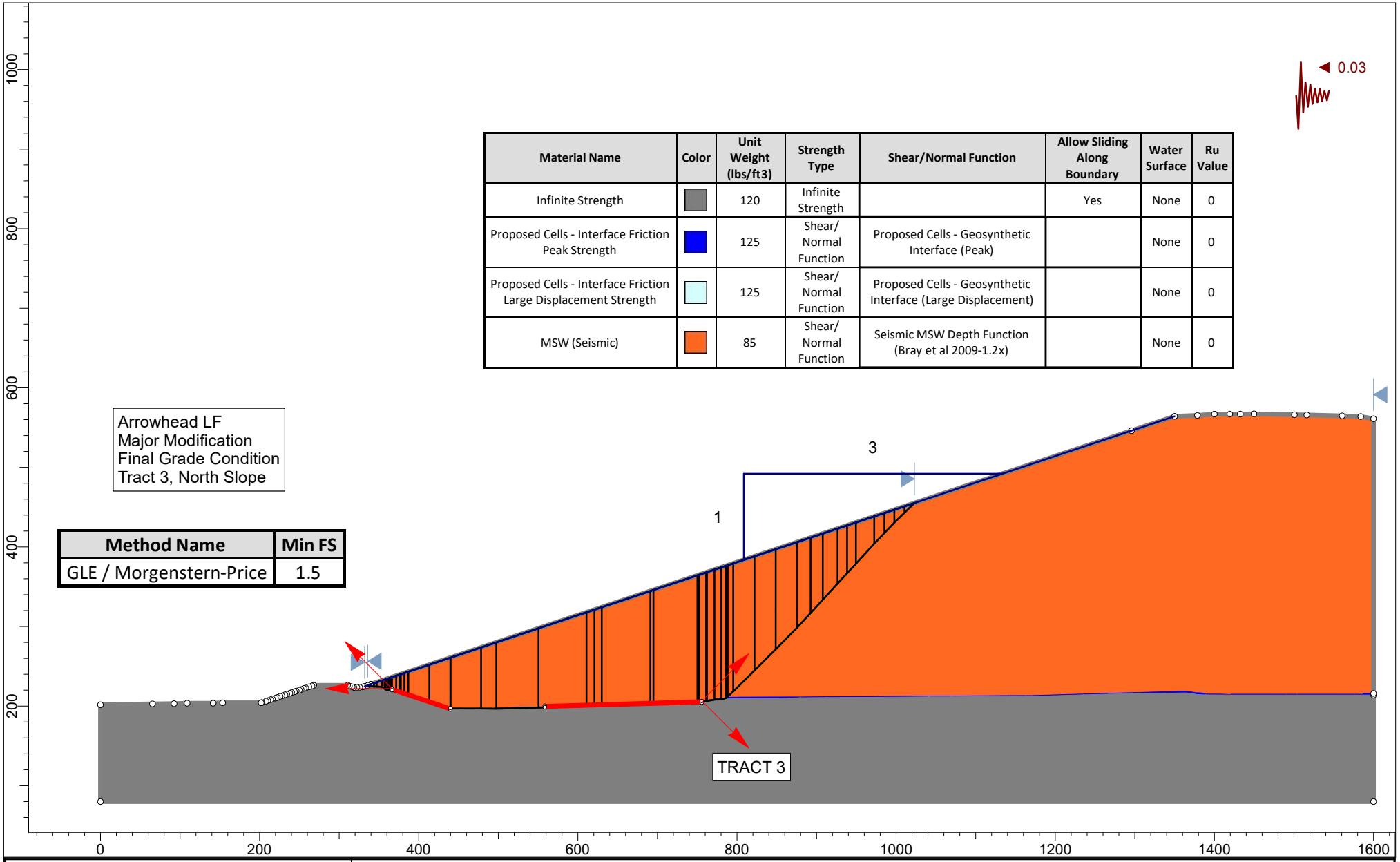
| | | | |
|---|---|---|---|
| Project | MAJOR MODIFICATION SUPPORT | | |
| Group | C-C' Seismic | Scenario | C.6 - Subgrade - Global |
| Drawn | T. Whitesell, E.I.T. | Company | Bunnell-Lammons Engineering, Inc. |
| Date | 11/8/2024 | File Name | AHLF C-C'.slmd |

| Material Name | Color | Unit Weight (lbs/ft3) | Strength Type | Shear/Normal Function | Allow Sliding Along Boundary | Water Surface | Ru Value |
|---|---|---|---|---|---|---|---|
| Infinite Strength | | 120 | Infinite Strength | | Yes | None | 0 |
| Proposed Cells - Interface Friction Peak Strength | | 125 | Shear/ Normal Function | Proposed Cells - Geosynthetic Interface (Peak) | | None | 0 |
| Proposed Cells - Interface Friction Large Displacement Strength | | 125 | Shear/ Normal Function | Proposed Cells - Geosynthetic Interface (Large Displacement) | | None | 0 |
| MSW (Seismic) | | 85 | Shear/ Normal Function | Seismic MSW Depth Function (Bray et al 2009-1.2x) | | None | 0 |

0.03

Arrowhead LF
Major Modification
Final Grade Condition
Tract 3, North Slope

| Method Name | Min FS |
|---|---|
| GLE / Morgenstern-Price | 1.5 |




SLIDEINTERPRET 9.031

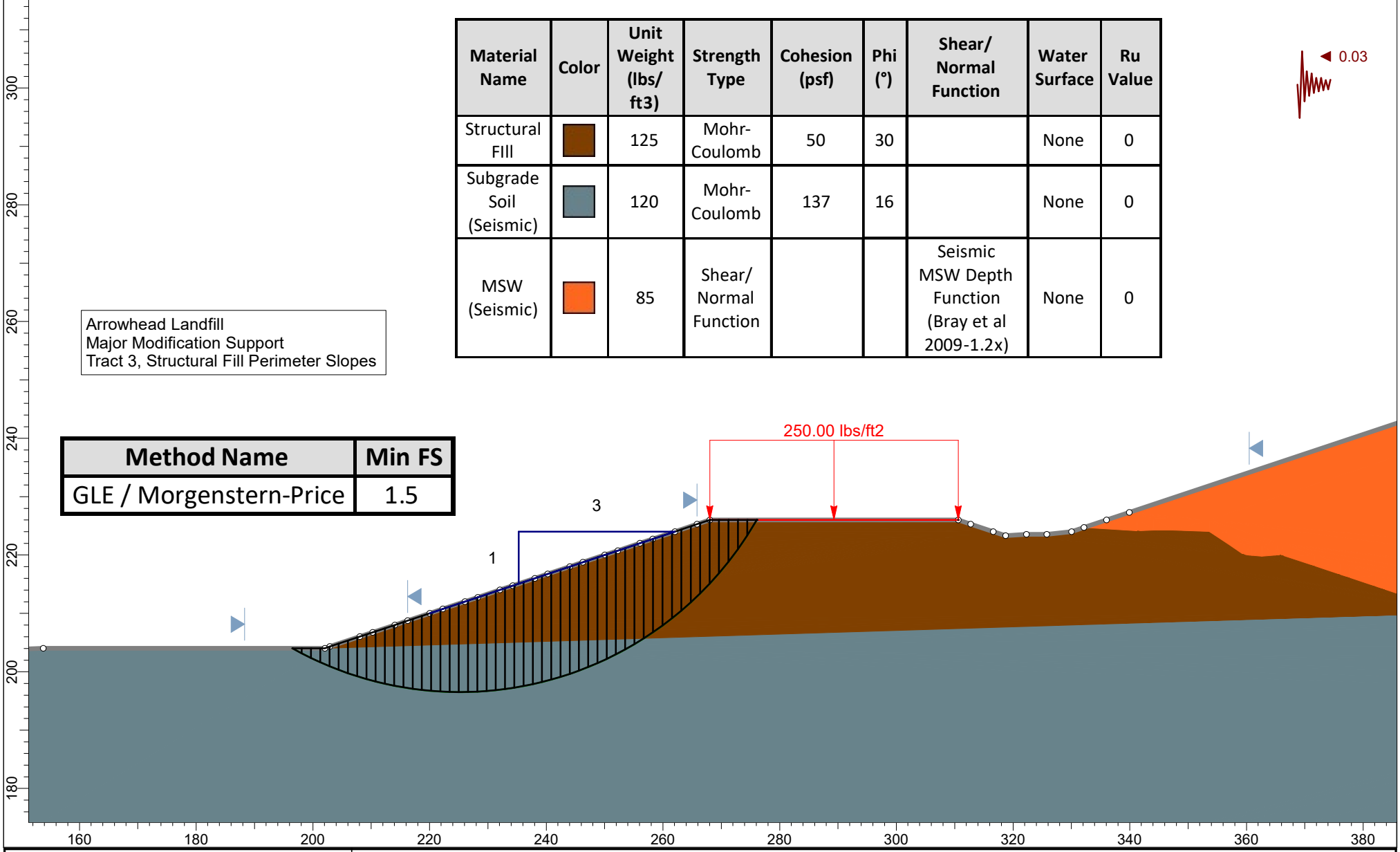
| | | | |
|---|---|---|---|
| Project | MAJOR MODIFICATION SUPPORT | | |
| Group | C-C' Seismic | Scenario | C.7 - IS - Peak - Block |
| Drawn | T. Whitesell, E.I.T. | Company | Bunnell-Lammons Engineering, Inc. |
| Date | 11/21/2024 | File Name | AHLF C-C'.slmd |

| Material Name | Color | Unit Weight (lbs/ ft3) | Strength Type | Cohesion (psf) | Phi (°) | Shear/ Normal Function | Water Surface | Ru Value |
|---|---|---|---|---|---|---|---|---|
| Structural FIll | | 125 | Mohr-Coulomb | 50 | 30 | | None | 0 |
| Subgrade Soil (Seismic) | | 120 | Mohr-Coulomb | 137 | 16 | | None | 0 |
| MSW (Seismic) | | 85 | Shear/ Normal Function | | | Seismic MSW Depth Function (Bray et al 2009-1.2x) | None | 0 |

0.03

Arrowhead Landfill
Major Modification Support
Tract 3, Structural Fill Perimeter Slopes

| Method Name | Min FS |
|---|---|
| GLE / Morgenstern-Price | 1.5 |




SLIDEINTERPRET 9.031

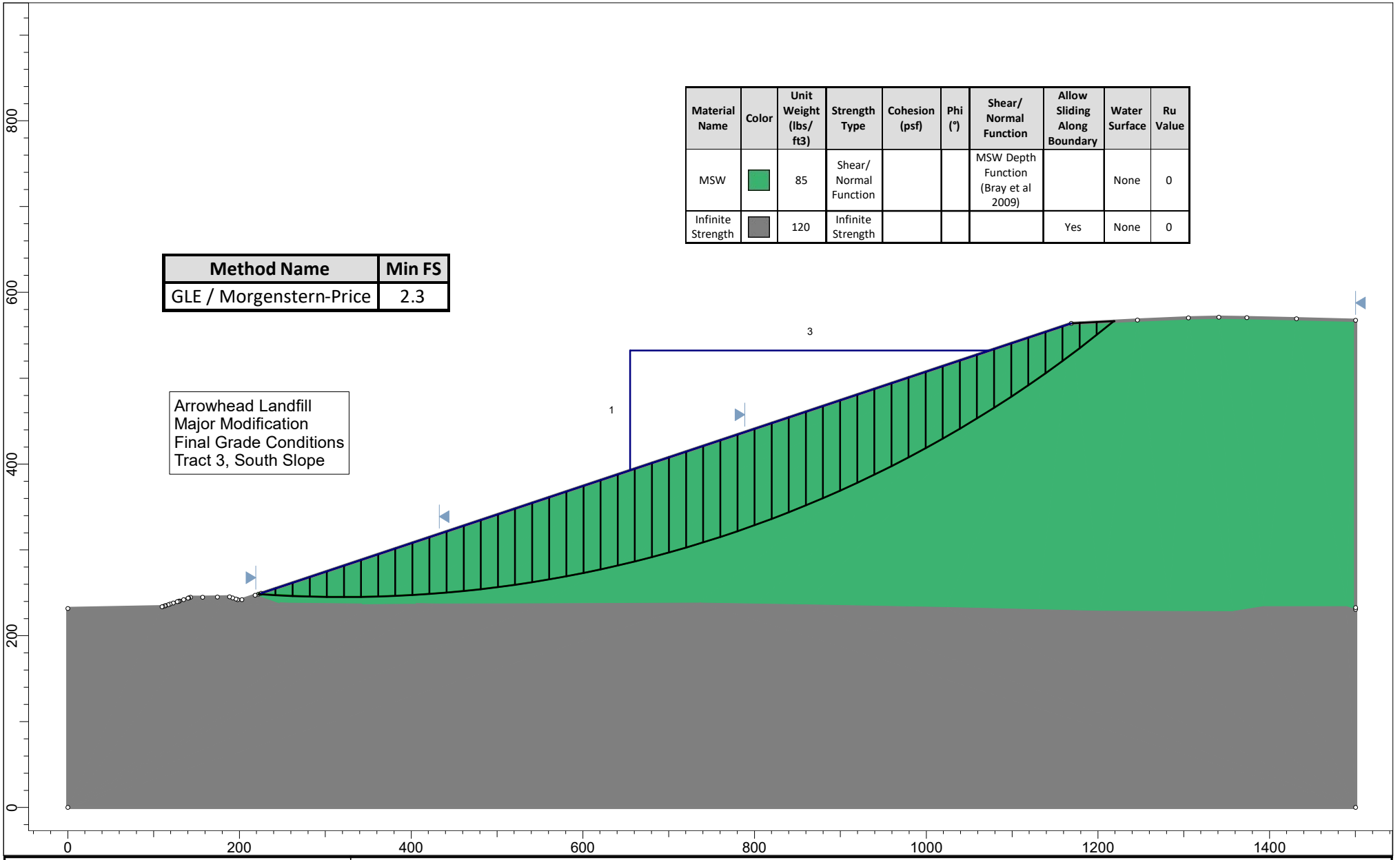
| | | | |
|---|---|---|---|
| Project | MAJOR MODIFICATION SUPPORT | | |
| Group | C-C' Seismic | Scenario | C.6.1 - Structural Fill |
| Drawn | T. Whitesell, E.I.T. | Company | Bunnell-Lammons Engineering, Inc. |
| Date | 11/8/2024 | File Name | AHLF C-C'.slmd |

# Table 8 Runs – D-D', Tract 3 South Slope

| Material Name | Color | Unit Weight (lbs/ ft3) | Strength Type | Cohesion (psf) | Phi (°) | Shear/ Normal Function | Allow Sliding Along Boundary | Water Surface | Ru Value |
|---|---|---|---|---|---|---|---|---|---|
| MSW | | 85 | Shear/ Normal Function | | | MSW Depth Function (Bray et al 2009) | | None | 0 |
| Infinite Strength | | 120 | Infinite Strength | | | | Yes | None | 0 |

| Method Name | Min FS |
|---|---|
| GLE / Morgenstern-Price | 2.3 |

Arrowhead Landfill
Major Modification
Final Grade Conditions
Tract 3, South Slope



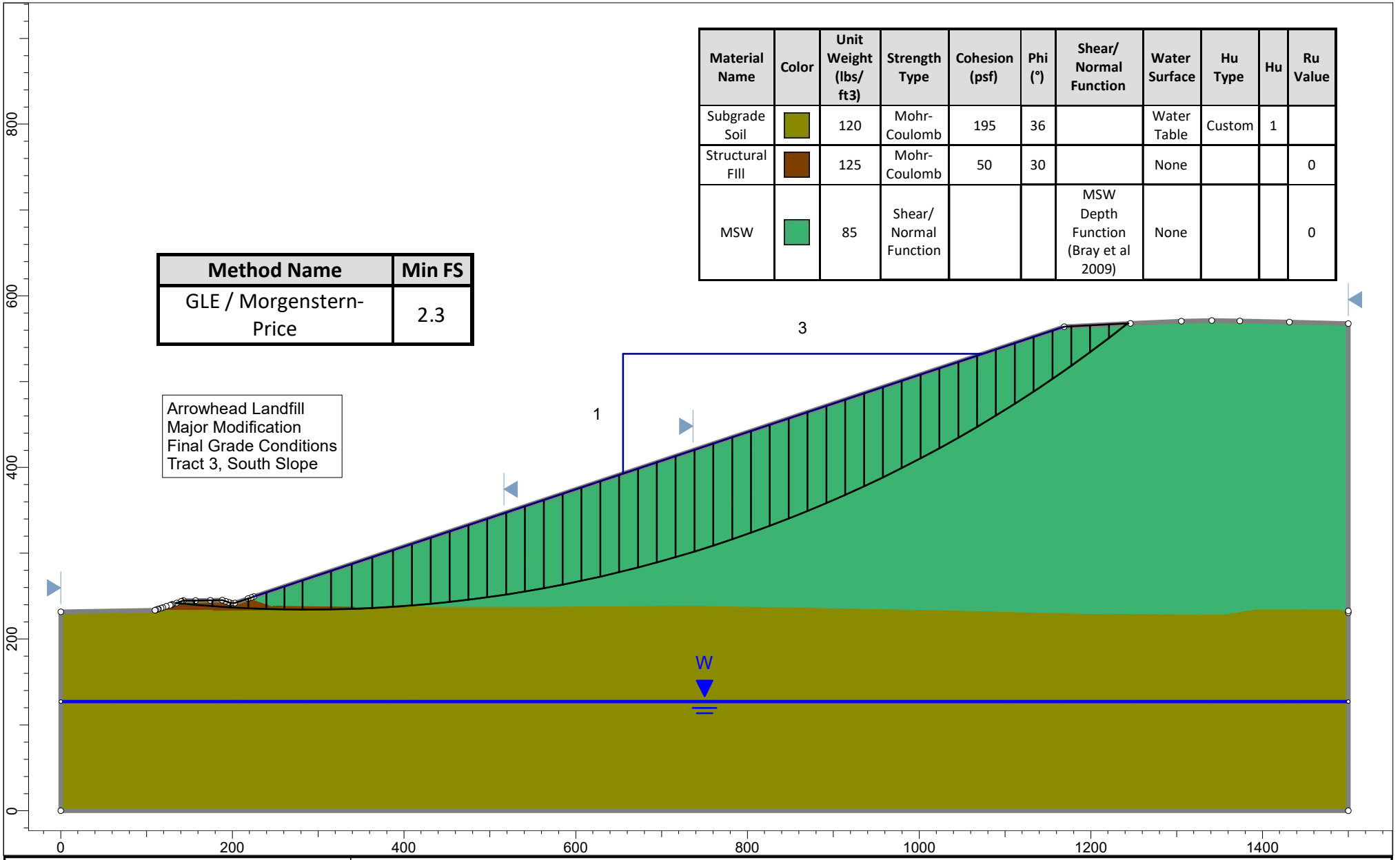

SLIDEINTERPRET 9.031

| | | | |
|---|---|---|---|
| *Project* | MAJOR MODIFICATION SUPPORT | | |
| *Group* | D-D Static | *Scenario* | D.1 - Waste Only |
| Drawn | T. Whitesell, E.I.T. | *Company* | Bunnell-Lammons Engineering, Inc. |
| *Date* | 11/8/2024 | *File Name* | AHLF D-D'.slmd |

| Material Name | Color | Unit Weight (lbs/ ft3) | Strength Type | Cohesion (psf) | Phi (°) | Shear/ Normal Function | Water Surface | Hu Type | Hu | Ru Value |
|---|---|---|---|---|---|---|---|---|---|---|
| Subgrade Soil | | 120 | Mohr-Coulomb | 195 | 36 | | Water Table | Custom | 1 | |
| Structural FIll | | 125 | Mohr-Coulomb | 50 | 30 | | None | | | 0 |
| MSW | | 85 | Shear/ Normal Function | | | MSW Depth Function (Bray et al 2009) | None | | | 0 |

| Method Name | Min FS |
|---|---|
| GLE / Morgenstern-Price | 2.3 |

Arrowhead Landfill
Major Modification
Final Grade Conditions
Tract 3, South Slope



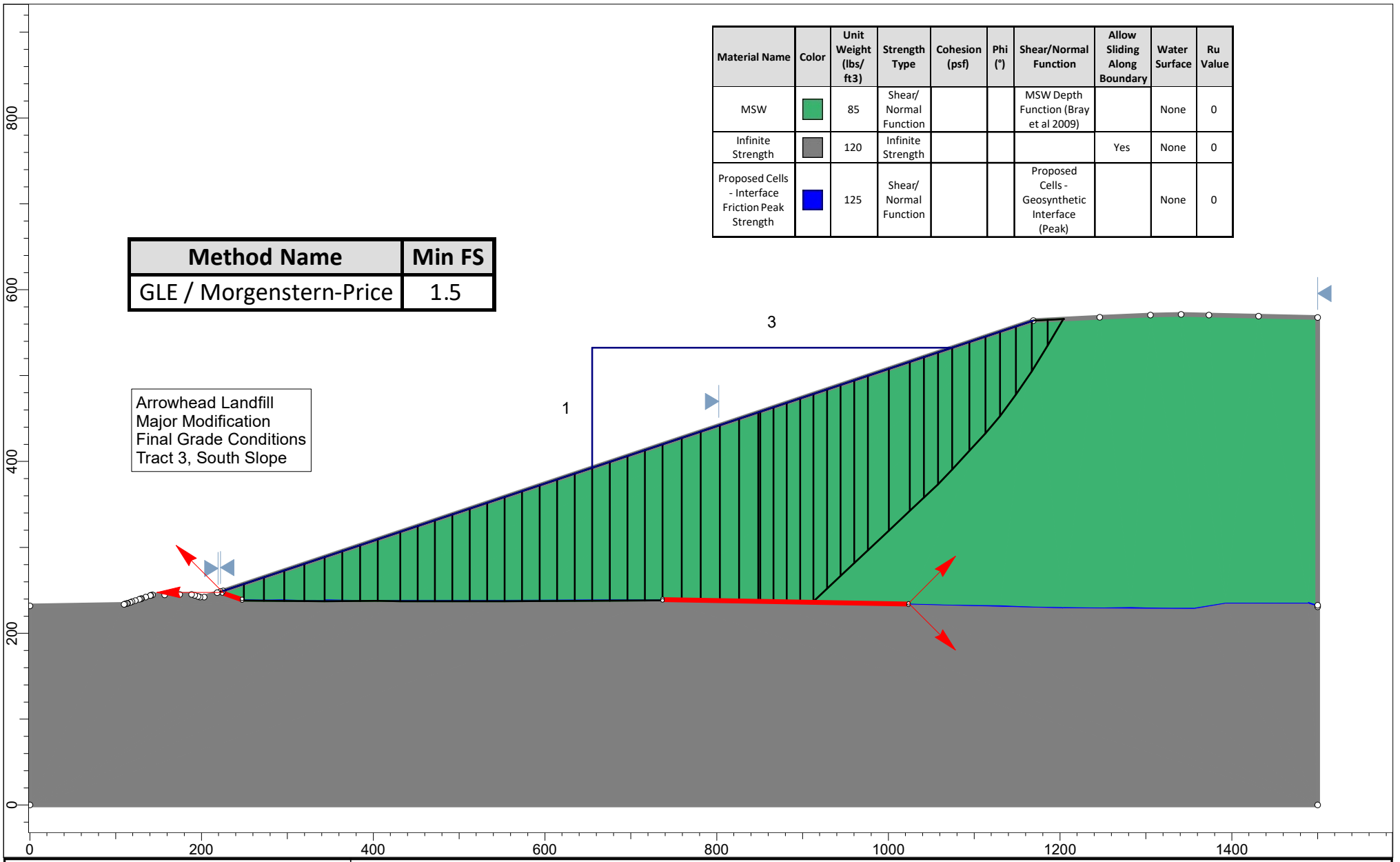

SLIDEINTERPRET 9.031

| | | | |
|---|---|---|---|
| Project | MAJOR MODIFICATION SUPPORT | | |
| Group | D-D Static | Scenario | D.2 - Subgrade - Global |
| Drawn | T. Whitesell, E.I.T. | Company | Bunnell-Lammons Engineering, Inc. |
| Date | 11/8/2024 | File Name | AHLF D-D'.slmd |

| Material Name | Color | Unit Weight (lbs/ ft3) | Strength Type | Cohesion (psf) | Phi (°) | Shear/Normal Function | Allow Sliding Along Boundary | Water Surface | Ru Value |
|---|---|---|---|---|---|---|---|---|---|
| MSW | | 85 | Shear/ Normal Function | | | MSW Depth Function (Bray et al 2009) | | None | 0 |
| Infinite Strength | | 120 | Infinite Strength | | | | Yes | None | 0 |
| Proposed Cells - Interface Friction Peak Strength | | 125 | Shear/ Normal Function | | | Proposed Cells - Geosynthetic Interface (Peak) | | None | 0 |

| Method Name | Min FS |
|---|---|
| GLE / Morgenstern-Price | 1.5 |

Arrowhead Landfill
Major Modification
Final Grade Conditions
Tract 3, South Slope

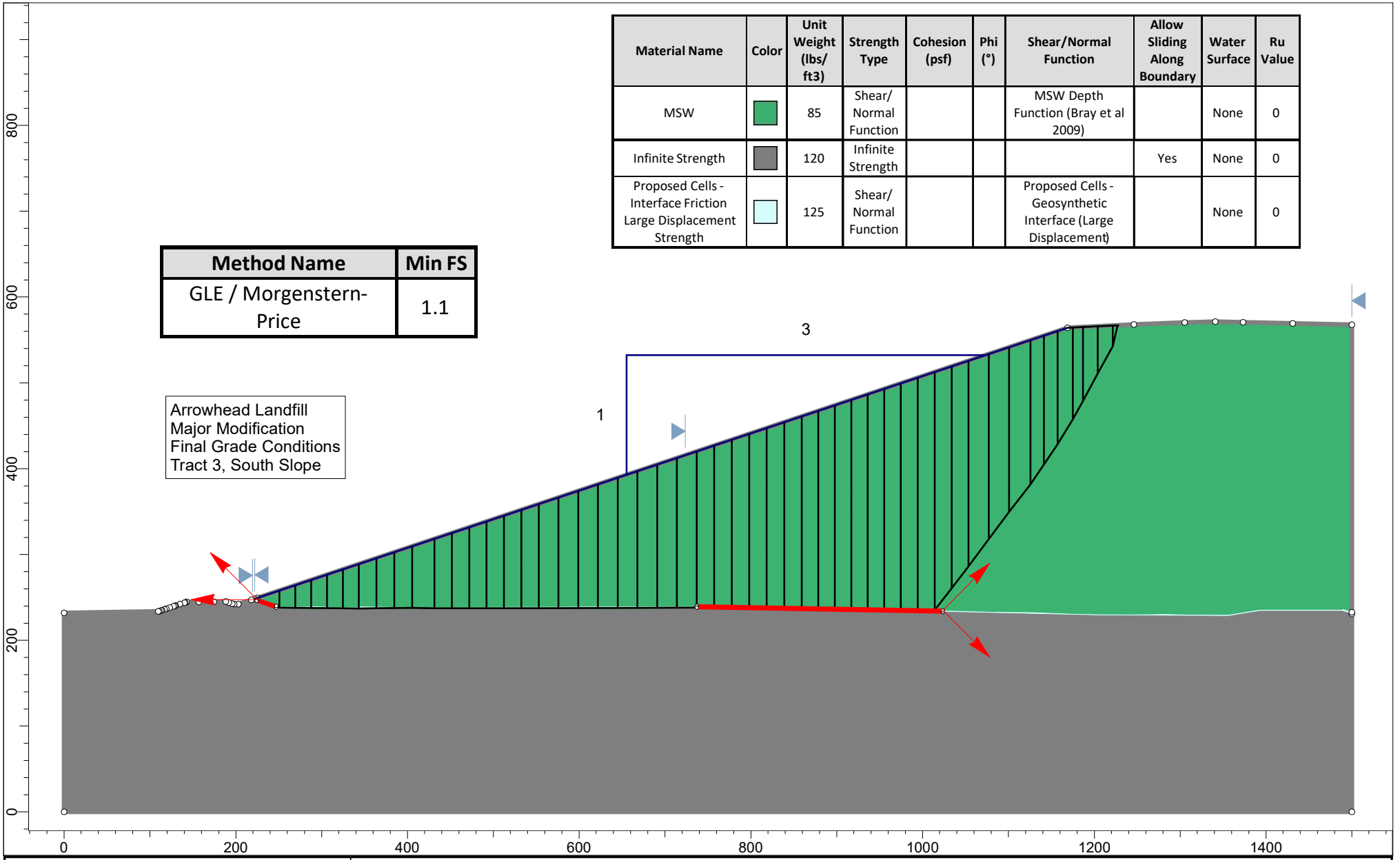



| | | | |
|---|---|---|---|
| | Project | MAJOR MODIFICATION SUPPORT | |
| | Group | D-D Static | Scenario: D.3 - IS - Peak - Block |
| | Drawn | T. Whitesell, E.I.T. | Company: Bunnell-Lammons Engineering, Inc. |
| SLIDEINTERPRET 9.031 | Date | 11/21/2024 | File Name: AHLF D-D'.slmd |

| Material Name | Color | Unit Weight (lbs/ ft3) | Strength Type | Cohesion (psf) | Phi (°) | Shear/Normal Function | Allow Sliding Along Boundary | Water Surface | Ru Value |
|---|---|---|---|---|---|---|---|---|---|
| MSW | | 85 | Shear/ Normal Function | | | MSW Depth Function (Bray et al 2009) | | None | 0 |
| Infinite Strength | | 120 | Infinite Strength | | | | Yes | None | 0 |
| Proposed Cells - Interface Friction Large Displacement Strength | | 125 | Shear/ Normal Function | | | Proposed Cells - Geosynthetic Interface (Large Displacement) | | None | 0 |

| Method Name | Min FS |
|---|---|
| GLE / Morgenstern-Price | 1.1 |

Arrowhead Landfill
Major Modification
Final Grade Conditions
Tract 3, South Slope




| | | | |
|---|---|---|---|
| Project | MAJOR MODIFICATION SUPPORT | | |
| Group | D-D Static | Scenario | D.4 - IS - Large Displacement - Block |
| Drawn | T. Whitesell, E.I.T. | Company | Bunnell-Lammons Engineering, Inc. |
| Date | 11/21/2024 | File Name | AHLF D-D'.slmd |

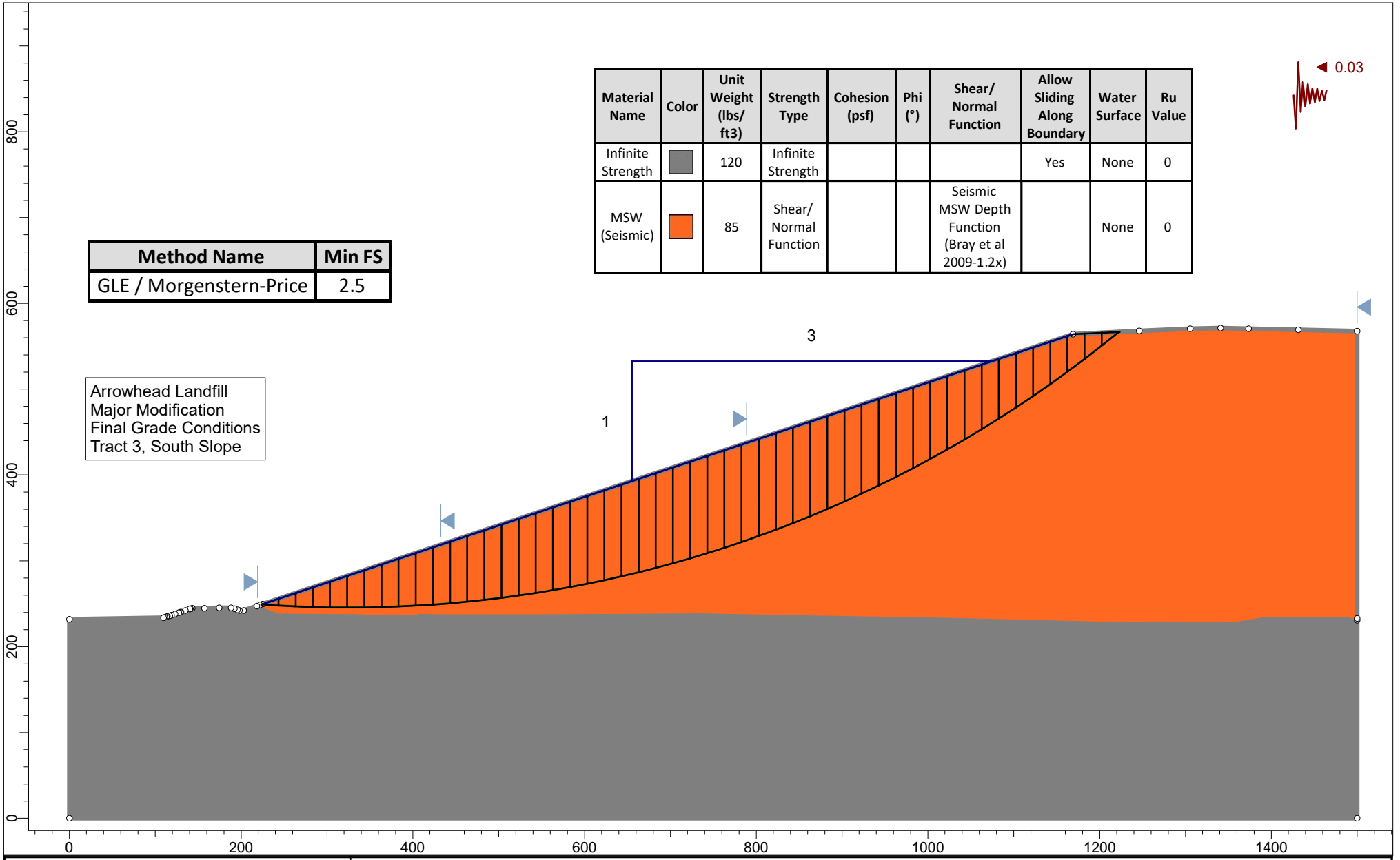
SLIDEINTERPRET 9.031

| Material Name | Color | Unit Weight (lbs/ ft3) | Strength Type | Cohesion (psf) | Phi (°) | Shear/ Normal Function | Allow Sliding Along Boundary | Water Surface | Ru Value |
|---|---|---|---|---|---|---|---|---|---|
| Infinite Strength | | 120 | Infinite Strength | | | | Yes | None | 0 |
| MSW (Seismic) | | 85 | Shear/ Normal Function | | | Seismic MSW Depth Function (Bray et al 2009-1.2x) | | None | 0 |

| Method Name | Min FS |
|---|---|
| GLE / Morgenstern-Price | 2.5 |

◀ 0.03

Arrowhead Landfill
Major Modification
Final Grade Conditions
Tract 3, South Slope



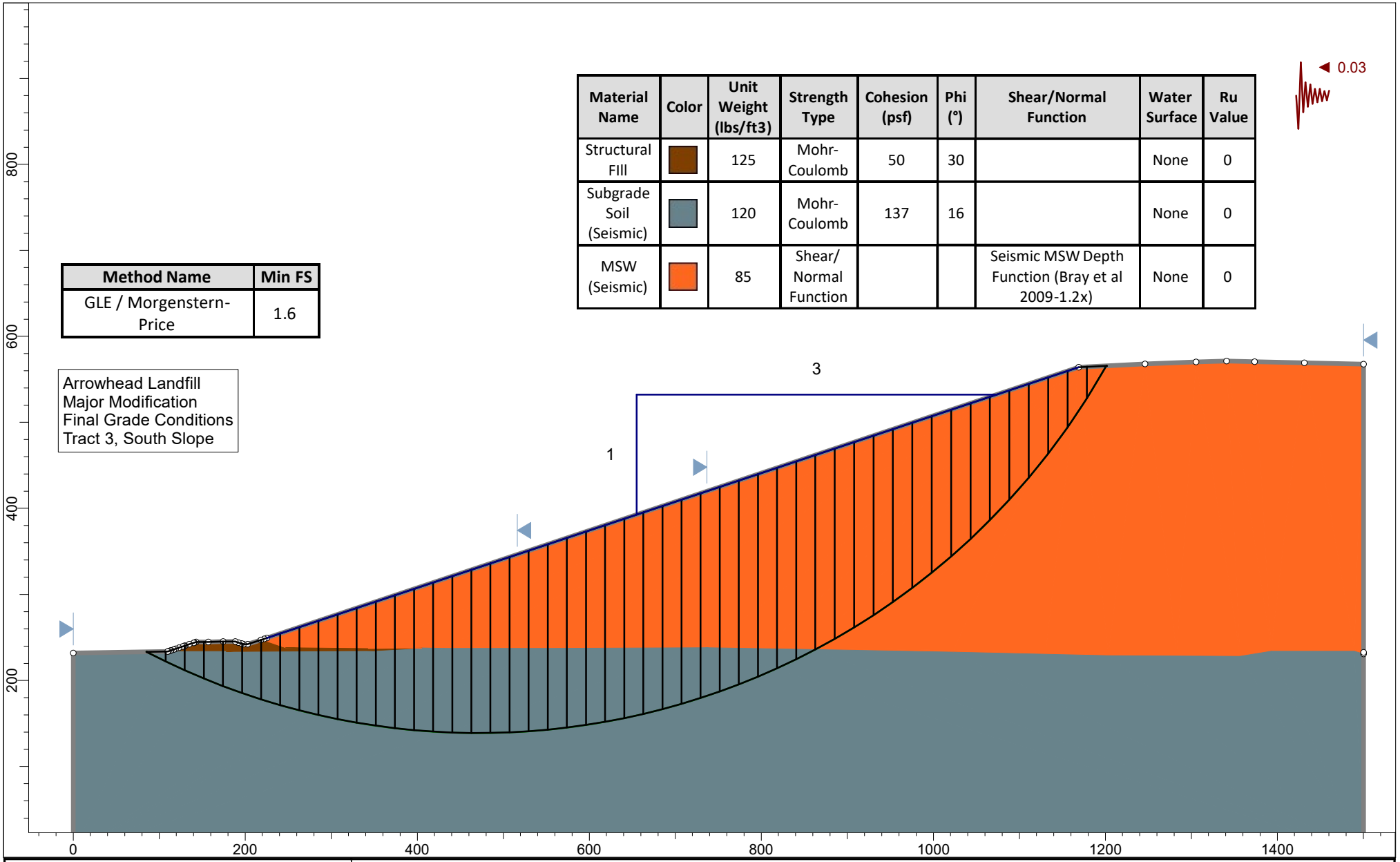

SLIDEINTERPRET 9.031

| | | | |
|---|---|---|---|
| Project | MAJOR MODIFICATION SUPPORT | | |
| Group | D-D Seismic | Scenario | D.5 - Waste Only - Seismic |
| Drawn | T. Whitesell, E.I.T. | Company | Bunnell-Lammons Engineering, Inc. |
| Date | 11/8/2024 | File Name | AHLF D-D'.slmd |

| Material Name | Color | Unit Weight (lbs/ft3) | Strength Type | Cohesion (psf) | Phi (°) | Shear/Normal Function | Water Surface | Ru Value |
|---|---|---|---|---|---|---|---|---|
| Structural FIll | | 125 | Mohr-Coulomb | 50 | 30 | | None | 0 |
| Subgrade Soil (Seismic) | | 120 | Mohr-Coulomb | 137 | 16 | | None | 0 |
| MSW (Seismic) | | 85 | Shear/ Normal Function | | | Seismic MSW Depth Function (Bray et al 2009-1.2x) | None | 0 |

| Method Name | Min FS |
|---|---|
| GLE / Morgenstern-Price | 1.6 |

Arrowhead Landfill
Major Modification
Final Grade Conditions
Tract 3, South Slope

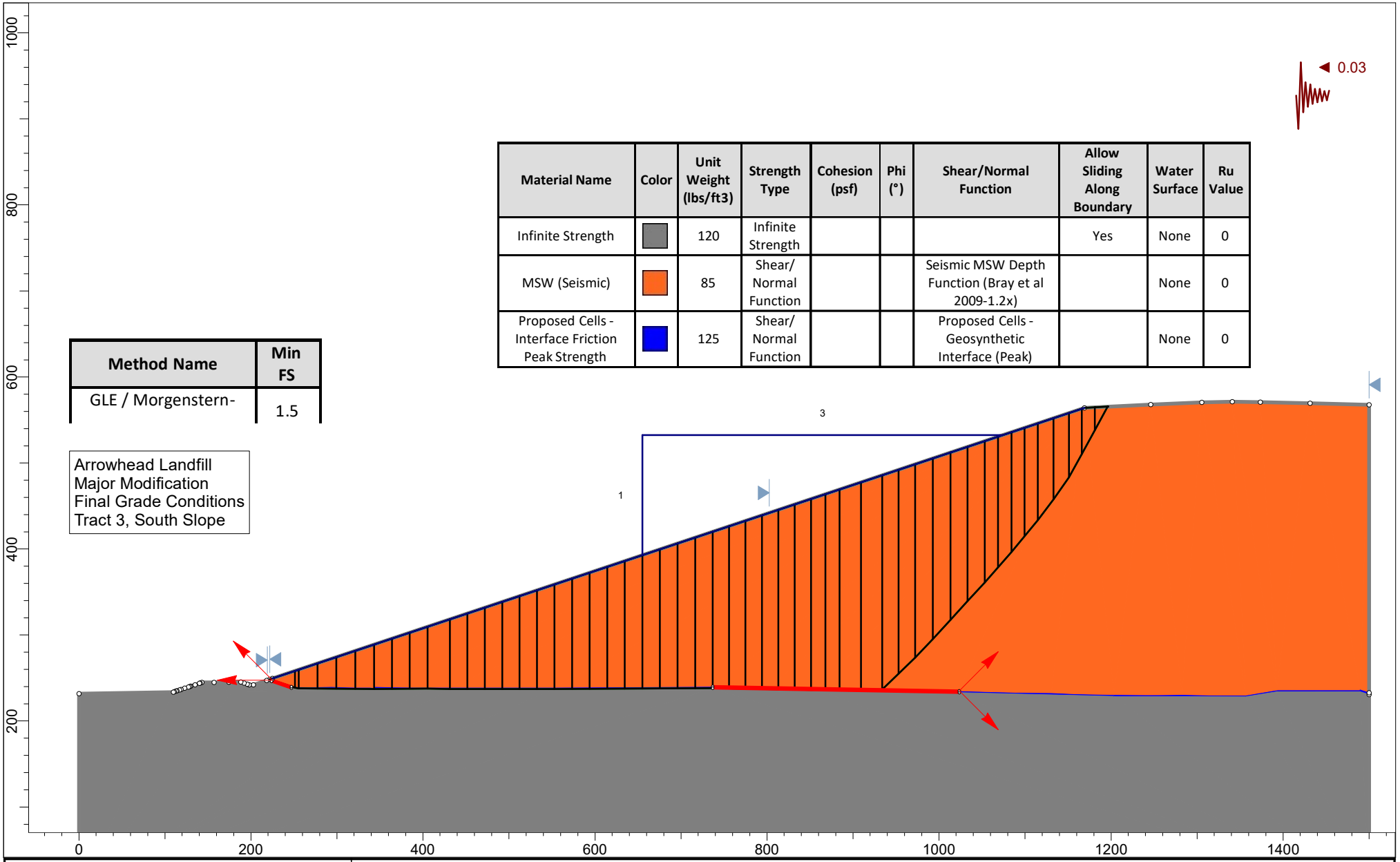



| | | | |
|---|---|---|---|
| | Project: MAJOR MODIFICATION SUPPORT | | |
| | Group: D-D Seismic | Scenario: D.6 - Subgrade - Global - Seismic | |
| | Drawn: T. Whitesell, E.I.T. | Company: Bunnell-Lammons Engineering, Inc. | |
| SLIDEINTERPRET 9.031 | Date: 11/8/2024 | File Name: AHLF D-D'.slmd | |

| Material Name | Color | Unit Weight (lbs/ft3) | Strength Type | Cohesion (psf) | Phi (°) | Shear/Normal Function | Allow Sliding Along Boundary | Water Surface | Ru Value |
|---|---|---|---|---|---|---|---|---|---|
| Infinite Strength | | 120 | Infinite Strength | | | | Yes | None | 0 |
| MSW (Seismic) | | 85 | Shear/ Normal Function | | | Seismic MSW Depth Function (Bray et al 2009-1.2x) | | None | 0 |
| Proposed Cells - Interface Friction Peak Strength | | 125 | Shear/ Normal Function | | | Proposed Cells - Geosynthetic Interface (Peak) | | None | 0 |

| Method Name | Min FS |
|---|---|
| GLE / Morgenstern- | 1.5 |

Arrowhead Landfill
Major Modification
Final Grade Conditions
Tract 3, South Slope




| | | | |
|---|---|---|---|
| Project | MAJOR MODIFICATION SUPPORT | | |
| Group | D-D Seismic | Scenario | D.7 - IS - Peak - Block - Seismic |
| Drawn | T. Whitesell, E.I.T. | Company | Bunnell-Lammons Engineering, Inc. |
| Date | 11/21/2024 | File Name | AHLF D-D'.slmd |

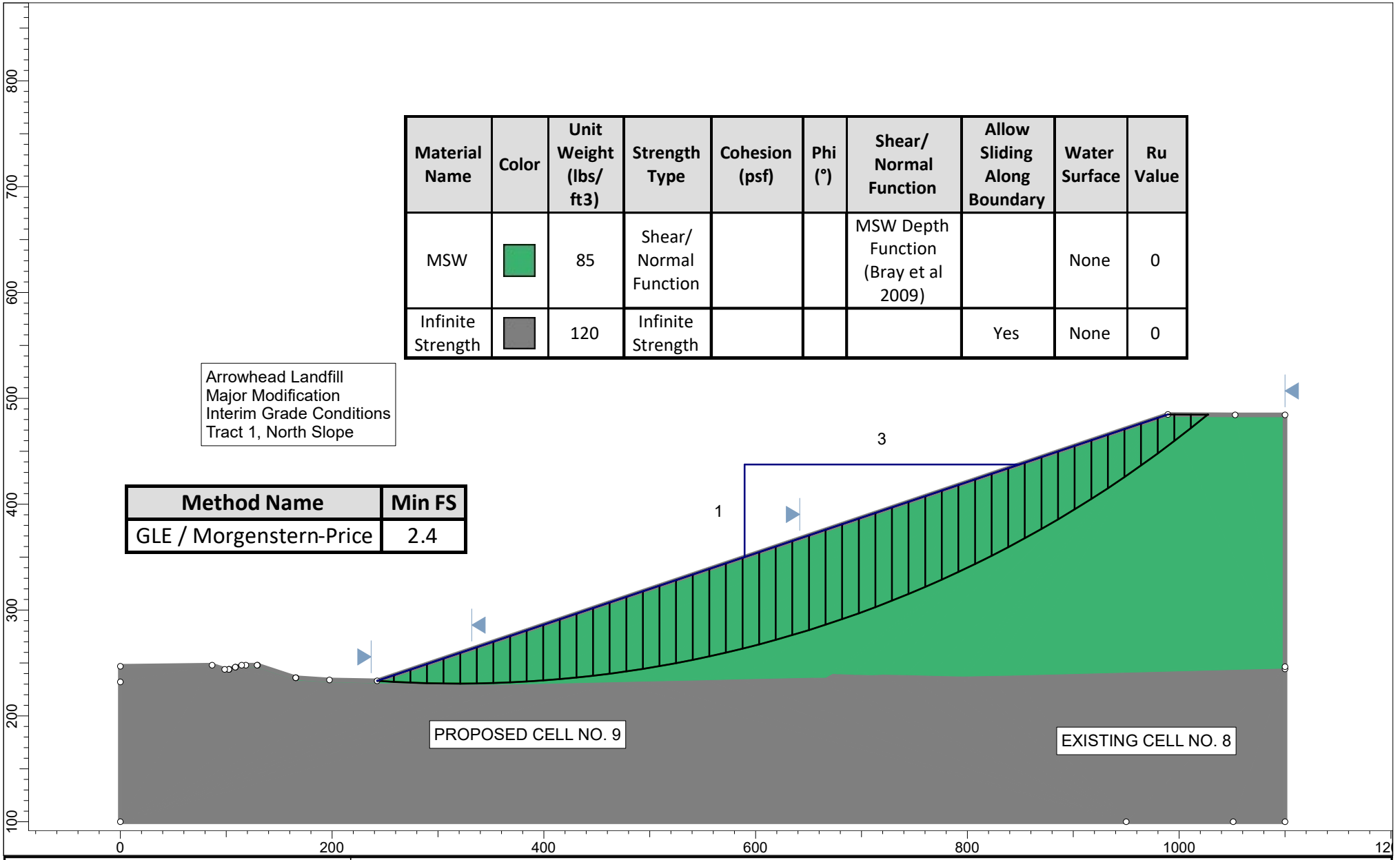
SLIDEINTERPRET 9.031

# Table 9 Runs – Interim Slope Conditions

| Material Name | Color | Unit Weight (lbs/ ft3) | Strength Type | Cohesion (psf) | Phi (°) | Shear/ Normal Function | Allow Sliding Along Boundary | Water Surface | Ru Value |
|---|---|---|---|---|---|---|---|---|---|
| MSW | | 85 | Shear/ Normal Function | | | MSW Depth Function (Bray et al 2009) | | None | 0 |
| Infinite Strength | | 120 | Infinite Strength | | | | Yes | None | 0 |

Arrowhead Landfill
Major Modification
Interim Grade Conditions
Tract 1, North Slope

| Method Name | Min FS |
|---|---|
| GLE / Morgenstern-Price | 2.4 |




SLIDEINTERPRET 9.031

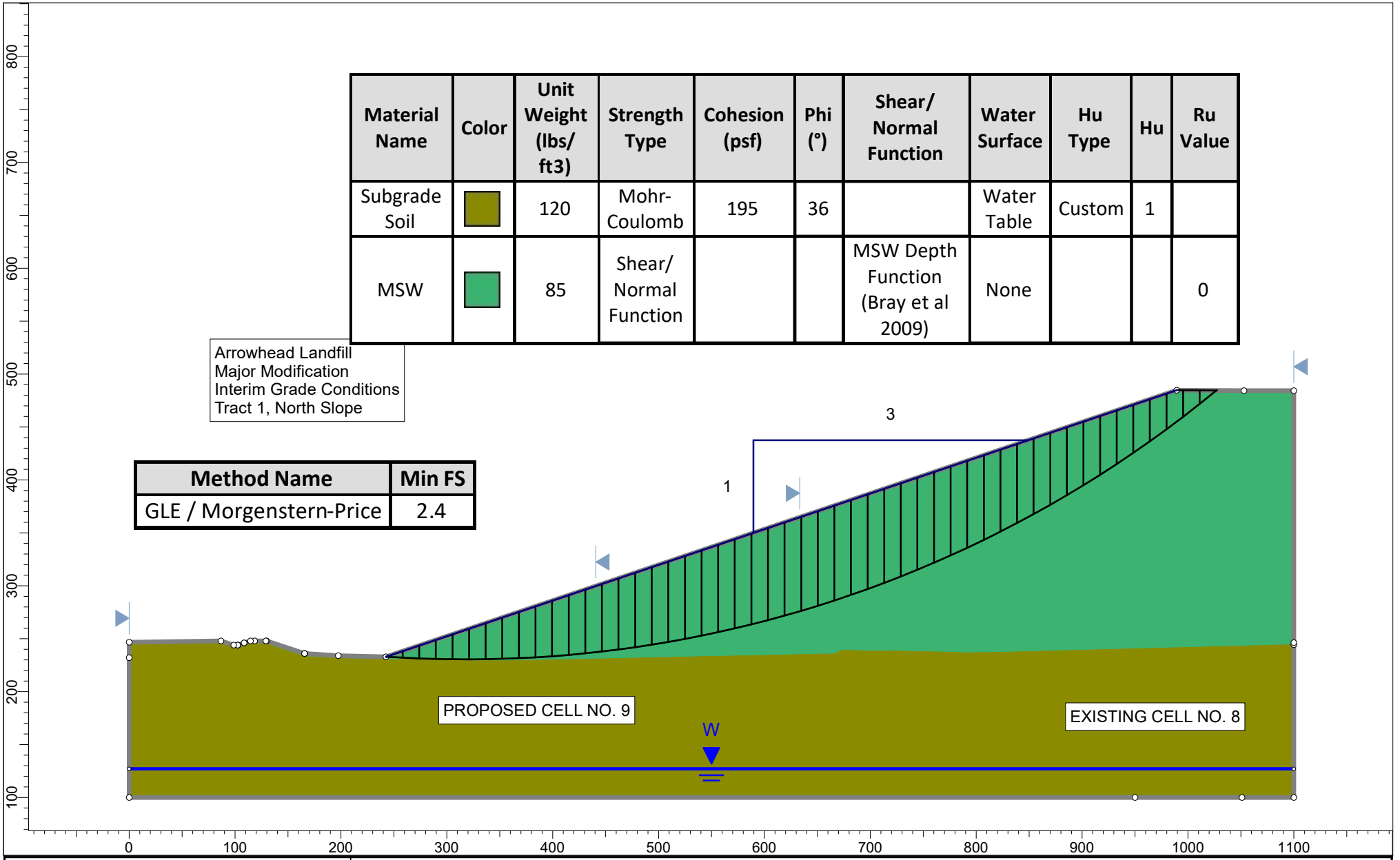
| | | | |
|---|---|---|---|
| Project | MAJOR MODIFICATION SUPPORT | | |
| Group | E-E Static - Interim Slope | Scenario | E.1 - Waste Only |
| Drawn | T. Whitesell, E.I.T. | Company | Bunnell-Lammons Engineering, Inc. |
| Date | 11/21/2024 | File Name | AHLF E-E'.slmd |

| Material Name | Color | Unit Weight (lbs/ ft3) | Strength Type | Cohesion (psf) | Phi (°) | Shear/ Normal Function | Water Surface | Hu Type | Hu | Ru Value |
|---|---|---|---|---|---|---|---|---|---|---|
| Subgrade Soil | | 120 | Mohr-Coulomb | 195 | 36 | | Water Table | Custom | 1 | |
| MSW | | 85 | Shear/ Normal Function | | | MSW Depth Function (Bray et al 2009) | None | | | 0 |

Arrowhead Landfill
Major Modification
Interim Grade Conditions
Tract 1, North Slope

| Method Name | Min FS |
|---|---|
| GLE / Morgenstern-Price | 2.4 |



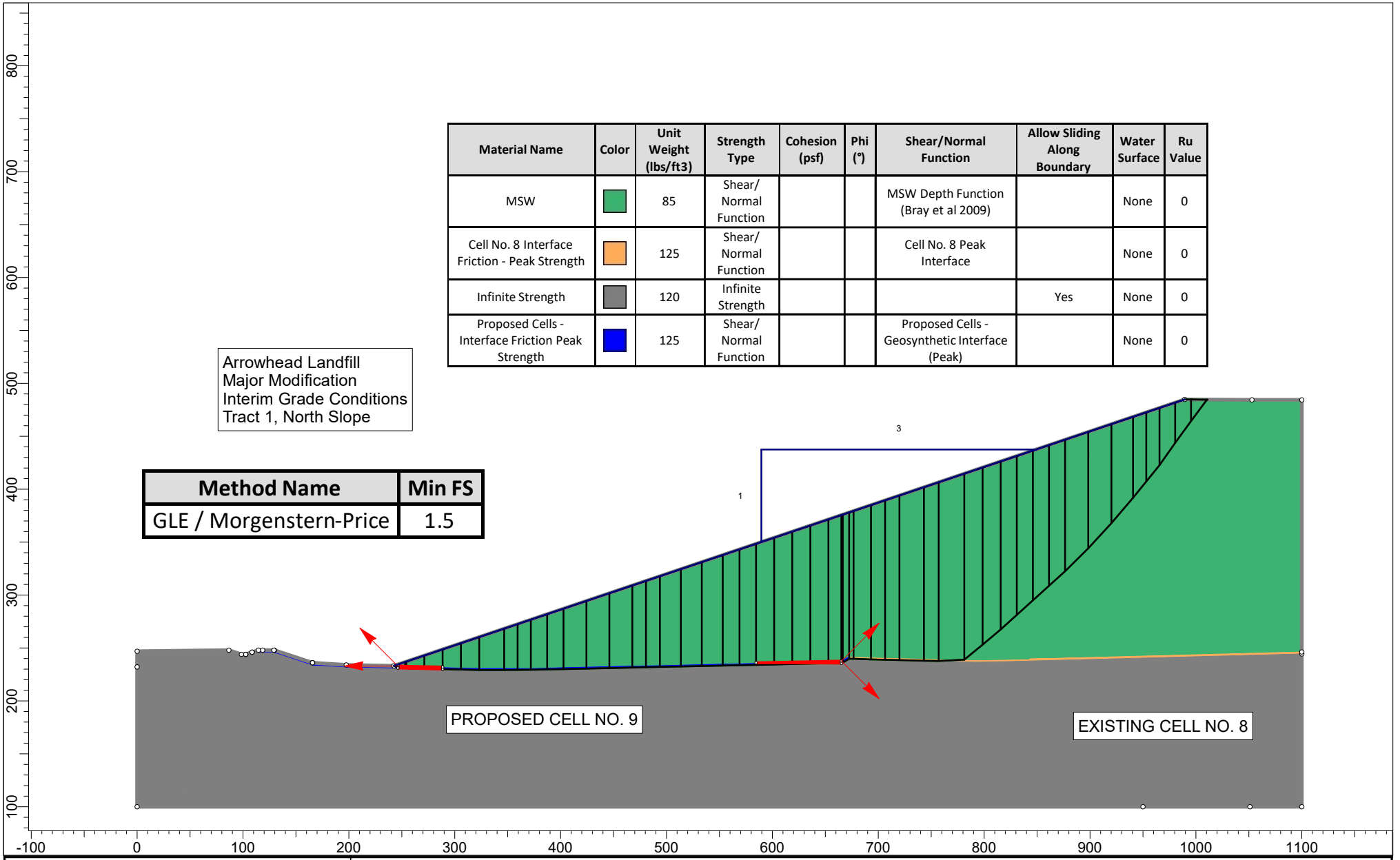

SLIDEINTERPRET 9.031

| | | | |
|---|---|---|---|
| Project | MAJOR MODIFICATION SUPPORT | | |
| Group | E-E Static - Interim Slope | Scenario | E.2 - Subgrade - Global |
| Drawn | T. Whitesell, E.I.T. | Company | Bunnell-Lammons Engineering, Inc. |
| Date | 11/21/2024 | File Name | AHLF E-E'.slmd |

| Material Name | Color | Unit Weight (lbs/ft3) | Strength Type | Cohesion (psf) | Phi (°) | Shear/Normal Function | Allow Sliding Along Boundary | Water Surface | Ru Value |
|---|---|---|---|---|---|---|---|---|---|
| MSW | | 85 | Shear/ Normal Function | | | MSW Depth Function (Bray et al 2009) | | None | 0 |
| Cell No. 8 Interface Friction - Peak Strength | | 125 | Shear/ Normal Function | | | Cell No. 8 Peak Interface | | None | 0 |
| Infinite Strength | | 120 | Infinite Strength | | | | Yes | None | 0 |
| Proposed Cells - Interface Friction Peak Strength | | 125 | Shear/ Normal Function | | | Proposed Cells - Geosynthetic Interface (Peak) | | None | 0 |

Arrowhead Landfill
Major Modification
Interim Grade Conditions
Tract 1, North Slope

| Method Name | Min FS |
|---|---|
| GLE / Morgenstern-Price | 1.5 |



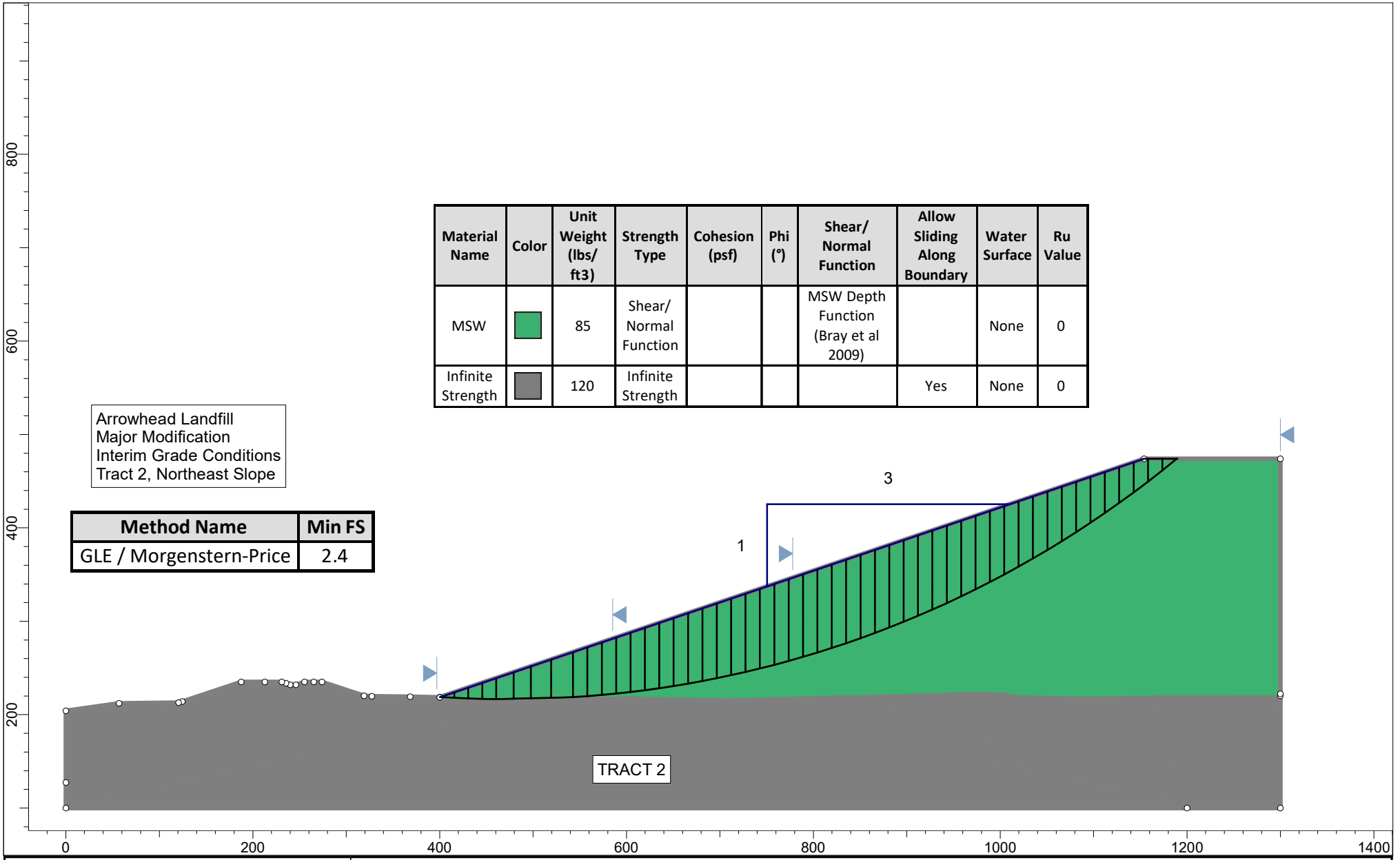

SLIDEINTERPRET 9.031

| | | | |
|---|---|---|---|
| Project | MAJOR MODIFICATION SUPPORT | | |
| Group | E-E Static - Interim Slope | Scenario | E.3. - IS - Peak - Block |
| Drawn | T. Whitesell, E.I.T. | Company | Bunnell-Lammons Engineering, Inc. |
| Date | 11/21/2024 | File Name | AHLF E-E'.slmd |

| Material Name | Color | Unit Weight (lbs/ ft3) | Strength Type | Cohesion (psf) | Phi (°) | Shear/ Normal Function | Allow Sliding Along Boundary | Water Surface | Ru Value |
|---|---|---|---|---|---|---|---|---|---|
| MSW | | 85 | Shear/ Normal Function | | | MSW Depth Function (Bray et al 2009) | | None | 0 |
| Infinite Strength | | 120 | Infinite Strength | | | | Yes | None | 0 |

Arrowhead Landfill
Major Modification
Interim Grade Conditions
Tract 2, Northeast Slope

| Method Name | Min FS |
|---|---|
| GLE / Morgenstern-Price | 2.4 |



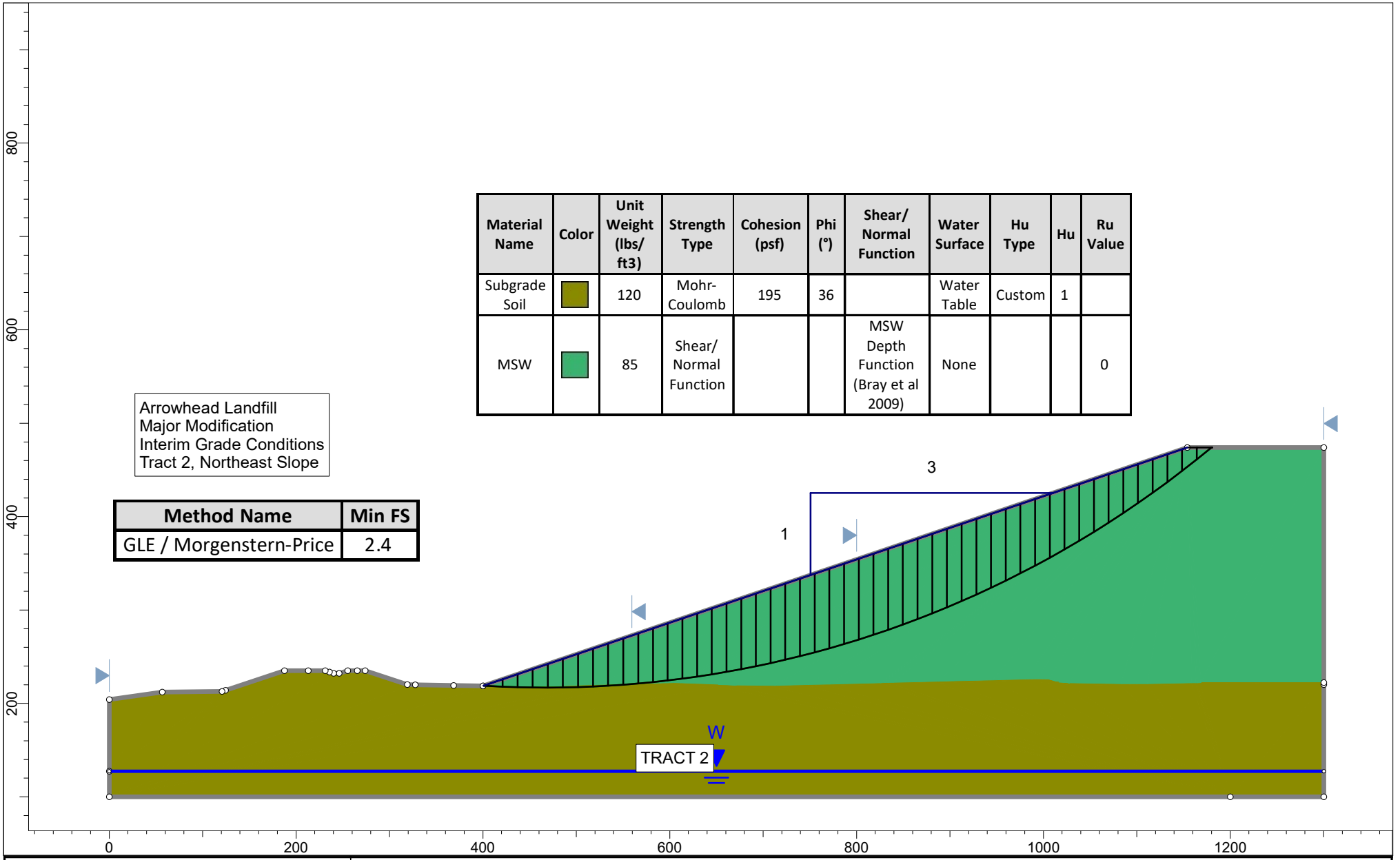

SLIDEINTERPRET 9.031

| | | | |
|---|---|---|---|
| Project | MAJOR MODIFICATION SUPPORT | | |
| Group | F-F Static - Interim Slope | Scenario | F.1 - Waste Only |
| Drawn | T. Whitesell, E.I.T. | Company | Bunnell-Lammons Engineering, Inc. |
| Date | 11/8/2024 | File Name | AHLF F-F'.slmd |

| Material Name | Color | Unit Weight (lbs/ ft3) | Strength Type | Cohesion (psf) | Phi (°) | Shear/ Normal Function | Water Surface | Hu Type | Hu | Ru Value |
|---|---|---|---|---|---|---|---|---|---|---|
| Subgrade Soil | | 120 | Mohr-Coulomb | 195 | 36 | | Water Table | Custom | 1 | |
| MSW | | 85 | Shear/ Normal Function | | | MSW Depth Function (Bray et al 2009) | None | | | 0 |

Arrowhead Landfill
Major Modification
Interim Grade Conditions
Tract 2, Northeast Slope

| Method Name | Min FS |
|---|---|
| GLE / Morgenstern-Price | 2.4 |




| | | | |
|---|---|---|---|
| BLE | Project | MAJOR MODIFICATION SUPPORT | |
| | Group | F-F Static - Interim Slope | Scenario: F.2 - Subgrade - Global |
| | Drawn | T. Whitesell, E.I.T. | Company: Bunnell-Lammons Engineering, Inc. |
| | Date | 11/8/2024 | File Name: AHLF F-F'.slmd |

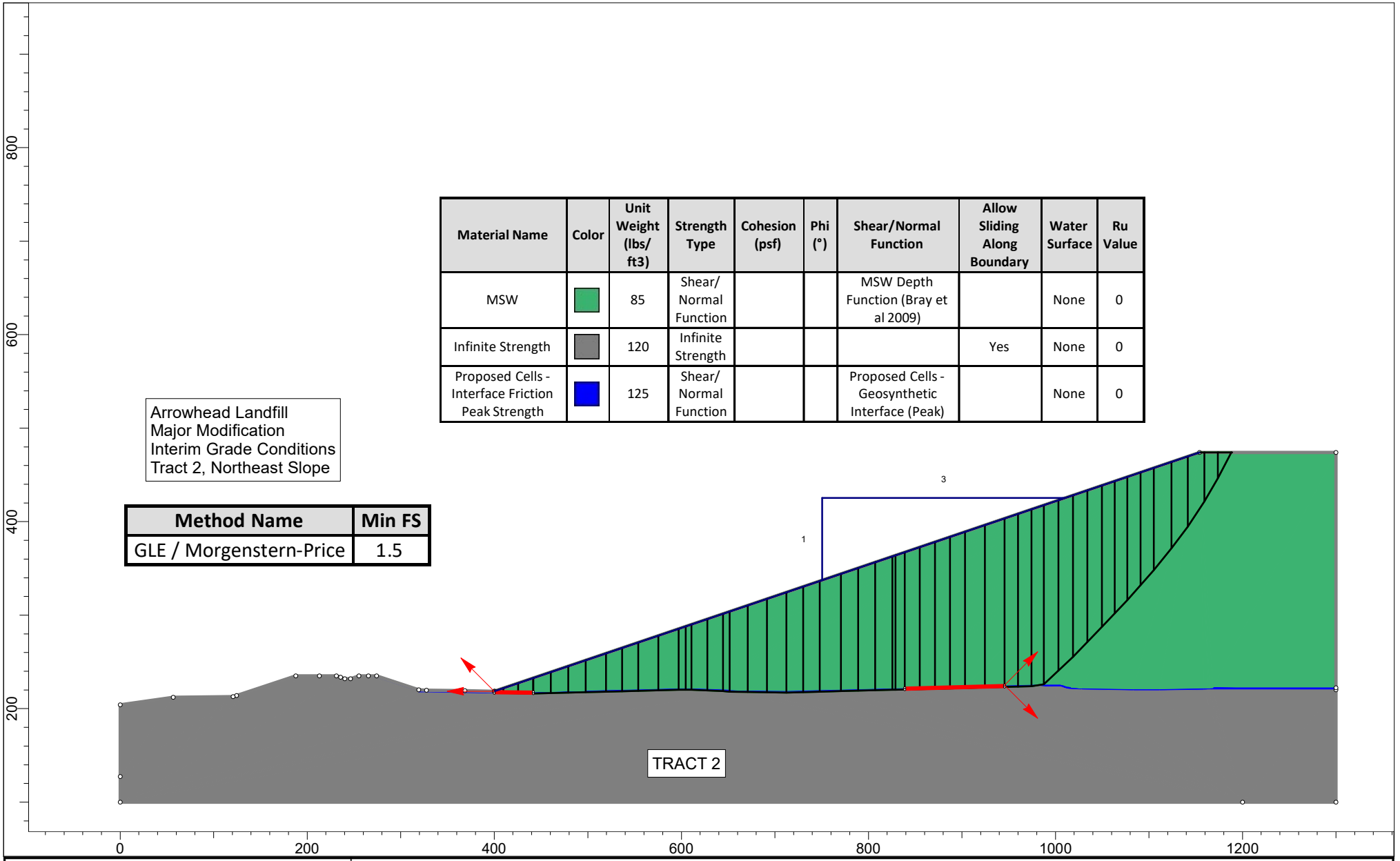
SLIDEINTERPRET 9.031

| Material Name | Color | Unit Weight (lbs/ ft3) | Strength Type | Cohesion (psf) | Phi (°) | Shear/Normal Function | Allow Sliding Along Boundary | Water Surface | Ru Value |
|---|---|---|---|---|---|---|---|---|---|
| MSW | | 85 | Shear/ Normal Function | | | MSW Depth Function (Bray et al 2009) | | None | 0 |
| Infinite Strength | | 120 | Infinite Strength | | | | Yes | None | 0 |
| Proposed Cells - Interface Friction Peak Strength | | 125 | Shear/ Normal Function | | | Proposed Cells - Geosynthetic Interface (Peak) | | None | 0 |

Arrowhead Landfill
Major Modification
Interim Grade Conditions
Tract 2, Northeast Slope

| Method Name | Min FS |
|---|---|
| GLE / Morgenstern-Price | 1.5 |



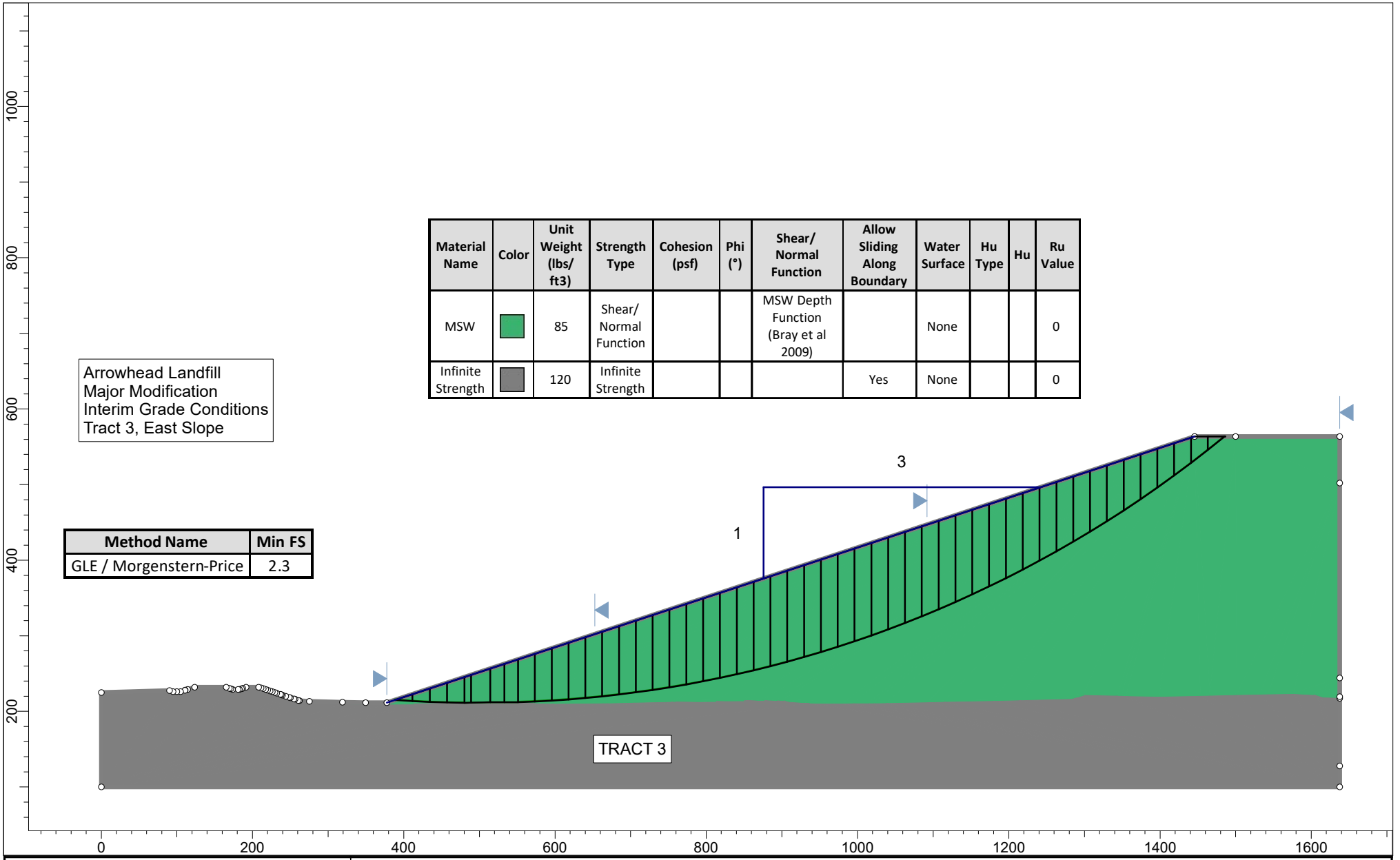

SLIDEINTERPRET 9.031

| | | | |
|---|---|---|---|
| Project | MAJOR MODIFICATION SUPPORT | | |
| Group | F-F Static - Interim Slope | Scenario | F.3. - IS - Peak - Block |
| Drawn | T. Whitesell, E.I.T. | Company | Bunnell-Lammons Engineering, Inc. |
| Date | 11/21/2024 | File Name | AHLF F-F'.slmd |

| Material Name | Color | Unit Weight (lbs/ ft3) | Strength Type | Cohesion (psf) | Phi (°) | Shear/ Normal Function | Allow Sliding Along Boundary | Water Surface | Hu Type | Hu | Ru Value |
|---|---|---|---|---|---|---|---|---|---|---|---|
| MSW | | 85 | Shear/ Normal Function | | | MSW Depth Function (Bray et al 2009) | | None | | | 0 |
| Infinite Strength | | 120 | Infinite Strength | | | | Yes | None | | | 0 |

Arrowhead Landfill
Major Modification
Interim Grade Conditions
Tract 3, East Slope

| Method Name | Min FS |
|---|---|
| GLE / Morgenstern-Price | 2.3 |

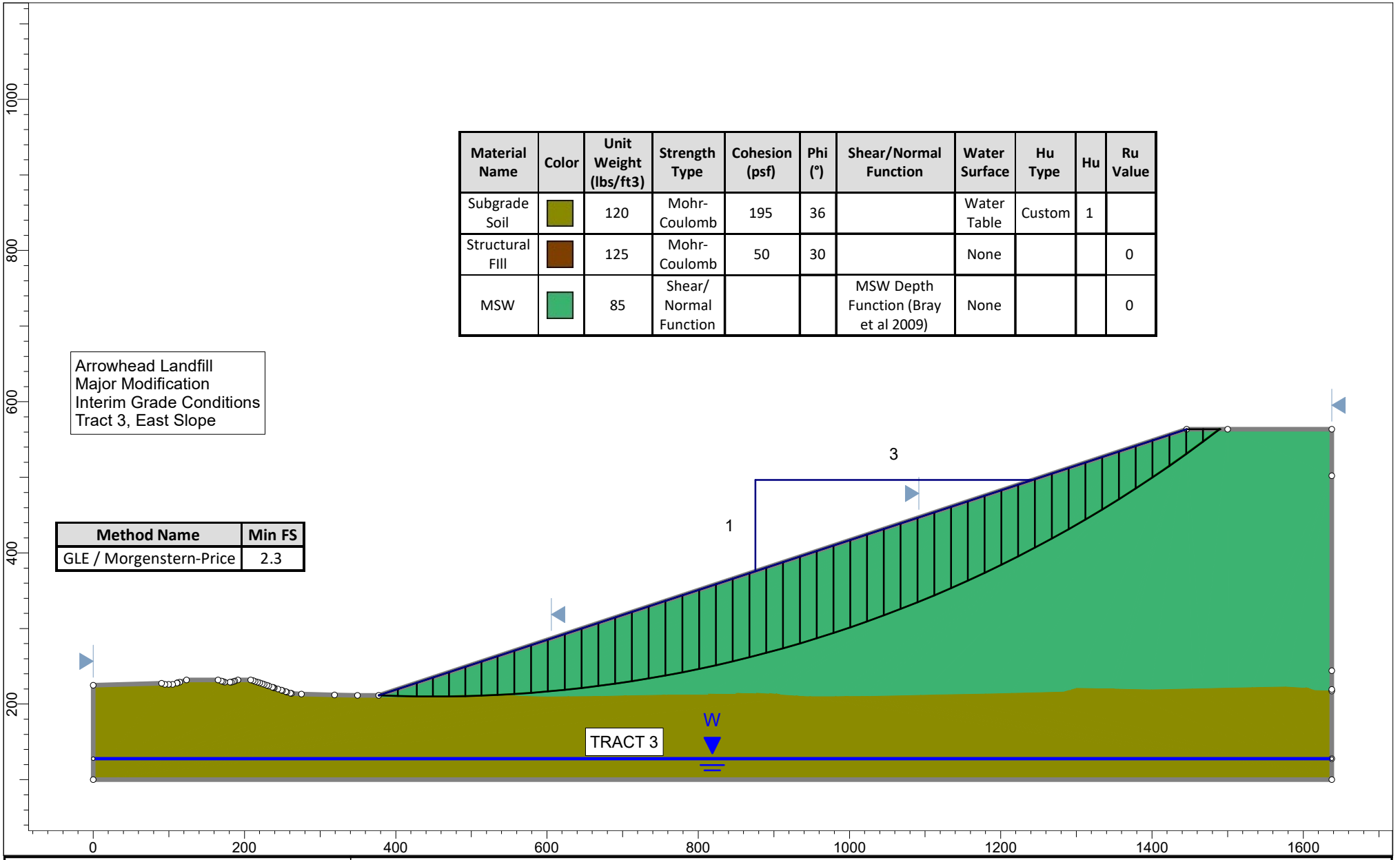



| | | | |
|---|---|---|---|
| | Project | MAJOR MODIFICATION SUPPORT | |
| | Group | G-G Static - Interim Slope | Scenario: G.1 - Waste Only |
| | Drawn | T. Whitesell, E.I.T. | Company: Bunnell-Lammons Engineering, Inc. |
| SLIDEINTERPRET 9.031 | Date | 11/13/2024 | File Name: AHLF G-G'.slmd |

| Material Name | Color | Unit Weight (lbs/ft3) | Strength Type | Cohesion (psf) | Phi (°) | Shear/Normal Function | Water Surface | Hu Type | Hu | Ru Value |
|---|---|---|---|---|---|---|---|---|---|---|
| Subgrade Soil | | 120 | Mohr-Coulomb | 195 | 36 | | Water Table | Custom | 1 | |
| Structural FIll | | 125 | Mohr-Coulomb | 50 | 30 | | None | | | 0 |
| MSW | | 85 | Shear/ Normal Function | | | MSW Depth Function (Bray et al 2009) | None | | | 0 |

Arrowhead Landfill
Major Modification
Interim Grade Conditions
Tract 3, East Slope

| Method Name | Min FS |
|---|---|
| GLE / Morgenstern-Price | 2.3 |



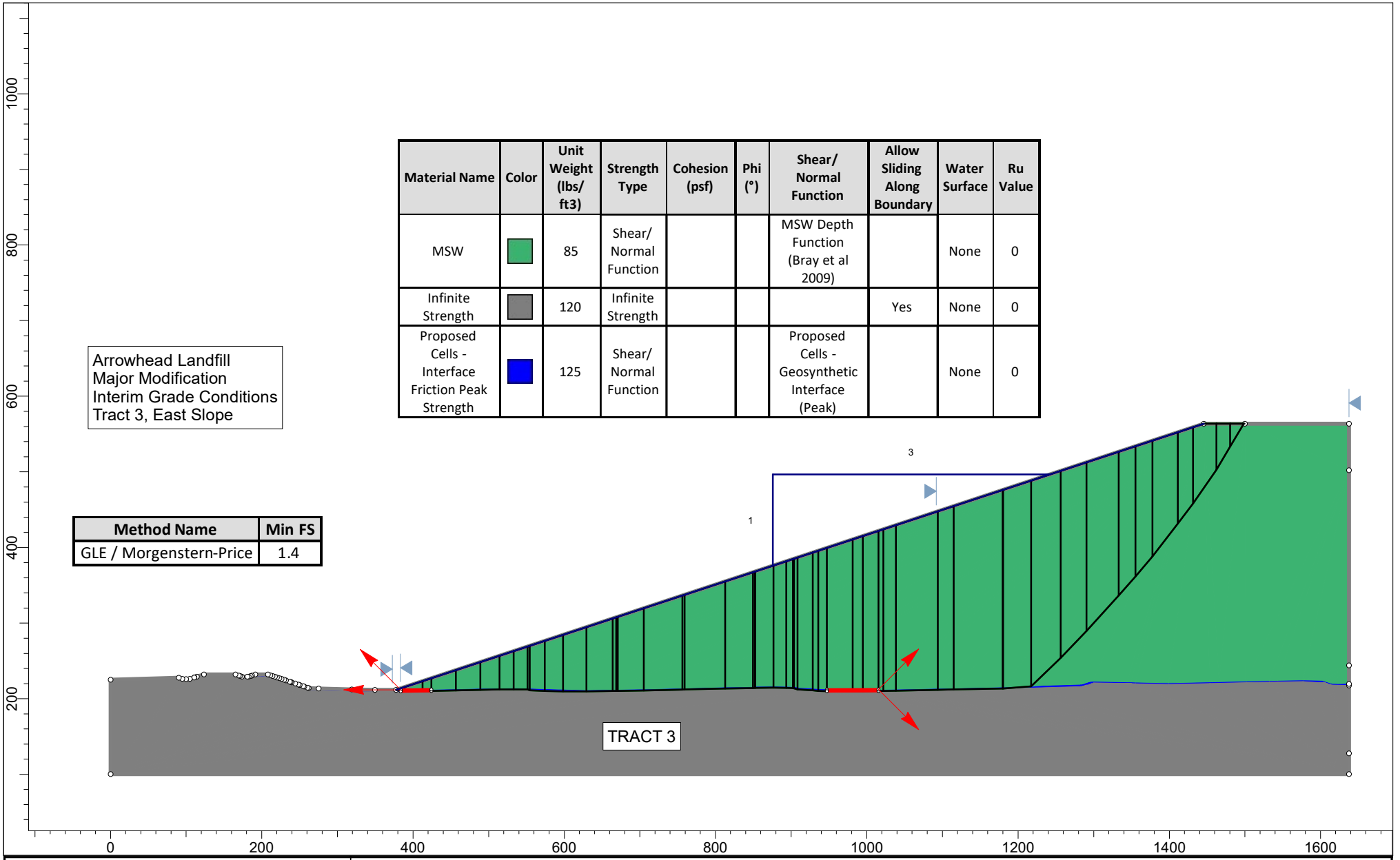

SLIDEINTERPRET 9.031

| | | | |
|---|---|---|---|
| Project | MAJOR MODIFICATION SUPPORT | | |
| Group | G-G Static - Interim Slope | Scenario | G.2 - Subgrade - Global |
| Drawn | T. Whitesell, E.I.T. | Company | Bunnell-Lammons Engineering, Inc. |
| Date | 11/13/2024 | File Name | AHLF G-G'.slmd |

| Material Name | Color | Unit Weight (lbs/ ft3) | Strength Type | Cohesion (psf) | Phi (°) | Shear/ Normal Function | Allow Sliding Along Boundary | Water Surface | Ru Value |
|---|---|---|---|---|---|---|---|---|---|
| MSW | | 85 | Shear/ Normal Function | | | MSW Depth Function (Bray et al 2009) | | None | 0 |
| Infinite Strength | | 120 | Infinite Strength | | | | Yes | None | 0 |
| Proposed Cells - Interface Friction Peak Strength | | 125 | Shear/ Normal Function | | | Proposed Cells - Geosynthetic Interface (Peak) | | None | 0 |

Arrowhead Landfill
Major Modification
Interim Grade Conditions
Tract 3, East Slope

| Method Name | Min FS |
|---|---|
| GLE / Morgenstern-Price | 1.4 |




SLIDEINTERPRET 9.031

| | | | |
|---|---|---|---|
| Project | MAJOR MODIFICATION SUPPORT | | |
| Group | G-G Static - Interim Slope | Scenario | G.3 - IS - Peak - Block |
| Drawn | T. Whitesell, E.I.T. | Company | Bunnell-Lammons Engineering, Inc. |
| Date | 11/21/2024 | File Name | AHLF G-G'.slmd |

# APPENDIX F

# VENEER STABILITY ANALYSIS

# Protective Cover Veneer Stability Analysis

# CALCULATION DOCUMENTATION

# BASE LINER
# VENEER SLIDING STABILITY

MAJOR MODIFICATION SUPPORT
ARROWHEAD LANDFILL
PERRY COUNTY, ALABAMA
BLE Project No. J24-4999-66

Prepared By: _____

Tanner A. Whitesell, E.I.T.

Date: January 30, 2025

Checked By: _____

William D. Yarbray, E.I.T.

Date: January 30, 2025

Reviewed By: _____

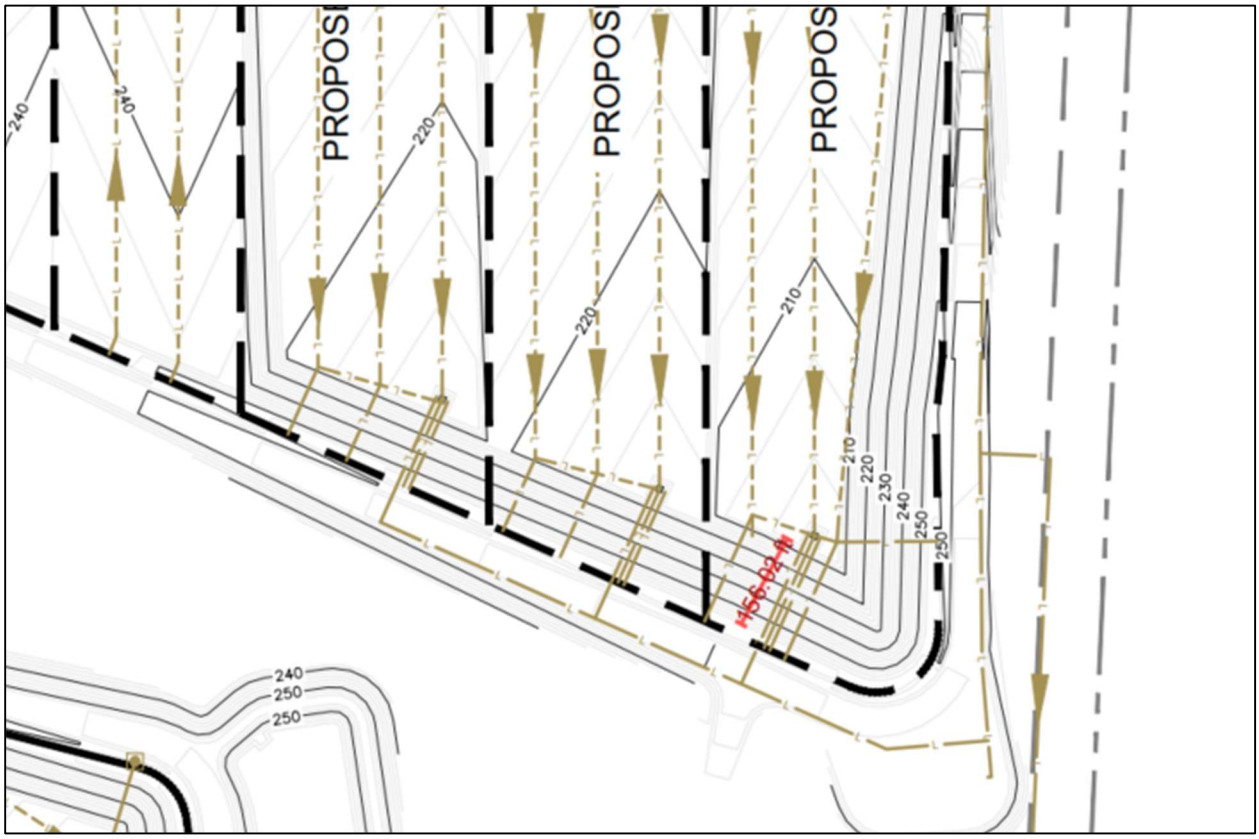
Larry A. Simonson, P.E.
Licensed, Alabama No. 36952

ALABAMA LICENSED No. 36952 PROFESSIONAL ENGINEER 1/30/25 LAWRENCE A. SIMONSON

Date: January 30, 2025

Bunnell-Lammons Engineering, Inc.
Greenville, South Carolina
864-288-1265 (Voice)
864-288-4430 (Fax)

**Veneer Slope Stability Analysis – Protective Cover Side Slope in Tract 3**
**Major Modification Support**
**Arrowhead Landfill**
BLE Project No. J24-4999-66




## Image taken from BLE Figure 4C.

3H:1V (18.43 deg) Side Slope of Proposed Tract 3

| | |
|---|---|
| Top of slope elevation = | 258 ft |
| Bottom of slope elevation = | 206 ft |
| Plan Length of slope (horizontal) = | 156 ft |
| Actual Slope Length = | 164 ft |

Performed by: Tanner Whitesell, E.I.T.
Checked by: David Yarbray, E.I.T.
Reviewed by: Larry Simonson, P.E.

# VENEER SLIDING STABILITY - BASE LINER SIDE SLOPE WITH EQUIPMENT LOADING 3H:1V SLOPES

MAJOR MODIFICATION SUPPORT

ARROWHEAD LANDFILL

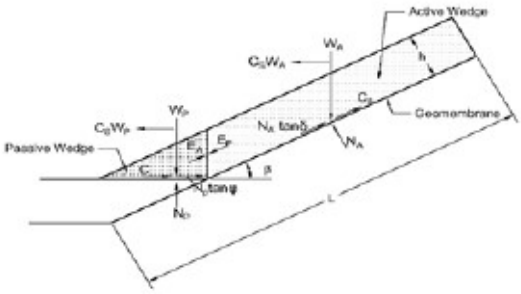
PERRY COUNTY, ALABAMA

BLE Project J24-4999-66

Reference: *Analysis and Design of Veneer Cover Soils* by R.M Koerner and T-Y Soong; Geosynthetics International, Special Issue on Giroud Lectures, 12, No. 1, pp.28-49.

This analysis method addresses finite slope stability of veneer covers considering gravitational forces from the protective cover soil over the geosynthetic layer and equipment loading due to specific low ground pressure type dozer spreading protective cover soils over a geosynthetic layer on a slope.

Check for GCL Interface Strength




**Input:**

| | |
|---|---|
| $\delta := 27\ deg$ | Interface friction angle along slip surface, target shear strength for normal stress < 1,000 psf |
| $\beta := 18.43\ deg$ | Veneer slope inclination 3H:1V |
| $\gamma := 120$ | Total unit weight (pcf) of protective cover soils |
| $h := 1$ | Thickness of protective cover soil (ft) above the slip surface (geosynthetic) |
| $H := 52$ | Height (H) and Width (W) for side slope $L := \sqrt{\left(H^2\right) + \left(W^2\right)}$ |
| $W := 156$ | |
| $L = 164.4$ | Length (ft) of base liner slope |
| $\phi := 30\ deg$ | Internal friction angle of the protective cover soil above the slip surface |
| $cc := 0$ | Cohesion (psf) of cover soil |
| $ca := 0$ | Adhesion (psf) between cover soil of the active wedge and the geosynthetic |
| $Wb := 50490$ | Weight (lbs) of Caterpillar D6N-LPG dozer or equivalent |
| $wt := 3$ | Dozer track width (ft) |

**Compute Factor of Safety of Cover Soil Due to Gravitational Forces**

$$Wa := \gamma \cdot h^2 \cdot \left( \frac{L}{h} - \frac{1}{\sin(\beta)} - \frac{\tan(\beta)}{2} \right)$$

Wa = total weight of active wedge

$$Na := Wa \cdot \cos(\beta)$$

Na = effective force normal to the failure plane of the active wedge

$$Ca := ca \cdot \left( L - \frac{h}{\sin(\beta)} \right)$$

Ca = adhesive force between cover soil of the active wedge and the geomembrane

$C := \frac{cc \cdot h}{\sin(\beta)}$ C = cohesive force along the failure plane of the passive wedge

$Wp := \frac{\gamma \cdot h^2}{\sin(2 \cdot \beta)}$ Wp = total weight of the passive wedge

**FS = Factor of Safety**

$X := (Wa - (Na \cdot \cos(\beta))) \cdot \cos(\beta)$

$Y := -((Wa - Na \cdot \cos(\beta)) \cdot \sin(\beta) \cdot \tan(\phi) + (Na \cdot \tan(\delta) + Ca) \cdot \sin(\beta) \cdot \cos(\beta) + \sin(\beta) \cdot (C + Wp \cdot \tan(\phi)))$

$Z := (Na \cdot \tan(\delta) + Ca) \cdot (\sin(\beta))^2 \cdot \tan(\phi)$

$FS := \frac{-Y + \sqrt{Y^2 - 4 \cdot X \cdot Z}}{2 \cdot X}$

Factor of Safety: $FS = 1.55$ **with respect to gravitational forces only**

**Compute Factor of Safety of Cover Soil Due to Construction Equipment Forces**

This analysis assumes dozer is pushing cover soil up from the toe of the slope to the crest. Therefore, acceleration (or deceleration) forces from the equipment are negligible.

$wh := \frac{wt}{h}$ wh is used in plot of influence value

$$Iwth := \begin{bmatrix} 0.2 & 0.3 \\ 0.275 & 0.4 \\ 0.35 & 0.5 \\ 0.45 & 0.6 \\ 0.57 & 0.7 \\ 0.71 & 0.8 \\ 0.85 & 0.9 \\ 1.0 & 0.93 \\ 1.5 & 0.95 \\ 2.0 & 0.96 \\ 3.0 & 0.98 \\ 4.0 & 0.99 \end{bmatrix}$$

$x := \text{col}(Iwth, 1)$
$y := \text{col}(Iwth, 2)$
$I := \text{linterp}(x, y, wh)$

$We := \frac{Wb}{2 \cdot wt} \cdot I$ We = equivalent equipment force per unit width at geomembrane interface

$Nae := (Wa + We) \cdot \cos(\beta)$ Na = effective force normal to the failure plane of the active wedge

**FS = Factor of Safety**

$$Xd := \left(We + Wa - \left(Nae \cdot \cos(\beta)\right)\right) \cdot \cos(\beta)$$

$$Yd := -\left(\left(We + Wa - Nae \cdot \cos(\beta)\right) \cdot \sin(\beta) \cdot \tan(\phi) + \left(Nae \cdot \tan(\delta) + Ca\right) \cdot \sin(\beta) \cdot \cos(\beta) + \sin(\beta) \cdot \left(C + Wp \cdot \tan(\phi)\right)\right)$$

$$Zd := \left(Nae \cdot \tan(\delta) + Ca\right) \cdot \left(\sin(\beta)\right)^2 \cdot \tan(\phi)$$

$$FSd := \frac{-Yd + \sqrt{Yd^2 - 4 \cdot Xd \cdot Zd}}{2 \cdot Xd}$$

**Factor of Safety**: $FSd = 1.54$ **with respect to gravitational plus equipment forces**

# Final Cover Veneer Stability Analysis

# CALCULATION DOCUMENTATION
# CLOSURE CAP
# VENEER SLIDING STABILITY

MAJOR MODIFICATION SUPPORT
ARROWHEAD LANDFILL
PERRY COUNTY, ALABAMA
BLE Project No. J24-4999-66

Prepared By: Tanner Whitesell

Tanner A. Whitesell, E.I.T.

Date: January 25, 2025

Checked By: William David Yarbray

William D. Yarbray, E.I.T.

Date: January 30, 2025

Reviewed By: Lawrence A Simonson

ALABAMA LICENSED No. 36952 PROFESSIONAL 1/30/25 ENGINEER LAWRENCE A. SIMONSON

Larry A. Simonson, P.E.
Licensed, Alabama No. 36952

Date: January 30, 2025

Bunnell-Lammons Engineering, Inc.
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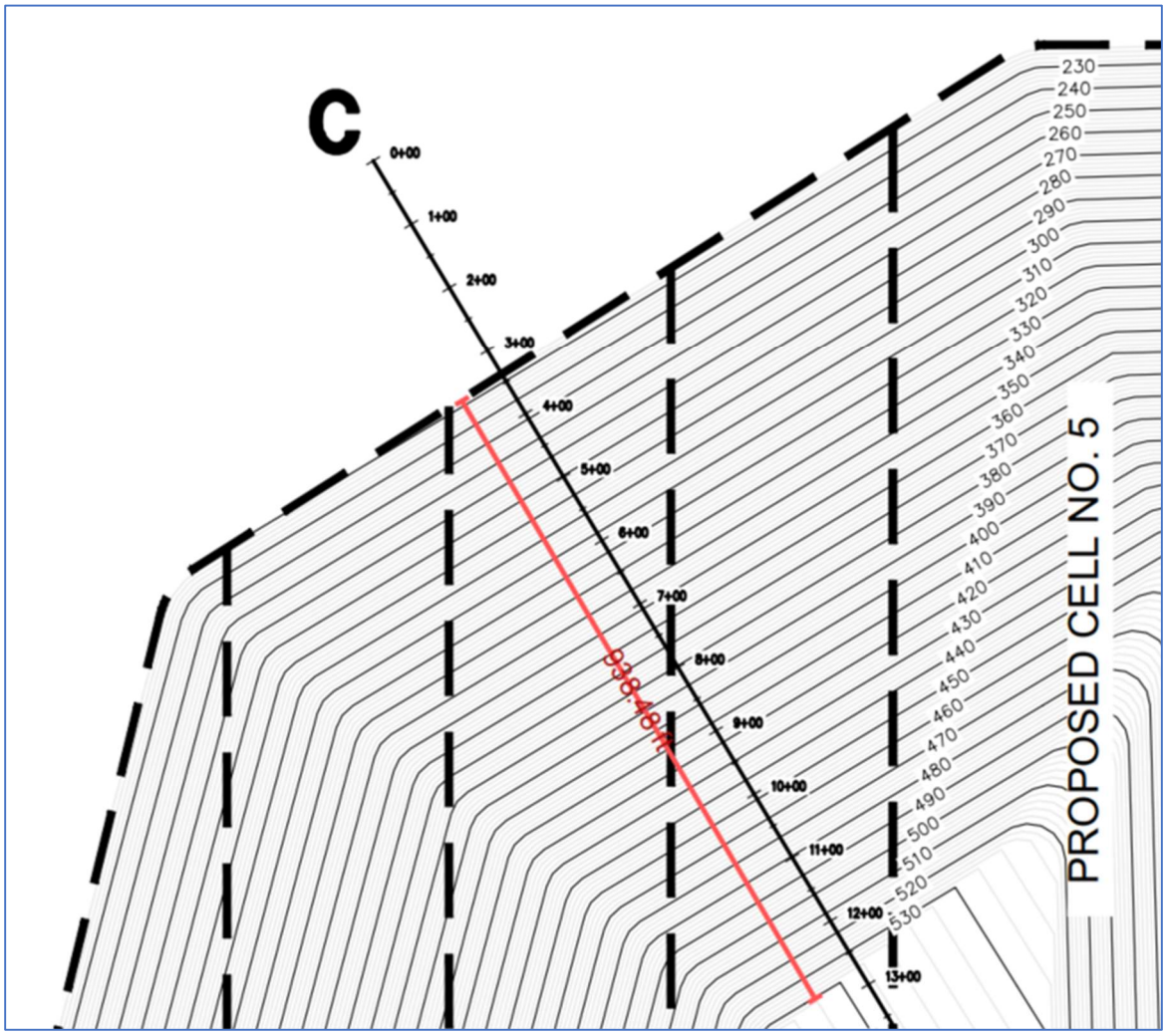
864-288-4430 (Fax)

**Veneer Slope Stability Analysis – Final Cover Slope in Tract 3**
**Major Modification Support**
**Arrowhead Landfill**
BLE Project No. J24-4999-66




## Image taken from BLE Figure 4D.

| | |
|---|---|
| Top of slope elevation = | 540 ft |
| Bottom of slope elevation = | 228 ft |
| Plan Length of slope (horizontal) = | 938 ft |
| Slope Inclination = | 3H:1V |
| Actual Slope Length = | 988 ft |

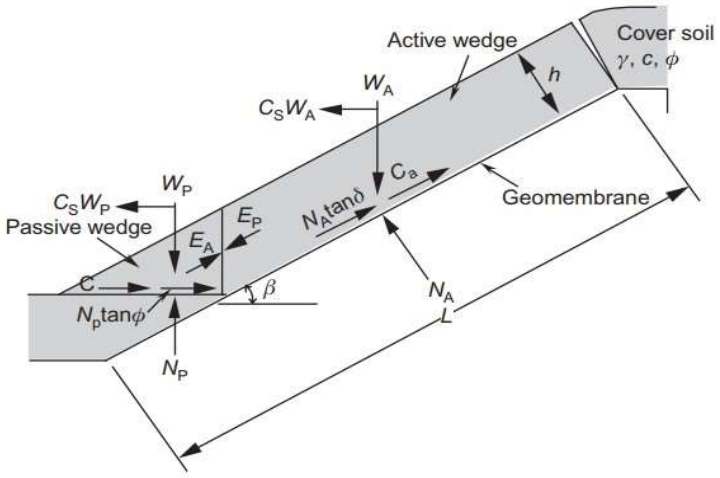
Performed by: Tanner Whitesell, E.I.T.
Checked by: David Yarbray, E.I.T.
Reviewed by: Larry Simonson, P.E.

# CLOSURE CAP VENEER SLIDING STABILITY - WITH EQUIPMENT LOADING
# 3:1 H:V SLOPES

MAJOR MODIFICATION SUPPORT
ARROWHEAD LANDFILL
PERRY COUNTY, PERRY
BLE Project No. J24-4999-66

Reference: Analysis and Design of Veneer Cover Soils
by R.M. Koerner and T-Y Soong, 2005
Geosynthetics International, Special Issue on Giroud Lectures, 12, No. 1, 28-49.

This analysis method addresses finite slope stability of veneer covers considering gravitational forces from the protective cover soil over the geosynthetic layer and equipment loading due to a specific low ground pressure type dozer spreading protective cover soils over a geosynthetic layer on a slope.




Input items shaded in yellow.

| | |
|---|---|
| $\delta := 30\ °$ | Assumed minimum peak interface friction angle along slip surface |
| $\beta := 18.43\ °$ | Veneer slope inclination for 3:1, H:V closure cap slopes |
| $\gamma := 110$ | Total unit weight (lb/ft3) of final cover material |
| $h := 2$ | Thickness of final cover layer soil (ft) above the slip surface, 24-inches vegetative/erosion layer above final cover geosynthetics |
| $L := 988$ | Length (ft) of tallest closure cap slope (Tract 3, northwest slope) |
| $\phi := 30\ °$ | Assumed Internal friction angle of the cover layer soil above the slip surface |
| $cc := 0$ | Assumed Cohesion (lb/ft2) of cover layer soil |
| $ca := 0$ | Assumed Adhesion (lb/ft2) between geosynthetics for static condition |
| $Wb := 50490$ | Weight (pounds) of Caterpillar D6N-LPG dozer or equivalent |
| $wt := 3$ | Dozer track width (ft) |
| $Cs := 0.20$ | Seismic coefficient for the top of the waste mound (unitless, measured as the maximum acceleration at the top of the landfill / g) ;PGA(final cover) = 0.20g |

## Compute Factor of Safety of Cover Soil Due to Gravitational Forces

$$Wa := \gamma \cdot h^2 \cdot \left( \frac{L}{h} - \frac{1}{\sin(\beta)} - \frac{\tan(\beta)}{2} \right)$$

Wa = total weight of active wedge

$$Wa = 2.1589 \cdot 10^5$$

$$Na := Wa \cdot \cos(\beta)$$

Na = effective force normal to the failure plane of the active wedge

$$Na = 2.0482 \cdot 10^5$$

$$Ca := ca \cdot \left( L - \frac{h}{\sin(\beta)} \right)$$

Ca = adhesive force between cover soil of the active wedge and the geomembrane

$$C := \frac{cc \cdot h}{\sin(\beta)}$$

C = cohesive force along the failure plane of the passive wedge

$$C = 0$$

$$Wp := \frac{\gamma \cdot h^2}{\sin(2 \cdot \beta)}$$

Wp = total weight of the passive wedge

$$Wp = 733.5023$$

**FS = Factor of Safety**

$$X := \left( Wa - \left( Na \cdot \cos(\beta) \right) \right) \cdot \cos(\beta)$$

$$X = 20471.5671$$

$$Y := -\left( \left( Wa - Na \cdot \cos(\beta) \right) \cdot \sin(\beta) \cdot \tan(\phi) + \left( Na \cdot \tan(\delta) + Ca \right) \cdot \sin(\beta) \cdot \cos(\beta) + \sin(\beta) \cdot \left( C + Wp \cdot \tan(\phi) \right) \right)$$

$$Y = -39540.5102$$

$$Z := \left( Na \cdot \tan(\delta) + Ca \right) \cdot \left( \sin(\beta) \right)^2 \cdot \tan(\phi)$$

$$Z = 6823.8557$$

$$FS := \frac{-Y + \sqrt{Y^2 - 4 \cdot X \cdot Z}}{2 \cdot X}$$

where, "X" represents "a"
"Y" represents "b"
"Z" represents "c"
in the traditional quadratic equation

Factor of Safety: $FS = 1.74$ **with respect to gravitational forces only**

## Compute Factor of Safety of Cover Soil Due to Construction Equipment Forces

This analysis assumes dozer is pushing cover soil up from the toe of the slope to the crest. Therefore, acceleration (or deceleration) forces from the equipment are negligible.

$$wh := \frac{wt}{h}$$

wh is used in plot of influence value

$$Iwth := \begin{bmatrix} 0.2 & 0.3 \\ 0.275 & 0.4 \\ 0.35 & 0.5 \\ 0.45 & 0.6 \\ 0.57 & 0.7 \\ 0.71 & 0.8 \\ 0.85 & 0.9 \\ 1.0 & 0.93 \\ 1.5 & 0.95 \\ 2.0 & 0.96 \\ 3.0 & 0.98 \\ 4.0 & 0.99 \end{bmatrix}$$

$x := \mathrm{col}(Iwth, 1)$
$y := \mathrm{col}(Iwth, 2)$
$I := \mathrm{linterp}(x, y, wh)$

$I = 0.95$

$We := \frac{Wb}{2 \cdot wt} \cdot I$ We = equivalent equipment force per unit width at geomembrane interface

$We = 7994.25$

$Nae := (Wa + We) \cdot \cos(\beta)$ Na = effective force normal to the failure plane of the active wedge

$Wa + We = 223889.175$

$Nae = 212406.0353$

**FS = Factor of Safety**

$Xd := (We + Wa - (Nae \cdot \cos(\beta))) \cdot \cos(\beta)$

$Xd = 21229.5971$

$Yd := -((We + Wa - Nae \cdot \cos(\beta)) \cdot \sin(\beta) \cdot \tan(\phi) + (Nae \cdot \tan(\delta) + Ca) \cdot \sin(\beta) \cdot \cos(\beta) + \sin(\beta) \cdot (C + Wp \cdot \tan(\phi)))$

$Yd = -40999.6757$

$Zd := (Nae \cdot \tan(\delta) + Ca) \cdot (\sin(\beta))^2 \cdot \tan(\phi)$

$Zd = 7076.5324$

$FSd := \frac{-Yd + \sqrt{Yd^2 - 4 \cdot Xd \cdot Zd}}{2 \cdot Xd}$

where, "X" represents "a"
"Y" represents "b"
"Z" represents "c"
in the traditional quadratic equation

**Factor of Safety**: $FSd = 1.74$ **with respect to gravitational plus equipment forces**

**Compute Factor of Safety of Cover Soil Due to Gravitational Forces-Seismic Case:**

$$Wa := \gamma \cdot h^2 \cdot \left( \frac{L}{h} - \frac{1}{\sin(\beta)} - \frac{\tan(\beta)}{2} \right)$$

Wa = total weight of active wedge

$$Wa = 2.1589 \cdot 10^5$$

$$Na := Wa \cdot \cos(\beta)$$

Na = effective force normal to the failure plane of the active wedge

$$Na = 2.0482 \cdot 10^5$$

$$Ca := ca \cdot \left( L - \frac{h}{\sin(\beta)} \right)$$

Ca = adhesive force between cover soil of the active wedge and the geomembrane

$$C := \frac{cc \cdot h}{\sin(\beta)}$$

C = cohesive force along the failure plane of the passive wedge

$$C = 0$$

$$Wp := \frac{\gamma \cdot h^2}{\sin(2 \cdot \beta)}$$

Wp = total weight of the passive wedge

$$Wp = 733.5023$$

**FS = Factor of Safety**

$$X := \left( Cs \cdot Wa + \left( Na \cdot \sin(\beta) \right) \right) \cdot \cos(\beta) + Cs \cdot Wp \cdot \cos(\beta)$$

$$X = 1.0254 \cdot 10^5$$

$$Y := -\left( \left( Cs \cdot Wa + Na \cdot \sin(\beta) \right) \cdot \sin(\beta) \cdot \tan(\phi) + \left( Na \cdot \tan(\delta) + Ca \right) \cdot \left( \cos(\beta) \right)^2 + \left( C + Wp \cdot \tan(\phi) \right) \cdot \cos(\beta) \right)$$

$$Y = -1.2654 \cdot 10^5$$

$$Z := \left( Na \cdot \tan(\delta) + Ca \right) \cdot \sin(\beta) \cdot \cos(\beta) \cdot \tan(\phi)$$

$$Z = 20477.4626$$

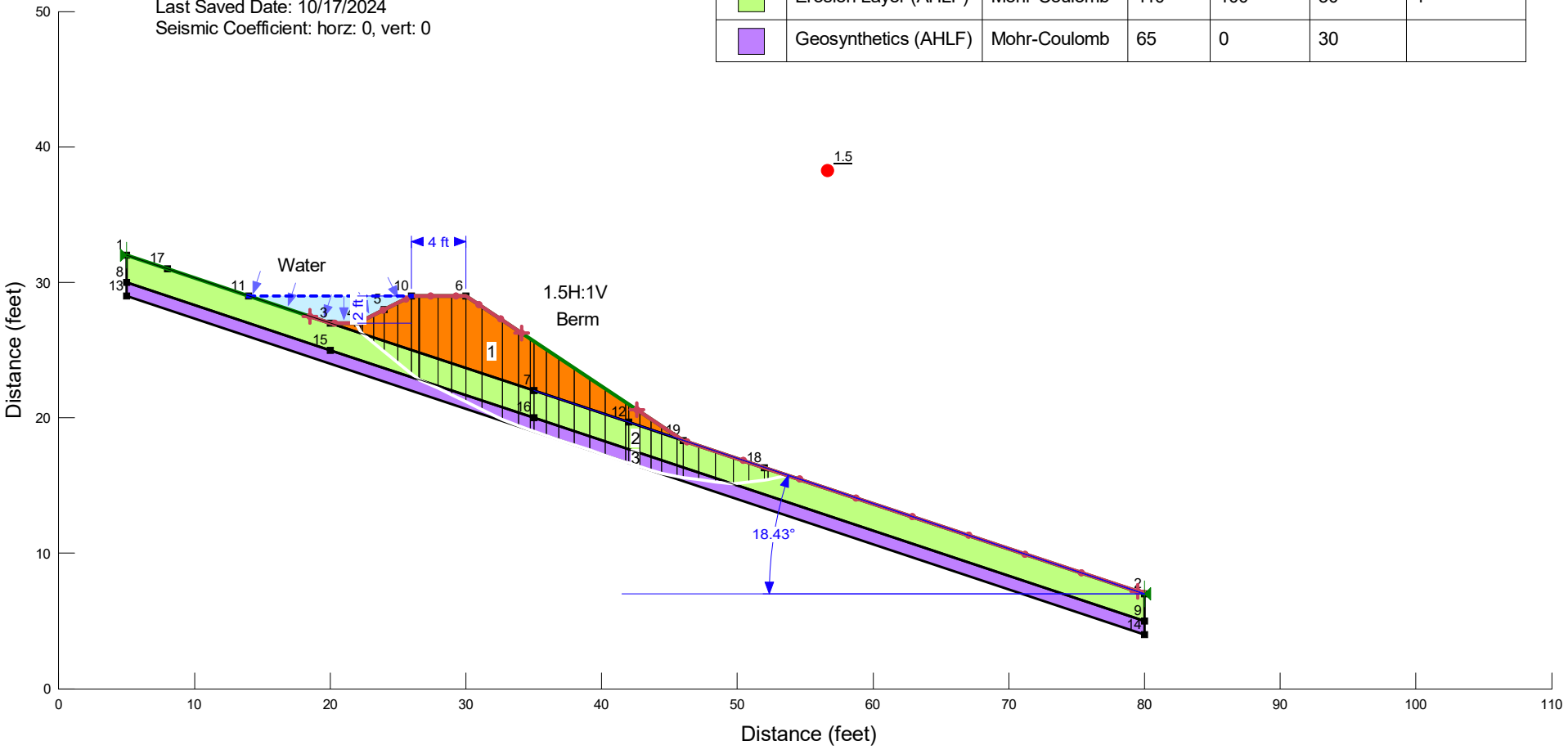
$$FS := \frac{-Y + \sqrt{Y^2 - 4 \cdot X \cdot Z}}{2 \cdot X}$$

where, "X" represents "a"
"Y" represents "b"
"Z" represents "c"
in the traditional quadratic equation

Factor of Safety: $FS = 1.04$ **with respect to gravitational forces only**

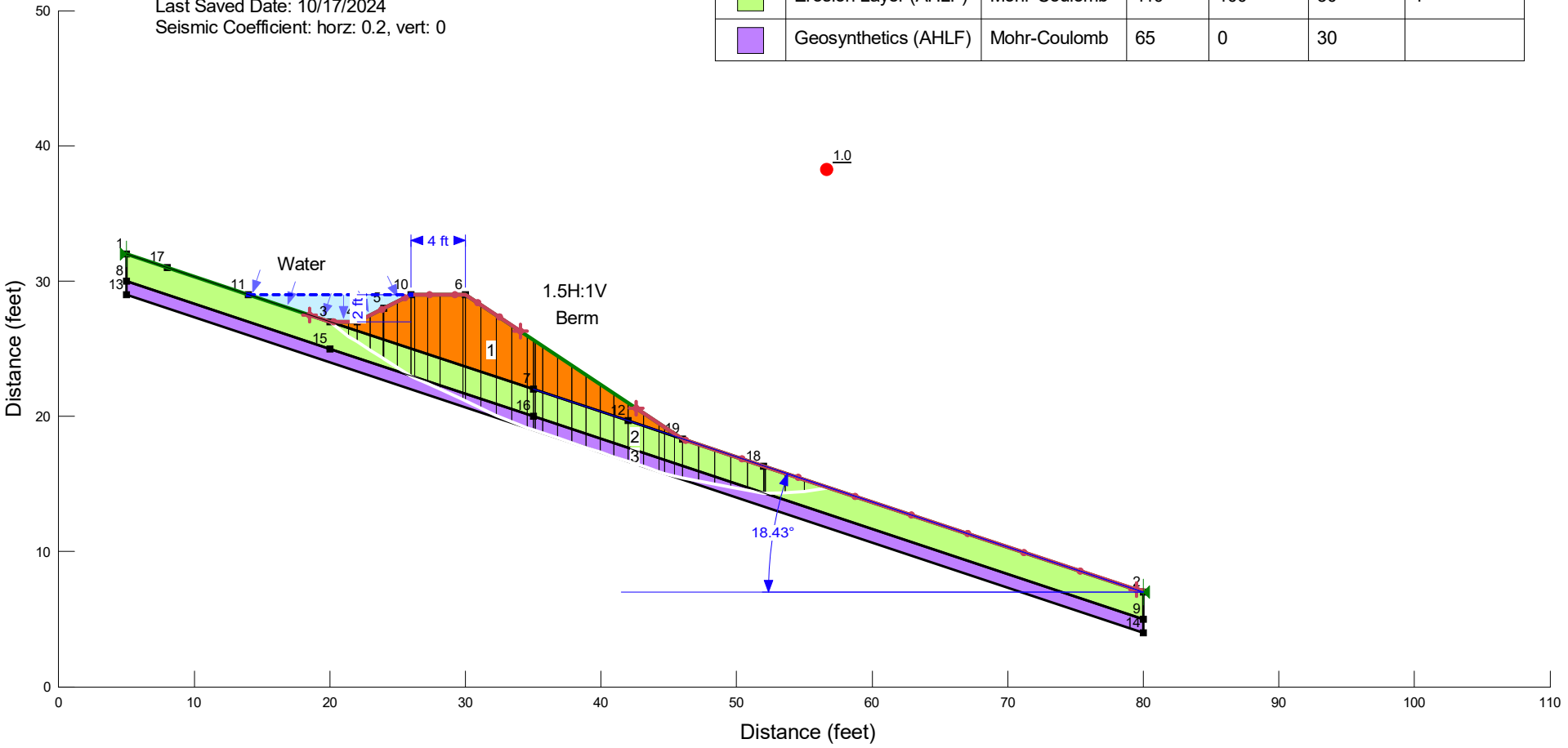
| Color | Name | Slope Stability Material Model | Unit Weight (pcf) | Effective Cohesion (psf) | Effective Friction Angle (°) | Piezometric Surface |
|---|---|---|---|---|---|---|
| | Berm Soil - (AHLF) | Mohr-Coulomb | 120 | 200 | 36 | 1 |
| | Erosion Layer (AHLF) | Mohr-Coulomb | 110 | 100 | 30 | 1 |
| | Geosynthetics (AHLF) | Mohr-Coulomb | 65 | 0 | 30 | |

File Name: Tack on Berm_Arrowhead.gsz
Name: 1.5H:1V, 2ft Tall & 4ft Wide (AHLF)
Name: 1A. Tack on berm (static)
Last Saved Date: 10/17/2024
Seismic Coefficient: horz: 0, vert: 0

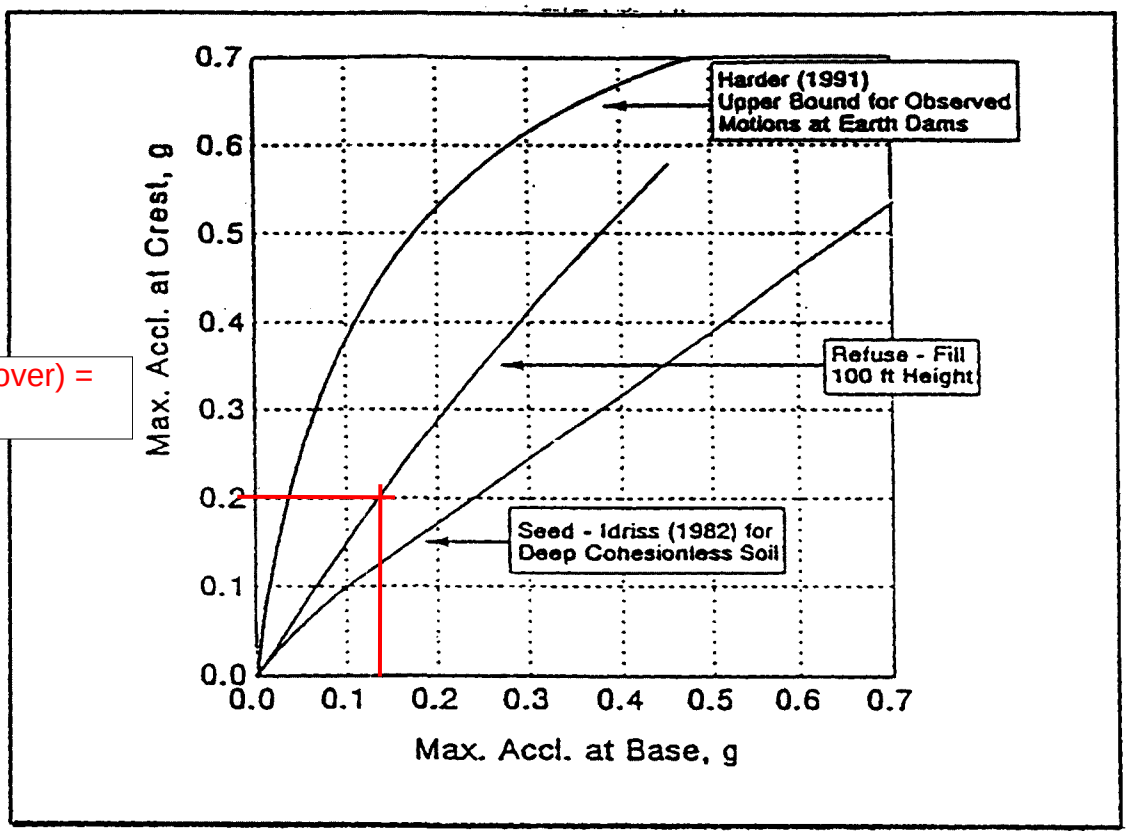


File Name: Tack on Berm_Arrowhead.gsz
Name: 1.5H:1V, 2ft Tall & 4ft Wide (AHLF)
Name: 2A. Tack on berm (seismic)
Last Saved Date: 10/17/2024
Seismic Coefficient: horz: 0.2, vert: 0

| Color | Name | Slope Stability Material Model | Unit Weight (pcf) | Effective Cohesion (psf) | Effective Friction Angle (°) | Piezometric Surface |
|---|---|---|---|---|---|---|
| | Berm Soil - (AHLF) | Mohr-Coulomb | 120 | 200 | 36 | 1 |
| | Erosion Layer (AHLF) | Mohr-Coulomb | 110 | 100 | 30 | 1 |
| | Geosynthetics (AHLF) | Mohr-Coulomb | 65 | 0 | 30 | |



PGA(final cover) = 0.2g




PGAm = 0.13g

Seismic PGAm = 0.13g for Site Class C soil, taken from ASCE 7 Hazards Report
PGAm is amplified to the top of the waste mound.

Figure 4.6 Approximate Relationship Between Maximum Accelerations at the Base and Crest for Various Ground Conditions (Singh and Sun, 1995)

# APPENDIX G

# FINAL COVER DRAINAGE LAYER ANALYSIS

# Geocomposite Drainage Media (GDM)
# Transmissivity Analysis

**DRAINAGE LAYER TRANSMISSIVITY ANALYSIS - FINAL COVER**
MAJOR MODIFICATION SUPPORT
ARROWHEAD LANDFILL
PERRY COUNTY, ALABAMA
BLE Project No. J24-4999-66

References:
Narejo & Zornberg, Structure Testing / Performance and Drainage, Geocomposites in Landfills, (2008)
Richardson, G. N., Giroud, JP, and Zhao, A. (2000), Design of Lateral Drainage Systems for Landfills. Also checked using Holtz, et al. (1997) as described in Richardson et al. (2000)
C.H. Benson, W.H. Albright, D.O. Fratta, J.M. Tinjum, E. Kucukkirca, S.H. Lee, J. Scalia, P.D. Schlicht, and X. Wang, Engineered Covers for Waste Containment: Changes in Engineering Properties and Implications for Long-Term Performance Assessment (2011)
Geosynthetics Institute (GSI), GRI Standard GC8-Determination of the Allowable Flow Rate of a Drainage Geocomposite, Rev 1 (2013)

The purpose of this analysis is to determine the required minimum transmissivity (θ) of the geosynthetic drainage media (GDM) to provide drainage for the final cover liner system. This analysis is based on the slope geometry depicted in the design drawings prepared by HHNT and the proposed final closure system. Based on the Final Cover detail in the Permit Renewal Plan prepared by HHNT dated March 2016, the final closure system is assumed to consist of the following components as presented in Figure 1 below:

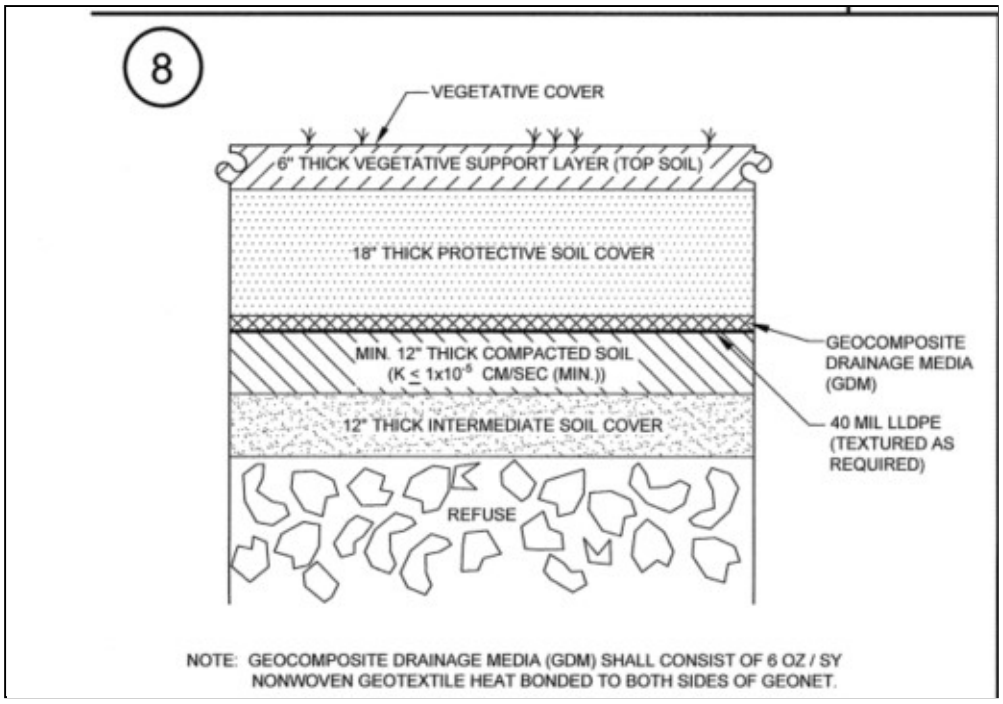



**Figure No. 1 : Final Cover Sytem Detail, (HHNT, 2016)**

## MINIMUM TRANSMISSIVITY - ANALYSIS OF DRAINAGE REQUIREMENT BY GDM

The required minimum transmissivity which is the in-plane hydraulic conductivity of the geonet portion of the geocomposite can be calculated as follows:

$$\theta_{required} = \frac{q_h L}{sin(\beta)}$$

Where:

qh = Fluid supply rate to the GDM (length/time)
L = Maximum horizontal drainage length (length)
β = Drainage slope inclination of maximum horizontal drainage length (slope)

For the purpose of this evaluation, the maximum fluid supply rate to the Geocomposite is assumed to be equivalent to the permeability of the overlying erosion cover layer soil during saturated conditions. Based on historical site soils lab testing, the borrow soil anticipated for use as the erosion layer soil could vary between low plasticity CLAY (CL) and sandy fat CLAY (CH). Considering, that historical hydraulic conductivity testing results for the site have generally been between k = 7.1x10^-6 cm/s and 1.4x10^-8 cm/sec. We have conservatively estimated that a soil such as a low plasticity to fat CLAY exhibiting a long-term permeability of k = 1x10^-6 cm/s will be used for the purpose of identifying a geocomposite capable of conveying the stormwater infiltration above the FML.

$$qlongterm := 1 \cdot 10^{-6} \frac{cm}{sec} = 1 \cdot 10^{-8} \frac{m}{s}$$

The proposed final cover system is predominantly sloped to a 3H:1V (18.43 deg) with drainage berms conservatively assumed to be spaced at a minimum every 40 vertical feet. The drainage berms collect stormwater which falls in the tributary area upslope and conveys water to an inlet for a downdrain pipe.

$L_horz := 120\ ft$ Horizontal Flow Distance for 3H:1V

$dH_slope := 40\ ft$ Vertical Component of Flow Path

$$m := \frac{dH_slope}{L_horz} = 33.33\ \%$$

$$\beta := \tanh\left(\frac{dH_slope}{L_horz}\right) = 18.42\ deg$$

The transmissivity of the in-place GDM reduces with time because of factors such as biological clogging. To offset the reduction in transmissivity, long term reduction factors and a factor of safety are used to calculate a recommended initial transmissivity to evaluate the suitability of proposed GDM products. The long term reduction factors and the factor of safety used in this analysis are as follows:

$RF_in := 1.0$ Elastic deformation & intrusion of the geotextile into the drainage media

$RF_cr := 1.0$ Creep deformation of drainage media core

$RF_cc := 1.2$ Chemical clogging

$RF_bc := 3.5$ Biological clogging

$FS_transmissivity := 2$ Factor of safety for drainage

$\Sigma RF := RF_in \cdot RF_cr \cdot RF_cc \cdot RF_bc \cdot FS_transmissivity = 8.4$ Cumulative reduction factor

The computed transmissivity required is as follows:

$$\theta_req_longterm := \frac{(qlongterm \cdot L_horz)}{\sin(\beta)} = 1.15746 \cdot 10^{-6} \frac{m^2}{sec}$$

$$\theta_recommended \geq \theta_req_longterm \cdot \Sigma RF$$

$$\theta_recommended := \theta_req_longterm \cdot \Sigma RF = 9.7227 \cdot 10^{-6} \frac{m^2}{sec}$$

**Therefore, the transmissivity requirement for the GDM of the closure cap system on 3H:1V slopes with low plasticity to fat CLAY (CL or CH) used in the protective soil cover layer should be greater than or equal to 9.7 x** $10^{(-6)} \frac{m^2}{s}$**.** Use of more cohesive soils such as CL and CH would be acceptable for use with the specified permeability as they will result in less iniltration (contingent on shear strength needed for veneer slope stability).

**A geocomposite net such as SKAPS TN 270 (or equivalent) would provide sufficient transmissivity to meet the long-term conditions. The transmissivity should be tested for 100 hours at a normal load of 500 psf under a gradient of 0.33 with site erosion layer soil as the upper boundary condition.**

## RETENTION OF EROSION LAYER SOIL - ANALYSIS OF INTERNAL SOIL STABILITY (RESISTANCE TO SUFFUSION)

Confirm that the up-gradient soils are retained by the upper geotextile of the drainage geocomposite using Holtz et al. (1997) as discussed in Richardson, et al. (2000)

- For fine grained soils with greater than 50% passing the No. 200 sieve, B=1.8
- For sands and clayey sands with less than 50% passing the No. 200 sieve, B is a function of the coefficient of uniformity, Cu =D60 / D10.

- B = 1 for 2 > Cu > 8
- B = 0.5 x Cu for 2 < Cu < 4
- B = 8 / Cu for 4 < Cu < 8
- To provide soil retention, O95 / D85 < B

If used for the final cover system, the cohesive, fine grained site soils such as sandy fat clay or low plasticity clay would require a more stringent retention and filtration criteria than sandy soils. These soil types have more than 50% of the particles finer than the No. 200 sieve, therefore B = 1.8. The D85 particle size for the cohesive site soils varies from 0.025 mm to 0.5 mm. For this analysis, a conservative estimate of D85 particle size was used to determine the minimum allowable value to prevent clogging of the geonet.

$D_85avg := 0.105\ mm$ $D_60 := (\blacksquare)\ mm$ $D_10 := \blacksquare\ mm$

$Cu := \frac{D_60}{D_10} = \blacksquare$ Cu not calculated for cohesive soil case (B = 1.8)

$B := 1.8$

$O_95_skaps8osy := 0.180\ mm$ SKAPS Industries 8-osy nonwoven geotextile AOS (#80 sieve)

$$SKAPS_8osy := \frac{O_95_skaps8osy}{D_85avg} = 1.71$$

```
if (SKAPS_8osy < B)        = "OK"
  "OK"
else if  SKAPS_8osy > B
  "SUSCEPT TO CLOGGING"
```

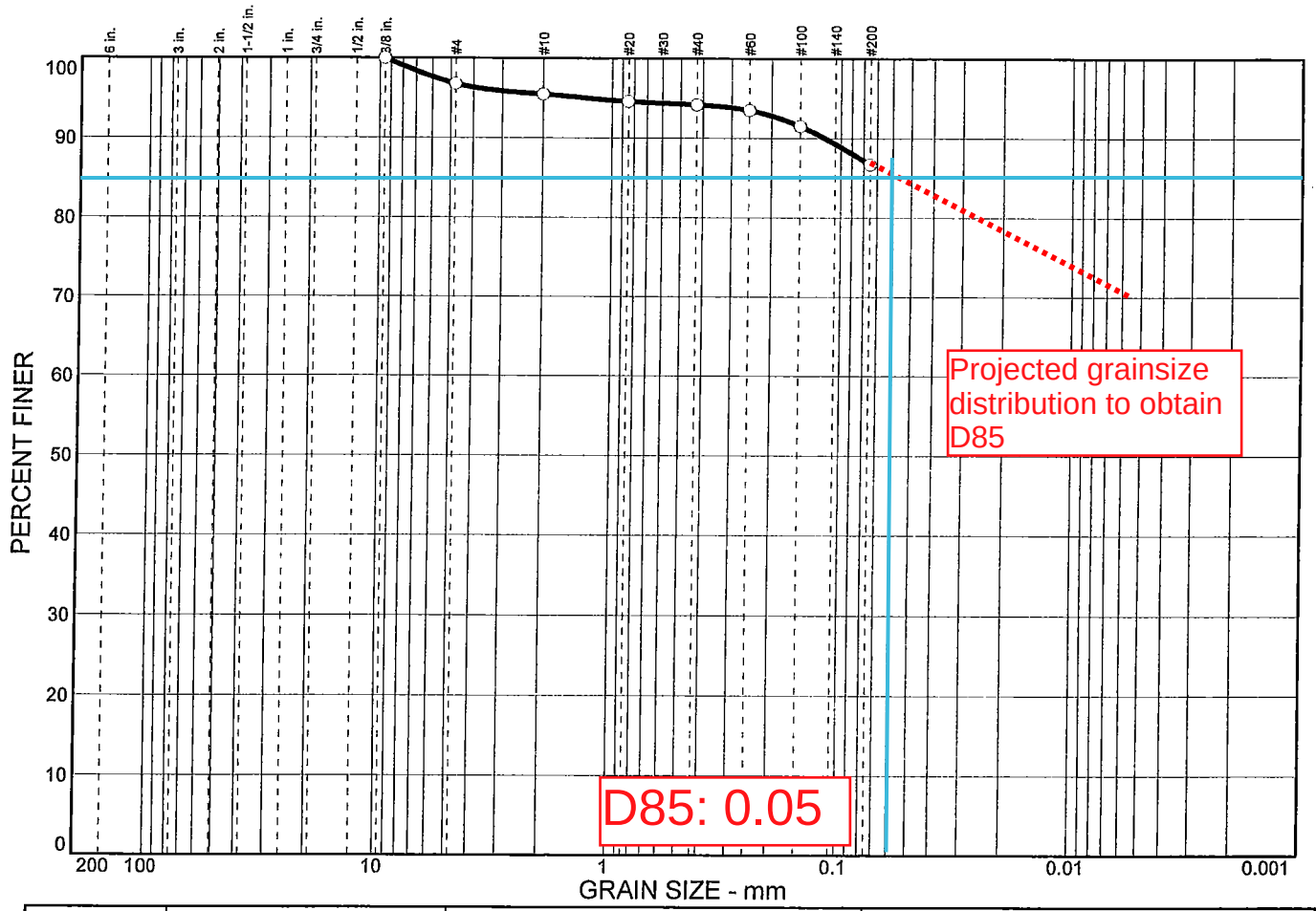
Using Holtz et al. (1997), O95 / D85 for a 8-osy non-woven fabric is equal to 1.71 which is less than 'B' of 1.8 for cohesive soils; **An AOS (O95) of 0.180 mm provided by the SKAPS GE 180 (or equivalent) 8-osy geotextile is sufficient to prevent clogging of the geonet by retaining the soil using the geotextile filter. However, based on the analysis performed, a minimum D85 of 0.1 mm is recommended for the proposed protective cover soils to prevent potential clogging of the geonet.**

Furthermore, according to AASHTO M288-96 (Table 2-2 in Richardson et al.), a geotextile to be used as a filter for a soil with greater than 50% fines should have a maxiumum AOS (O95) of 0.22 mm. A non-woven, 8-osy geotextile, similar to the SKAPS GE 180, will meet the required properties listed by AASHTO M288-96 provided above for the cover soil to be used for the closure project.

If the selected protective soil cover material has a D85 particle size finer than 0.5mm and the plasticity index (PI) is less than 15 (i.e. the soil is non-plastic and therefore susceptible to suffusion), then a soil specific filtration analysis should be perfored using the actual D85 for the project soil. If the PI > 15, the soil is not susceptible to suffusion and therefore there is limited clogging potential (Richardson et al., 2000).

# Historical Particle Size Distribution Test Results – Partial Closure Cap Project (BLE, 2011)

# Particle Size Distribution Report




| | % COBBLES | % GRAVEL | | % SAND | | | % FINES | |
|---|---|---|---|---|---|---|---|---|
| | | CRS. | FINE | CRS. | MEDIUM | FINE | SILT | CLAY |
| ○ | 0.0 | 0.0 | 3.2 | 1.3 | 1.3 | 7.5 | 86.7 | |

## SOIL DATA

| SYMBOL | SOURCE | SAMPLE NO. | DEPTH (ft.) | DESCRIPTION | USCS |
|---|---|---|---|---|---|
| ○ | Liner | CLBW-2 | | Tan & brown fi. sandy CLAY | CL |

Particle Size Distribution Report

**Bunnell Lammons Engineering, Inc.**

**Greenville, SC**

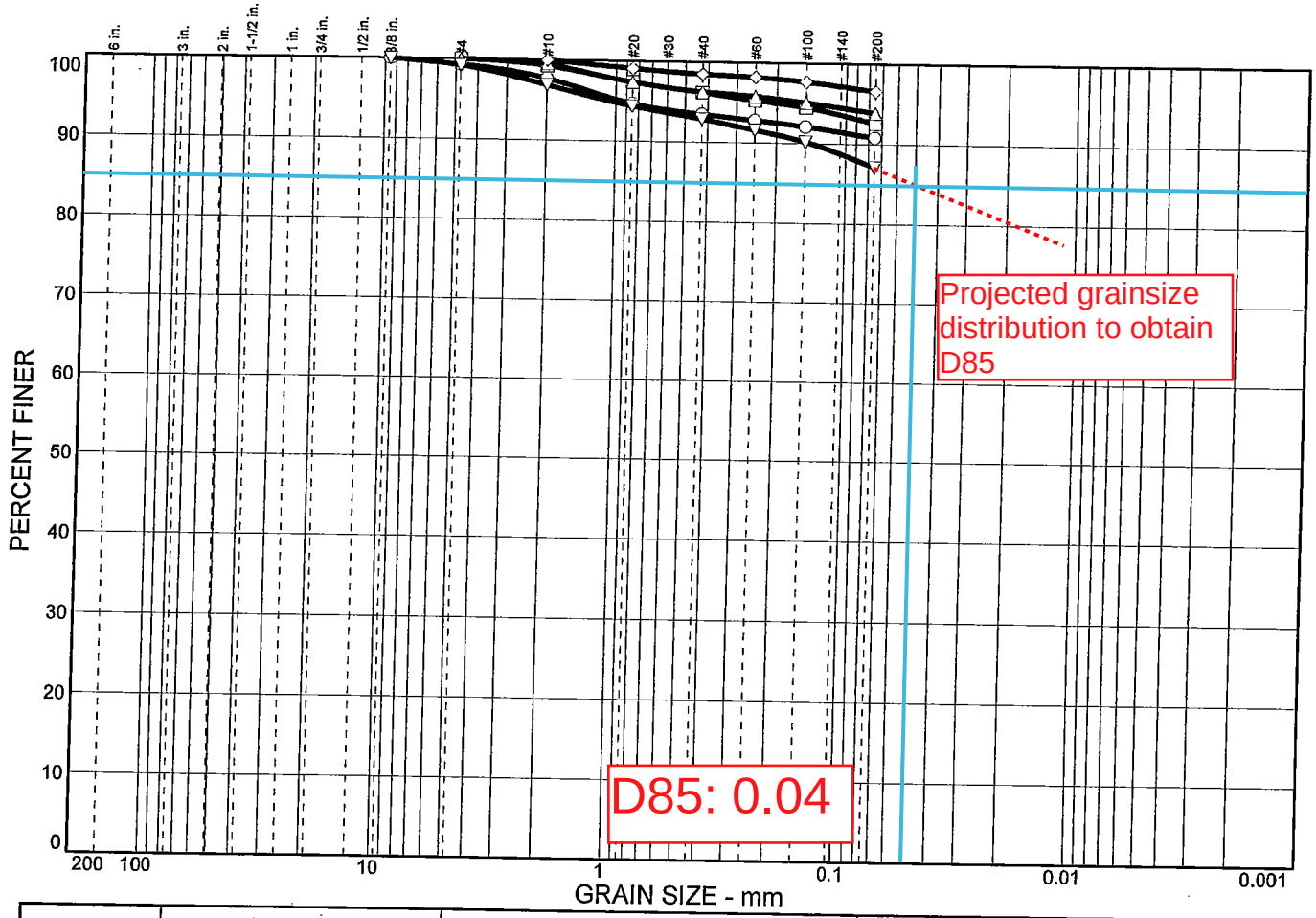
**Client:** HHNT

**Project:** Arrowhead Landfill

**Project No.:** J11-4999-27

**Figure**

# Particle Size Distribution Report




| | % COBBLES | % GRAVEL | | % SAND | | | % FINES | |
|---|---|---|---|---|---|---|---|---|
| | | CRS. | FINE | CRS. | MEDIUM | FINE | SILT | CLAY |
| ○ | 0.0 | 0.0 | 0.7 | 1.6 | 4.2 | 2.7 | 90.8 | |
| □ | 0.0 | 0.0 | 0.0 | 0.7 | 3.1 | 3.6 | 92.6 | |
| △ | 0.0 | 0.0 | 0.0 | 0.4 | 3.3 | 2.4 | 93.9 | |
| ◇ | 0.0 | 0.0 | 0.0 | 0.0 | 1.5 | 1.9 | 96.6 | |
| ▽ | 0.0 | 0.0 | 0.8 | 2.3 | 4.0 | 5.8 | 87.1 | |

## SOIL DATA

| SYMBOL | SOURCE | SAMPLE NO. | DEPTH (ft.) | DESCRIPTION | USCS |
|---|---|---|---|---|---|
| ○ | Prot. Cover | PC-6 | | Grey CLAY | CH |
| □ | Prot. Cover | PC-7 | | Grey CLAY | CH |
| △ | Prot. Cover | PC-8 | | Grey CLAY | CH |
| ◇ | Prot. Cover | PC-9 | | Grey CLAY | CH |
| ▽ | Prot. Cover | PC-10 | | Grey fi. sandy CLAY | CH |

Particle Size Distribution Report

**Bunnell Lammons Engineering, Inc.**

**Greenville, SC**

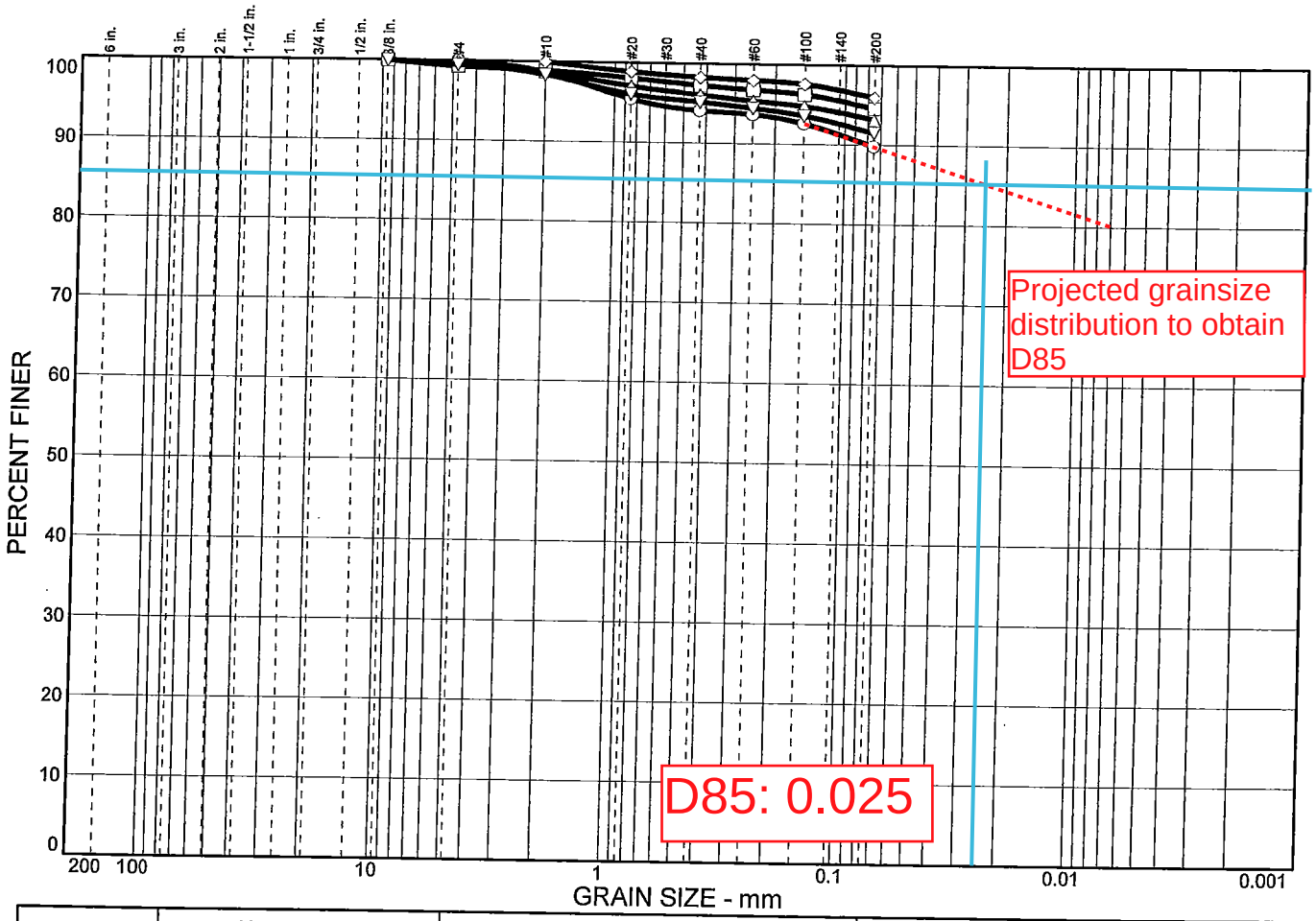
**Client:** HHNT

**Project:** Arrowhead Landfill

**Project No.:** J11-4999-27

**Figure**

# Particle Size Distribution Report




| | % COBBLES | % GRAVEL | | % SAND | | | % FINES | |
|---|---|---|---|---|---|---|---|---|
| | | CRS. | FINE | CRS. | MEDIUM | FINE | SILT | CLAY |
| ○ | 0.0 | 0.0 | 0.0 | 1.3 | 4.6 | 4.3 | 89.8 | |
| □ | 0.0 | 0.0 | 0.7 | 0.4 | 1.6 | 2.7 | 94.6 | |
| △ | 0.0 | 0.0 | 0.0 | 1.2 | 2.7 | 2.9 | 93.2 | |
| ◇ | 0.0 | 0.0 | 0.0 | 0.0 | 1.7 | 2.3 | 96.0 | |
| ▽ | 0.0 | 0.0 | 0.5 | 1.1 | 3.2 | 3.7 | 91.5 | |

## SOIL DATA

| SYMBOL | SOURCE | SAMPLE NO. | DEPTH (ft.) | DESCRIPTION | USCS |
|---|---|---|---|---|---|
| ○ | Prot. Cover | PC-11 | | Grey CLAY | CH |
| □ | Prot. Cover | PC-12 | | Grey CLAY | CH |
| △ | Prot. Cover | PC-13 | | Grey CLAY | CH |
| ◇ | Prot. Cover | PC-14 | | Grey CLAY | CH |
| ▽ | Prot. Cover | PC-15 | | Grey CLAY | CH |

Particle Size Distribution Report

**Bunnell Lammons Engineering, Inc.**

**Greenville, SC**

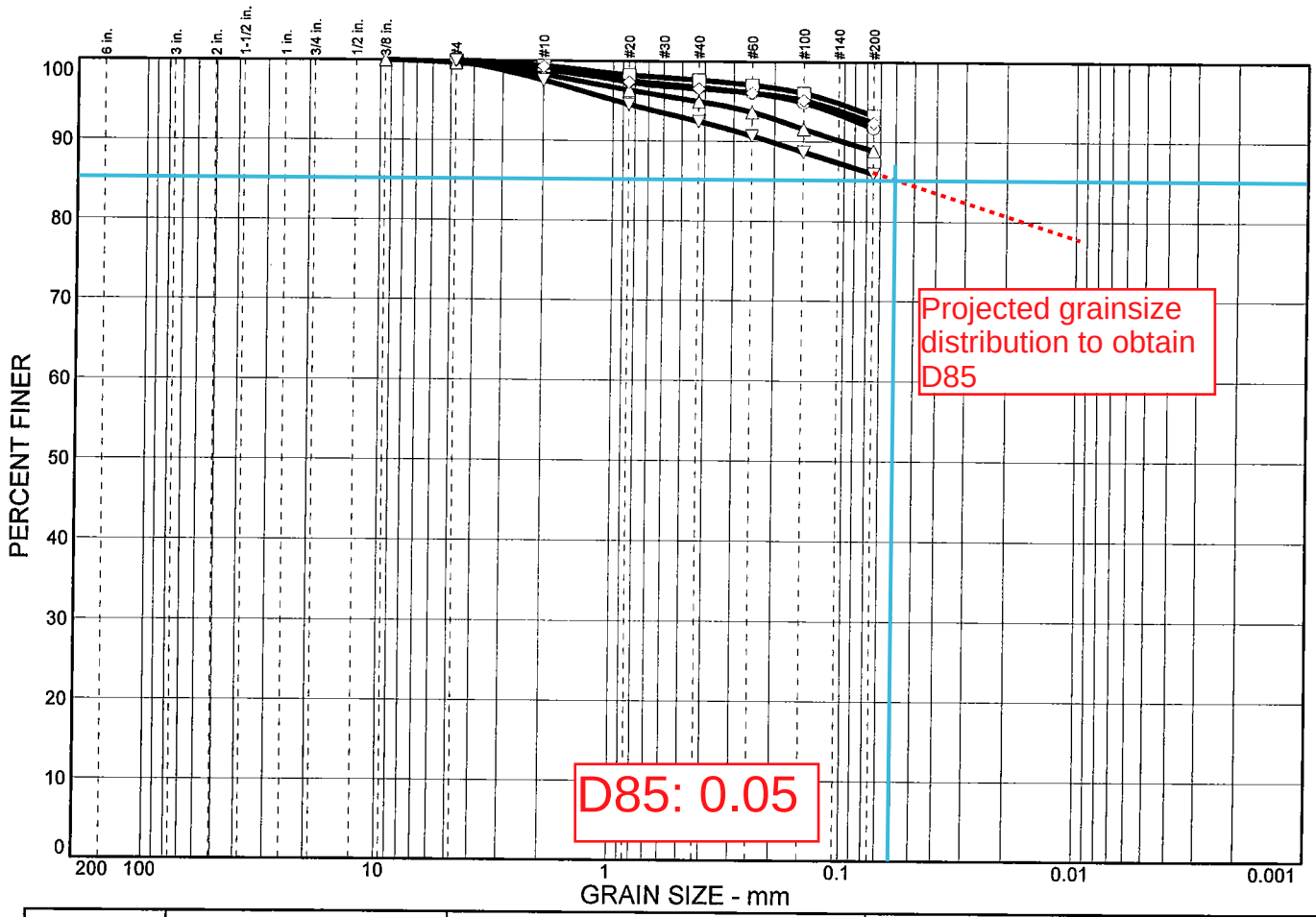
**Client:** HHNT

**Project:** Arrowhead Landfill

**Project No.:** J11-4999-27

**Figure**

# Particle Size Distribution Report




| | % COBBLES | % GRAVEL | | % SAND | | | % FINES | |
|---|---|---|---|---|---|---|---|---|
| | | CRS. | FINE | CRS. | MEDIUM | FINE | SILT | CLAY |
| ○ | 0.0 | 0.0 | 0.0 | 1.1 | 2.1 | 5.1 | 91.7 | |
| □ | 0.0 | 0.0 | 0.0 | 0.6 | 1.7 | 4.4 | 93.3 | |
| △ | 0.0 | 0.0 | 0.3 | 1.4 | 3.3 | 6.1 | 88.9 | |
| ◇ | 0.0 | 0.0 | 0.0 | 0.7 | 2.7 | 4.2 | 92.4 | |
| ▽ | 0.0 | 0.0 | 0.0 | 2.4 | 5.1 | 6.5 | 86.0 | |

## SOIL DATA

| SYMBOL | SOURCE | SAMPLE NO. | DEPTH (ft.) | DESCRIPTION | USCS |
|---|---|---|---|---|---|
| ○ | Prot. Cover | PC-16 | | Grey CLAY | CH |
| □ | Prot. Cover | PC-17 | | Grey CLAY | CH |
| △ | Prot. Cover | PC-18 | | Grey CLAY w/some fi. sand | CH |
| ◇ | Prot. Cover | PC-19 | | Grey CLAY | CH |
| ▽ | Prot. Cover | PC-20 | | Grey fi. sandy CLAY | CH |

Particle Size Distribution Report

**Bunnell Lammons Engineering, Inc.**

**Greenville, SC**

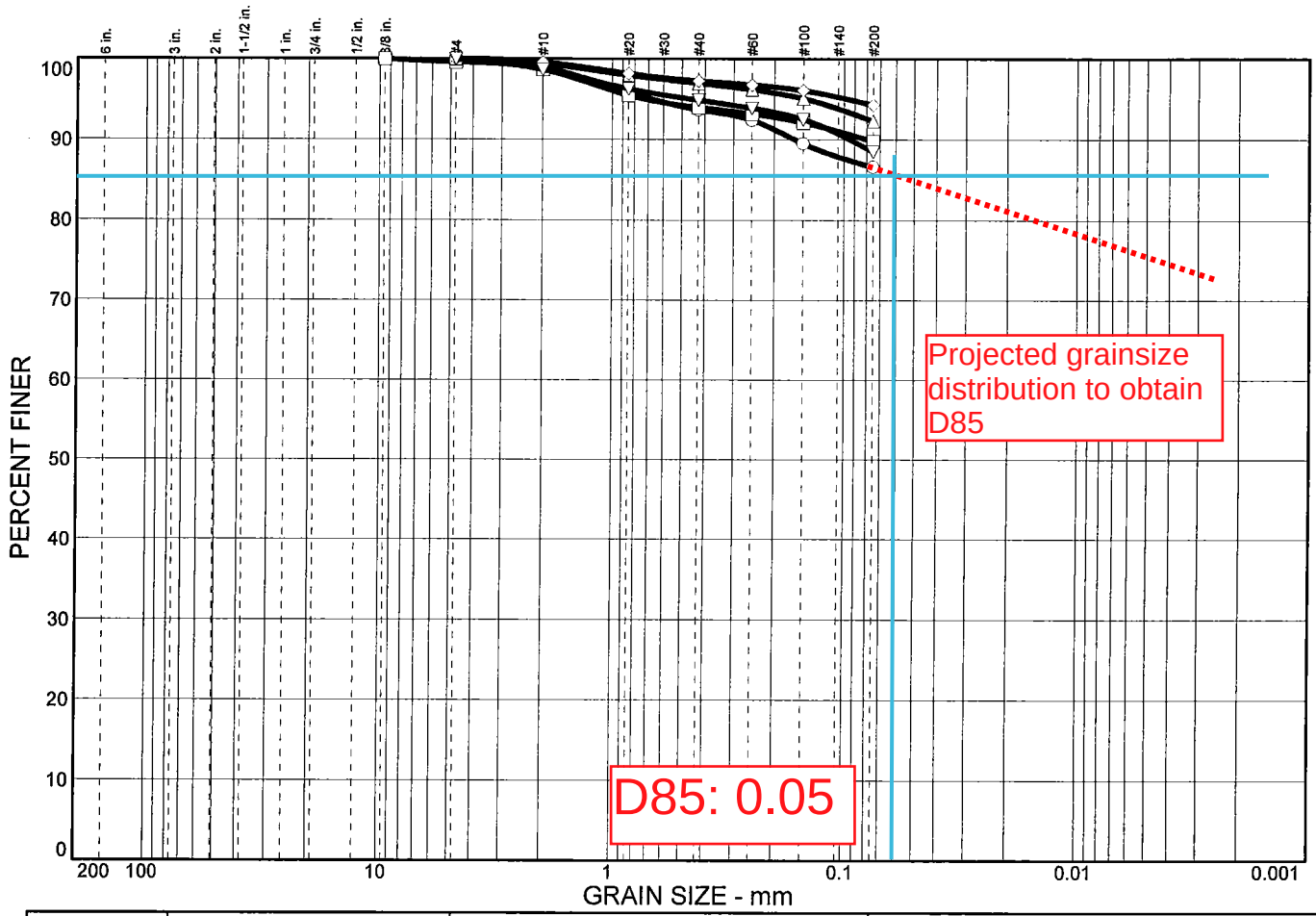
**Client:** HHNT

**Project:** Arrowhead Landfill

**Project No.:** J11-4999-27

**Figure**

# Particle Size Distribution Report




| | % COBBLES | % GRAVEL | | % SAND | | | % FINES | |
|---|---|---|---|---|---|---|---|---|
| | | CRS. | FINE | CRS. | MEDIUM | FINE | SILT | CLAY |
| ○ | 0.0 | 0.0 | 0.0 | 1.0 | 5.3 | 7.1 | 86.6 | |
| □ | 0.0 | 0.0 | 0.4 | 0.9 | 4.7 | 4.2 | 89.8 | |
| △ | 0.0 | 0.0 | 0.0 | 0.6 | 2.4 | 4.7 | 92.3 | |
| ◇ | 0.0 | 0.0 | 0.0 | 0.4 | 2.3 | 3.0 | 94.3 | |
| ▽ | 0.0 | 0.0 | 0.0 | 1.3 | 3.8 | 6.4 | 88.5 | |

## SOIL DATA

| SYMBOL | SOURCE | SAMPLE NO. | DEPTH (ft.) | DESCRIPTION | USCS |
|---|---|---|---|---|---|
| ○ | Prot. Cover | PC-21 | | Grey fi. sandy CLAY | CH |
| □ | Prot. Cover | PC-22 | | Grey CLAY | CH |
| △ | Prot. Cover | PC-23 | | Grey CLAY | CH |
| ◇ | Prot. Cover | PC-24 | | Grey CLAY | CH |
| ▽ | Prot. Cover | PC-25 | | Grey CLAY w/some fi. sand | CH |

Particle Size Distribution Report

**Bunnell Lammons Engineering, Inc.**

**Greenville, SC**

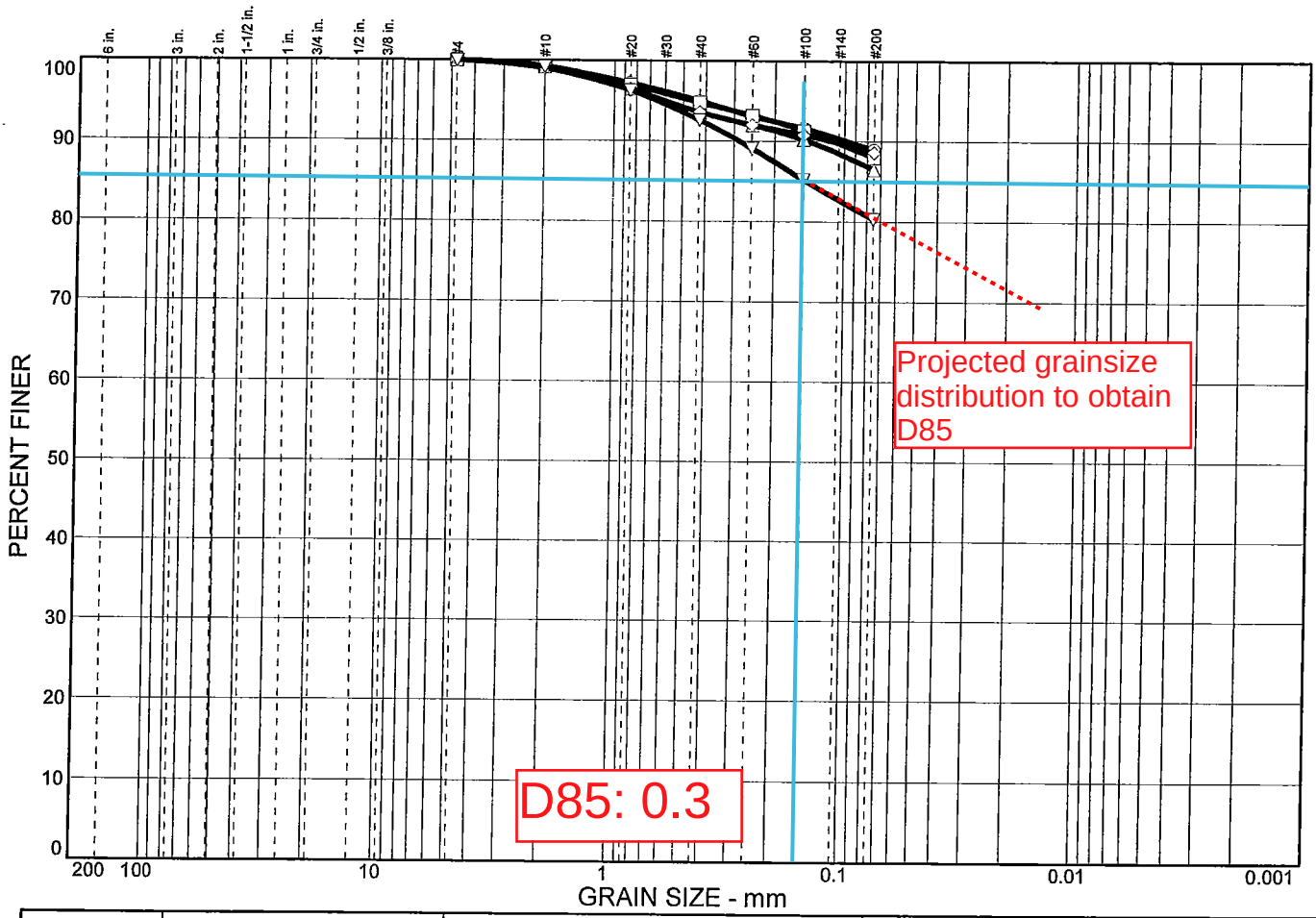
**Client:** HHNT

**Project:** Arrowhead Landfill

**Project No.:** J11-4999-27

**Figure**

# Particle Size Distribution Report




| | % COBBLES | % GRAVEL | | % SAND | | | % FINES | |
|---|---|---|---|---|---|---|---|---|
| | | CRS. | FINE | CRS. | MEDIUM | FINE | SILT | CLAY |
| ○ | 0.0 | 0.0 | 0.0 | 0.8 | 4.2 | 6.1 | 88.9 | |
| □ | 0.0 | 0.0 | 0.0 | 0.7 | 4.5 | 6.8 | 88.0 | |
| △ | 0.0 | 0.0 | 0.0 | 0.8 | 5.6 | 7.1 | 86.5 | |
| ◇ | 0.0 | 0.0 | 0.0 | 1.0 | 5.4 | 5.0 | 88.6 | |
| ▽ | 0.0 | 0.0 | 0.0 | 0.8 | 6.6 | 12.3 | 80.3 | |

## SOIL DATA

| SYMBOL | SOURCE | SAMPLE NO. | DEPTH (ft.) | DESCRIPTION | USCS |
|---|---|---|---|---|---|
| ○ | Prot. Cover | PC-26 | | Brown & grey fi. sandy CLAY | CH |
| □ | Prot. Cover | PC-27 | | Brown & grey fi. sandy CLAY | CH |
| △ | Prot. Cover | PC-28 | | Brown & grey fi. sandy CLAY | CH |
| ◇ | Prot. Cover | PC-29 | | Brown & grey fi. sandy CLAY | CH |
| ▽ | Prot. Cover | PC-30 | | Brown & grey fi.-med. sandy CLAY | CH |

Particle Size Distribution Report

**Bunnell Lammons Engineering, Inc.**

**Greenville, SC**

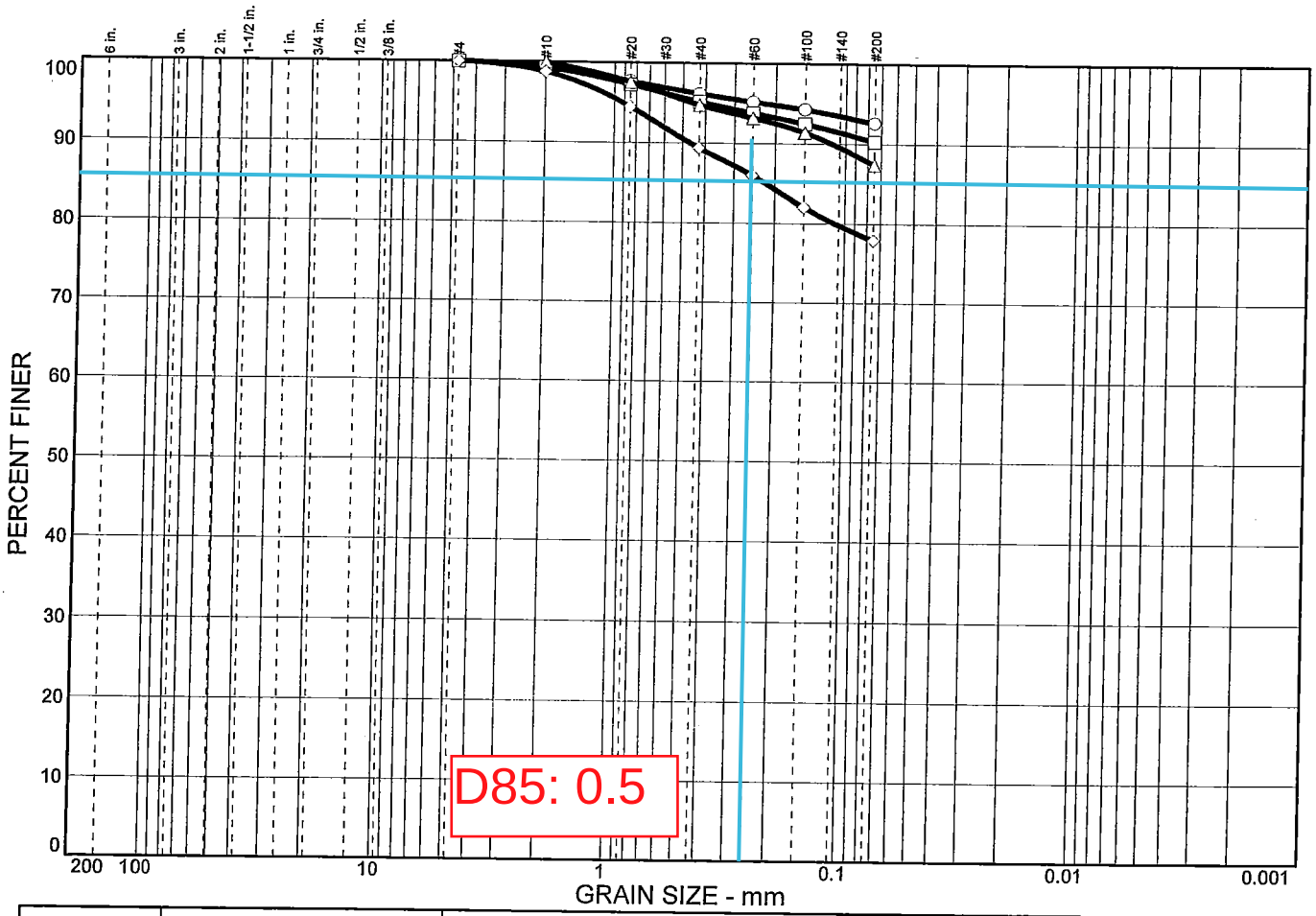
**Client:** HHNT

**Project:** Arrowhead Landfill

**Project No.:** J11-4999-27

**Figure**

# Particle Size Distribution Report




| | % COBBLES | % GRAVEL | | % SAND | | | % FINES | |
|---|---|---|---|---|---|---|---|---|
| | | CRS. | FINE | CRS. | MEDIUM | FINE | SILT | CLAY |
| ○ | 0.0 | 0.0 | 0.0 | 0.6 | 3.2 | 3.6 | 92.6 | |
| □ | 0.0 | 0.0 | 0.0 | 0.7 | 4.1 | 4.9 | 90.3 | |
| △ | 0.0 | 0.0 | 0.0 | 0.0 | 5.2 | 7.4 | 87.4 | |
| ◇ | 0.0 | 0.0 | 0.0 | 1.2 | 9.4 | 11.5 | 77.9 | |
| | | | | | | | | |

## SOIL DATA

| SYMBOL | SOURCE | SAMPLE NO. | DEPTH (ft.) | DESCRIPTION | USCS |
|---|---|---|---|---|---|
| ○ | Prot. Cover | PC-31 | | Brown & grey CLAY | CH |
| □ | Prot. Cover | PC-32 | | Brown & grey CLAY | CH |
| △ | Prot. Cover | PC-33 | | Brown & grey fi. sandy CLAY | CH |
| ◇ | Prot. Cover | PC-34 | | Brown & grey fi.-med. sandy CLAY | CH |
| | | | | | |

Particle Size Distribution Report

**Bunnell Lammons Engineering, Inc.**

**Greenville, SC**

**Client:** HHNT

**Project:** Arrowhead Landfill

**Project No.:** J11-4999-27

**Figure**

# Historical Hydraulic Conductivity Test Results – Partial Closure Cap Project (BLE, 2011)

BLE INC.

# HYDRAULIC CONDUCTIVITY TEST REPORT

**CONSTANT VOLUME APPARATUS (ASTM D 5084)**

| | | | |
|---|---|---|---|
| PROJECT: | **ARROWHEAD LANDFILL** | TESTED BY: | **JOHN MATHEW** |
| PROJECT NO.: | **J11-4999-27** | CHECKED BY: | **PAUL YARBER** |
| DATE RECEIVED: | **4-4-11** | | |

| | | | |
|---|---|---|---|
| SAMPLE NO. | **P-1** | SAMPLE LOCATION: | **CAP** |
| TYPE | **UNDISTURBED** | SAMPLE DESCRIPTION: | **RED & GREY CLAY** |

## SAMPLE DIMENSIONS AND PROPERTIES

| ITEM | INITIAL | | FINAL | |
|---|---|---|---|---|
| | inches | centimeters | inches | centimeters |
| Sample Length | 3.009 | 7.643 | 3.017 | 7.663 |
| Sample Diameter | 2.856 | 7.254 | 2.847 | 7.231 |
| Length/Diameter Ratio | | 1.05 | | |
| Moisture Content (%) | WW= 129.6 DW= 104.4 | 24.1 | WW= 218.9 DW= 171.2 | 27.9 |
| Sample Wet Weight (grams) | 597.2 | | 608.3 | |
| Wet Density (pcf) | 118.0 | | 120.7 | |
| Dry Density (pcf) | 95.1 | | 94.4 | |
| Saturation (%) ASSUMED SG= 2.7 | 84 | | 96 | |

## HYDRAULIC CONDUCTIVITY TESTING MEASUREMENT

(PERMOMETER)

| Confining Pressure (psi) 75 | Influent Pressure (psi) 70 | Effluent Pressure (psi) 70 | B-Value 0.96 |
|---|---|---|---|

| Reset (Y/N) | Date | Clock Time | Elapsed Time | $HA_{OUT}$ (cm) | $HA_{IN}$ (cm) | Temp °C | Gradient | K (cm/sec) | Temp Correction | $K_{20°C}$ (cm/sec) |
|---|---|---|---|---|---|---|---|---|---|---|
| Y | 4-5-11 | 1:03:13 | | 10.5 | 1.55 | 22.0 | 15 | | | |
| | 4-5-11 | 1:18:23 | 0:15:10 | 9.0 | 1.61 | 22.0 | 12 | 9.4E-08 | 0.953 | 9.0E-08 |
| | 4-5-11 | 1:19:37 | 0:16:24 | 8.9 | 1.61 | 22.0 | 12 | 9.4E-08 | 0.953 | 8.9E-08 |
| | 4-5-11 | 1:20:53 | 0:17:40 | 8.8 | 1.62 | 22.0 | 12 | 9.3E-08 | 0.953 | 8.9E-08 |
| | 4-5-11 | 1:22:07 | 0:18:54 | 8.7 | 1.62 | 22.0 | 12 | 9.3E-08 | 0.953 | 8.8E-08 |

**HYDRAULIC CONDUCTIVITY ($K_{20°C}$) 8.9E-08 cm/sec**

BLE INC.

# HYDRAULIC CONDUCTIVITY TEST REPORT

**CONSTANT VOLUME APPARATUS (ASTM D 5084)**

| | | | |
|---|---|---|---|
| PROJECT: | **ARROWHEAD LANDFILL** | TESTED BY: | **JOHN MATHEW** |
| PROJECT NO.: | **J11-4999-27** | CHECKED BY: | **PAUL YARBER** |
| DATE RECEIVED: | **1-18-11** | | |

| | | | |
|---|---|---|---|
| SAMPLE NO. | **P-2** | SAMPLE LOCATION: | **CAP** |
| TYPE | **UNDISTURBED** | SAMPLE DESCRIPTION: | **GRAY SELMA CHALK** |

## SAMPLE DIMENSIONS AND PROPERTIES

| ITEM | INITIAL | | FINAL | |
|---|---|---|---|---|
| | inches | centimeters | inches | centimeters |
| Sample Length | 3.060 | 7.772 | 3.039 | 7.719 |
| Sample Diameter | 2.856 | 7.254 | 2.863 | 7.272 |
| Length/Diameter Ratio | | 1.07 | | |
| Moisture Content (%) | WW= 139.6 DW= 111.1 | 25.7 | WW= 278.3 DW= 220.4 | 26.3 |
| Sample Wet Weight (grams) | 618.8 | | 626.8 | |
| Wet Density (pcf) | 120.3 | | 122.0 | |
| Dry Density (pcf) | 95.7 | | 96.7 | |
| Saturation (%) ASSUMED SG= 2.7 | 91 | | 95 | |

## HYDRAULIC CONDUCTIVITY TESTING MEASUREMENT

(PERMOMETER)

| Confining Pressure (psi) 65 | Influent Pressure (psi) 60 | Effluent Pressure (psi) 60 | B-Value 0.97 |
|---|---|---|---|

| Reset (Y/N) | Date | Clock Time | Elapsed Time | $HA_{OUT}$ (cm) | $HA_{IN}$ (cm) | Temp °C | Gradient | K (cm/sec) | Temp Correction | $K_{20°C}$ (cm/sec) |
|---|---|---|---|---|---|---|---|---|---|---|
| Y | 1-19-11 | 1:37:28 | | 7.5 | 1.57 | 22.3 | 10 | | | |
| | 1-19-11 | 1:41:45 | 0:04:17 | 6.5 | 1.61 | 22.3 | 8 | 3.4E-07 | 0.947 | 3.2E-07 |
| | 1-19-11 | 1:42:18 | 0:04:50 | 6.4 | 1.61 | 22.3 | 8 | 3.3E-07 | 0.947 | 3.1E-07 |
| | 1-19-11 | 1:42:53 | 0:05:25 | 6.3 | 1.62 | 22.3 | 8 | 3.2E-07 | 0.947 | 3.1E-07 |
| | 1-19-11 | 1:43:20 | 0:05:52 | 6.2 | 1.62 | 22.3 | 8 | 3.3E-07 | 0.947 | 3.1E-07 |

**HYDRAULIC CONDUCTIVITY ($K_{20°C}$) 3.1E-07 cm/sec**

BLE INC.

# HYDRAULIC CONDUCTIVITY TEST REPORT

**CONSTANT VOLUME APPARATUS (ASTM D 5084)**

| | | | |
|---|---|---|---|
| PROJECT: | **ARROWHEAD LANDFILL** | TESTED BY: | **JOHN MATHEW** |
| PROJECT NO.: | **J11-4999-27** | CHECKED BY: | **PAUL YARBER** |
| DATE RECEIVED: | **1-18-11** | | |

| | | | |
|---|---|---|---|
| SAMPLE NO. | **P-3** | SAMPLE LOCATION: | **CAP** |
| TYPE | **UNDISTURBED** | SAMPLE DESCRIPTION: | **GRAY SELMA CHALK** |

## SAMPLE DIMENSIONS AND PROPERTIES

| ITEM | INITIAL | | FINAL | |
|---|---|---|---|---|
| | inches | centimeters | inches | centimeters |
| Sample Length | 2.916 | 7.407 | 2.930 | 7.442 |
| Sample Diameter | 2.855 | 7.252 | 2.863 | 7.272 |
| Length/Diameter Ratio | | 1.02 | | |
| Moisture Content (%) | WW= 159.0 DW= 125.4 | 26.8 | WW= 238.3 DW= 184.4 | 29.2 |
| Sample Wet Weight (grams) | 599.1 | | 603.5 | |
| Wet Density (pcf) | 122.3 | | 121.9 | |
| Dry Density (pcf) | 96.4 | | 94.3 | |
| Saturation (%) ASSUMED SG= 2.7 | 97 | | 100 | |

## HYDRAULIC CONDUCTIVITY TESTING MEASUREMENT

(PERMOMETER)

| Confining Pressure (psi) 65 | Influent Pressure (psi) 60 | Effluent Pressure (psi) 60 | B-Value 0.96 |
|---|---|---|---|

| Reset (Y/N) | Date | Clock Time | Elapsed Time | $HA_{OUT}$ (cm) | $HA_{IN}$ (cm) | Temp °C | Gradient | K (cm/sec) | Temp Correction | $K_{20°C}$ (cm/sec) |
|---|---|---|---|---|---|---|---|---|---|---|
| Y | 1-19-11 | 8:22:23 | | 10.1 | 1.46 | 20.7 | 15 | | | |
| | 1-19-11 | 8:47:42 | 0:25:19 | 9.7 | 1.48 | 20.7 | 14 | 1.4E-08 | 0.983 | 1.4E-08 |
| | 1-19-11 | 8:54:37 | 0:32:14 | 9.6 | 1.48 | 20.7 | 14 | 1.4E-08 | 0.983 | 1.4E-08 |
| | 1-19-11 | 9:01:39 | 0:39:16 | 9.5 | 1.48 | 20.7 | 14 | 1.4E-08 | 0.983 | 1.3E-08 |
| | 1-19-11 | 9:08:31 | 0:46:08 | 9.4 | 1.49 | 20.7 | 14 | 1.4E-08 | 0.983 | 1.3E-08 |

**HYDRAULIC CONDUCTIVITY ($K_{20°C}$) 1.4E-08 cm/sec**

IBLE INC.

# HYDRAULIC CONDUCTIVITY TEST REPORT

**CONSTANT VOLUME APPARATUS (ASTM D 5084)**

| | | | |
|---|---|---|---|
| PROJECT: | **ARROWHEAD LANDFILL** | TESTED BY: | **JOHN MATHEW** |
| PROJECT NO.: | **J11-4999-27** | CHECKED BY: | **PAUL YARBER** |
| DATE RECEIVED: | **5-9-11** | | |

| | | | |
|---|---|---|---|
| SAMPLE NO. | **P-4** | SAMPLE LOCATION: | **CAP** |
| TYPE | **UNDISTURBED** | SAMPLE DESCRIPTION: | **RED & GREY CLAY** |

## SAMPLE DIMENSIONS AND PROPERTIES

| ITEM | INITIAL | | FINAL | |
|---|---|---|---|---|
| | inches | centimeters | inches | centimeters |
| Sample Length | 2.973 | 7.551 | 2.984 | 7.579 |
| Sample Diameter | 2.848 | 7.234 | 2.868 | 7.285 |
| Length/Diameter Ratio | | 1.04 | | |
| Moisture Content (%) | WW= 186.6 DW= 151.4 | 23.2 | WW= 192.0 DW= 149.0 | 28.9 |
| Sample Wet Weight (grams) | 592.9 | | 601.2 | |
| Wet Density (pcf) | 119.3 | | 118.8 | |
| Dry Density (pcf) | 96.8 | | 92.2 | |
| Saturation (%) ASSUMED SG= 2.7 | 85 | | 94 | |

## HYDRAULIC CONDUCTIVITY TESTING MEASUREMENT

(PERMOMETER)

| Confining Pressure (psi) | 75 | Influent Pressure (psi) | 70 | Effluent Pressure (psi) | 70 | B-Value | 0.96 |
|---|---|---|---|---|---|---|---|

| Reset (Y/N) | Date | Clock Time | Elapsed Time | $HA_{OUT}$ (cm) | $HA_{IN}$ (cm) | Temp °C | Gradient | K (cm/sec) | Temp Correction | $K_{20°C}$ (cm/sec) |
|---|---|---|---|---|---|---|---|---|---|---|
| Y | 5-10-11 | 9:53:10 | | 7.5 | 1.67 | 24.1 | 10 | | | |
| | 5-10-11 | 10:17:32 | 0:24:22 | 6.1 | 1.73 | 24.1 | 8 | 8.6E-08 | 0.908 | 7.8E-08 |
| | 5-10-11 | 10:19:55 | 0:26:45 | 6.0 | 1.73 | 24.1 | 7 | 8.5E-08 | 0.908 | 7.7E-08 |
| | 5-10-11 | 10:21:58 | 0:28:48 | 5.9 | 1.74 | 24.1 | 7 | 8.5E-08 | 0.908 | 7.7E-08 |
| | 5-10-11 | 10:24:45 | 0:31:35 | 5.8 | 1.74 | 24.1 | 7 | 8.3E-08 | 0.908 | 7.6E-08 |

**HYDRAULIC CONDUCTIVITY ($K_{20°C}$) 7.7E-08 cm/sec**

BLE INC.

# HYDRAULIC CONDUCTIVITY TEST REPORT

**CONSTANT VOLUME APPARATUS (ASTM D 5084)**

| | | | |
|---|---|---|---|
| PROJECT: | **ARROWHEAD LANDFILL** | TESTED BY: | **JOHN MATHEW** |
| PROJECT NO.: | **J11-4999-27** | CHECKED BY: | **PAUL YARBER** |
| DATE RECEIVED: | **1-18-11** | | |

| | | | |
|---|---|---|---|
| SAMPLE NO. | **P-5** | SAMPLE LOCATION: | **CAP** |
| TYPE | **UNDISTURBED** | SAMPLE DESCRIPTION: | **GRAY SELMA CHALK** |

## SAMPLE DIMENSIONS AND PROPERTIES

| ITEM | INITIAL | | FINAL | |
|---|---|---|---|---|
| | inches | centimeters | inches | centimeters |
| Sample Length | 2.856 | 7.254 | 2.872 | 7.295 |
| Sample Diameter | 2.864 | 7.275 | 2.862 | 7.269 |
| Length/Diameter Ratio | | 1.00 | | |
| Moisture Content (%) | WW= 119.5 DW= 91.6 | 30.5 | WW= 219.9 DW= 169.0 | 30.1 |
| Sample Wet Weight (grams) | 561.2 | | 572.4 | |
| Wet Density (pcf) | 116.2 | | 118.0 | |
| Dry Density (pcf) | 89.1 | | 90.7 | |
| Saturation (%) ASSUMED SG= 2.7 | 92 | | 95 | |

## HYDRAULIC CONDUCTIVITY TESTING MEASUREMENT

(PERMOMETER)

| Confining Pressure (psi) | 75 | Influent Pressure (psi) | 70 | Effluent Pressure (psi) | 70 | B-Value | 0.96 |
|---|---|---|---|---|---|---|---|

| Reset (Y/N) | Date | Clock Time | Elapsed Time | $HA_{OUT}$ (cm) | $HA_{IN}$ (cm) | Temp °C | Gradient | K (cm/sec) | Temp Correction | $K_{20°C}$ (cm/sec) |
|---|---|---|---|---|---|---|---|---|---|---|
| Y | 1-19-11 | 1:59:44 | | 7.1 | 1.58 | 22.3 | 10 | | | |
| | 1-19-11 | 2:11:30 | 0:11:46 | 5.0 | 1.67 | 22.3 | 6 | 3.0E-07 | 0.947 | 2.9E-07 |
| | 1-19-11 | 2:12:18 | 0:12:34 | 4.9 | 1.67 | 22.3 | 6 | 3.0E-07 | 0.947 | 2.8E-07 |
| | 1-19-11 | 2:13:05 | 0:13:21 | 4.8 | 1.68 | 22.3 | 6 | 3.0E-07 | 0.947 | 2.8E-07 |
| | 1-19-11 | 2:13:47 | 0:14:03 | 4.7 | 1.68 | 22.3 | 6 | 3.0E-07 | 0.947 | 2.9E-07 |

**HYDRAULIC CONDUCTIVITY ($K_{20°C}$) 2.8E-07 cm/sec**

BLE INC.

# HYDRAULIC CONDUCTIVITY TEST REPORT

**CONSTANT VOLUME APPARATUS (ASTM D 5084)**

| | | | |
|---|---|---|---|
| PROJECT: | **ARROWHEAD LANDFILL** | TESTED BY: | **JOHN MATHEW** |
| PROJECT NO.: | **J11-4999-27** | CHECKED BY: | **PAUL YARBER** |
| DATE RECEIVED: | **1-18-11** | | |

| | | | |
|---|---|---|---|
| SAMPLE NO. | **P-6** | SAMPLE LOCATION: | **CAP** |
| TYPE | **UNDISTURBED** | SAMPLE DESCRIPTION: | **GRAY SELMA CHALK** |

## SAMPLE DIMENSIONS AND PROPERTIES

| ITEM | INITIAL | | FINAL | |
|---|---|---|---|---|
| | inches | centimeters | inches | centimeters |
| Sample Length | 2.984 | 7.579 | 2.993 | 7.602 |
| Sample Diameter | 2.848 | 7.234 | 2.851 | 7.242 |
| Length/Diameter Ratio | | 1.05 | | |
| Moisture Content (%) | WW= 148.6 DW= 115.7 | 28.4 | WW= 229.6 DW= 177.2 | 29.6 |
| Sample Wet Weight (grams) | 558.5 | | 591.4 | |
| Wet Density (pcf) | 111.9 | | 117.9 | |
| Dry Density (pcf) | 87.1 | | 91.0 | |
| Saturation (%) ASSUMED SG= 2.7 | 82 | | 94 | |

## HYDRAULIC CONDUCTIVITY TESTING MEASUREMENT

(PERMOMETER)

| Confining Pressure (psi) 75 | Influent Pressure (psi) 70 | Effluent Pressure (psi) 70 | B-Value 0.96 |
|---|---|---|---|

| Reset (Y/N) | Date | Clock Time | Elapsed Time | $HA_{OUT}$ (cm) | $HA_{IN}$ (cm) | Temp °C | Gradient | K (cm/sec) | Temp Correction | $K_{20°C}$ (cm/sec) |
|---|---|---|---|---|---|---|---|---|---|---|
| Y | 1-19-11 | 2:10:24 | | 7.5 | 1.67 | 22.3 | 10 | | | |
| | 1-19-11 | 2:11:44 | 0:01:20 | 6.1 | 1.73 | 22.3 | 8 | 1.6E-06 | 0.947 | 1.5E-06 |
| | 1-19-11 | 2:12:00 | 0:01:36 | 5.9 | 1.74 | 22.3 | 7 | 1.6E-06 | 0.947 | 1.5E-06 |
| | 1-19-11 | 2:12:16 | 0:01:52 | 5.7 | 1.74 | 22.3 | 7 | 1.5E-06 | 0.947 | 1.5E-06 |
| | 1-19-11 | 2:12:31 | 0:02:07 | 5.5 | 1.75 | 22.3 | 7 | 1.5E-06 | 0.947 | 1.5E-06 |

**HYDRAULIC CONDUCTIVITY ($K_{20°C}$) 1.5E-06 cm/sec**

IBLE INC.

# HYDRAULIC CONDUCTIVITY TEST REPORT

**CONSTANT VOLUME APPARATUS (ASTM D 5084)**

| | | | |
|---|---|---|---|
| PROJECT: | **ARROWHEAD LANDFILL** | TESTED BY: | **JOHN MATHEW** |
| PROJECT NO.: | **J11-4999-27** | CHECKED BY: | **PAUL YARBER** |
| DATE RECEIVED: | **1-18-11** | | |

| | | | |
|---|---|---|---|
| SAMPLE NO. | **P-7** | SAMPLE LOCATION: | **CAP** |
| TYPE | **UNDISTURBED** | SAMPLE DESCRIPTION: | **GRAY SELMA CHALK** |

## SAMPLE DIMENSIONS AND PROPERTIES

| ITEM | INITIAL | | FINAL | |
|---|---|---|---|---|
| | inches | centimeters | inches | centimeters |
| Sample Length | 3.010 | 7.645 | 3.034 | 7.706 |
| Sample Diameter | 2.852 | 7.244 | 2.854 | 7.249 |
| Length/Diameter Ratio | | 1.06 | | |
| Moisture Content (%) | WW= 153.4 DW= 122.5 | 25.2 | WW= 274.3 DW= 214.8 | 27.7 |
| Sample Wet Weight (grams) | 595.4 | | 610.6 | |
| Wet Density (pcf) | 118.0 | | 119.8 | |
| Dry Density (pcf) | 94.2 | | 93.8 | |
| Saturation (%) ASSUMED SG= 2.7 | 86 | | 94 | |

## HYDRAULIC CONDUCTIVITY TESTING MEASUREMENT

(PERMOMETER)

| Confining Pressure (psi) 75 | Influent Pressure (psi) 70 | Effluent Pressure (psi) 70 | B-Value 0.96 |
|---|---|---|---|

| Reset (Y/N) | Date | Clock Time | Elapsed Time | $HA_{OUT}$ (cm) | $HA_{IN}$ (cm) | Temp °C | Gradient | K (cm/sec) | Temp Correction | $K_{20°C}$ (cm/sec) |
|---|---|---|---|---|---|---|---|---|---|---|
| Y | 1-19-11 | 2:44:26 | | 7.4 | 1.57 | 22.3 | 10 | | | |
| | 1-19-11 | 2:50:18 | 0:05:52 | 5.0 | 1.67 | 22.3 | 6 | 7.1E-07 | 0.947 | 6.8E-07 |
| | 1-19-11 | 2:50:39 | 0:06:13 | 4.9 | 1.67 | 22.3 | 6 | 7.1E-07 | 0.947 | 6.7E-07 |
| | 1-19-11 | 2:51:03 | 0:06:37 | 4.8 | 1.68 | 22.3 | 5 | 7.1E-07 | 0.947 | 6.7E-07 |
| | 1-19-11 | 2:51:24 | 0:06:58 | 4.7 | 1.68 | 22.3 | 5 | 7.1E-07 | 0.947 | 6.7E-07 |

**HYDRAULIC CONDUCTIVITY ($K_{20°C}$) 6.7E-07 cm/sec**

BLE INC.

# HYDRAULIC CONDUCTIVITY TEST REPORT

**CONSTANT VOLUME APPARATUS (ASTM D 5084)**

| | | | |
|---|---|---|---|
| PROJECT: | **ARROWHEAD LANDFILL** | TESTED BY: | **JOHN MATHEW** |
| PROJECT NO.: | **J11-4999-27** | CHECKED BY: | **PAUL YARBER** |
| DATE RECEIVED: | **1-18-11** | | |

| | | | |
|---|---|---|---|
| SAMPLE NO. | **P-8** | SAMPLE LOCATION: | **CAP** |
| TYPE | **UNDISTURBED** | SAMPLE DESCRIPTION: | **GRAY SELMA CHALK** |

## SAMPLE DIMENSIONS AND PROPERTIES

| ITEM | INITIAL | | FINAL | |
|---|---|---|---|---|
| | inches | centimeters | inches | centimeters |
| Sample Length | 2.981 | 7.572 | 2.990 | 7.595 |
| Sample Diameter | 2.855 | 7.252 | 2.861 | 7.267 |
| Length/Diameter Ratio | | 1.04 | | |
| Moisture Content (%) | WW= 203.0 DW= 161.9 | 25.4 | WW= 168.3 DW= 129.2 | 30.3 |
| Sample Wet Weight (grams) | 566.7 | | 583.5 | |
| Wet Density (pcf) | 113.1 | | 115.6 | |
| Dry Density (pcf) | 90.2 | | 88.8 | |
| Saturation (%) ASSUMED SG= 2.7 | 79 | | 91 | |

## HYDRAULIC CONDUCTIVITY TESTING MEASUREMENT

(PERMOMETER)

| Confining Pressure (psi) 75 | Influent Pressure (psi) 70 | Effluent Pressure (psi) 70 | B-Value 0.96 |
|---|---|---|---|

| Reset (Y/N) | Date | Clock Time | Elapsed Time | $HA_{OUT}$ (cm) | $HA_{IN}$ (cm) | Temp °C | Gradient | K (cm/sec) | Temp Correction | $K_{20°C}$ (cm/sec) |
|---|---|---|---|---|---|---|---|---|---|---|
| Y | 1-19-11 | 2:45:08 | | 7.5 | 1.67 | 22.3 | 10 | | | |
| | 1-19-11 | 2:46:45 | 0:01:37 | 4.2 | 1.81 | 22.3 | 4 | 4.0E-06 | 0.947 | 3.8E-06 |
| | 1-19-11 | 2:46:57 | 0:01:49 | 4.0 | 1.81 | 22.3 | 4 | 4.0E-06 | 0.947 | 3.7E-06 |
| | 1-19-11 | 2:47:08 | 0:02:00 | 3.8 | 1.82 | 22.3 | 4 | 4.0E-06 | 0.947 | 3.8E-06 |
| | 1-19-11 | 2:47:19 | 0:02:11 | 3.6 | 1.83 | 22.3 | 3 | 4.0E-06 | 0.947 | 3.8E-06 |

**HYDRAULIC CONDUCTIVITY ($K_{20°C}$) 3.8E-06 cm/sec**

BLE INC.

# HYDRAULIC CONDUCTIVITY TEST REPORT

**CONSTANT VOLUME APPARATUS (ASTM D 5084)**

| | | | |
|---|---|---|---|
| PROJECT: | **ARROWHEAD LANDFILL** | TESTED BY: | **JOHN MATHEW** |
| PROJECT NO.: | **J11-4999-27** | CHECKED BY: | **PAUL YARBER** |
| DATE RECEIVED: | **1-18-11** | | |

| | | | |
|---|---|---|---|
| SAMPLE NO. | **P-9** | SAMPLE LOCATION: | **CAP** |
| TYPE | **UNDISTURBED** | SAMPLE DESCRIPTION: | **GRAY SELMA CHALK w/some brown fi.-med. sandy CLAY** |

## SAMPLE DIMENSIONS AND PROPERTIES

| ITEM | INITIAL | | FINAL | |
|---|---|---|---|---|
| | inches | centimeters | inches | centimeters |
| Sample Length | 2.906 | 7.381 | 2.897 | 7.358 |
| Sample Diameter | 2.853 | 7.247 | 2.853 | 7.247 |
| Length/Diameter Ratio | | 1.02 | | |
| Moisture Content (%) | WW= 115.4 DW= 91.0 | 26.8 | WW= 183.9 DW= 138.3 | 33.0 |
| Sample Wet Weight (grams) | 545.5 | | 556.1 | |
| Wet Density (pcf) | 111.9 | | 114.4 | |
| Dry Density (pcf) | 88.2 | | 86.0 | |
| Saturation (%) ASSUMED SG= 2.7 | 80 | | 93 | |

## HYDRAULIC CONDUCTIVITY TESTING MEASUREMENT

(PERMOMETER)

| Confining Pressure (psi) 75 | Influent Pressure (psi) 70 | Effluent Pressure (psi) 70 | B-Value 0.96 |
|---|---|---|---|

| Reset (Y/N) | Date | Clock Time | Elapsed Time | $HA_{OUT}$ (cm) | $HA_{IN}$ (cm) | Temp °C | Gradient | K (cm/sec) | Temp Correction | $K_{20°C}$ (cm/sec) |
|---|---|---|---|---|---|---|---|---|---|---|
| Y | 1-19-11 | 3:13:10 | | 7.4 | 1.57 | 22.3 | 10 | | | |
| | 1-19-11 | 3:16:30 | 0:03:20 | 5.0 | 1.67 | 22.3 | 6 | 1.2E-06 | 0.947 | 1.1E-06 |
| | 1-19-11 | 3:16:49 | 0:03:39 | 4.9 | 1.67 | 22.3 | 6 | 1.2E-06 | 0.947 | 1.1E-06 |
| | 1-19-11 | 3:17:08 | 0:03:58 | 4.8 | 1.68 | 22.3 | 6 | 1.1E-06 | 0.947 | 1.1E-06 |
| | 1-19-11 | 3:17:31 | 0:04:21 | 4.7 | 1.68 | 22.3 | 6 | 1.1E-06 | 0.947 | 1.0E-06 |

**HYDRAULIC CONDUCTIVITY ($K_{20°C}$) 1.1E-06 cm/sec**

BLE INC.

# HYDRAULIC CONDUCTIVITY TEST REPORT

**CONSTANT VOLUME APPARATUS (ASTM D 5084)**

| | | | |
|---|---|---|---|
| PROJECT: | **ARROWHEAD LANDFILL** | TESTED BY: | **JOHN MATHEW** |
| PROJECT NO.: | **J11-4999-27** | CHECKED BY: | **PAUL YARBER** |
| DATE RECEIVED: | **1-18-11** | | |

| | | | |
|---|---|---|---|
| SAMPLE NO. | **P-10** | SAMPLE LOCATION: | **CAP** |
| TYPE | **UNDISTURBED** | SAMPLE DESCRIPTION: | **GRAY SELMA CHALK w/some brown fi.-med. sandy CLAY** |

## SAMPLE DIMENSIONS AND PROPERTIES

| ITEM | INITIAL | | FINAL | |
|---|---|---|---|---|
| | inches | centimeters | inches | centimeters |
| Sample Length | 2.828 | 7.183 | 2.815 | 7.150 |
| Sample Diameter | 2.851 | 7.242 | 2.838 | 7.209 |
| Length/Diameter Ratio | | 0.99 | | |
| Moisture Content (%) | WW= 177.3 DW= 146.1 | 21.4 | WW= 208.0 DW= 167.0 | 24.6 |
| Sample Wet Weight (grams) | 584.4 | | 590.4 | |
| Wet Density (pcf) | 123.3 | | 126.3 | |
| Dry Density (pcf) | 101.6 | | 101.4 | |
| Saturation (%) ASSUMED SG= 2.7 | 88 | | 100 | |

## HYDRAULIC CONDUCTIVITY TESTING MEASUREMENT

(PERMOMETER)

| Confining Pressure (psi) 75 | Influent Pressure (psi) 70 | Effluent Pressure (psi) 70 | B-Value 0.96 |
|---|---|---|---|

| Reset (Y/N) | Date | Clock Time | Elapsed Time | $HA_{OUT}$ (cm) | $HA_{IN}$ (cm) | Temp °C | Gradient | K (cm/sec) | Temp Correction | $K_{20°C}$ (cm/sec) |
|---|---|---|---|---|---|---|---|---|---|---|
| Y | 1-19-11 | 3:13:40 | | 7.2 | 1.68 | 22.3 | 10 | | | |
| | 1-19-11 | 3:37:23 | 0:23:43 | 6.2 | 1.72 | 22.3 | 8 | 6.2E-08 | 0.947 | 5.9E-08 |
| | 1-19-11 | 3:40:05 | 0:26:25 | 6.1 | 1.73 | 22.3 | 8 | 6.2E-08 | 0.947 | 5.8E-08 |
| | 1-19-11 | 3:42:48 | 0:29:08 | 6.0 | 1.73 | 22.3 | 8 | 6.2E-08 | 0.947 | 5.8E-08 |
| | 1-19-11 | 3:45:37 | 0:31:57 | 5.9 | 1.74 | 22.3 | 8 | 6.2E-08 | 0.947 | 5.8E-08 |

**HYDRAULIC CONDUCTIVITY ($K_{20°C}$) 5.8E-08 cm/sec**

BLE INC.

# HYDRAULIC CONDUCTIVITY TEST REPORT

**CONSTANT VOLUME APPARATUS (ASTM D 5084)**

| | | | |
|---|---|---|---|
| PROJECT: | **ARROWHEAD LANDFILL** | TESTED BY: | **JOHN MATHEW** |
| PROJECT NO.: | **J11-4999-27** | CHECKED BY: | **PAUL YARBER** |
| DATE RECEIVED: | **4-4-11** | | |

| | | | |
|---|---|---|---|
| SAMPLE NO. | **P-11** | SAMPLE LOCATION: | **CAP** |
| TYPE | **UNDISTURBED** | SAMPLE DESCRIPTION: | **RED & GREY CLAY** |

## SAMPLE DIMENSIONS AND PROPERTIES

| ITEM | INITIAL | | FINAL | |
|---|---|---|---|---|
| | inches | centimeters | inches | centimeters |
| Sample Length | 2.949 | 7.490 | 2.949 | 7.490 |
| Sample Diameter | 2.854 | 7.249 | 2.879 | 7.313 |
| Length/Diameter Ratio | | 1.03 | | |
| Moisture Content (%) | WW= 127.8 DW= 100.7 | 26.9 | WW= 242.6 DW= 190.3 | 27.5 |
| Sample Wet Weight (grams) | 611.2 | | 617.4 | |
| Wet Density (pcf) | 123.4 | | 122.5 | |
| Dry Density (pcf) | 97.2 | | 96.1 | |
| Saturation (%) ASSUMED SG= 2.7 | 99 | | 99 | |

## HYDRAULIC CONDUCTIVITY TESTING MEASUREMENT

(PERMOMETER)

| Confining Pressure (psi) | 75 | Influent Pressure (psi) | 70 | Effluent Pressure (psi) | 70 | B-Value | 0.96 |
|---|---|---|---|---|---|---|---|

| Reset (Y/N) | Date | Clock Time | Elapsed Time | $HA_{OUT}$ (cm) | $HA_{IN}$ (cm) | Temp °C | Gradient | K (cm/sec) | Temp Correction | $K_{20°C}$ (cm/sec) |
|---|---|---|---|---|---|---|---|---|---|---|
| Y | 4-5-11 | 2:34:37 | | 10.2 | 1.46 | 22.0 | 15 | | | |
| | 4-5-11 | 2:50:33 | 0:15:56 | 9.5 | 1.48 | 22.0 | 14 | 3.9E-08 | 0.953 | 3.7E-08 |
| | 4-5-11 | 2:52:40 | 0:18:03 | 9.4 | 1.49 | 22.0 | 14 | 4.0E-08 | 0.953 | 3.8E-08 |
| | 4-5-11 | 2:55:15 | 0:20:38 | 9.3 | 1.49 | 22.0 | 13 | 3.9E-08 | 0.953 | 3.7E-08 |
| | 4-5-11 | 2:57:35 | 0:22:58 | 9.2 | 1.50 | 22.0 | 13 | 3.9E-08 | 0.953 | 3.8E-08 |

**HYDRAULIC CONDUCTIVITY ($K_{20°C}$) 3.7E-08 cm/sec**

IBLE INC.

# HYDRAULIC CONDUCTIVITY TEST REPORT

**CONSTANT VOLUME APPARATUS (ASTM D 5084)**

| | | | |
|---|---|---|---|
| PROJECT: | **ARROWHEAD LANDFILL** | TESTED BY: | **JOHN MATHEW** |
| PROJECT NO.: | **J11-4999-27** | CHECKED BY: | **PAUL YARBER** |
| DATE RECEIVED: | **1-18-11** | | |

| | | | |
|---|---|---|---|
| SAMPLE NO. | **P-12** | SAMPLE LOCATION: | **CAP** |
| TYPE | **UNDISTURBED** | SAMPLE DESCRIPTION: | **GRAY SELMA CHALK w/some brown fi.-med. sandy CLAY** |

## SAMPLE DIMENSIONS AND PROPERTIES

| ITEM | INITIAL | | FINAL | |
|---|---|---|---|---|
| | inches | centimeters | inches | centimeters |
| Sample Length | 2.910 | 7.391 | 2.919 | 7.414 |
| Sample Diameter | 2.853 | 7.247 | 2.878 | 7.310 |
| Length/Diameter Ratio | | 1.02 | | |
| Moisture Content (%) | WW= 196.8 DW= 151.7 | 29.7 | WW= 234.3 DW= 177.6 | 31.9 |
| Sample Wet Weight (grams) | 561.9 | | 573.1 | |
| Wet Density (pcf) | 115.1 | | 115.0 | |
| Dry Density (pcf) | 88.7 | | 87.1 | |
| Saturation (%) ASSUMED SG= 2.7 | 89 | | 92 | |

## HYDRAULIC CONDUCTIVITY TESTING MEASUREMENT

(PERMOMETER)

| Confining Pressure (psi) | 75 | Influent Pressure (psi) | 70 | Effluent Pressure (psi) | 70 | B-Value | 0.96 |
|---|---|---|---|---|---|---|---|

| Reset (Y/N) | Date | Clock Time | Elapsed Time | $HA_{OUT}$ (cm) | $HA_{IN}$ (cm) | Temp °C | Gradient | K (cm/sec) | Temp Correction | $K_{20°C}$ (cm/sec) |
|---|---|---|---|---|---|---|---|---|---|---|
| Y | 1-19-11 | 3:45:54 | | 4.5 | 1.79 | 22.3 | 5 | | | |
| | 1-19-11 | 3:46:21 | 0:00:27 | 3.5 | 1.83 | 22.3 | 3 | 7.6E-06 | 0.947 | 7.2E-06 |
| | 1-19-11 | 3:46:29 | 0:00:35 | 3.3 | 1.84 | 22.3 | 3 | 7.5E-06 | 0.947 | 7.1E-06 |
| | 1-19-11 | 3:46:43 | 0:00:49 | 3.0 | 1.85 | 22.3 | 2 | 7.4E-06 | 0.947 | 7.0E-06 |
| | 1-19-11 | 3:46:54 | 0:01:00 | 2.8 | 1.86 | 22.3 | 2 | 7.5E-06 | 0.947 | 7.1E-06 |

**HYDRAULIC CONDUCTIVITY ($K_{20°C}$) 7.1E-06 cm/sec**

BLE INC.

# HYDRAULIC CONDUCTIVITY TEST REPORT

**CONSTANT VOLUME APPARATUS (ASTM D 5084)**

| | | | |
|---|---|---|---|
| PROJECT: | **ARROWHEAD LANDFILL** | TESTED BY: | **JOHN MATHEW** |
| PROJECT NO.: | **J11-4999-27** | CHECKED BY: | **PAUL YARBER** |
| DATE RECEIVED: | **4-4-11** | | |

| | | | |
|---|---|---|---|
| SAMPLE NO. | **P-13** | SAMPLE LOCATION: | **CAP** |
| TYPE | **UNDISTURBED** | SAMPLE DESCRIPTION: | **RED & GREY CLAY** |

## SAMPLE DIMENSIONS AND PROPERTIES

| ITEM | INITIAL | | FINAL | |
|---|---|---|---|---|
| | inches | centimeters | inches | centimeters |
| Sample Length | 2.959 | 7.516 | 2.950 | 7.493 |
| Sample Diameter | 2.852 | 7.244 | 2.855 | 7.252 |
| Length/Diameter Ratio | | 1.04 | | |
| Moisture Content (%) | WW= 120.8 DW= 97.6 | 23.8 | WW= 202.3 DW= 161.0 | 25.7 |
| Sample Wet Weight (grams) | 608.2 | | 617.8 | |
| Wet Density (pcf) | 122.6 | | 124.6 | |
| Dry Density (pcf) | 99.0 | | 99.2 | |
| Saturation (%) ASSUMED SG= 2.7 | 92 | | 99 | |

## HYDRAULIC CONDUCTIVITY TESTING MEASUREMENT

(PERMOMETER)

| Confining Pressure (psi) 75 | Influent Pressure (psi) 70 | Effluent Pressure (psi) 70 | B-Value 0.96 |
|---|---|---|---|

| Reset (Y/N) | Date | Clock Time | Elapsed Time | $HA_{OUT}$ (cm) | $HA_{IN}$ (cm) | Temp °C | Gradient | K (cm/sec) | Temp Correction | $K_{20°C}$ (cm/sec) |
|---|---|---|---|---|---|---|---|---|---|---|
| Y | 4-5-11 | 1:04:22 | | 10.2 | 1.46 | 22.0 | 15 | | | |
| | 4-5-11 | 1:22:18 | 0:17:56 | 9.5 | 1.48 | 22.0 | 14 | 3.5E-08 | 0.953 | 3.4E-08 |
| | 4-5-11 | 1:25:46 | 0:21:24 | 9.4 | 1.49 | 22.0 | 14 | 3.4E-08 | 0.953 | 3.2E-08 |
| | 4-5-11 | 1:29:05 | 0:24:43 | 9.3 | 1.49 | 22.0 | 13 | 3.3E-08 | 0.953 | 3.2E-08 |
| | 4-5-11 | 1:32:19 | 0:27:57 | 9.2 | 1.50 | 22.0 | 13 | 3.3E-08 | 0.953 | 3.1E-08 |

**HYDRAULIC CONDUCTIVITY ($K_{20°C}$) 3.2E-08 cm/sec**

BLE INC.

# HYDRAULIC CONDUCTIVITY TEST REPORT

**CONSTANT VOLUME APPARATUS (ASTM D 5084)**

| | | | |
|---|---|---|---|
| PROJECT: | **ARROWHEAD LANDFILL** | TESTED BY: | **JOHN MATHEW** |
| PROJECT NO.: | **J11-4999-27** | CHECKED BY: | **PAUL YARBER** |
| DATE RECEIVED: | **4-4-11** | | |

| | | | |
|---|---|---|---|
| SAMPLE NO. | **P-14** | SAMPLE LOCATION: | **CAP** |
| TYPE | **UNDISTURBED** | SAMPLE DESCRIPTION: | **RED & GREY CLAY** |

## SAMPLE DIMENSIONS AND PROPERTIES

| ITEM | INITIAL | | FINAL | |
|---|---|---|---|---|
| | inches | centimeters | inches | centimeters |
| Sample Length | 2.948 | 7.488 | 2.958 | 7.513 |
| Sample Diameter | 2.852 | 7.244 | 2.859 | 7.262 |
| Length/Diameter Ratio | | 1.03 | | |
| Moisture Content (%) | WW= 178.9 DW= 145.2 | 23.2 | WW= 272.4 DW= 214.4 | 27.1 |
| Sample Wet Weight (grams) | 582.9 | | 598.3 | |
| Wet Density (pcf) | 117.9 | | 120.0 | |
| Dry Density (pcf) | 95.7 | | 94.5 | |
| Saturation (%) ASSUMED SG= 2.7 | 82 | | 93 | |

## HYDRAULIC CONDUCTIVITY TESTING MEASUREMENT

(PERMOMETER)

| Confining Pressure (psi) 75 | Influent Pressure (psi) 70 | Effluent Pressure (psi) 70 | B-Value 0.96 |
|---|---|---|---|

| Reset (Y/N) | Date | Clock Time | Elapsed Time | $HA_{OUT}$ (cm) | $HA_{IN}$ (cm) | Temp °C | Gradient | K (cm/sec) | Temp Correction | $K_{20°C}$ (cm/sec) |
|---|---|---|---|---|---|---|---|---|---|---|
| Y | 4-5-11 | 1:25:50 | | 10.2 | 1.46 | 22.0 | 15 | | | |
| | 4-5-11 | 1:47:45 | 0:21:55 | 8.5 | 1.53 | 22.0 | 12 | 7.5E-08 | 0.953 | 7.1E-08 |
| | 4-5-11 | 1:49:12 | 0:23:22 | 8.4 | 1.53 | 22.0 | 12 | 7.5E-08 | 0.953 | 7.1E-08 |
| | 4-5-11 | 1:50:49 | 0:24:59 | 8.3 | 1.53 | 22.0 | 12 | 7.5E-08 | 0.953 | 7.1E-08 |
| | 4-5-11 | 1:52:23 | 0:26:33 | 8.2 | 1.54 | 22.0 | 11 | 7.4E-08 | 0.953 | 7.1E-08 |

**HYDRAULIC CONDUCTIVITY ($K_{20°C}$) 7.1E-08 cm/sec**

IBLE INC.

# HYDRAULIC CONDUCTIVITY TEST REPORT

**CONSTANT VOLUME APPARATUS (ASTM D 5084)**

| | | | |
|---|---|---|---|
| PROJECT: | **ARROWHEAD LANDFILL** | TESTED BY: | **JOHN MATHEW** |
| PROJECT NO.: | **J11-4999-27** | CHECKED BY: | **PAUL YARBER** |
| DATE RECEIVED: | **4-4-11** | | |

| | | | |
|---|---|---|---|
| SAMPLE NO. | **P-15** | SAMPLE LOCATION: | **CAP** |
| TYPE | **UNDISTURBED** | SAMPLE DESCRIPTION: | **RED & GREY CLAY** |

## SAMPLE DIMENSIONS AND PROPERTIES

| ITEM | INITIAL | | FINAL | |
|---|---|---|---|---|
| | inches | centimeters | inches | centimeters |
| Sample Length | 2.901 | 7.369 | 2.875 | 7.303 |
| Sample Diameter | 2.852 | 7.244 | 2.849 | 7.236 |
| Length/Diameter Ratio | | 1.02 | | |
| Moisture Content (%) | WW= 164.3 DW= 131.1 | 25.3 | WW= 248.6 DW= 195.3 | 27.3 |
| Sample Wet Weight (grams) | 595.9 | | 603.6 | |
| Wet Density (pcf) | 122.5 | | 125.5 | |
| Dry Density (pcf) | 97.7 | | 98.6 | |
| Saturation (%) ASSUMED SG= 2.7 | 94 | | 104 | |

## HYDRAULIC CONDUCTIVITY TESTING MEASUREMENT

(PERMOMETER)

| Confining Pressure (psi) 75 | Influent Pressure (psi) 70 | Effluent Pressure (psi) 70 | B-Value 0.96 |
|---|---|---|---|

| Reset (Y/N) | Date | Clock Time | Elapsed Time | $HA_{OUT}$ (cm) | $HA_{IN}$ (cm) | Temp °C | Gradient | K (cm/sec) | Temp Correction | $K_{20°C}$ (cm/sec) |
|---|---|---|---|---|---|---|---|---|---|---|
| Y | 4-5-11 | 1:39:36 | | 10.1 | 1.56 | 22.0 | 15 | | | |
| | 4-5-11 | 2:00:05 | 0:20:29 | 9.0 | 1.61 | 22.0 | 13 | 5.0E-08 | 0.953 | 4.8E-08 |
| | 4-5-11 | 2:02:08 | 0:22:32 | 8.9 | 1.61 | 22.0 | 13 | 5.0E-08 | 0.953 | 4.8E-08 |
| | 4-5-11 | 2:04:19 | 0:24:43 | 8.8 | 1.62 | 22.0 | 13 | 5.0E-08 | 0.953 | 4.7E-08 |
| | 4-5-11 | 2:06:31 | 0:26:55 | 8.7 | 1.62 | 22.0 | 13 | 4.9E-08 | 0.953 | 4.7E-08 |

**HYDRAULIC CONDUCTIVITY ($K_{20°C}$) 4.7E-08 cm/sec**

BLE INC.

# HYDRAULIC CONDUCTIVITY TEST REPORT

**CONSTANT VOLUME APPARATUS (ASTM D 5084)**

| | | | |
|---|---|---|---|
| PROJECT: | **ARROWHEAD LANDFILL** | TESTED BY: | **JOHN MATHEW** |
| PROJECT NO.: | **J11-4999-27** | CHECKED BY: | **PAUL YARBER** |
| DATE RECEIVED: | **4-4-11** | | |

| | | | |
|---|---|---|---|
| SAMPLE NO. | **P-16** | SAMPLE LOCATION: | **CAP** |
| TYPE | **UNDISTURBED** | SAMPLE DESCRIPTION: | **RED & GREY CLAY** |

## SAMPLE DIMENSIONS AND PROPERTIES

| ITEM | INITIAL | | FINAL | |
|---|---|---|---|---|
| | inches | centimeters | inches | centimeters |
| Sample Length | 2.942 | 7.473 | 2.914 | 7.402 |
| Sample Diameter | 2.851 | 7.242 | 2.855 | 7.252 |
| Length/Diameter Ratio | | 1.03 | | |
| Moisture Content (%) | WW= 142.9 DW= 116.5 | 22.7 | WW= 220.1 DW= 174.8 | 25.9 |
| Sample Wet Weight (grams) | 601.0 | | 606.1 | |
| Wet Density (pcf) | 121.9 | | 123.8 | |
| Dry Density (pcf) | 99.4 | | 98.3 | |
| Saturation (%) ASSUMED SG= 2.7 | 88 | | 98 | |

## HYDRAULIC CONDUCTIVITY TESTING MEASUREMENT

(PERMOMETER)

| Confining Pressure (psi) 75 | Influent Pressure (psi) 70 | Effluent Pressure (psi) 70 | B-Value 0.96 |
|---|---|---|---|

| Reset (Y/N) | Date | Clock Time | Elapsed Time | $HA_{OUT}$ (cm) | $HA_{IN}$ (cm) | Temp °C | Gradient | K (cm/sec) | Temp Correction | $K_{20°C}$ (cm/sec) |
|---|---|---|---|---|---|---|---|---|---|---|
| Y | 4-5-11 | 2:15:04 | | 10.3 | 1.56 | 22.0 | 15 | | | |
| | 4-5-11 | 2:30:10 | 0:15:06 | 9.9 | 1.57 | 22.0 | 14 | 2.3E-08 | 0.953 | 2.2E-08 |
| | 4-5-11 | 2:34:50 | 0:19:46 | 9.8 | 1.58 | 22.0 | 14 | 2.2E-08 | 0.953 | 2.1E-08 |
| | 4-5-11 | 2:39:05 | 0:24:01 | 9.7 | 1.58 | 22.0 | 14 | 2.2E-08 | 0.953 | 2.1E-08 |
| | 4-5-11 | 2:44:18 | 0:29:14 | 9.6 | 1.58 | 22.0 | 14 | 2.1E-08 | 0.953 | 2.0E-08 |

**HYDRAULIC CONDUCTIVITY ($K_{20°C}$) 2.1E-08 cm/sec**

IBLE INC.

# HYDRAULIC CONDUCTIVITY TEST REPORT

**CONSTANT VOLUME APPARATUS (ASTM D 5084)**

| | | | |
|---|---|---|---|
| PROJECT: | **ARROWHEAD LANDFILL** | TESTED BY: | **JOHN MATHEW** |
| PROJECT NO.: | **J11-4999-27** | CHECKED BY: | **PAUL YARBER** |
| DATE RECEIVED: | **4-4-11** | | |

| | | | |
|---|---|---|---|
| SAMPLE NO. | **P-17** | SAMPLE LOCATION: | **CAP** |
| TYPE | **UNDISTURBED** | SAMPLE DESCRIPTION: | **RED & GREY CLAY** |

## SAMPLE DIMENSIONS AND PROPERTIES

| ITEM | INITIAL | | FINAL | |
|---|---|---|---|---|
| | inches | centimeters | inches | centimeters |
| Sample Length | 2.928 | 7.437 | 2.940 | 7.468 |
| Sample Diameter | 2.851 | 7.242 | 2.847 | 7.231 |
| Length/Diameter Ratio | | 1.03 | | |
| Moisture Content (%) | WW= 116.1 DW= 93.2 | 24.6 | WW= 248.2 DW= 196.7 | 26.2 |
| Sample Wet Weight (grams) | 600.0 | | 605.8 | |
| Wet Density (pcf) | 122.3 | | 123.3 | |
| Dry Density (pcf) | 98.2 | | 97.7 | |
| Saturation (%) ASSUMED SG= 2.7 | 93 | | 98 | |

## HYDRAULIC CONDUCTIVITY TESTING MEASUREMENT

(PERMOMETER)

| Confining Pressure (psi) | 75 | Influent Pressure (psi) | 70 | Effluent Pressure (psi) | 70 | B-Value | 0.96 |
|---|---|---|---|---|---|---|---|

| Reset (Y/N) | Date | Clock Time | Elapsed Time | $HA_{OUT}$ (cm) | $HA_{IN}$ (cm) | Temp °C | Gradient | K (cm/sec) | Temp Correction | $K_{20°C}$ (cm/sec) |
|---|---|---|---|---|---|---|---|---|---|---|
| Y | 4-5-11 | 2:01:02 | | 10.1 | 1.46 | 22.0 | 15 | | | |
| | 4-5-11 | 2:17:11 | 0:16:09 | 9.5 | 1.48 | 22.0 | 14 | 3.4E-08 | 0.953 | 3.2E-08 |
| | 4-5-11 | 2:20:17 | 0:19:15 | 9.4 | 1.49 | 22.0 | 14 | 3.3E-08 | 0.953 | 3.2E-08 |
| | 4-5-11 | 2:23:28 | 0:22:26 | 9.3 | 1.49 | 22.0 | 13 | 3.3E-08 | 0.953 | 3.1E-08 |
| | 4-5-11 | 2:26:37 | 0:25:35 | 9.2 | 1.50 | 22.0 | 13 | 3.3E-08 | 0.953 | 3.1E-08 |

**HYDRAULIC CONDUCTIVITY ($K_{20°C}$) 3.2E-08 cm/sec**

BLE INC.

# HYDRAULIC CONDUCTIVITY TEST REPORT

**CONSTANT VOLUME APPARATUS (ASTM D 5084)**

| | | | |
|---|---|---|---|
| PROJECT: | **ARROWHEAD LANDFILL** | TESTED BY: | **JOHN MATHEW** |
| PROJECT NO.: | **J11-4999-27** | CHECKED BY: | **PAUL YARBER** |
| DATE RECEIVED: | **4-21-11** | | |

| | | | |
|---|---|---|---|
| SAMPLE NO. | **P-18** | SAMPLE LOCATION: | **CAP** |
| TYPE | **UNDISTURBED** | SAMPLE DESCRIPTION: | **RED & GREY CLAY** |

## SAMPLE DIMENSIONS AND PROPERTIES

| ITEM | INITIAL | | FINAL | |
|---|---|---|---|---|
| | inches | centimeters | inches | centimeters |
| Sample Length | 2.938 | 7.463 | 2.952 | 7.498 |
| Sample Diameter | 2.853 | 7.247 | 2.868 | 7.285 |
| Length/Diameter Ratio | | 1.03 | | |
| Moisture Content (%) | WW= 182.1 DW= 150.4 | 21.1 | WW= 242.5 DW= 194.3 | 24.8 |
| Sample Wet Weight (grams) | 609.1 | | 624.6 | |
| Wet Density (pcf) | 123.5 | | 124.8 | |
| Dry Density (pcf) | 102.0 | | 100.0 | |
| Saturation (%) ASSUMED SG= 2.7 | 87 | | 98 | |

## HYDRAULIC CONDUCTIVITY TESTING MEASUREMENT

(PERMOMETER)

| Confining Pressure (psi) 75 | Influent Pressure (psi) 70 | Effluent Pressure (psi) 70 | B-Value 0.96 |
|---|---|---|---|

| Reset (Y/N) | Date | Clock Time | Elapsed Time | $HA_{OUT}$ (cm) | $HA_{IN}$ (cm) | Temp °C | Gradient | K (cm/sec) | Temp Correction | $K_{20°C}$ (cm/sec) |
|---|---|---|---|---|---|---|---|---|---|---|
| Y | 4-23-11 | 10:53:10 | | 7.4 | 1.67 | 20.2 | 10 | | | |
| | 4-23-11 | 10:56:23 | 0:03:13 | 6.5 | 1.71 | 20.2 | 8 | 4.0E-07 | 0.995 | 4.0E-07 |
| | 4-23-11 | 10:56:49 | 0:03:39 | 6.4 | 1.72 | 20.2 | 8 | 4.0E-07 | 0.995 | 3.9E-07 |
| | 4-23-11 | 10:57:15 | 0:04:05 | 6.3 | 1.72 | 20.2 | 8 | 3.9E-07 | 0.995 | 3.9E-07 |
| | 4-23-11 | 10:57:40 | 0:04:30 | 6.2 | 1.72 | 20.2 | 8 | 3.9E-07 | 0.995 | 3.9E-07 |

**HYDRAULIC CONDUCTIVITY ($K_{20°C}$) 3.9E-07 cm/sec**

BLE INC.

# HYDRAULIC CONDUCTIVITY TEST REPORT

**CONSTANT VOLUME APPARATUS (ASTM D 5084)**

| | | | |
|---|---|---|---|
| PROJECT: | **ARROWHEAD LANDFILL** | TESTED BY: | **JOHN MATHEW** |
| PROJECT NO.: | **J11-4999-27** | CHECKED BY: | **PAUL YARBER** |
| DATE RECEIVED: | **4-4-11** | | |

| | | | |
|---|---|---|---|
| SAMPLE NO. | **P-19** | SAMPLE LOCATION: | **CAP** |
| TYPE | **UNDISTURBED** | SAMPLE DESCRIPTION: | **RED & GREY CLAY** |

## SAMPLE DIMENSIONS AND PROPERTIES

| ITEM | INITIAL | | FINAL | |
|---|---|---|---|---|
| | inches | centimeters | inches | centimeters |
| Sample Length | 2.977 | 7.562 | 2.942 | 7.473 |
| Sample Diameter | 2.851 | 7.242 | 2.862 | 7.269 |
| Length/Diameter Ratio | | 1.04 | | |
| Moisture Content (%) | WW= 157.4 DW= 126.4 | 24.5 | WW= 252.1 DW= 198.5 | 27.0 |
| Sample Wet Weight (grams) | 601.8 | | 607.3 | |
| Wet Density (pcf) | 120.6 | | 122.2 | |
| Dry Density (pcf) | 96.9 | | 96.2 | |
| Saturation (%) ASSUMED SG= 2.7 | 90 | | 97 | |

## HYDRAULIC CONDUCTIVITY TESTING MEASUREMENT

(PERMOMETER)

| Confining Pressure (psi) | 75 | Influent Pressure (psi) | 70 | Effluent Pressure (psi) | 70 | B-Value | 0.96 |
|---|---|---|---|---|---|---|---|

| Reset (Y/N) | Date | Clock Time | Elapsed Time | $HA_{OUT}$ (cm) | $HA_{IN}$ (cm) | Temp °C | Gradient | K (cm/sec) | Temp Correction | $K_{20°C}$ (cm/sec) |
|---|---|---|---|---|---|---|---|---|---|---|
| Y | 4-5-11 | 2:47:25 | | 10.4 | 1.55 | 22.0 | 15 | | | |
| | 4-5-11 | 3:03:58 | 0:16:33 | 9.5 | 1.59 | 22.0 | 14 | 4.9E-08 | 0.953 | 4.6E-08 |
| | 4-5-11 | 3:05:55 | 0:18:30 | 9.4 | 1.59 | 22.0 | 13 | 4.9E-08 | 0.953 | 4.6E-08 |
| | 4-5-11 | 3:08:23 | 0:20:58 | 9.3 | 1.60 | 22.0 | 13 | 4.8E-08 | 0.953 | 4.5E-08 |
| | 4-5-11 | 3:10:49 | 0:23:24 | 9.2 | 1.60 | 22.0 | 13 | 4.7E-08 | 0.953 | 4.5E-08 |

**HYDRAULIC CONDUCTIVITY ($K_{20°C}$) 4.6E-08 cm/sec**

BLE INC.

# HYDRAULIC CONDUCTIVITY TEST REPORT

**CONSTANT VOLUME APPARATUS (ASTM D 5084)**

| | | | |
|---|---|---|---|
| PROJECT: | **ARROWHEAD LANDFILL** | TESTED BY: | **JOHN MATHEW** |
| PROJECT NO.: | **J11-4999-27** | CHECKED BY: | **PAUL YARBER** |
| DATE RECEIVED: | **4-4-11** | | |

| | | | |
|---|---|---|---|
| SAMPLE NO. | **P-20** | SAMPLE LOCATION: | **CAP** |
| TYPE | **UNDISTURBED** | SAMPLE DESCRIPTION: | **RED & GREY CLAY** |

## SAMPLE DIMENSIONS AND PROPERTIES

| ITEM | INITIAL | | FINAL | |
|---|---|---|---|---|
| | inches | centimeters | inches | centimeters |
| Sample Length | 2.957 | 7.511 | 2.951 | 7.496 |
| Sample Diameter | 2.844 | 7.224 | 2.840 | 7.214 |
| Length/Diameter Ratio | | 1.04 | | |
| Moisture Content (%) | WW= 130.3 DW= 105.7 | 23.3 | WW= 261.5 DW= 205.6 | 27.2 |
| Sample Wet Weight (grams) | 589.5 | | 599.4 | |
| Wet Density (pcf) | 119.6 | | 122.1 | |
| Dry Density (pcf) | 97.0 | | 96.0 | |
| Saturation (%) ASSUMED SG= 2.7 | 85 | | 97 | |

## HYDRAULIC CONDUCTIVITY TESTING MEASUREMENT

(PERMOMETER)

| Confining Pressure (psi) 75 | Influent Pressure (psi) 70 | Effluent Pressure (psi) 70 | B-Value 0.96 |
|---|---|---|---|

| Reset (Y/N) | Date | Clock Time | Elapsed Time | $HA_{OUT}$ (cm) | $HA_{IN}$ (cm) | Temp °C | Gradient | K (cm/sec) | Temp Correction | $K_{20°C}$ (cm/sec) |
|---|---|---|---|---|---|---|---|---|---|---|
| Y | 4-5-11 | 3:23:10 | | 10.3 | 1.56 | 22.0 | 15 | | | |
| | 4-5-11 | 3:39:18 | 0:16:08 | 9.4 | 1.59 | 22.0 | 13 | 5.2E-08 | 0.953 | 4.9E-08 |
| | 4-5-11 | 3:41:45 | 0:18:35 | 9.3 | 1.60 | 22.0 | 13 | 5.0E-08 | 0.953 | 4.8E-08 |
| | 4-5-11 | 3:43:58 | 0:20:48 | 9.2 | 1.60 | 22.0 | 13 | 5.0E-08 | 0.953 | 4.7E-08 |
| | 4-5-11 | 3:46:07 | 0:22:57 | 9.1 | 1.61 | 22.0 | 13 | 4.9E-08 | 0.953 | 4.7E-08 |

**HYDRAULIC CONDUCTIVITY ($K_{20°C}$) 4.8E-08 cm/sec**

BLE INC.

# HYDRAULIC CONDUCTIVITY TEST REPORT

**CONSTANT VOLUME APPARATUS (ASTM D 5084)**

| | | | |
|---|---|---|---|
| PROJECT: | **ARROWHEAD LANDFILL** | TESTED BY: | **JOHN MATHEW** |
| PROJECT NO.: | **J11-4999-27** | CHECKED BY: | **PAUL YARBER** |
| DATE RECEIVED: | **4-4-11** | | |

| | | | |
|---|---|---|---|
| SAMPLE NO. | **P-21** | SAMPLE LOCATION: | **CAP** |
| TYPE | **UNDISTURBED** | SAMPLE DESCRIPTION: | **RED & GREY CLAY** |

## SAMPLE DIMENSIONS AND PROPERTIES

| ITEM | INITIAL | | FINAL | |
|---|---|---|---|---|
| | inches | centimeters | inches | centimeters |
| Sample Length | 2.945 | 7.481 | 2.909 | 7.389 |
| Sample Diameter | 2.851 | 7.242 | 2.845 | 7.226 |
| Length/Diameter Ratio | | 1.03 | | |
| Moisture Content (%) | WW= 168.0 DW= 132.5 | 26.8 | WW= 225.6 DW= 175.9 | 28.3 |
| Sample Wet Weight (grams) | 583.4 | | 589.0 | |
| Wet Density (pcf) | 118.2 | | 121.3 | |
| Dry Density (pcf) | 93.2 | | 94.6 | |
| Saturation (%) ASSUMED SG= 2.7 | 90 | | 98 | |

## HYDRAULIC CONDUCTIVITY TESTING MEASUREMENT

(PERMOMETER)

| Confining Pressure (psi) | 75 | Influent Pressure (psi) | 70 | Effluent Pressure (psi) | 70 | B-Value | 0.96 |
|---|---|---|---|---|---|---|---|

| Reset (Y/N) | Date | Clock Time | Elapsed Time | $HA_{OUT}$ (cm) | $HA_{IN}$ (cm) | Temp °C | Gradient | K (cm/sec) | Temp Correction | $K_{20°C}$ (cm/sec) |
|---|---|---|---|---|---|---|---|---|---|---|
| Y | 4-5-11 | 3:04:38 | | 10.2 | 1.46 | 22.0 | 15 | | | |
| | 4-5-11 | 3:21:15 | 0:16:37 | 9.4 | 1.49 | 22.0 | 14 | 4.3E-08 | 0.953 | 4.1E-08 |
| | 4-5-11 | 3:23:19 | 0:18:41 | 9.3 | 1.49 | 22.0 | 14 | 4.4E-08 | 0.953 | 4.2E-08 |
| | 4-5-11 | 3:25:25 | 0:20:47 | 9.2 | 1.50 | 22.0 | 13 | 4.4E-08 | 0.953 | 4.2E-08 |
| | 4-5-11 | 3:27:39 | 0:23:01 | 9.1 | 1.50 | 22.0 | 13 | 4.4E-08 | 0.953 | 4.2E-08 |

**HYDRAULIC CONDUCTIVITY ($K_{20°C}$) 4.2E-08 cm/sec**

BLE INC.

# HYDRAULIC CONDUCTIVITY TEST REPORT

**CONSTANT VOLUME APPARATUS (ASTM D 5084)**

| | | | |
|---|---|---|---|
| PROJECT: | **ARROWHEAD LANDFILL** | TESTED BY: | **JOHN MATHEW** |
| PROJECT NO.: | **J11-4999-27** | CHECKED BY: | **PAUL YARBER** |
| DATE RECEIVED: | **4-15-11** | | |

| | | | |
|---|---|---|---|
| SAMPLE NO. | **P-22** | SAMPLE LOCATION: | **CAP** |
| TYPE | **UNDISTURBED** | SAMPLE DESCRIPTION: | **RED & GREY CLAY** |

## SAMPLE DIMENSIONS AND PROPERTIES

| ITEM | INITIAL | | FINAL | |
|---|---|---|---|---|
| | inches | centimeters | inches | centimeters |
| Sample Length | 2.886 | 7.330 | 2.874 | 7.300 |
| Sample Diameter | 2.857 | 7.257 | 2.851 | 7.242 |
| Length/Diameter Ratio | | 1.01 | | |
| Moisture Content (%) | WW= 136.7 DW= 108.0 | 26.6 | WW= 275.5 DW= 216.6 | 27.2 |
| Sample Wet Weight (grams) | 590.3 | | 594.7 | |
| Wet Density (pcf) | 121.5 | | 123.5 | |
| Dry Density (pcf) | 96.0 | | 97.1 | |
| Saturation (%) ASSUMED SG= 2.7 | 95 | | 100 | |

## HYDRAULIC CONDUCTIVITY TESTING MEASUREMENT

(PERMOMETER)

| Confining Pressure (psi) | 75 | Influent Pressure (psi) | 70 | Effluent Pressure (psi) | 70 | B-Value | 0.96 |
|---|---|---|---|---|---|---|---|

| Reset (Y/N) | Date | Clock Time | Elapsed Time | $HA_{OUT}$ (cm) | $HA_{IN}$ (cm) | Temp °C | Gradient | K (cm/sec) | Temp Correction | $K_{20°C}$ (cm/sec) |
|---|---|---|---|---|---|---|---|---|---|---|
| Y | 4-17-11 | 1:34:27 | | 7.2 | 1.58 | 21.5 | 10 | | | |
| | 4-17-11 | 1:43:16 | 0:08:49 | 6.6 | 1.60 | 21.5 | 9 | 9.5E-08 | 0.965 | 9.2E-08 |
| | 4-17-11 | 1:44:40 | 0:10:13 | 6.5 | 1.61 | 21.5 | 9 | 9.6E-08 | 0.965 | 9.3E-08 |
| | 4-17-11 | 1:46:21 | 0:11:54 | 6.4 | 1.61 | 21.5 | 9 | 9.6E-08 | 0.965 | 9.2E-08 |
| | 4-17-11 | 1:48:03 | 0:13:36 | 6.3 | 1.62 | 21.5 | 8 | 9.5E-08 | 0.965 | 9.2E-08 |

**HYDRAULIC CONDUCTIVITY ($K_{20°C}$) 9.2E-08 cm/sec**

IBLE INC.

# HYDRAULIC CONDUCTIVITY TEST REPORT

**CONSTANT VOLUME APPARATUS (ASTM D 5084)**

| | | | |
|---|---|---|---|
| PROJECT: | **ARROWHEAD LANDFILL** | TESTED BY: | **JOHN MATHEW** |
| PROJECT NO.: | **J11-4999-27** | CHECKED BY: | **PAUL YARBER** |
| DATE RECEIVED: | **4-15-11** | | |

| | | | |
|---|---|---|---|
| SAMPLE NO. | **P-23** | SAMPLE LOCATION: | **CAP** |
| TYPE | **UNDISTURBED** | SAMPLE DESCRIPTION: | **RED & GREY CLAY** |

## SAMPLE DIMENSIONS AND PROPERTIES

| ITEM | INITIAL | | FINAL | |
|---|---|---|---|---|
| | inches | centimeters | inches | centimeters |
| Sample Length | 2.399 | 6.093 | 2.383 | 6.053 |
| Sample Diameter | 2.860 | 7.264 | 2.860 | 7.264 |
| Length/Diameter Ratio | | 0.84 | | |
| Moisture Content (%) | WW= 162.7 DW= 132.6 | 22.7 | WW= 160.9 DW= 126.7 | 27.0 |
| Sample Wet Weight (grams) | 469.8 | | 485.1 | |
| Wet Density (pcf) | 116.1 | | 120.7 | |
| Dry Density (pcf) | 94.6 | | 95.1 | |
| Saturation (%) ASSUMED SG= 2.7 | 79 | | 94 | |

## HYDRAULIC CONDUCTIVITY TESTING MEASUREMENT

(PERMOMETER)

| Confining Pressure (psi) | 75 | Influent Pressure (psi) | 70 | Effluent Pressure (psi) | 70 | B-Value | 0.95 |
|---|---|---|---|---|---|---|---|

| Reset (Y/N) | Date | Clock Time | Elapsed Time | $HA_{OUT}$ (cm) | $HA_{IN}$ (cm) | Temp °C | Gradient | K (cm/sec) | Temp Correction | $K_{20°C}$ (cm/sec) |
|---|---|---|---|---|---|---|---|---|---|---|
| Y | 4-17-11 | 1:35:40 | | 4.0 | 1.81 | 21.5 | 5 | | | |
| | 4-17-11 | 1:36:03 | 0:00:23 | 3.5 | 1.83 | 21.5 | 4 | 4.1E-06 | 0.965 | 4.0E-06 |
| | 4-17-11 | 1:36:21 | 0:00:41 | 3.2 | 1.85 | 21.5 | 3 | 4.1E-06 | 0.965 | 4.0E-06 |
| | 4-17-11 | 1:36:37 | 0:00:57 | 3.0 | 1.85 | 21.5 | 3 | 4.0E-06 | 0.965 | 3.8E-06 |
| | 4-17-11 | 1:36:54 | 0:01:14 | 2.8 | 1.86 | 21.5 | 2 | 4.0E-06 | 0.965 | 3.9E-06 |

**HYDRAULIC CONDUCTIVITY ($K_{20°C}$) 3.9E-06 cm/sec**

BLE INC.

# HYDRAULIC CONDUCTIVITY TEST REPORT

**CONSTANT VOLUME APPARATUS (ASTM D 5084)**

| | | | |
|---|---|---|---|
| PROJECT: | **ARROWHEAD LANDFILL** | TESTED BY: | **JOHN MATHEW** |
| PROJECT NO.: | **J11-4999-27** | CHECKED BY: | **PAUL YARBER** |
| DATE RECEIVED: | **4-15-11** | | |

| | | | |
|---|---|---|---|
| SAMPLE NO. | **P-24** | SAMPLE LOCATION: | **CAP** |
| TYPE | **UNDISTURBED** | SAMPLE DESCRIPTION: | **RED & GREY CLAY** |

## SAMPLE DIMENSIONS AND PROPERTIES

| ITEM | INITIAL | | FINAL | |
|---|---|---|---|---|
| | inches | centimeters | inches | centimeters |
| Sample Length | 2.960 | 7.518 | 2.978 | 7.564 |
| Sample Diameter | 2.847 | 7.231 | 2.850 | 7.239 |
| Length/Diameter Ratio | | 1.04 | | |
| Moisture Content (%) | WW= 155.8 DW= 128.4 | 21.3 | WW= 253.1 DW= 200.9 | 26.0 |
| Sample Wet Weight (grams) | 579.6 | | 606.5 | |
| Wet Density (pcf) | 117.2 | | 121.6 | |
| Dry Density (pcf) | 96.6 | | 96.5 | |
| Saturation (%) ASSUMED SG= 2.7 | 77 | | 94 | |

## HYDRAULIC CONDUCTIVITY TESTING MEASUREMENT

(PERMOMETER)

| Confining Pressure (psi) 75 | Influent Pressure (psi) 70 | Effluent Pressure (psi) 70 | B-Value 0.96 |
|---|---|---|---|

| Reset (Y/N) | Date | Clock Time | Elapsed Time | $HA_{OUT}$ (cm) | $HA_{IN}$ (cm) | Temp °C | Gradient | K (cm/sec) | Temp Correction | $K_{20°C}$ (cm/sec) |
|---|---|---|---|---|---|---|---|---|---|---|
| Y | 4-17-11 | 1:43:16 | | 7.4 | 1.67 | 21.5 | 10 | | | |
| | 4-17-11 | 1:52:14 | 0:08:58 | 3.5 | 1.83 | 21.5 | 3 | 1.0E-06 | 0.965 | 9.8E-07 |
| | 4-17-11 | 1:52:41 | 0:09:25 | 3.4 | 1.84 | 21.5 | 3 | 1.0E-06 | 0.965 | 9.8E-07 |
| | 4-17-11 | 1:53:17 | 0:10:01 | 3.3 | 1.84 | 21.5 | 3 | 1.0E-06 | 0.965 | 9.7E-07 |
| | 4-17-11 | 1:53:49 | 0:10:33 | 3.2 | 1.85 | 21.5 | 3 | 1.0E-06 | 0.965 | 9.7E-07 |

**HYDRAULIC CONDUCTIVITY ($K_{20°C}$) 9.7E-07 cm/sec**

BLE INC.

# HYDRAULIC CONDUCTIVITY TEST REPORT

**CONSTANT VOLUME APPARATUS (ASTM D 5084)**

| | | | |
|---|---|---|---|
| PROJECT: | **ARROWHEAD LANDFILL** | TESTED BY: | **JOHN MATHEW** |
| PROJECT NO.: | **J11-4999-27** | CHECKED BY: | **PAUL YARBER** |
| DATE RECEIVED: | **4-15-11** | | |

| | | | |
|---|---|---|---|
| SAMPLE NO. | **P-25** | SAMPLE LOCATION: | **CAP** |
| TYPE | **UNDISTURBED** | SAMPLE DESCRIPTION: | **RED & GREY CLAY** |

## SAMPLE DIMENSIONS AND PROPERTIES

| ITEM | INITIAL | | FINAL | |
|---|---|---|---|---|
| | inches | centimeters | inches | centimeters |
| Sample Length | 2.941 | 7.470 | 2.945 | 7.480 |
| Sample Diameter | 2.856 | 7.254 | 2.864 | 7.275 |
| Length/Diameter Ratio | | 1.03 | | |
| Moisture Content (%) | WW= 156.9 DW= 123.9 | 26.6 | WW= 215.0 DW= 169.2 | 27.1 |
| Sample Wet Weight (grams) | 596.3 | | 605.6 | |
| Wet Density (pcf) | 120.6 | | 121.6 | |
| Dry Density (pcf) | 95.2 | | 95.7 | |
| Saturation (%) ASSUMED SG= 2.7 | 93 | | 96 | |

## HYDRAULIC CONDUCTIVITY TESTING MEASUREMENT

(PERMOMETER)

| Confining Pressure (psi) 75 | Influent Pressure (psi) 70 | Effluent Pressure (psi) 70 | B-Value 0.96 |
|---|---|---|---|

| Reset (Y/N) | Date | Clock Time | Elapsed Time | $HA_{OUT}$ (cm) | $HA_{IN}$ (cm) | Temp °C | Gradient | K (cm/sec) | Temp Correction | $K_{20°C}$ (cm/sec) |
|---|---|---|---|---|---|---|---|---|---|---|
| Y | 4-17-11 | 1:51:42 | | 7.3 | 1.57 | 21.5 | 10 | | | |
| | 4-17-11 | 2:01:14 | 0:09:32 | 6.5 | 1.61 | 21.5 | 9 | 1.2E-07 | 0.965 | 1.1E-07 |
| | 4-17-11 | 2:02:15 | 0:10:33 | 6.4 | 1.61 | 21.5 | 8 | 1.2E-07 | 0.965 | 1.2E-07 |
| | 4-17-11 | 2:03:28 | 0:11:46 | 6.3 | 1.62 | 21.5 | 8 | 1.2E-07 | 0.965 | 1.2E-07 |
| | 4-17-11 | 2:04:49 | 0:13:07 | 6.2 | 1.62 | 21.5 | 8 | 1.2E-07 | 0.965 | 1.2E-07 |

**HYDRAULIC CONDUCTIVITY ($K_{20°C}$) 1.2E-07 cm/sec**

BLE INC.

# HYDRAULIC CONDUCTIVITY TEST REPORT

**CONSTANT VOLUME APPARATUS (ASTM D 5084)**

| | | | |
|---|---|---|---|
| PROJECT: | **ARROWHEAD LANDFILL** | TESTED BY: | **JOHN MATHEW** |
| PROJECT NO.: | **J11-4999-27** | CHECKED BY: | **PAUL YARBER** |
| DATE RECEIVED: | **4-15-11** | | |

| | | | |
|---|---|---|---|
| SAMPLE NO. | **P-26** | SAMPLE LOCATION: | **CAP** |
| TYPE | **UNDISTURBED** | SAMPLE DESCRIPTION: | **RED & GREY CLAY** |

## SAMPLE DIMENSIONS AND PROPERTIES

| ITEM | INITIAL | | FINAL | |
|---|---|---|---|---|
| | inches | centimeters | inches | centimeters |
| Sample Length | 2.901 | 7.369 | 2.894 | 7.351 |
| Sample Diameter | 2.850 | 7.239 | 2.858 | 7.259 |
| Length/Diameter Ratio | | 1.02 | | |
| Moisture Content (%) | WW= 150.0 DW= 115.7 | 29.6 | WW= 226.3 DW= 173.3 | 30.6 |
| Sample Wet Weight (grams) | 570.4 | | 580.9 | |
| Wet Density (pcf) | 117.4 | | 119.2 | |
| Dry Density (pcf) | 90.6 | | 91.3 | |
| Saturation (%) ASSUMED SG= 2.7 | 93 | | 98 | |

## HYDRAULIC CONDUCTIVITY TESTING MEASUREMENT

(PERMOMETER)

| Confining Pressure (psi) | 75 | Influent Pressure (psi) | 70 | Effluent Pressure (psi) | 70 | B-Value | 0.96 |
|---|---|---|---|---|---|---|---|

| Reset (Y/N) | Date | Clock Time | Elapsed Time | $HA_{OUT}$ (cm) | $HA_{IN}$ (cm) | Temp °C | Gradient | K (cm/sec) | Temp Correction | $K_{20°C}$ (cm/sec) |
|---|---|---|---|---|---|---|---|---|---|---|
| Y | 4-17-11 | 2:01:26 | | 7.3 | 1.68 | 21.5 | 10 | | | |
| | 4-17-11 | 2:06:47 | 0:05:21 | 5.8 | 1.74 | 21.5 | 7 | 4.3E-07 | 0.965 | 4.2E-07 |
| | 4-17-11 | 2:07:13 | 0:05:47 | 5.7 | 1.74 | 21.5 | 7 | 4.3E-07 | 0.965 | 4.2E-07 |
| | 4-17-11 | 2:07:51 | 0:06:25 | 5.6 | 1.75 | 21.5 | 7 | 4.2E-07 | 0.965 | 4.0E-07 |
| | 4-17-11 | 2:08:19 | 0:06:53 | 5.5 | 1.75 | 21.5 | 7 | 4.2E-07 | 0.965 | 4.0E-07 |

**HYDRAULIC CONDUCTIVITY ($K_{20°C}$) 4.1E-07 cm/sec**

BLB INC.

# HYDRAULIC CONDUCTIVITY TEST REPORT

**CONSTANT VOLUME APPARATUS (ASTM D 5084)**

| | | | |
|---|---|---|---|
| PROJECT: | **ARROWHEAD LANDFILL** | TESTED BY: | **JOHN MATHEW** |
| PROJECT NO.: | **J11-4999-27** | CHECKED BY: | **PAUL YARBER** |
| DATE RECEIVED: | **5-2-11** | | |

| | | | |
|---|---|---|---|
| SAMPLE NO. | **P-27** | SAMPLE LOCATION: | **CAP** |
| TYPE | **UNDISTURBED** | SAMPLE DESCRIPTION: | **RED & GREY CLAY** |

## SAMPLE DIMENSIONS AND PROPERTIES

| ITEM | INITIAL | | FINAL | |
|---|---|---|---|---|
| | inches | centimeters | inches | centimeters |
| Sample Length | 2.954 | 7.503 | 2.865 | 7.277 |
| Sample Diameter | 2.856 | 7.254 | 2.851 | 7.242 |
| Length/Diameter Ratio | | 1.03 | | |
| Moisture Content (%) | WW= 130.8 DW= 105.1 | 24.5 | WW= 233.7 DW= 186.1 | 25.6 |
| Sample Wet Weight (grams) | 610.3 | | 598.8 | |
| Wet Density (pcf) | 122.9 | | 124.7 | |
| Dry Density (pcf) | 98.7 | | 99.3 | |
| Saturation (%) ASSUMED SG= 2.7 | 93 | | 99 | |

## HYDRAULIC CONDUCTIVITY TESTING MEASUREMENT

(PERMOMETER)

| Confining Pressure (psi) 75 | Influent Pressure (psi) 70 | Effluent Pressure (psi) 70 | B-Value 0.96 |
|---|---|---|---|

| Reset (Y/N) | Date | Clock Time | Elapsed Time | $HA_{OUT}$ (cm) | $HA_{IN}$ (cm) | Temp °C | Gradient | K (cm/sec) | Temp Correction | $K_{20°C}$ (cm/sec) |
|---|---|---|---|---|---|---|---|---|---|---|
| Y | 5-3-11 | 2:30:30 | | 7.4 | 1.67 | 22.1 | 10 | | | |
| | 5-3-11 | 2:40:47 | 0:10:17 | 6.5 | 1.71 | 22.1 | 9 | 1.2E-07 | 0.951 | 1.2E-07 |
| | 5-3-11 | 2:41:54 | 0:11:24 | 6.4 | 1.72 | 22.1 | 8 | 1.2E-07 | 0.951 | 1.2E-07 |
| | 5-3-11 | 2:43:09 | 0:12:39 | 6.3 | 1.72 | 22.1 | 8 | 1.2E-07 | 0.951 | 1.2E-07 |
| | 5-3-11 | 2:44:24 | 0:13:54 | 6.2 | 1.72 | 22.1 | 8 | 1.3E-07 | 0.951 | 1.2E-07 |

**HYDRAULIC CONDUCTIVITY ($K_{20°C}$) 1.2E-07 cm/sec**

IBLE INC.

# HYDRAULIC CONDUCTIVITY TEST REPORT

**CONSTANT VOLUME APPARATUS (ASTM D 5084)**

| | | | |
|---|---|---|---|
| PROJECT: | **ARROWHEAD LANDFILL** | TESTED BY: | **JOHN MATHEW** |
| PROJECT NO.: | **J11-4999-27** | CHECKED BY: | **PAUL YARBER** |
| DATE RECEIVED: | **5-2-11** | | |

| | | | |
|---|---|---|---|
| SAMPLE NO. | **P-28** | SAMPLE LOCATION: | **CAP** |
| TYPE | **UNDISTURBED** | SAMPLE DESCRIPTION: | **RED & GREY CLAY** |

## SAMPLE DIMENSIONS AND PROPERTIES

| ITEM | INITIAL | | FINAL | |
|---|---|---|---|---|
| | inches | centimeters | inches | centimeters |
| Sample Length | 2.859 | 7.262 | 2.964 | 7.529 |
| Sample Diameter | 2.852 | 7.244 | 2.854 | 7.249 |
| Length/Diameter Ratio | | 1.00 | | |
| Moisture Content (%) | WW= 195.8 DW= 158.5 | 23.5 | WW= 257.5 DW= 204.8 | 25.7 |
| Sample Wet Weight (grams) | 588.5 | | 619.7 | |
| Wet Density (pcf) | 122.7 | | 124.5 | |
| Dry Density (pcf) | 99.4 | | 99.0 | |
| Saturation (%) ASSUMED SG= 2.7 | 91 | | 99 | |

## HYDRAULIC CONDUCTIVITY TESTING MEASUREMENT

(PERMOMETER)

| Confining Pressure (psi) 75 | Influent Pressure (psi) 70 | Effluent Pressure (psi) 70 | B-Value 0.95 |
|---|---|---|---|

| Reset (Y/N) | Date | Clock Time | Elapsed Time | $HA_{OUT}$ (cm) | $HA_{IN}$ (cm) | Temp °C | Gradient | K (cm/sec) | Temp Correction | $K_{20°C}$ (cm/sec) |
|---|---|---|---|---|---|---|---|---|---|---|
| Y | 5-3-11 | 3:02:00 | | 7.2 | 1.68 | 22.1 | 10 | | | |
| | 5-3-11 | 3:10:21 | 0:08:21 | 6.2 | 1.72 | 22.1 | 8 | 1.8E-07 | 0.951 | 1.7E-07 |
| | 5-3-11 | 3:11:36 | 0:09:36 | 6.1 | 1.73 | 22.1 | 8 | 1.8E-07 | 0.951 | 1.7E-07 |
| | 5-3-11 | 3:12:54 | 0:10:54 | 6.0 | 1.73 | 22.1 | 7 | 1.7E-07 | 0.951 | 1.6E-07 |
| | 5-3-11 | 3:14:16 | 0:12:16 | 5.9 | 1.74 | 22.1 | 7 | 1.7E-07 | 0.951 | 1.6E-07 |

**HYDRAULIC CONDUCTIVITY ($K_{20°C}$) 1.7E-07 cm/sec**

BLE INC.

# HYDRAULIC CONDUCTIVITY TEST REPORT

**CONSTANT VOLUME APPARATUS (ASTM D 5084)**

| | | | |
|---|---|---|---|
| PROJECT: | **ARROWHEAD LANDFILL** | TESTED BY: | **JOHN MATHEW** |
| PROJECT NO.: | **J11-4999-27** | CHECKED BY: | **PAUL YARBER** |
| DATE RECEIVED: | **5-2-11** | | |

| | | | |
|---|---|---|---|
| SAMPLE NO. | **P-29** | SAMPLE LOCATION: | **CAP** |
| TYPE | **UNDISTURBED** | SAMPLE DESCRIPTION: | **RED & GREY CLAY** |

## SAMPLE DIMENSIONS AND PROPERTIES

| ITEM | INITIAL | | FINAL | |
|---|---|---|---|---|
| | inches | centimeters | inches | centimeters |
| Sample Length | 2.978 | 7.564 | 2.955 | 7.506 |
| Sample Diameter | 2.852 | 7.244 | 2.849 | 7.236 |
| Length/Diameter Ratio | | 1.04 | | |
| Moisture Content (%) | WW= 149.7 DW= 117.8 | 27.1 | WW= 257.8 DW= 202.4 | 27.4 |
| Sample Wet Weight (grams) | 601.6 | | 606.8 | |
| Wet Density (pcf) | 120.5 | | 122.7 | |
| Dry Density (pcf) | 94.8 | | 96.3 | |
| Saturation (%) ASSUMED SG= 2.7 | 94 | | 99 | |

## HYDRAULIC CONDUCTIVITY TESTING MEASUREMENT

(PERMOMETER)

| Confining Pressure (psi) 75 | Influent Pressure (psi) 70 | Effluent Pressure (psi) 70 | B-Value 0.95 |
|---|---|---|---|

| Reset (Y/N) | Date | Clock Time | Elapsed Time | $HA_{OUT}$ (cm) | $HA_{IN}$ (cm) | Temp °C | Gradient | K (cm/sec) | Temp Correction | $K_{20°C}$ (cm/sec) |
|---|---|---|---|---|---|---|---|---|---|---|
| Y | 5-3-11 | 3:14:03 | | 7.5 | 1.67 | 22.1 | 10 | | | |
| | 5-3-11 | 3:30:47 | 0:16:44 | 6.5 | 1.71 | 22.1 | 8 | 8.6E-08 | 0.951 | 8.2E-08 |
| | 5-3-11 | 3:32:40 | 0:18:37 | 6.4 | 1.72 | 22.1 | 8 | 8.6E-08 | 0.951 | 8.2E-08 |
| | 5-3-11 | 3:34:43 | 0:20:40 | 6.3 | 1.72 | 22.1 | 8 | 8.5E-08 | 0.951 | 8.1E-08 |
| | 5-3-11 | 3:36:51 | 0:22:48 | 6.2 | 1.72 | 22.1 | 8 | 8.5E-08 | 0.951 | 8.0E-08 |

**HYDRAULIC CONDUCTIVITY ($K_{20°C}$) 8.1E-08 cm/sec**

BLE INC.

# HYDRAULIC CONDUCTIVITY TEST REPORT

**CONSTANT VOLUME APPARATUS (ASTM D 5084)**

| | | | |
|---|---|---|---|
| PROJECT: | **ARROWHEAD LANDFILL** | TESTED BY: | **JOHN MATHEW** |
| PROJECT NO.: | **J11-4999-27** | CHECKED BY: | **PAUL YARBER** |
| DATE RECEIVED: | **5-2-11** | | |

| | | | |
|---|---|---|---|
| SAMPLE NO. | **P-30** | SAMPLE LOCATION: | **CAP** |
| TYPE | **UNDISTURBED** | SAMPLE DESCRIPTION: | **RED & GREY CLAY** |

## SAMPLE DIMENSIONS AND PROPERTIES

| ITEM | INITIAL | | FINAL | |
|---|---|---|---|---|
| | inches | centimeters | inches | centimeters |
| Sample Length | 2.879 | 7.313 | 2.911 | 7.394 |
| Sample Diameter | 2.848 | 7.234 | 2.883 | 7.323 |
| Length/Diameter Ratio | | 1.01 | | |
| Moisture Content (%) | WW= 179.4 DW= 144.3 | 24.3 | WW= 190.9 DW= 146.1 | 30.7 |
| Sample Wet Weight (grams) | 588.0 | | 589.5 | |
| Wet Density (pcf) | 122.1 | | 118.2 | |
| Dry Density (pcf) | 98.2 | | 90.4 | |
| Saturation (%) ASSUMED SG= 2.7 | 92 | | 96 | |

## HYDRAULIC CONDUCTIVITY TESTING MEASUREMENT

(PERMOMETER)

| Confining Pressure (psi) 75 | Influent Pressure (psi) 70 | Effluent Pressure (psi) 70 | B-Value 0.95 |
|---|---|---|---|

| Reset (Y/N) | Date | Clock Time | Elapsed Time | $HA_{OUT}$ (cm) | $HA_{IN}$ (cm) | Temp °C | Gradient | K (cm/sec) | Temp Correction | $K_{20°C}$ (cm/sec) |
|---|---|---|---|---|---|---|---|---|---|---|
| Y | 5-3-11 | 2:18:07 | | 4.5 | 1.79 | 22.1 | 5 | | | |
| | 5-3-11 | 2:21:33 | 0:03:26 | 3.9 | 1.82 | 22.1 | 4 | 5.4E-07 | 0.951 | 5.1E-07 |
| | 5-3-11 | 2:22:10 | 0:04:03 | 3.8 | 1.82 | 22.1 | 4 | 5.4E-07 | 0.951 | 5.2E-07 |
| | 5-3-11 | 2:22:49 | 0:04:42 | 3.7 | 1.83 | 22.1 | 4 | 5.5E-07 | 0.951 | 5.2E-07 |
| | 5-3-11 | 2:23:31 | 0:05:24 | 3.6 | 1.83 | 22.1 | 3 | 5.5E-07 | 0.951 | 5.3E-07 |

**HYDRAULIC CONDUCTIVITY ($K_{20°C}$) 5.2E-07 cm/sec**

BLE INC.

# HYDRAULIC CONDUCTIVITY TEST REPORT

**CONSTANT VOLUME APPARATUS (ASTM D 5084)**

| | | | |
|---|---|---|---|
| PROJECT: | **ARROWHEAD LANDFILL** | TESTED BY: | **JOHN MATHEW** |
| PROJECT NO.: | **J11-4999-27** | CHECKED BY: | **PAUL YARBER** |
| DATE RECEIVED: | **5-9-11** | | |

| | | | |
|---|---|---|---|
| SAMPLE NO. | **P-31** | SAMPLE LOCATION: | **CAP** |
| TYPE | **UNDISTURBED** | SAMPLE DESCRIPTION: | **RED & GREY CLAY** |

## SAMPLE DIMENSIONS AND PROPERTIES

| ITEM | INITIAL | | FINAL | |
|---|---|---|---|---|
| | inches | centimeters | inches | centimeters |
| Sample Length | 2.973 | 7.551 | 2.978 | 7.564 |
| Sample Diameter | 2.851 | 7.242 | 2.856 | 7.254 |
| Length/Diameter Ratio | | 1.04 | | |
| Moisture Content (%) | WW= 150.3 DW= 121.8 | 23.4 | WW= 218.9 DW= 172.1 | 27.2 |
| Sample Wet Weight (grams) | 594.5 | | 600.9 | |
| Wet Density (pcf) | 119.3 | | 120.0 | |
| Dry Density (pcf) | 96.7 | | 94.3 | |
| Saturation (%) ASSUMED SG= 2.7 | 85 | | 93 | |

## HYDRAULIC CONDUCTIVITY TESTING MEASUREMENT

(PERMOMETER)

| Confining Pressure (psi) 75 | Influent Pressure (psi) 70 | Effluent Pressure (psi) 70 | B-Value 0.96 |
|---|---|---|---|

| Reset (Y/N) | Date | Clock Time | Elapsed Time | $HA_{OUT}$ (cm) | $HA_{IN}$ (cm) | Temp °C | Gradient | K (cm/sec) | Temp Correction | $K_{20°C}$ (cm/sec) |
|---|---|---|---|---|---|---|---|---|---|---|
| Y | 5-10-11 | 10:17:16 | | 7.4 | 1.57 | 23.5 | 10 | | | |
| | 5-10-11 | 10:21:27 | 0:04:11 | 6.9 | 1.59 | 23.5 | 9 | 1.6E-07 | 0.920 | 1.5E-07 |
| | 5-10-11 | 10:22:35 | 0:05:19 | 6.8 | 1.60 | 23.5 | 9 | 1.6E-07 | 0.920 | 1.4E-07 |
| | 5-10-11 | 10:23:47 | 0:06:31 | 6.7 | 1.60 | 23.5 | 9 | 1.5E-07 | 0.920 | 1.4E-07 |
| | 5-10-11 | 10:24:53 | 0:07:37 | 6.6 | 1.60 | 23.5 | 9 | 1.5E-07 | 0.920 | 1.4E-07 |

**HYDRAULIC CONDUCTIVITY ($K_{20°C}$) 1.4E-07 cm/sec**

BLE INC.

# HYDRAULIC CONDUCTIVITY TEST REPORT

**CONSTANT VOLUME APPARATUS (ASTM D 5084)**

| | | | |
|---|---|---|---|
| PROJECT: | **ARROWHEAD LANDFILL** | TESTED BY: | **JOHN MATHEW** |
| PROJECT NO.: | **J11-4999-27** | CHECKED BY: | **PAUL YARBER** |
| DATE RECEIVED: | **5-9-11** | | |

| | | | |
|---|---|---|---|
| SAMPLE NO. | **P-32** | SAMPLE LOCATION: | **CAP** |
| TYPE | **UNDISTURBED** | SAMPLE DESCRIPTION: | **RED & GREY CLAY** |

## SAMPLE DIMENSIONS AND PROPERTIES

| ITEM | INITIAL | | FINAL | |
|---|---|---|---|---|
| | inches | centimeters | inches | centimeters |
| Sample Length | 2.869 | 7.287 | 2.880 | 7.315 |
| Sample Diameter | 2.858 | 7.259 | 2.867 | 7.282 |
| Length/Diameter Ratio | | 1.00 | | |
| Moisture Content (%) | WW= 126.1 DW= 102.3 | 23.3 | WW= 210.5 DW= 165.8 | 27.0 |
| Sample Wet Weight (grams) | 587.8 | | 597.2 | |
| Wet Density (pcf) | 121.7 | | 122.4 | |
| Dry Density (pcf) | 98.7 | | 96.4 | |
| Saturation (%) ASSUMED SG= 2.7 | 89 | | 97 | |

## HYDRAULIC CONDUCTIVITY TESTING MEASUREMENT

(PERMOMETER)

| Confining Pressure (psi) 75 | Influent Pressure (psi) 70 | Effluent Pressure (psi) 70 | B-Value 0.96 |
|---|---|---|---|

| Reset (Y/N) | Date | Clock Time | Elapsed Time | $HA_{OUT}$ (cm) | $HA_{IN}$ (cm) | Temp °C | Gradient | K (cm/sec) | Temp Correction | $K_{20°C}$ (cm/sec) |
|---|---|---|---|---|---|---|---|---|---|---|
| Y | 5-10-11 | 10:27:45 | | 7.2 | 1.58 | 23.5 | 10 | | | |
| | 5-10-11 | 10:48:20 | 0:20:35 | 6.7 | 1.60 | 23.5 | 9 | 3.3E-08 | 0.920 | 3.1E-08 |
| | 5-10-11 | 10:52:35 | 0:24:50 | 6.6 | 1.60 | 23.5 | 9 | 3.3E-08 | 0.920 | 3.1E-08 |
| | 5-10-11 | 10:57:06 | 0:29:21 | 6.5 | 1.61 | 23.5 | 9 | 3.3E-08 | 0.920 | 3.1E-08 |
| | 5-10-11 | 11:02:43 | 0:34:58 | 6.4 | 1.61 | 23.5 | 9 | 3.2E-08 | 0.920 | 3.0E-08 |

**HYDRAULIC CONDUCTIVITY ($K_{20°C}$) 3.0E-08 cm/sec**

BLB INC.

# HYDRAULIC CONDUCTIVITY TEST REPORT

**CONSTANT VOLUME APPARATUS (ASTM D 5084)**

| | | | |
|---|---|---|---|
| PROJECT: | **ARROWHEAD LANDFILL** | TESTED BY: | **JOHN MATHEW** |
| PROJECT NO.: | **J11-4999-27** | CHECKED BY: | **PAUL YARBER** |
| DATE RECEIVED: | **5-9-11** | | |

| | | | |
|---|---|---|---|
| SAMPLE NO. | **P-33** | SAMPLE LOCATION: | **CAP** |
| TYPE | **UNDISTURBED** | SAMPLE DESCRIPTION: | **RED & GREY CLAY** |

## SAMPLE DIMENSIONS AND PROPERTIES

| ITEM | INITIAL | | FINAL | |
|---|---|---|---|---|
| | inches | centimeters | inches | centimeters |
| Sample Length | 2.886 | 7.330 | 2.880 | 7.315 |
| Sample Diameter | 2.859 | 7.262 | 2.858 | 7.259 |
| Length/Diameter Ratio | | 1.01 | | |
| Moisture Content (%) | WW= 123.8 DW= 97.5 | 27.0 | WW= 244.5 DW= 189.6 | 29.0 |
| Sample Wet Weight (grams) | 576.3 | | 580.9 | |
| Wet Density (pcf) | 118.5 | | 119.8 | |
| Dry Density (pcf) | 93.3 | | 92.9 | |
| Saturation (%) ASSUMED SG= 2.7 | 90 | | 96 | |

## HYDRAULIC CONDUCTIVITY TESTING MEASUREMENT

(PERMOMETER)

| Confining Pressure (psi) 75 | Influent Pressure (psi) 70 | Effluent Pressure (psi) 70 | B-Value 0.96 |
|---|---|---|---|

| Reset (Y/N) | Date | Clock Time | Elapsed Time | $HA_{OUT}$ (cm) | $HA_{IN}$ (cm) | Temp °C | Gradient | K (cm/sec) | Temp Correction | $K_{20°C}$ (cm/sec) |
|---|---|---|---|---|---|---|---|---|---|---|
| Y | 5-10-11 | 10:37:03 | | 7.3 | 1.68 | 23.5 | 10 | | | |
| | 5-10-11 | 10:58:45 | 0:21:42 | 6.4 | 1.72 | 23.5 | 8 | 5.9E-08 | 0.920 | 5.5E-08 |
| | 5-10-11 | 11:01:45 | 0:24:42 | 6.3 | 1.72 | 23.5 | 8 | 5.9E-08 | 0.920 | 5.4E-08 |
| | 5-10-11 | 11:04:37 | 0:27:34 | 6.2 | 1.72 | 23.5 | 8 | 5.8E-08 | 0.920 | 5.4E-08 |
| | 5-10-11 | 11:07:48 | 0:30:45 | 6.1 | 1.73 | 23.5 | 8 | 5.8E-08 | 0.920 | 5.3E-08 |

**HYDRAULIC CONDUCTIVITY ($K_{20°C}$) 5.4E-08 cm/sec**

BLE INC.

# HYDRAULIC CONDUCTIVITY TEST REPORT

**CONSTANT VOLUME APPARATUS (ASTM D 5084)**

| | | | |
|---|---|---|---|
| PROJECT: | **ARROWHEAD LANDFILL** | TESTED BY: | **JOHN MATHEW** |
| PROJECT NO.: | **J11-4999-27** | CHECKED BY: | **PAUL YARBER** |
| DATE RECEIVED: | **5-9-11** | | |

| | | | |
|---|---|---|---|
| SAMPLE NO. | **P-34** | SAMPLE LOCATION: | **CAP** |
| TYPE | **UNDISTURBED** | SAMPLE DESCRIPTION: | **RED & GREY CLAY** |

## SAMPLE DIMENSIONS AND PROPERTIES

| ITEM | INITIAL | | FINAL | |
|---|---|---|---|---|
| | inches | centimeters | inches | centimeters |
| Sample Length | 2.968 | 7.539 | 2.948 | 7.488 |
| Sample Diameter | 2.859 | 7.262 | 2.874 | 7.300 |
| Length/Diameter Ratio | | 1.04 | | |
| Moisture Content (%) | WW= 220.7 DW= 175.4 | 25.8 | WW= 248.3 DW= 196.8 | 26.2 |
| Sample Wet Weight (grams) | 600.8 | | 607.5 | |
| Wet Density (pcf) | 120.1 | | 121.0 | |
| Dry Density (pcf) | 95.5 | | 95.9 | |
| Saturation (%) ASSUMED SG= 2.7 | 91 | | 93 | |

## HYDRAULIC CONDUCTIVITY TESTING MEASUREMENT

(PERMOMETER)

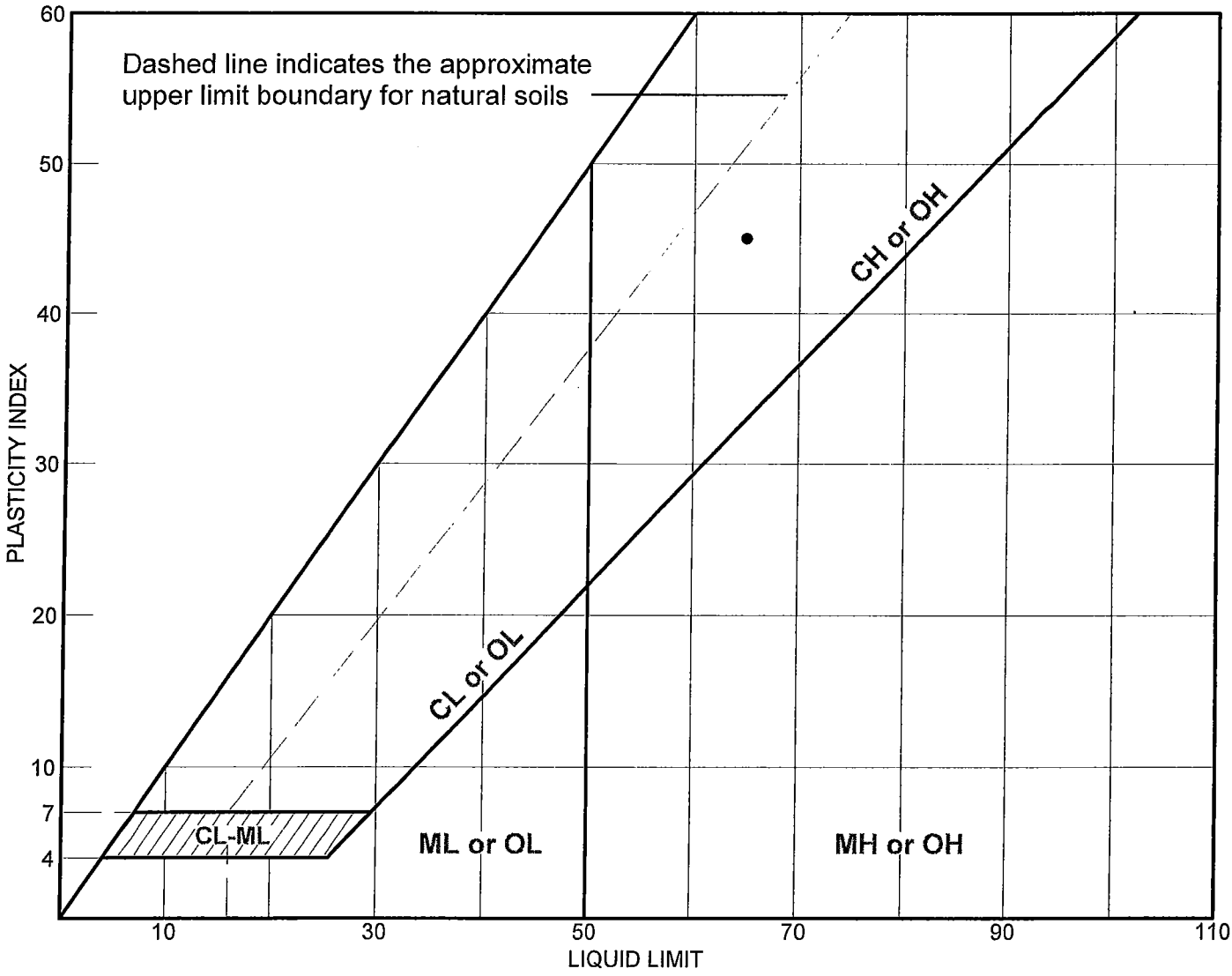
| Confining Pressure (psi) | 75 | Influent Pressure (psi) | 70 | Effluent Pressure (psi) | 70 | B-Value | 0.96 |
|---|---|---|---|---|---|---|---|

| Reset (Y/N) | Date | Clock Time | Elapsed Time | $HA_{OUT}$ (cm) | $HA_{IN}$ (cm) | Temp °C | Gradient | K (cm/sec) | Temp Correction | $K_{20°C}$ (cm/sec) |
|---|---|---|---|---|---|---|---|---|---|---|
| Y | 5-10-11 | 11:11:38 | | 7.5 | 1.67 | 23.5 | 10 | | | |
| | 5-10-11 | 11:24:14 | 0:12:36 | 6.9 | 1.70 | 23.5 | 9 | 6.4E-08 | 0.920 | 5.9E-08 |
| | 5-10-11 | 11:26:27 | 0:14:49 | 6.8 | 1.70 | 23.5 | 9 | 6.5E-08 | 0.920 | 5.9E-08 |
| | 5-10-11 | 11:28:53 | 0:17:15 | 6.7 | 1.70 | 23.5 | 9 | 6.4E-08 | 0.920 | 5.9E-08 |
| | 5-10-11 | 11:31:23 | 0:19:45 | 6.6 | 1.71 | 23.5 | 9 | 6.4E-08 | 0.920 | 5.8E-08 |

**HYDRAULIC CONDUCTIVITY ($K_{20°C}$) 5.9E-08 cm/sec**

# Historical Atterberg Limit Test Results – Partial Closure Cap Project (BLE, 2011)

# LIQUID AND PLASTIC LIMITS TEST REPORT

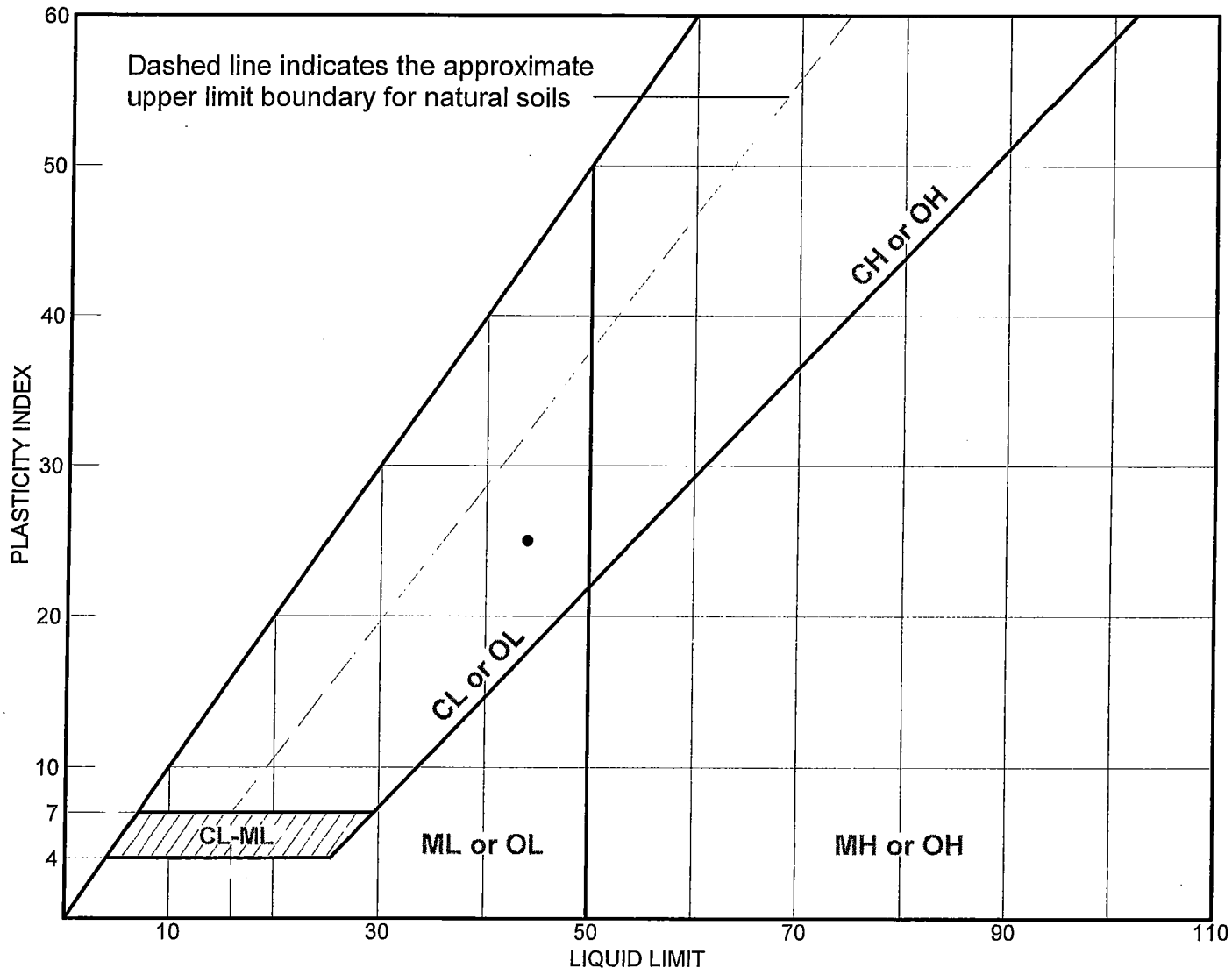



**SOIL DATA**

| SYMBOL | SOURCE | SAMPLE NO. | DEPTH (ft.) | NATURAL WATER CONTENT (%) | PLASTIC LIMIT (%) | LIQUID LIMIT (%) | PLASTICITY INDEX (%) | USCS |
|---|---|---|---|---|---|---|---|---|
| ● | Struct. Fill | SF-2 | | | 20 | 65 | 45 | CH |

| | |
|---|---|
| LIQUID AND PLASTIC LIMITS TEST REPORT<br>**Bunnell Lammons Engineering, Inc.**<br>**Greenville, SC** | **Client:** Hodges, Harbin, Newberry & Tribble Inc.<br>**Project:** Perry Uniontown Landfill<br>Cells 3, 4 & 5<br>**Project No.:** J07-4999-04 **Figure** |

# LIQUID AND PLASTIC LIMITS TEST REPORT




**SOIL DATA**

| SYMBOL | SOURCE | SAMPLE NO. | DEPTH (ft.) | NATURAL WATER CONTENT (%) | PLASTIC LIMIT (%) | LIQUID LIMIT (%) | PLASTICITY INDEX (%) | USCS |
|---|---|---|---|---|---|---|---|---|
| ● | Liner | CLBW-2 | | 22.7 | 19 | 44 | 25 | CL |

| | |
|---|---|
| LIQUID AND PLASTIC LIMITS TEST REPORT<br>**Bunnell Lammons Engineering, Inc.**<br>**Greenville, SC** | **Client:** HHNT<br>**Project:** Arrowhead Landfill<br>**Project No.:** J11-4999-27 **Figure** |

# APPENDIX H

# IMPORTANT INFORMATION ABOUT THIS GEOTECHNICAL-ENGINEERING REPORT

# IMPORTANT INFORMATION ABOUT THIS

# GEOTECHNICAL-ENGINEERING REPORT

**Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes.**

**While you cannot eliminate all such risks, you can manage them. The following information is provided to help.**

**Bunnell-Lammons Engineering, Inc. (BLE) has prepared this advisory to help you interpret and apply this geotechnical-engineering report as effectively as possible. In that way, you can benefit from a lowered exposure to problems associated with subsurface conditions at project sites and their development, which for decades have been a principal cause of construction delays, cost overruns, claims, and disputes. If you have questions or want more information about any of the issues discussed herein, reach to your BLE contact.**

## Understand the Geotechnical-Engineering Services Provided for this Report

Geotechnical-engineering services typically include the planning, collection, interpretation, and analysis of exploratory data from widely spaced borings and/or test pits. Field data are combined with results from laboratory tests of soil and rock samples obtained from field exploration (if applicable), observations made during site reconnaissance, and historical information to form one or more models of the expected subsurface conditions beneath the site. Local geology and alterations of the site surface and subsurface by previous and proposed construction are also important considerations. Geotechnical engineers apply their engineering training, experience, and judgment to adapt the requirements of the prospective project to the subsurface model(s). Estimates are made of the subsurface conditions that will likely be exposed during construction as well as the expected performance of foundations and other structures being planned and/or affected by construction activities.

The culmination of these geotechnical-engineering services is typically a geotechnical-engineering report providing the data obtained, a discussion of the subsurface model(s), the engineering and geologic engineering assessments and analyses made, and the recommendations developed to satisfy the given requirements of the project. These reports may be titled investigations, explorations, studies, assessments, or evaluations. Regardless of the title used, the geotechnical-engineering report is an engineering interpretation of the subsurface conditions within the context of the project and does not represent a close examination, systematic inquiry, or thorough investigation of all site and subsurface conditions.

## Geotechnical-Engineering Services are Performed for Specific Purposes, Persons, and Projects, And At Specific Times

Geotechnical engineers structure their services to meet the specific needs, goals, and risk management preferences of their clients. A geotechnical-engineering study conducted for a given civil engineer will not likely meet the needs of a civil-works constructor or even a different civil engineer. Because each geotechnical-engineering study is unique, each geotechnical-engineering report is unique, prepared *solely* for the client.

Likewise, geotechnical-engineering services are performed for a specific project and purpose. For example, it is unlikely that a geotechnical-engineering study for a refrigerated warehouse will be the same as one prepared for a parking garage; and a few borings drilled during a preliminary study to evaluate site feasibility will not be adequate to develop geotechnical design recommendations for the project.

*Do not rely on this report* if your geotechnical engineer prepared it:

- for a different client;
- for a different project or purpose;
- for a different site (that may or may not include all or a portion of the original site); or
- before important events occurred at the site or adjacent to it; e.g., man-made events like construction or environmental remediation, or natural events like floods, droughts, earthquakes, or groundwater fluctuations.

Note, too, the reliability of a geotechnical-engineering report can be affected by the passage of time, because of factors like changed subsurface conditions; new or modified codes, standards, or regulations; or new techniques or tools. *If you are the least bit uncertain* about the continued reliability of this report, contact your geotechnical engineer before applying the recommendations in it. A minor amount of additional testing or analysis after the passage of time – if any is required at all – could prevent major problems.

## Read this Report in Full

Costly problems have occurred because those relying on a geotechnical-engineering report did not read the report in its entirety. Do not rely on an executive summary. Do not read selective elements only. *Read and refer to the report in full.*

## You Need to Inform Your Geotechnical Engineer About Change

Your geotechnical engineer considered unique, project-specific factors when developing the scope of study behind this report and developing the confirmation-dependent recommendations the report conveys. Typical changes that could erode the reliability of this report include those that affect:

- the site's size or shape;
- the elevation, configuration, location, orientation, function or weight of the proposed structure and the desired performance criteria;
- the composition of the design team; or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project or site changes – even minor ones – and request an assessment of their impact. *The geotechnical engineer who prepared this report cannot accept responsibility or liability for problems that arise because the geotechnical engineer was not informed about developments the engineer otherwise would have considered.*

## Most of the "Findings" Related in This Report Are Professional Opinions

Before construction begins, geotechnical engineers explore a site's subsurface using various sampling and testing procedures. *Geotechnical engineers can observe actual subsurface conditions only at those specific locations where sampling and testing is performed.* The data derived from that sampling and testing were reviewed by your geotechnical engineer, who then applied professional judgment to form opinions about subsurface conditions throughout the site. Actual sitewide-subsurface conditions may differ – maybe significantly – from those indicated in this report. Confront that risk by retaining your geotechnical engineer to serve on the design team through project completion to obtain informed guidance quickly, whenever needed.

## This Report's Recommendations Are Confirmation-Dependent

The recommendations included in this report – including any options or alternatives – are confirmation-dependent. In other words, they are not final, because the geotechnical engineer who developed them relied heavily on judgment and opinion to do so. Your geotechnical engineer can finalize the recommendations *only after observing actual subsurface conditions* exposed during construction. If through observation your geotechnical engineer confirms that the conditions assumed to exist actually do exist, the recommendations can be relied upon, assuming no other changes have occurred. *The geotechnical engineer who prepared this report cannot assume responsibility or liability for confirmation-dependent recommendations if you fail to retain that engineer to perform construction observation.*

## This Report Could Be Misinterpreted

Other design professionals' misinterpretation of geotechnical-engineering reports has resulted in costly problems. Confront that risk by having your geotechnical engineer serve as a continuing member of the design team, to:

- confer with other design-team members;
- help develop specifications;
- review pertinent elements of other design professionals' plans and specifications; and
- be available whenever geotechnical-engineering guidance is needed.

You should also confront the risk of constructors misinterpreting this report. Do so by retaining your geotechnical engineer to participate in prebid and preconstruction conferences and to perform construction-phase observations.

## Give Constructors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can shift unanticipated-subsurface-conditions liability to constructors by limiting the information they provide for bid preparation. To help prevent the costly, contentious problems this practice has caused, include the complete geotechnical-engineering report, along with any attachments or appendices, with your contract documents, b*ut be certain to note conspicuously that you've included the material for information purposes only.* To avoid misunderstanding, you may also want to note that "informational purposes" means constructors have no right to rely on the interpretations, opinions, conclusions, or recommendations in the report. Be certain that constructors know they may learn about specific project requirements, including options selected from the report, *only* from the design drawings and specifications. Remind constructors that they may perform their own studies if they want to, and *be sure to allow enough time* to permit them to do so. Only then might you be in a position to give constructors the information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions. Conducting prebid and preconstruction conferences can also be valuable in this respect.

## Read Responsibility Provisions Closely

Some client representatives, design professionals, and constructors do not realize that geotechnical engineering is far less exact than other engineering disciplines. This happens in part because soil and rock on project sites are typically heterogeneous and not manufactured materials with well-defined engineering properties like steel and concrete. That lack of understanding has nurtured unrealistic expectations that have resulted in disappointments, delays, cost overruns, claims, and disputes. To confront that risk, geotechnical engineers commonly include explanatory provisions in their reports. Sometimes labeled "limitations," many of these provisions indicate where geotechnical engineers' responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely.* Ask questions. Your geotechnical engineer should respond fully and frankly.

## Geoenvironmental Concerns Are Not Covered

The personnel, equipment, and techniques used to perform an environmental study – e.g., a "phase-one" or "phase-two" environmental site assessment – differ significantly from those used to perform a geotechnical-engineering study. For that reason, a geotechnical-engineering report does not usually provide environmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated subsurface environmental problems have led to project failures.* If you have not obtained your own environmental information about the project site, ask your geotechnical consultant for a recommendation on how to find environmental risk-management guidance.

## Obtain Professional Assistance to Deal with Moisture Infiltration and Mold

While your geotechnical engineer may have addressed groundwater, water infiltration, or similar issues in this report, the engineer's services were not designed, conducted, or intended to prevent migration of moisture – including water vapor – from the soil through building slabs and walls and into the building interior, where it can cause mold growth and material-performance deficiencies. Accordingly, ***proper implementation of the geotechnical engineer's recommendations will not of itself be sufficient to prevent moisture infiltration. Confront the risk of moisture infiltration*** by including building-envelope or mold specialists on the design team. ***Geotechnical engineers are not building-envelope or mold specialists***.

# APPENDIX

A. Permit Application (Form 439)

B. Application Fee

C. List of Adjacent Property Owners & Addresses

D. Site Location Map

E. Site Analysis Report, prepared by JJ&G Inc. & dated September 2005 - (Hydrogeologic Evaluation)

F. Alabama Historical Commission Clearance Letter

G. Updated FEMA Flood Insurance Rate Map

H. Statement of Consistency from the Alabama-Tombigbee Regional Commission

I. Host Government Approval

J. CCR Acceptance Plan

# A. PERMIT APPLICATION (FORM 439)

# SOLID WASTE DISPOSAL FACILITY

## PERMIT APPLICATION PACKAGE

January 16, 2018

**M E M O R A N D U M**

TO: Applicants Seeking a Permit for Solid Waste Facilities

FROM: Stephen A. Cobb, Chief
Land Division
Alabama Department of Environmental Management

RE: Processing Solid Waste Permits by ADEM

Any permit issued by ADEM must be in accordance with §22-27-48 and §22-27-48.1 Code of Alabama. This section indicates that ADEM may not consider an application for a new or modified permit unless such application has received approval by the affected unit of local government having an approved plan. ADEM, therefore, will require the following before it can process a new or modified permit application:

1. The local government having jurisdiction must approve the permit application in accordance with §22-27-48 and §22-27-48.1 Code of Alabama.

2. Local governments should follow the procedures outlined in §22-27-48 and §22-27-48.1 Code of Alabama and the siting standards included in the local approved plan in considering approval of a facility.

This procedure applies to applications for new or modified permits. ADEM cannot review an application unless it includes approval from the affected local government. This procedure shall not apply to exempted industrial landfills receiving waste generated on site only by the permittee.

Please contact the Solid Waste Branch of ADEM at (334) 274-4201 if there are any questions.

SAC/sss/abj

# SOLID WASTE APPLICATION

**PERMIT APPLICATION**
**SOLID WASTE DISPOSAL FACILITY**
**ALABAMA DEPARTMENT OF ENVIRONMENTAL MANAGEMENT**
**(Submit in Triplicate)**

1. **Facility type:**
   - ✓ Municipal Solid Waste Landfill (MSWLF)
   - _____ Industrial Landfill (ILF)
   - _____ Construction and Demolition Landfill (C/DLF)
   - _____ CCR Landfill (CCRLF)
   - _____ CCR Surface Impoundment (CCRSI)
   - _____ Other (explain)_____

2. **Facility Name** Arrowhead Landfill

3. **Applicant/Permittee:**

   **Name:** Perry County Associates, LLC

   **Address:** 33 South Wood Ave, Suite 810
   Iselin, NJ 08830

   **Telephone:** (551) 999-8261

   **If applicant/permittee is a Corporation, please list officers:**
   William Gay

4. **Location: (include county highway map or USGS map)**

   **Township** 17 North **Range** 6 East
   **Section** 21, 22, 27 & 28 **County** Perry

5. **Land Owner:**

   **Name:** Howling Coyote, LLC

   **Address:** 33 South Wood Ave, Suite 810
   Iselin, NJ 08830

   **Telephone:** (551) 999-8261

   **(Attach copy of agreement from landowner if applicable.)**

6. Contact Person:

Name William Gay

Position or Affiliation Division Vice President

Address: 33 South Wood Ave, Suite 810
Iselin, NJ 08830

Telephone: (551) 999-8261

7. Size of Facility: 973.85 Acres

Size of Disposal Area(s): 425.33 Acres

8. Identify proposed service area or specific industry that waste will be received from:

States of Alabama, Arkansas, Connecticut, Delaware, Florida, Georgia, Illinois, Indiana, Iowa, Kentucky Louisanna, Maine, Maryland, Massachusetts, Michigan, Minnesota, Mississippi, Missouri, New Hampshire, New Jersey, New York, North Carolina, Ohio, Oklahoma, Pennsylvania, Rhode Island, South Carolina, Tennessee, Texas, Vermont, Virginia, West Virginia, and Wisconsin.

9. Proposed maximum average daily volume to be received at landfill (choose one):

15,000 Tons/Day _____ Cubic Yards/Day

10. List all waste streams to be accepted at the facility (i.e., household solid waste, wood boiler ash, tires, trees, limbs, stumps, etc.):

Nonhazardous solid wastes; noninfectious putrescible and nonputrescible wastes including but not limited to household garbage, commercial waste, industrial waste, construction and demolition debris, tires and other similar types of materials.

SIGNATURE (Responsible official of permit applicant):

TITLE: Division Vice President

William Gay
(please print or type name)

DATE: 7/31/25

## ADDITIONAL REQUIRED INFORMATION

Applicants seeking to obtain a permit to construct and/or continue to operate a municipal solid waste (MSW) landfill, industrial landfill, construction and demolition (C/D) landfill, coal combustion residuals (CCR) landfill, or CCR surface impoundment are required to submit additional information as part of the Solid Waste Disposal Facility Permit Application. These additional information requirements vary depending on the facility type.

For new and existing landfill units, refer to ADEM Admin Code 335-13-5-.02 for a list of additional information to be submitted in the permit application. Some requirements apply only to MSW landfills and CCR landfills, while other requirements apply to industrial landfills and C/D landfills. You need only to address the requirements that pertain to your type landfill. For new and existing CCR surface impoundments, refer to ADEM Admin Code 335-13-15-.09 for additional information to be submitted in the permit application.

Each rule that is applicable to your type landfill or surface impoundment must be addressed in detail in the operational narrative and/or engineering drawings before the review process can be completed. All operational narratives, engineering drawings, survey maps and legal descriptions are to be prepared by licensed engineers or surveyors registered in the State of Alabama and with their stamp or seal on each drawing/map and cover of the narrative.

Act No. 89-824 Section 9(a) states "The department may not consider an application for a new or modified permit for a facility unless such application has received approval by the affected unit of local government having an approved plan." This document must be received by the Department prior to processing the application.

The referenced rules are covered in greater detail in ADEM's Administrative Code, Division 13. Clarification can be obtained by reviewing the regulations. Copies of the ADEM Administrative Code, Division 13 regulations, can be obtained for a fee by contacting ADEM's Permits and Services Division. If the Department can answer any questions, please contact the Solid Waste Branch at (334) 274-4201.

## B. APPLICATION FEE

WASTE CONNECTIONS

| DATE | 1/28/2025 | CHECK NUMBER | 5129036 |
|---|---|---|---|

| Invoice | Invoice Date | PO No. | Description | Net Amount |
|---|---|---|---|---|
| 01/2025 | 1/17/2025 | PO-6603-25-00123 | Check to ADEM for vertical expansion permitting- CER 6603-25-0004 has | 32,615.00 |

| Vendor No. | U0045091 | Pay To | OFFICE OF GENERAL COUNSEL | Net Total | $ 32,615.00 |
|---|---|---|---|---|---|

FOLD FOLD

WLPSZ8511VTL28 (3240)

For invoice payment status, please visit https://WasteConnections.InvoiceInfo.com

THE FACE OF THIS DOCUMENT HAS A COLORED BACKGROUND ON WHITE PAPER. THERMOCHROMIC INK ON BACK.

WASTE CONNECTIONS
*Connect with the Future*

WASTE CONNECTIONS
3 WATERWAY SQUARE PLACE, SUITE 110
THE WOODLANDS, TX 77380

BANK OF AMERICA 52-153/112 ME

*** PROTECTED BY POSITIVE PAY ***

| DATE | 1/28/2025 | CHECK NUMBER | 5129036 |
|---|---|---|---|

Details on back.

PAY Thirty-two thousand six hundred fifteen and 00/100 US Dollars **********

TO THE ORDER OF
ALABAMA DEPARTMENT OF ENVIRONMENTAL MANA
PO BOX 301463
MONTGOMERY AL 36130-14
USA

| AMOUNT | $ **********32,615.00 |
|---|---|

VOID AFTER 180 DAYS

Authorized Signature

Security features included.

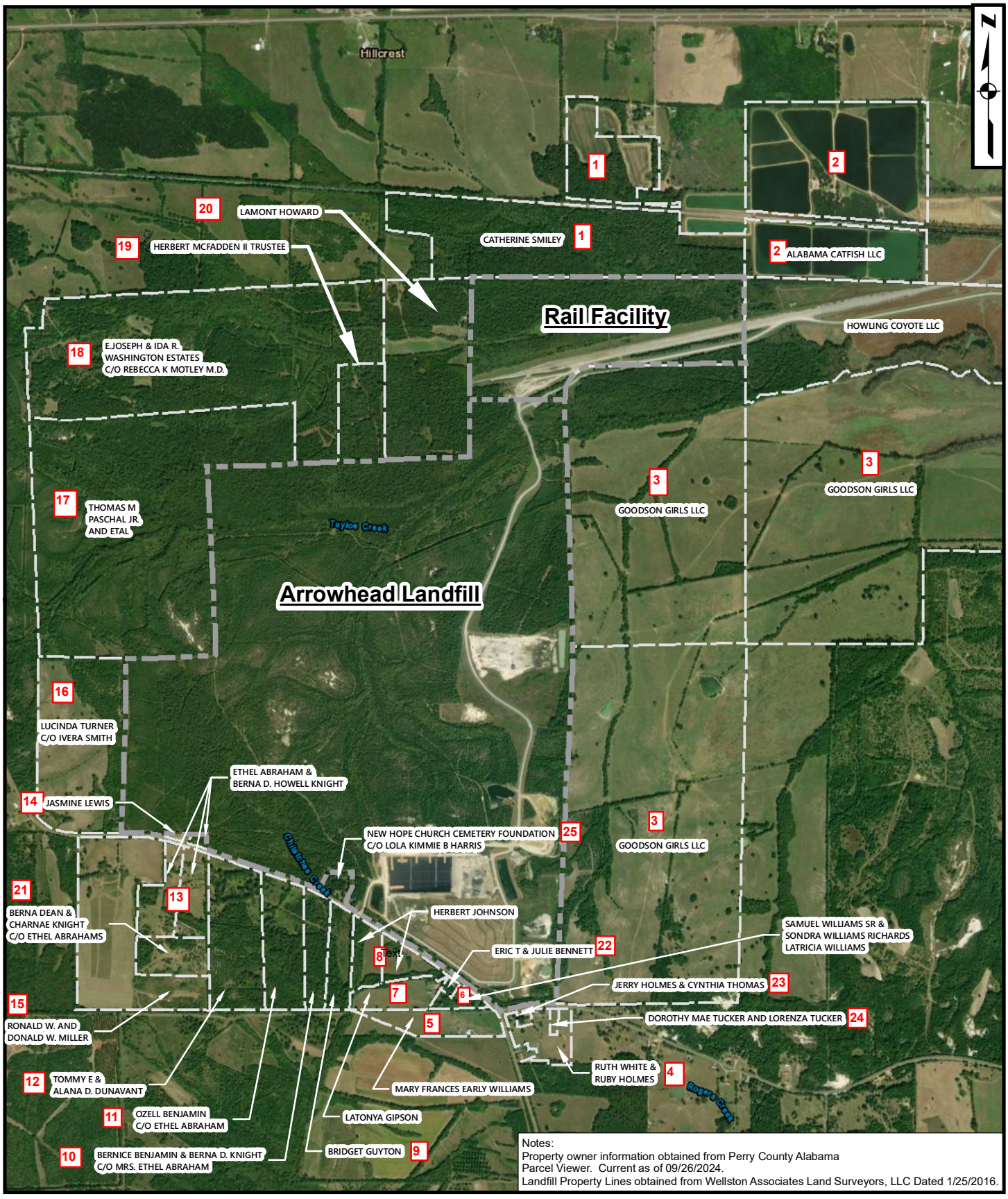
⑈5129036⑈ ⑆011201539⑆ 222010556 3⑈

*See Other Side For Opening Instructions*

WASTE CONNECTIONS
3 WATERWAY SQUARE PLACE, SUITE 110
THE WOODLANDS, TX 77380

ALABAMA DEPARTMENT OF ENVIRONMENTAL
MANA
PO BOX 301463
MONTGOMERY AL 36130-14
USA

## C. LIST OF ADJACENT PROPERTY OWNERS & ADDRESSES




2,000 1,000 0 2,000

GRAPHIC SCALE IN FEET

Vivid Maxar Aerial October 1, 2019

# Adjacent Property Owners Map

## Arrowhead Landfill

Date: 1/27/2025

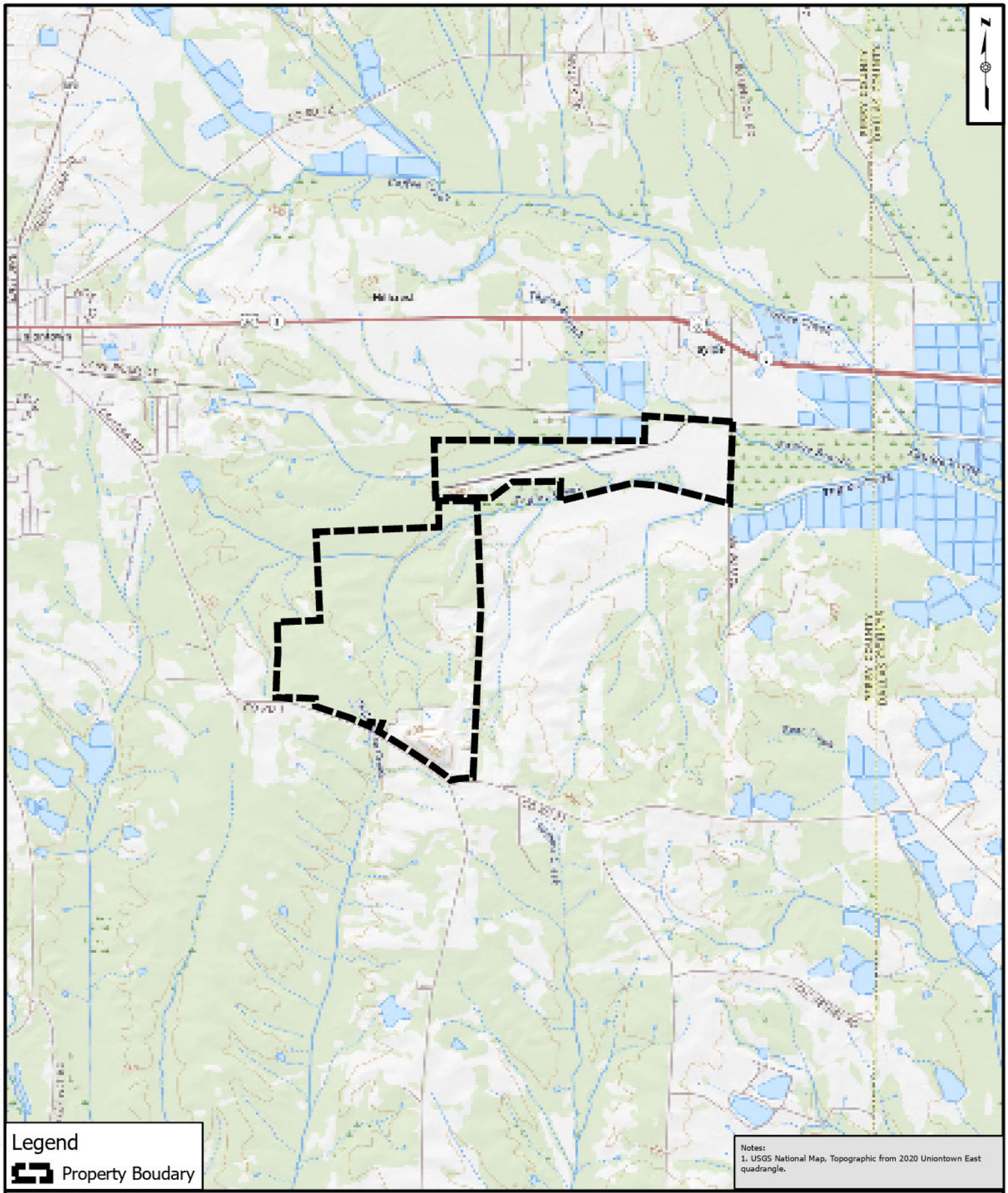
HNT ENVIRONMENTAL CONSULTANTS

| | Name and Address | Parcel Number |
|---|---|---|
| 1. | Catherine L. Smiley (Deceased)<br>c/o C. B. Smiley, Jr.<br>P. O. Box 538<br>Uniontown, AL 36786 | 53-22-05-15-0-000-012.000 |
| 2. | Alabama Catfish LLC<br>1550 McFarland Blvd<br>Tuscaloosa, AL 36506 | 53-22-06-14-0-000-010.000 |
| 3. | Goodson Girls, LLC<br>701 2nd Ave Ste. 1<br>Tuscaloosa, AL 35401 | 53-22-05-22-0-000-003.000<br>53-22-06-23-0-000-001.000<br>53-22-08-27-0-000-001.000 |
| 4. | Ruby Holmes & Ruth White<br>110 Shaw Rd.<br>Uniontown, AL 36786 | 53-22-08-34-0-000-003.000 |
| 5. | Mary Frances Early Williams<br>4060 Central Mills Road<br>Uniontown, AL 36786 | 53-22-08-34-0-000-005.001 |
| 6. | Samuel Williams Sr &<br>Sondra Williams Richards<br>Latricia Williams<br>13583 Date Street<br>Northport, AL 35475 | 53-22-08-27-0-000-003.000 |
| 7. | LaTonya Gipson<br>7585 Highway 14<br>Selma, AL 36701 | 53-22-08-27-0-000-003.001 |
| 8. | Herbert Johnson<br>75 Daylily Lane<br>Uniontown, AL 36786 | 53-22-08-27-0-000-004.000<br>53-22-08-28-0-000-012.000 |
| 9. | Bridget Guyton<br>3420 NE 43rd Place<br>Ocala, FL 34479 | 53-22-08-28-0-000-010.000 |
| 10. | Bernice Benjamin and Berna D. Knight<br>c/o Mrs. Ethel Abraham<br>3044 Central Mills Road<br>Uniontown, AL 36786 | 53-22-08-28-0-000-009.002 |

| Name and Address | Parcel Number |
|---|---|
| 11. Ozell Benjamin<br>c/o Ethel Abraham<br>3044 Central Mills Road<br>Uniontown, AL 36786 | 53-22-08-28-0-000-009.000 |
| 12. Tommy E. & Alana D. Dunavant<br>461 New Orleans St.<br>Gulf Shores, AL 36542 | 53-22-08-28-0-000-008.000 |
| 13. Ethel Abraham and Berna D. Howell<br>3044 Central Mills Road<br>Uniontown, AL 36786 | 53-22-08-28-0-000-007.000<br>53-22-08-28-0-000-007.002 |
| 14. Jasmine Lewis<br>P. O. Box 1154<br>Uniontown, AL 36786 | 53-22-08-28-0-000-007.001 |
| 15. Ronald W. and Donald W. Miller<br>250 Shaw Road<br>Uniontown, AL 36786 | 53-22-08-28-0-000-006.000 |
| 16. Lucinda Turner<br>c/o Ivera Smith<br>15340 Little Field<br>Detroit, MI 48227 | 53-22-08-28-0-000-002.000 |
| 17. Thomas M. Paschal, Jr., et al<br>1054 Foxcraft Road NW<br>Atlanta, GA 30327 | 53-22-05-21-0-000-004.000 |
| 18. E. Joseph & Ida R. Washington Estates<br>c/o Rebecca K Motley M.D.<br>23040 Valley Crest Lane<br>Southfield, MI 48034 | 53-22-08-21-0-000-001.000 |
| 19. Herbert McFadden II Trustee<br>337 1st Ave North<br>Birmingham, AL 35204 | 53-22-08-21-0-000-002.000 |
| 20. Lamont G Howard<br>9916 Highway 5<br>Marion, AL 36756 | 53-22-05-22-0-000-002.000 |

| Name and Address | Parcel Number |
|---|---|
| 21. Berna Dean & Charnae Knight<br>c/o Ethel Abrahams<br>3648 Madison St.<br>College Park, GA 30337 | 53-22-08-28-0-000-007.003 0 |
| 22. Eric T & Julie Bennett<br>PO Box 588<br>Uniontown, AL 36786 | 53-22-08-27-0-000-003.002 0 |
| 23. Jerry Holmes & Cynthia Thomas<br>30 Shaw Rd<br>Uniontown, AL 36786 | 53-22-08-34-0-000-003.002 0 |
| 24. Dorothy Mae Tucker & Lorenza Tucker<br>230 Shaw Road,<br>Uniontown, AL 36786 | 53-22-08-34-0-000-003.003 0 |
| 25. New Hope Church Cemetery Foundation<br>C/O Lola Kimmie B Harris<br>86 Banks Quarter<br>Uniontown, AL 36786 | 53-22-08-28-0-000-001.002 0 |

## D. SITE LOCATION MAP




# Location Map

Arrowhead Landfill
Arrowhead Environmental Partners, LLC
Perry County, Alabama

*8/10/2023*

0 2,000 4,000 Feet
1 inch equals 4,000 Feet

DISCLAIMER:
This drawing and the information contained herein is for general presentation purposes only and is a compilation of shapefile(s) provided by various source(s). The source and accuracy of the file(s) has not been verified by HHNT and therefore the drawing is not intended for use as a engineering drawing or for design purposes.

HHNT
HODGES, HARBIN, NEWBERRY & TRIBBLE, INC.
*Consulting Engineers*

Path: B:\GIS\Arrowhead\Location Map\Location Map.aprx User: elambert

## E. SITE ANALYSIS REPORT, PREPARED BY JJ&G INC. & DATED SEPTEMBER 2005 - (HYDROGEOLOGIC EVALUATION)

JORDAN
JONES &
GOULDING

6801 Governors Lake Parkway
Building 200
Norcross, Georgia 30071
T 770.455.8555
F 770.455.7391
www.jjg.com

September 23, 2005

Mr. James Bryant, Chief
Solid Waste Branch, Land Division
Alabama Department of Environmental Management
1400 Coliseum Boulevard
Montgomery, Alabama 36110-2059

RE: Revised Design and Operations Plan Report and Design Plan Drawings
Proposed Perry County Associates Landfill
Perry County, Alabama

Dear Mr. Bryant:

On behalf of Perry County Associates, L.L.C., Jordan, Jones & Goulding (JJG) submits this revised Design & Operations Plan Report and Design Plan Drawings for the proposed Perry County Associates Municipal Solid Waste Landfill (PCA Landfill) located in Perry County, Alabama. This report is Volume 2 of 2 in support of a Solid Waste Disposal Facility Permit Application for the proposed PCA Landfill. Detailed information and data to demonstrate the suitability of the proposed PCA Landfill site in connection with geology and hydrogeology is provided in an accompanying report (Volume 1 of 2). Three copies of the above listed information are being transmitted. This information has been prepared to meet the requirements of the Alabama Department of Environmental Management (ADEM) Land Division – Solid Waste Program Regulation Chapter 335-13-4.

Please call either Mr. Larry Matthews, of PCA, at (678) 297-0252, or me at (770) 455-8555 with any questions you may have regarding this submittal.

Sincerely,

JORDAN, JONES & GOULDING, INC.

Michael T. Feeney, P.E.

Copy to: Larry Matthews, PCA
Project file 4305-001

report

September 2005

# Solid Waste Permit Application
# Volume 1/2

*Site Analysis*
*Perry County Associates Landfill*
*Perry County, Alabama*

**Prepared for**

Alabama Department of
Environmental Management

Perry County Associates, L.L.C.

JORDAN
JONES &
GOULDING

working to better our communities and environment

4305_001cov.fh11

# SOLID WASTE PERMIT APPLICATION

## VOLUME 1/2

## LANDFILL DESIGN & OPERATIONS PLAN

For

## PERRY COUNTY ASSOCIATES LANDFILL

Prepared for

**Perry County Associates, L.L.C**

**By**
**Jordan, Jones & Goulding, Inc**
**Atlanta, Georgia**

**September 2005**

# Perry County Associates Landfill
# Design & Operations Plan
# Volume 1/2
# Site Analysis

## Table of Contents


1.0. INTRODUCTION — Page

Purpose and Scope ..... 1-1
General Site Description ..... 1-1
Report Organization ..... 1-2

2.0 SITE EVALUATION

Overview ..... 2-1
Floodplains ..... 2-1
Threatened Endangered Species ..... 2-2
Wetlands ..... 2-2
Airports ..... 2-2
Unstable Areas ..... 2-3
Archaeology/Historical ..... 2-5
Water Quality ..... 2-5

3.0 HYDROGEOLOGIC EVALUATION

Overview ..... 3-1
Site Setting ..... 3-1
Regional Geology ..... 3-1
Regional Hydrogeology ..... 3-2
Site Characterization ..... 3-3
Site Geology ..... 3-4
Site Hydrogeology ..... 3-5
Water-Well Inventory ..... 3-8

4.0 SUMMARY AND CONCLUSION

5.0 REFERENCES

RESUMES

## List of Tables

Table 1 Summary of Wetlands Classification
Table 2 Summary of Waters of United States Classification
Table 3 Groundwater Levels and Elevations
Table 4 Summary of Soil Test Results
Table 5 Groundwater Flow Calculations
Table 6 Water Wells and Construction Details

## List of Figures

Figure 1 Site Location Map
Figure 2 Site Conditions
Figure 3 Regional Geology
Figure 4 Seismicity Map
Figure 5 Geologic Units Present in Perry County and Water-Bearing Characteristics
Figure 6 Locations of Piezometers, and Cross Sections
Figure 7 Cross-Section A-A'
Figure 8 Cross-Section B-B'
Figure 9 Potentiometric Surface – Eutaw Formation Aquifer
Figure 10 Water Well Inventory

## Appendices

Appendix A Local Zoning Approval and Statement of Consistency
Appendix B Legal Property Description
Appendix C Flood Plain Study
Appendix D Ecological Studies Report
Appendix E U.S. Fish and Wildlife Service Clearance
Appendix F Letter of Concurrence Army Corps of Engineers (Wetlands), Alabama State Historic Preservation Office - Letter of Certification, and Environmental Resources Analysis, Inc. Report
Appendix G Boring Logs for Shallow and Deep Piezometers
Appendix H Slug Test Data for DW-1, DW-2, and DW-3
Appendix I Geotechnical Analyses Data

Jordan Jones & Goulding INCORPORATED

# SECTION 1

# Introduction

# SECTION 1
# Introduction

In March 2002, a Site Analysis Report (SAR) for the proposed Perry County Municipal Solid Landfill (MSWLF) was submitted to the Alabama Department of Environmental Management (ADEM). The SAR provided ADEM information and data needed to demonstrate the suitability of the proposed PCA landfill. The permitting process for the proposed Perry County MSWLF was temporarily halted in order to address concerns expressed by those apposed to the construction of the facility.

Perry County Associates (PCA) wishes to proceed with the permitting process for the proposed landfill in Perry County, Alabama. On behalf of PCS, JJG will submit an updated Solid Waste Disposal Facility Permit Application for the proposed PCA Municipal Solid Waste landfill (PCA Landfill). The site analysis report and permit application have been updated to comply with the requirements set forth by the Alabama Department of Environmental Management (ADEM) Land Division – Solid Waste Program Regulation Chapter 335-13-4.

The updated site analysis report was prepared by Mr. Todd Tharpe, and Mr. Leo Gentile (Alabama P.G. Number 983), and reviewed by Mr. Mike Feeney, P.E., (Alabama P.E. Number 15895). All are employed by JJG. Copies of their resumes are provided with this report.

## Purpose and Scope

This Site Analysis Report (Volume 1) provides information and data which are required demonstrate the suitability of the proposed PCA Landfill site in accordance with Chapter 335-13-4-.01. This report also provides a detailed description of the site geology and hydrogeology in accordance with the requirements of Chapter 335-13-4-.13. Detailed landfill design and operations plans are provided in an accompanying report (Volume 2), which includes Permit Design Plans and the Permit Application. The Siting Analysis Report, Landfill Design and Operation (D&O) Plans, and Permit Design Plans comprise the information required by ADEM regulations to review and approve a Solid Waste Facility Permit for the PCA landfill.

## General Site Description

The proposed PCA landfill site is located in the southern portion of Perry County, Alabama, about one and one-half miles southeast of Uniontown, Alabama. The property comprises approximately 1,100 acres situated along Perry County Road 1 (Cahaba Road) and within portions of Sections 21, 22, 27, and 28 of Township 17 North, Range 6 East (Figure 1).

The site property is fallow agricultural land (pasture) which is surrounded by other agricultural land and sparse rural residences. Other nearby land uses include a catfish farm north of the PCA landfill

site and across Tayloe Creek, and the Uniontown Industrial park, located about one-half mile west of the PCA landfill site.

The site topography slopes generally northward toward Tayloe Creek. Topography on site ranges from about 290 feet in the southeastern corner to about 180 feet in the northeastern corner of the property. Numerous ephemeral drainages cross the property, nearly all of which slope northward toward Tayloe Creek. Other minor drainages slope west, east, and south from the site (Figure 2). Tayloe Creek, the only perennial riverine system on site, flows eastward parallel to the northern site boundary (Figure 2). Permanent man-made palustine (pond) systems have been created by constructing dikes across four of the ephemeral drainages (Figure 2), apparently to supply water for grazing animals. A dike was also constructed on Tayloe Creek to create a pond.

A resolution recommending local approval for the PCA landfill was issued by the Perry County Commission June 28, 2005. A copy of the resolution is included in Appendix A.

The Alabama Tombigbee Regional Commission issued a Statement of Consistency for the facility on June 22, 2005. A copy of the Statement of Consistency is included in Appendix A.

The conceptual facility design calls for sequential development of landfill cells in three tracts as needed and required by the volume of waste received. Initially, Tract 1 will comprise 5 cells and will be constructed in the south-eastern portion of the property. A detailed description of the design is provided in the landfill D&O plans (Volume 2).

The site topography was surveyed by LandAir Surveyors, of Roswell, Georgia in April 2001. The site boundary was surveyed by JJG in April 2001 to provide a detailed description of the property. A legal description of the 1,100-acre site and each landfill tract is provided in Appendix B of this report. Figure 2 shows site conditions based on the results of these two land surveys.

## Report Organization

The remainder of this report is organized as follows:

- Results of the siting evaluation are presented in Section 2;
- The site hydrogeologic characterization is provided in Section 3;
- A summary of the findings of the report and conclusions, based on these findings, are presented in Section 4;
- References used on preparing the document are listed in Section 5;
- Supporting documentation for wetlands, and floodplain analysis are provided as appendices to this report.

Jordan Jones & Goulding INCORPORATED

# SECTION 2

# Site Evaluation

# SECTION 2
# Site Evaluation

## Overview

This section provides information and data to demonstrate that the proposed PCA landfill meets applicable ADEM siting criteria and that the design will prevent adverse effects on health and the environment. ADEM regulations Chapter 335-13-4-.01 specify that the facility comply with certain criteria regarding location including:

- Floodplains;
- threatened or endangered species;
- wetlands;
- airports;
- areas of active faults, seismic impact zone or unstable areas;
- archaeologically or historically sensitive areas; and
- water quality standards.

## Floodplains

Perry County does not participate in the Federal Emergency Management Administration (FEMA) Flood Insurance Program. As such, delineation of the 100-year floodplain from FEMA is not available. Some of the ephemeral drainages on site form the headwaters of Tayloe Creek. Tayloe Creek and the proposed landfill are not in a regulated floodplain. A floodplain is a "normally dry area adjoining rivers, streams, lakes, bays, or oceans that is inundated during flood events" (Chow et al). Additionally, the site is not located in a low-lying area. Therefore, no regulated floodplain concerns have been identified. A hydraulic analysis was performed to demonstrate that the PCA landfill will not: restrict the flow of a 100-year flood; reduce temporary water storage capacity of the floodplain, or result in washout of solid waste, so as to pose a hazard to human health and the environment. The hydraulic analysis was conducted using HEC-RAS 3.0.1 to assess the potential for flooding on the property as a result of the 100-year storm. A summary of the results of this analysis is provided below. The study and calculations are provided in Appendix C.

The results of an aerial survey that provided 2-foot (ft) contours, along with a site inspection, was utilized to develop stream cross-sections, assume Manning's-n values, and determine current land use for the model. The USGS Rural Regression Equations for Region 3 (Alabama) were used to calculate the 100-year peak flows. The model was divided into ten sub-basins and appropriate flows assigned to cross-sections in each subbasin. Peak 100-year flows ranged from 78 cubic feet per second (cfs) at the headwaters to 1618 cfs downstream of the property line. Manning's "n" values were based on Chow (1952) and a visual inspection of the stream channels and surrounding areas.

An evaluation of the results of hydraulic analysis shows that the 100-year storm would be contained within the channel banks (Figure 2). Additionally, the analysis shows that backwater caused by Tayloe Creek downstream of the property line would not cause the 100-year storm to "exceed" or "breech" the channel banks on the project site. The proposed project design includes maintaining a minimum distance of 200 feet from Tayloe Creek and its onsite ephemeral drainages (see Volume 2). Therefore, the proposed project will not be adversely affected by a 100-year flood event, and no adverse effects to human health and the environment are anticipated by the proposed project from a 100-year flood event.

## Threatened/Endangered Species

In June 2001, Ecological Solutions, Inc. performed an evaluation of the proposed PCA landfill to assess the potential for impacts to threatened or endangered (T&E) species and their habitats. The evaluation included an office review and site reconnaissance. A list of T&E species potentially present in Perry County was developed from a review of the U.S. Fish and Wildlife Service (USFWS) county listing and from the USFWS Daphne, Alabama office. The results of the office study identified three species:

- southern bald eagle (*Haliaeetus leuocephalus*) – threatened
- red-cockaded woodpecker (*Picoides borealis*) – endangered
- cahaba shiner *(Notropis cahabae*) – endangered

Site reconnaissance was performed by JJG to identify potential habitats for these federally-listed T&E species.

No federally protected or state protected species were observed within the proposed 1,100-acre parcel during the field studies. Habitat was not observed for any protected species of potential occurrence within the study corridor. Aquatic sampling was not conducted in the study; however, it is considered unlikely that protected aquatic species would be found in the study area, because suitable habitat was not encountered. Based on these findings, construction of this project would not have an impact on the federal and state protected species.

In June 2005, another review of the USFWS T&E list was performed. It was determined that no additional threatened and/or endangered species have been added to the list since the time the initial site evaluation was performed in June 2001. A detailed discussion of the T&E study performed for this project site is provided in Appendix D. A copy of a letter from USFWS concurring with the results of this assessment is provided as Appendix E.

## Wetlands

The proposed project corridor was surveyed with respect to jurisdictional wetlands, as required by the provisions of Executive Order 11990 and subsequent federal regulations. Jurisdictional areas are those that satisfy the criteria of a wetland, including:

- prevalence of hydrophytic vegetation;
- hydric soils; and
- permanent or periodic inundation or saturation.

Evaluation of a habitat to determine whether it meets the criteria defining a jurisdictional wetland is accomplished using one of three methods outlined in the *Corps of Engineers (ACOE) Wetlands Delineation Manual (1987 Federal Manual)*. All three methods take into account site soils, vegetation, and hydrology parameters to determine whether a habitat should be classified as a jurisdictional wetland.

The most common method for performing a jurisdictional assessment is the Routine Determination. This method evaluates each parameter and involves a qualitative collection of data. Prior to performing field studies, resources such as U.S. Geological Survey (USGS) topographical maps, aerial photography, and county soil survey information are reviewed to identify the potential areas of jurisdictional wetlands and to delineate the extent of the systems. The 1987 ACOE Data Forms are completed for each community type within each wetland system.

For this project, the Routine Determination methodology was followed during the identification of jurisdictional areas within the study area. Based on this methodology, each wetland parameter was evaluated to make the wetland determination.

Field studies identified the presence of 16 jurisdictional wetlands (Table 1) and 25 jurisdictional waters (Table 2) in the study corridor. The jurisdictional wetlands were classified as palustrine forested, emergent, and scrub/shrub systems and total approximately 13.75 acres. The jurisdictional waters were classified as lower perennial and intermittent systems. A map of the site showing the location of jurisdictional areas is provided on Figure 2. Construction of the proposed PCA landfill, as currently proposed, would not impact areas within the jurisdiction of the ACOE; therefore, a Section 404 permit is not required for the project. Details of the Jurisdictional Studies including information pertaining to the type and the location of jurisdictional areas within the study corridor are provided in the Ecological Studies Report provided as Appendix D. A copy of a letter, which was issued on May 13, 2003, from ACOE concurring with this assessment, is provided as Appendix F. As of June 2005, the design and footprint of the proposed facility has not changed. Thus, the verification letter from the ACOE is valid until May 13, 2008.

## Airports

The proposed project site is not located within 10,000 ft. of an airport runway end. An abandoned airfield, identified on the USGS Uniontown East Topographic Quadrangle (Figure 1), is located about 4,000 ft. west of the project site. According to Perry County Commissioners, the airfield has not been used since 1980 and is now closed. A former U.S. Air Force (USAF) air

field, Vaden Field, is located about six miles (31,700 ft) northeast of the PCA landfill site (Figure 3). USAF deeded the airfield to Perry County and the airfield is used for small private aircraft. The nearest commercial airport is Tuscaloosa, Alabama, more than 60 miles north of the project site.

## Unstable Areas

An evaluation of the PCA landfill site was performed to assess whether the site is located in a zone of active faults, seismic impact zone, or unstable area. To evaluate proximity to active (e.g., Holocene age) faults, available literature from the Geological Survey of Alabama was reviewed and site reconnaissance was performed. The Selma Group chalks (Demopolis chalk) crop out at the PCA landfill site. Faults in the Selma Group chalk occur as irregularly distributed normal faults with less than one foot of displacement and a zone of more pronounced normal and reverse faulting (Beg and Odom, 1985). The latter type of faulting is associated with an area referred to as the Livingston Fault zone, located 15 miles west the PCA landfill site, in Sumter and Marengo Counties (Beg and Odom, 1985). Based on the literature review, no Holocene-age faulting is located at the site or within 200 feet of the site. Faulting in the Selma Chalk has been dated at 130,000 to 300,000 years ago; using Uranium-Thorium techniques. Site reconnaissance did not reveal the presence of fault scarps, or areas of pronounced visible jointing which could indicate faults.

Further evaluation was performed to assess whether the PCA landfill site is located in a seismic impact zone. As defined by 40 CRF 258.14, a seismic impact zone is an area where a 10-percent or greater probability that the maximum horizontal acceleration in lithified earth material, expressed as a percentage of the earth's gravitational pull (g) will exceed 0.10g in 250 years. Figure 4 shows a portion of the USGS Map MF2120 – Probabilistic Earthquake Acceleration and Velocity Maps for the U.S. and Puerto, Rico (Adgermissen, 1991). The Perry County site is located in an area where there is less than 10 percent probability that earthquake acceleration will exceed 0.10g, and is therefore not located in a seismic impact zone. Based on this criteria, the nearest seismic impact zone is located approximately 30 miles northeast of the PCA landfill site.

Unstable areas are defined under 40 CRF 258.15 as locations which are susceptible to natural or human induced events or forces capable of impairing the integrity of some or all of the landfill structural components responsible for preventing releases from a landfill. Examples of unstable areas can include poor foundation conditions, areas susceptible to mass movements, and karst terrains. Central Alabama, including Perry County is underlain by thick (400 to 500 feet) chalk sequences which comprise the Cretaceous Selma Group. The chalk can weather to varying depths, and form a thin soil layer and alluvial accumulation in low-lying areas. However, the chalk is considered a structurally stable material for foundations. Construction of the landfill will require removal of soil and weathered chalk to depths of up to 20 feet to provide cover material during landfill operation. Therefore, the landfill foundation will be constructed primarily upon unweathered chalk bedrock. No mines or oil/gas wells have been identified on

site or in the vicinity of the PCA landfill site. The PCA landfill site is not located in an unstable area.

The site topography is flat to gently sloping from elevation of about 290 feet at the southeast corner to about 180 feet in the northeast corner of the site. The PCA landfill site is not considered prone to mass movement due to relatively flat topography together with shallow stable bedrock. Furthermore, the site is not located in an area of karst terrain. The Selma group chalks are massive, low-permeability formations, which generally do not contain groundwater (Reed et al, 1972). As such, development of karst conditions in the Selma Group chalks have not been identified in the geological literature, nor was evidence of karst (such as surface sinkholes, or voids during drilling) identified on site.

## Archaeology/Historical

In October of 2001, a Phase 1 historical and archaeological study of the PCA landfill site was conducted by Environmental Resource Analysts, Inc. of Auburn, Alabama. The study was performed on behalf of PCA and is included in Appendix F. On March 21, 2002, a Memorandum of Agreement, concurring with the results of the Phase 1 study, was issued by the Alabama Historical Commission. On May 26, 2005, a meeting was conducted with the Alabama State Historical Commission. The purpose of the meeting was to discuss areas of historical interest which were delineated during the October 2001 Phase 1 study. An updated letter, from the Alabama Historical Commission, demonstrating certification of the archaeological and historical study, is pending and will provided to ADEM under separate cover. The original Memorandum of agreement is included in Appendix F.

## Water Quality

The PCA landfill has been designed such that no adverse impact to water quality will result from landfill operations. In accordance with the requirements of ADEM Chapter 335-13-4.01(2), the facility design will include the following:

- Run on and run off shall be controlled such that precipitation which may contact waste is contained and does not flow off site.
- Storm water from precipitation events will be routed through sedimentation basins.
- Routine surface water monitoring will be performed to help verify compliance with applicable National Pollution Discharge Elimination System (NPDES) and the Alabama Water Pollution Control Act.
- The Facility, including buffer zones, will not be constructed in wetlands, beaches, or dunes, and therefore will not significantly degrade these environments.

Further details of the engineering and permitting, which will be in place to prevent impacts to water quality are provided in the accompanying report Design and Operations Plans (D&O) (Volume 2).

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# SECTION 3

# Hydrogeologic Evaluation

# SECTION 3
# Hydrogeologic Evaluation

## Overview

This section presents the results of an information and literature review and site-specific evaluation to characterize the geology and hydrogeology of the PCA landfill site and vicinity. This information is provided to meet the requirements of ADEM Chapter 335-13-4-.11(2), 335-13-4-12-.12(2)(b), 335-13-4-.13, and 335-13-4-.14. A description of the site setting, regional geology, and regional hydrogeology is provided, based on a review of technical literature and publications, primarily from the Geological Survey of Alabama. A description of the site geology and hydrogeology, which is based on an investigation conducted in February through May 2001, is also provided. Additionally, in an effort to confirm that site conditions have not changed significantly since the time of the initial hydrogeological investigation, water levels were recorded in January and May of 2005. A discussion concerning the updated water level elevations is provided below.

## Site Setting

The PCA landfill site is located in the west-central position of the Black Prairie Belt physiographic province of the East Gulf Coastal Plain in Alabama (Szabo, 1973). The Black Prairie Belt is characterized by gently rolling to hilly topography, which is strongly influenced by the attitude and geology of the underlying bedrock formations. Erosion caused by numerous small draws, creeks, and rivers has also influenced topography.

Perry County is divided by two major drainages, the Alabama River to the east and Tombigbee River to the west. The PCA landfill site is located in the Alabama River drainage. Tayloe Creek, which is located along the northern edge of the site flows east to become a tributary of Mud Creek, then Boque Chitto Creek, then into the Cahaba River which flows into the Alabama River.

The topography of the PCA landfill site is gently sloping northward from elevations of about 290 feet along County Road 1 toward Tayloe Creek, elevation 180 feet. Numerous emphemeral draws have developed on the site as the result of erosion from surface water. Dikes were constructed in the past across some of the draws to collect surface water and create stock tanks for grazing animals. Four shallow tanks remain on the property which are shown on Figure 2. Almost all of the emphemeral draws on site drain to Tayloe Creek, which is the only perennial stream identified at the PCA landfill site. One small drainage flows from the site southward beneath County Road 1. Several minor drainages flow eastwardly from the site, and several to the west.

## Regional Geology

This section provides a summary of the regional geology for the vicinity of the PCA landfill site. The information provided is largely from the GSA Map 118 (and accompanying text) *Geology of Perry County, Alabama* (Reed, 1972). The general stratigraphy of Perry County comprises geologic units of Upper Cretaceous age in some places overlain by Quaternary alluvium (Figure 3). A description of the principle geologic units present in Perry County is provided on Figure 5. The upper Cretaceous rocks strike northwestward and dip southwestward a rate of about 35 to 50 feet per mile. The quaternary deposits are primarily sand and gravel occurring as low terrace and alluvial deposits, along drainages and stream courses, and range from 0-50 feet thick.

The upper Cretaceous rocks are primarily clays and chalks of the Selma Group, which comprises the Ripley Formation, Demopolis chalk, Arcola Limestone Member, and Mooreville chalk. The Ripley Formation is a sandy, micaceous, fossiliferous clay that ranges in thickness from 0 to 40 feet in Perry County. The Ripley Formation is not present on the PCA site but does crop out in extreme southern Perry County. The Mooreville chalk is light gray fossilferous and argillaceous and ranges in thickness from 0 to 400 feet in Perry County. The Arcola limestone is a relatively thin (10 to 20 feet) fossiliferous glauconitic limestone that separates the Mooreville from the Demopolis chalk. The Demopolis chalk is light gray sandy argillaceous and fossilferous and ranges in thickness from 0 to over 600 feet in Perry County.

The Selma Group is uncomfortably underlain by the Eutaw Formation and the Tuscaloosa Group also of Upper Cretaceous Age. The Eutaw Formation comprises micaceous glauconitic sands, which range in thickness from 0 to over 400 feet. The Eutaw Formation crops out in the northern portion of Perry County (Figure 3).

The Tuscaloosa Group comprises the Gordo and Coker Formations, which underlay the Eutaw Formation. Tuscaloosa Group sediments are sands, gravels, and carbonaceous sand, clays, which range in total thickness from 400 to over 1,100 feet.

### Regional Hydrogeology

This section provides a summary of the regional hydrogeology for the vicinity of the PCA landfill site. The information provided is largely from the GSA map 127 (and accompanying text) *Water Availability in Perry County*, Alabama (Reed, et al 1972). Large quantities of groundwater have been produced from wells which tap the deep sand and gravel aquifers of the Eutaw, Gordo, and Coker Formations. Groundwater has not been identified in the thick Selma Group chalks (Dempolis and Mooreville); however, small quantities of groundwater are reportedly available in the Ripley Formation (Figure 5). Locally, a zone of saturation may develop in the upper weathered zone (0-60 feet) of the chalks. Sand and gravel beds in low-lying areas which are hydraulically connected to streams have also been identified as locally productive aquifers. Figure 5 includes descriptions of

the water-bearing characteristics of the geologic units present in Perry County, and water quality yielded from wells.

Wells tapping Upper Cretaceous deposits range in depth from 20 to over 1,000 feet deep. Well yields range from 0.5 to 3 million gallons per day. Wells which are located in the southwestern portion of Perry County are deepest but have the greatest potential yield. The Upper Cretaceous aquifers are confined and the potentiometric surface rises to within 40 to 300 feet of the ground surface. Despite this vertical upward gradient in the Eutaw Formation, no evidence of interconnection between the Eutaw Aquifer and Selma Group chalks, or local alluvial aquifers has been identified in the literature on Perry County hydrogeology. The Eutaw, Coker, and Gordon Formations crop out in the northern portion of Perry County. Aquifer recharge occurs in these outcrop areas from the average 55 inches of annual rainfall. Regional hydraulic gradients range from 40 to 50 feet per mile.

The town of Uniontown operates wells that produce groundwater from the Eutaw Formation aquifer. The wells range in depth from 915 to 1,300 feet (Reed et al, 1972). Water from the wells is used by the Uniontown Utilities District, which supply water to residences and businesses in southern Perry County.

Only one spring was identified in Perry County by the GSA (Reed, et al, 1972). The spring flows from the Eutaw Formation where the formation crops out, about 14 miles north of the PCA landfill site.

## Site Characterization

A detailed site-specific study was performed to characterize the geology and hydrogeology of the PCA landfill site. The study was performed to meet the requirements of ADEM Chapter 335-13-4-.13(1) and (2)(a), and 335-13-4-.14(1)(b)(1). The scope of the study included:

- characterizing the geology of the site by advancing seven borings to depths of up to 600 feet;
- collecting and describing samples of soil and bedrock encountered during drilling;
- laboratory testing of selected geologic samples to determine soil characteristics including permeability;
- site reconnaissance by a qualified geologist to observe surface geologic features;
- completing piezometers in each of the seven borings advanced at the site to characterize the uppermost saturated zone and uppermost aquifer at the site;
- measuring and recording water levels in the piezometers to characterize the highest measured groundwater level, as required by Chapter 335-13-4-.11(2)(a);
- performing and analyzing the results of *in situ* well tests to characterize aquifer hydraulic conductivity;

- surveying piezometer location and datum elevations to mean sea level (North American Datum (NAD) 1983);
- preparing geologic cross sections using data from surface geology and subsurface geology (borings);
- developing a potentiometric surface map to characterize the hydraulic gradient (direction and flow rate); and
- a review of available geologic information pertinent to the PCA site from sources such as the Geological Survey of Alabama (GSA);
- Excavated trenches for the purposes of evaluating subsurface soil conditions

The results of the study are summarized and discussed in the sections that follow.

## Site Geology

The geology of the PCA landfill site is consistent with descriptions of the regional geology from the GSA, based on the results of the study conducted for this report. Upper Cretaceous Demopolis chalk crops out in some places on site, and with the exception of thin alluvial deposits in stream channels, is the only formation exposed at the site surface. The Ripley Formation is not present at the PCA landfill site. Mooreville chalk underlies the Demopolis chalk. The Arcola Limestone Member, which is described by Reed (1972) as upper member of the Mooreville chalk separating the Demopolis and Mooreville chalks, was not identified in borings at the PCA landfill site. As such, the thickness of each chalk cannot be readily estimated. The total thickness of the Selma Group at the PCA site ranged from 500 feet in boring DW-3 to 570 feet in DW-1. The Selma Group chalks encountered in borings is characterized as dry, light gray to light greenish gray, silty, slightly pyritic, and occasionally jointed. Boring logs are provided in Appendix G.

On May 9, 2001, a site reconnaissance was performed by a JJG senior geologist to observe surface geological features such as soil type, bedrock outcrops, possible faulting, sinkholes, springs, streams, or man-made feature which could affect geology. In addition to site reconnaissance, the subsurface geology was characterized by advancing a total of seven borings at the site. In February 2001, PCA retained Allen & Willis to drill three deep borings through the Selma Group chalks and install piezometers to measure groundwater levels in the Eutaw Formation. Allen & Willis also advanced two borings into the uppermost Demopolis chalk, and installed shallow piezometers. In May 2001, three additional shallow borings were advanced into the Demopolis chalk and piezometers installed. The three additional borings and piezometers were installed by QORE Property Science of Duluth, Georgia, and the drilling activities and geology recorded by a JJG geologist. Undisturbed (Shelby-tube) samples were collected for laboratory testing to characterize the soil/rock type encountered during drilling for the three additional piezometers installed in May 2001.

Two geologic cross sections were developed using information obtained from drilling activities. The locations of the section transects are shown on Figure 6. Section A-A' (Figure 7) is oriented parallel to regional strike of the Selma Group chalks, i.e., northwest – southeast (Reed 1972). The geology depicted on the section is consistent with interpretations reported for the Perry County and west-central Alabama (Reed, 1972; Beg 1985; and Szabo, 1972). The Demopolis chalk and underlying Mooreville chalk have a combined thickness of about 530 feet. These formations were described from drill cuttings as light gray to medium-yellowish gray fossiliferrous chalk, chalky marl, and clayey chalk. Examination of Shelby tube and split spoon samples of the chalk and marl indicated presence of pyrite and occasional fractures or jointing, and possible thin bedding or laminations. Three of the seven borings were advanced through the Selma Group to the underlying Cretaceous Eutaw Formation. The Eutaw Formation was encountered in deep borings underlying the Mooreville chalk. The boring penetrated only the upper 30 feet of the Eutaw, which consisted of clayey sand and gravel underlain by sand. According to Reed et al (1972), the Eutaw Formation ranges from 300 to 400 feet thick in the southern portion of Perry County where the PCA landfill site is located.

Geologic cross-section B-B' (Figure 8) intersects Section A-A' at boring SW-2. Section B-B' is oriented northeast-southwest, along regional dip for the upper Cretaceous formations in west-southwest Alabama. The contact between the Mooreville chalk and Eutaw Formation is inferred from deep borings, DW-1 and DW-3. The dip of this contact is approximately 0.005 feet/feet or about 27 feet per mile. This attitude is slightly less than, but consistent with regional dips for the Upper Cretaceous formations, which ranges from 35 to 50 feet per mile (Reed, 1972).

On July 27, 2001, representatives of the Alabama Department of Environmental Management (ADEM), accompanied by Leo Gentile, P.G. of JJG, conducted a reconnaissance of the Perry County Associates, Inc. (PCA) landfill site. ADEM requested the site visit to excavate trenches to assess subsurface soil conditions, examine surface drainages for presence of water, and measure and record groundwater levels in existing piezometers at the site.

A rubber-tired backhoe and operator was arranged to be on site by PCA. Trench locations were selected by ADEM and are shown schematically on the attached Figure 2. Each trench was excavated through soil residuum into weathered chalk to the maximum attainable by the equipment until the weathered chalk was too hard to be excavated. A summary of the trench depth and conditions are provided below. All trenches were left open for a period of about one hour and were observed to be dry. Trenches were backfilled the same day.

| Trench Number | Total Depth (ft) | Remarks |
|---|---|---|
| 1 | 9 | 0-3 ft: gray weathered chalk residuum<br>3-9 ft: tan to gray weathered chalk, dry |
| 2 | 11.5 | 0-9 ft: weathered brown clay (chalk residuum)<br>9-11.5 ft: slightly moist and gray massive clay (slightly weathered chalk) |
| 3 | 11.5 | 0-3 ft: rust reddish-brown clayey soil<br>3-10 ft: tan weathered chalk, moist<br>10-11.5 ft: light gray, partially weathered chalk, moist |

## Site Hydrogeology

The site hydrogeology was characterized using the information on site geology described previously together with water level data from piezometers installed at the site, slug tests, and laboratory soil testing. In accordance with ADEM Chapter 335-13-4-.11(2)(a), depth to groundwater level was measured and recorded in February, March, and April 2001, with no two consecutive measurements made less than 12 days apart, to establish the seasonal high groundwater elevation (Table 3). To update this report, additional groundwater level measurements were made on January 20, 2005 and on May 19, 2005. Table 3 has been updated with the additional water level measurements. A description of the uppermost aquifer and other pertinent site hydrogeological data is provided in the paragraphs that follow.

The uppermost aquifer identified at the PCA landfill site is the Upper Cretaceous Eutaw Formation. Stratigraphically below the Eutaw Formation are the Gordo Formation and the Coker Formation (Figure 5). As described in the regional hydrogeological setting discussion, groundwater occurs in the Eutaw Formation under confined conditions. The confining unit is the 500 to 600-foot thick Selma Group chalks. The potentiometric surface for the Eutaw Formation ranges from an elevation of about 100 feet in the southern portion of the site to about 140 feet in the northeastern corner of the site. The highest groundwater elevations measured during the required three months was recorded on March 15, 2001 (Table 3). It should be noted that the highest groundwater elevations recorded at the site, to date, were recorded on March 15, 2001. The hydraulic gradient is 0.004 toward the southwest, based on the contours on Figure 9. Recharge to the Eutaw Formation is from precipitation infiltrating its outcrop area located 12 to 15 miles north and hydraulically up gradient of the PCA landfill site.

Five piezometers were installed in borings advanced at the site to depths of about 60 feet each. Damp or wet soil was rarely encountered during drilling of these borings. Several attempts were made to measure water levels in each piezometer. The results are summarized on Table 3. Field

notes recorded during field activities indicate that fluids measured inside the PVC well casing was remnant drilling fluids and/or water used to hydrate bentonite seals. Fluid levels in piezometers SW-1 and SW-2 remained about the same in February and March 2001, then fell to the bottom of the well. One anomalous value was recorded in May 2001 in SW-2, which may be the result of water used for well construction entering the well screen. Fluid levels were initially recorded at the time of installation in piezometers P-1 through P-3, and with time each became dry and remained dry until July 2001.

Given that piezometers P-1 through P-3 remained dry for an extended period, it was reported in the March 2002 Site Acceptability Report that a zone of saturation was not encountered in the uppermost Demopolis chalk at the PCA landfill site. However, between July 2001 and May 2005, groundwater water infiltrated piezometers P-1 through P-3. Table 3 has been updated to include the most recent water level measurements taken at the proposed site. Given the length of time in which the piezometers remained dry, it is believed that the water level values obtained at the groundwater level monitoring points are anomalous. The infiltrating groundwater may be attributed to the construction of each of the monitoring points. For each of these piezometers, the top of the well screen lies at approximately ten feet below ground surface. It is possible that the long screen length and relatively shallow top of screen depth has contributed to soil moisture or surface water entering these wells, and the extremely low permeability values encountered in the Demopolis chalk may explain why the infiltrating groundwater does not readily drain from the piezometers.

No springs or seeps were identified on site. Due to the depth to the potentiometric surface (i.e., greater than 100 feet), and the relatively low permeability of the Selma Group chalks (i.e., less than $1 \times 10^{-8}$ cm/sec – see Table 4), the potential for springs to develop is considered to be low at the PCA landfill site.

Undisturbed samples of the Demopolis chalk were collected to characterize the geotechnical properties of the material for laboratory testing by QORE Property Science. Undisturbed samples were collected during drilling borings for piezometers P-1, P-2, and P-3, by driving a Shelby tube. Samples were collected from depths ranging from about 28 to 40 feet. Once the samples were driven and retrieved, the ends of the tubes were sealed with melted paraffin, and the tube ends wrapped in aluminum foil. Laboratory testing included:

- Atterberg Limits (ASTM D422)
- Natural Moisture Content (ASTM D2216)
- Unified Soil Classification (ASTM D2487)
- Specific Gravity (ASTM D854)
- Organic Content (ASTM D2974)
- Cation Exchange Capacity
- Dry Density
- Vertical Permeability (ASTM D5084)

The results of the testing are summarized on Table 4 and the laboratory report is provided in Appendix I.

The samples were similar in characteristics although each was collected from a boring located in different portions of the site. Based on the testing results, the chalk is characterized as a high plasticity clay (CH) with relatively low natural moisture content and low organic content. Permeability is also relatively low ranging from $2.5 \times 10^{-8}$ cm/sec to $7.3 \times 10^{-9}$ cm/sec. The chalk is therefore considered to be an effective confining layer and no indication of saturated conditions was identified.

To date, the highest groundwater level elevations, measured in the Eutaw Aquifer, occurred on March 15, 2001. Thus, for landfill design purposes, the high groundwater level elevations recorded in March 2001 represent the most conservative values to be obtained from site conditions. As such, the design of the landfill, as well as the following figures and hydrogeological discussion, will continue to be based upon those values.

Groundwater levels measured in the Eutaw Aquifer are included on the geologic cross sections (Figures 7 and 8). As shown on the cross sections, the potentiometric surface for the Eutaw Formation aquifer ranges in elevation from about 100 to 140 feet, or to within 100 to 280 feet below ground surface (Figure 9). Design specifications for the PCA landfill include excavating in portions of the site to depths of up to 20 feet. As shown on the sections, a minimum separation of 50 feet exists between the proposed base of the landfill and the seasonal high potentiometric surface. Furthermore, approximately 500 feet of dry very low permeability Selma Group chalk will separate the landfill disposal cells from the upper most aquifer. No evidence of interconnection between the Eutaw Aquifer and overlaying Selma Group chalks was identified at the PCA landfill site.

The hydraulic conductivity of the Upper Eutaw Formation aquifer was evaluated by performing in situ (slug) tests in the three piezometers installed to the Eutaw. Tests were performed by a JJG geologist on May 2 and 3, 2001, utilizing an In Situ Model 3000 data logger and pressure transducer. Results of test analyses are provided in Appendix H. Due to the presence of clayey sand in the screened portion of the aquifer, hydraulic conductivity is considered to be relatively low, ranging from 0.03 to 0.06 ft/day. Using this range of values and hydraulic gradient, the rate at groundwater flow was calculated. Assuming a range of effective porosity of 10-30 percent, groundwater flow rates range from 0.3 feet/year to 0.9 feet/year. Calculations are provided on Table 5.

## Water Well Survey

In 2001, an investigation was performed to identify water supply wells located within one mile of the PCA landfill site. The investigation included reconnaissance by a JJG geologist to identify

wells, an interview with Perry County Commissioner and City of Uniontown officials, a review of GSA publications, and an interview with Chris Jung of ADEM. Due to the great depth (500-600 feet), few wells have apparently been drilled in rural Perry County. Fourteen wells were identified within one mile of the PCA site, and nineteen were identified in the township where the site is located.

In an effort to update the Site Acceptability report, another site reconnaissance was performed by a JJG geologist to identify wells located within one mile of the proposed landfill. The reconnaissance was performed on May 19, 2005. No additional wells were identified during the reconnaissance. Figure 10 indicates the locations of the wells identified with one mile of the PCA landfill site. Table 6 provides details on construction and depth of wells.

A recent document entitled "Uniontown Utilities Local Wellhead Protection Plan" (Layne, 1998) describes water supply and use in Uniontown and the vicinity. A municipal system, which is supplied by three wells located in town, serves the community. The wells are located upgradient and/or cross-gradient more than one mile from the PCA site. The supply system serves the residents of Uniontown plus rural residents within about five miles of town. According to Uniontown officials, drinking water is supplied to all residents near the PCA landfill site from wells in town. Eight of the fourteen wells located within a mile of the site are either not in use or supply water for agricultural purposes. Well number V-8 (Figure 10) is located adjacent to the PCA landfill site, across County Road 1. The well is 850 feet deep and was originally drilled for agricultural and domestic use for a dairy farm. The farm is no longer worked and the well no longer used. The residences along County Road 1 are all served by Uniontown Utilities. Similarly, well V-7 is 530 feet deep and is located east and cross gradient of the PCA site. The well is no longer in use and the residence is supplied by Uniontown Utilities. Well V-4 is 950 feet deep, is located northwest of the site and no longer used. The remaining three wells identified within a mile of the PCA landfill site are situated along U.S. Highway 80. Two are Uniontown Utilities wells (Numbers V-2 and V-3), and are 915 and 1300 feet deep, respectively. The other is a private supply well located about one-half mile east of wells V-2 and V-3 and supplies a catfish farm and a residence.

In 2001, Chris Jung of ADEM identified eight wells within a one-mile radius of the site. These wells are identified as P1 through P8 on Figure 10. Local residents or neighbors verified that wells P2, P4, P5, and P8 are in use and wells P3 and P6 are not in use. According to the Perry County Commissioners Office, all of the residences along County Road 1 where these wells have been identified received drinking water from the Uniontown Utilities system. The status of wells P1 and P7 is unknown. Well construction details were not available for wells P1 through P8.

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# SECTION 4

## Summary and Conclusion

# SECTION 4
# Summary and Conclusion

## Summary

A site analysis study was performed to gather data and information to meet the requirements of ADEM Chapter 335-13-4 regarding location of municipal solid waste landfills. The study evaluated the following seven criteria:

| | |
|---|---|
| Airport Safety: | No active airports are located within 10,000 feet of the PCA landfill site. |
| Flood Plains: | The proposed PCA landfill will not be constructed in areas which could impact the 100-year flood plain or be affected by the 100-year flood event. |
| Wetlands: | The PCA landfill will not be constructed in jurisdictional wetlands or waters, therefore no additional mitigation or permitting is required. |
| Fault Areas: | No active (Holocene or recent) faulting was identified within 200 feet of the site, in fact no such fault areas were identified within 15 miles of the project site. |
| Seismic Impact Zones: | Perry County is not located in a seismic impact zone. The nearest seismic impact zone is 30 miles northeast of the site. |
| Archaeology and Cultural Features: | Archaeological or cultural features identified near the proposed PCA Landfill will be protected and no construction activities will occur within 100 feet of these sites. |
| Unstable Areas: | No natural geologic features, such as karst, or manmade features such as mines were identified in the vicinity of the site. Surface mining for sand and gravel occurs along rivers and streams 2 miles from the site. |

In addition to the above location criteria, the study also evaluated geology and hydrogeology and the potential for impacts to water supplies.

The study included a characterization of:

- Site and regional geology and hydrogeology
- Establishing the uppermost aquifer
- Evaluating uppermost saturated zone

- Estimating hydraulic gradient
- Identifying water wells within one mile of the site
- Preparing detailed hydrogeologic cross sections
- Measuring and recording groundwater levels on site in February, March, and April of 2001, and making additional groundwater level measurements in January and May of 2005.
- Charactering underlying aquifers and interconnections.

## Conclusion

Based on a review of the site study, there are no location criteria, which would not be met by the PCA landfill project. No significant potential threat to groundwater resources from the proposed PCA landfill project was identified. The site is situated on a thick dry relatively impermeable confining layer (Selma Group chalks) more than 500 feet thick. The uppermost aquifer is the Eutaw Formation, which is confined with a vertical upward gradient. No surficial aquifer or saturated zones were identified that could be affected by the landfill project, or which were interconnected to the uppermost aquifer.

It is concluded that the required siting information data has been provided for ADEM review of the PCA landfill permit application. It is further concluded that no significant conditions exist which preclude development of a MSW landfill at the site.

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# Section 5
# References

# SECTION 5
# References


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# RESUMES

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Master of Civil Engineering (Geotechnical Engineering), North Carolina State University, 1981

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## Professional Experience

Mr. Feeney is JJG's Geotechnical Discipline Director and specializes in the design, permitting, and construction of solid and hazardous waste landfills, landfill gas systems, earth dams, waste impoundments, and other projects. Mr. Feeney is considered an expert of the Georgia Environmental Protection Division's rules and regulations and has developed an excellent repute with the Division. Mr. Feeney worked for over 20 years on the largest hazardous waste (Subtitle C) disposal facility in the Southeastern United States. He has also directed projects to define site geologic and groundwater conditions, assess the extent of soil and groundwater contamination, and install or expand groundwater monitoring well networks. Mr. Feeney has completed landfill designs or site characterizations for over 200 landfill cells in 14 states and has prepared permit applications and supporting documents for facilities permitting under Resource Conservation and Recovery Act (RCRA), National Pollutant Discharge Elimination System (NPDES), and state solid waste management programs.

Specific project experience includes:

- Project manager for the hydrogeologic characterization of municipal solid waste landfill sites in Georgia. Directed all phases of the field investigation and testing, analysis, and report preparation. The characterization report was prepared in accordance with EPD criteria and submitted for review. All of the sites have received regulatory approval and been issued a Letter of Site Acceptability.

- Prepared groundwater and/or methane monitoring plans for numerous municipal solid waste landfills. Plan preparation required completion of site characterization; preparation of site hydrogeologic model; location of monitoring well locations; and description of well installation, sampling, and reporting procedures. Also negotiated with regulatory authorities regarding the number and location of proposed monitoring wells.

- Directed the operation of two landfill gas extraction and flare systems, closed municipal solid waste landfills in Georgia. Responsible for all aspects of system operation, adjustment, monitoring, maintenance, and repair. Submitted operations reports to landfill owner and monitoring reports to regulatory authorities.

- Project manager for design and construction of active landfill gas systems at several municipal landfills. Projects include NSPS/EG designs for entire facilities, additions to existing systems, construction services, and Title V permitting.

- Project manager for the installation of groundwater and methane monitoring wells at a number of solid and hazardous waste landfills and at RCRA hazardous waste management facilities. Work elements included well installations in soil, fractured rock, and sedimentary rocks; well development; and sampling. Also directed the installation of double-cased monitoring wells to permit monitoring below zones of known contamination.

- Conducted methane gas migration assessments at a number of solid waste landfills. Evaluated the extent and significance of the migration; prepared corrective action plans for submittal to regulatory authorities; directed modifications to methane monitoring systems in response to gas migration.

- Completed stability analyses at numerous solid and hazardous waste landfills. Analyses have been completed to evaluate both static and seismic conditions. The stability of containment systems, berms, and waste masses has been evaluated to ensure effective landfill performance.

- Project manager for design and permitting for both vertical and lateral sanitary landfill expansions, of approximately 100 acres, near Columbia, South Carolina.

- Project manager for design and permitting of a 15-acre sanitary landfill expansion near Charleston, South Carolina, and for preparation of a master plan for continued development of approximately 80 acres at the same facility.

- Project manager for all aspects of landfill design, permitting, and construction quality assurance and for hydrogeologic studies, at Chemical Waste Management's hazardous waste disposal facility in Emelle, Alabama. This facility, with approximately 275 acres of existing or permitted landfills, is one of the largest hazardous waste facilities in the world and utilizes state-of-the-art technology, including geosynthetic lining and drain materials. Mr. Feeney has been actively involved at this facility for over 20 years.

- Project manager or engineer of record for the closure of 75 acres of landfill cells and three waste impoundments at Chemical Waste Management's Emelle, Alabama hazardous waste facility.

- Technical expert responsible for conceptual design of a geomembrane liner for the 200-foot-high vertical face of a rock quarry in the United Kingdom. The quarry was being permitted for eventual use as a sanitary landfill.

- Project manager for preparation of design and construction documents for a closure cover, including a geomembrane liner and over 15 acres of radioactive waste landfill cells in Barnwell, South Carolina. This project

was the first use of geomembrane liners at this facility, and the project included presentations and meetings with the client and South Carolina regulatory officials.

- Technical consultant for various sanitary and hazardous waste landfill design, construction, and closure projects in New York, Pennsylvania, Ohio, Kansas, Louisiana, Virginia, and North Carolina.

**Professional Affiliations**

American Society of Civil Engineers
North American Geosynthetics Society
Industrial Fabrics Association International
Solid Waste Association of North America
SWANA Landfill Gas Technical Division
Association of State Dam Safety Officials

**Publications and Presentations**

"Field Performance of Double Liner Systems in Landfills", presented at Geosynthetics '93, March, 1993, Vancouver, British Columbia, Canada and published subsequently in *Geotextiles and Geomembranes*.

"Geomembranes in Landfill Closures - Design Considerations", *Geotextiles and Geomembranes*, Vol. 10, Nos. 5-6, 1991.

"Variability of Leachate Generation with Closure Conditions", Southeastern Regional Solid Waste Symposium, November, 1994.

"Alternative Liner Design for Georgia Landfills", Conference on Engineering Solid Waste Disposal Solutions, Atlanta, Georgia, October, 1995.

"Can You Believe Your Well Monitoring Data," Georgia Water Pollution and Control Association Conference, February 1996.

"Use of Alternative Liners in Georgia," Solid Waste Association of North America, March 1996.

"Design of Landfill Gas Extraction Systems," A Seminar for the Georgia Environmental Protection Division, October 1997.

"Alternative Liner and LCS Design for Georgia Landfills," Solid Waste Association of North America, May 1998.

**Awards**

*Who's Who in Science and Engineering*, Marquis Who's Who in America

MASTER LIST

# *Michael T. Feeney, P.E.*

1. Project manager for design and permitting for both vertical and lateral sanitary landfill expansions, of approximately 100 acres, near Columbia, South Carolina.

2. Project manager for design and permitting of a 15-acre sanitary landfill expansion near Charleston, South Carolina, and for preparation of a master plan for continued development of approximately 80 acres at the same facility.

3. Project manager and engineer-of-record for construction quality assurance services at a new 12-acre sanitary landfill in Atlanta, Georgia.

4. Project manager for all aspects of landfill design, permitting, construction quality assurance, and hydrogeologic studies at Chemical Waste Management's hazardous waste disposal facility in Emelle, Alabama. This facility, with approximately 275 acres of existing or permitted landfills, is one of the largest hazardous waste facilities in the world and utilizes state-of-the-art technology, including geosynthetic lining and drain materials. Mr. Feeney has been actively involved at this facility for over 20 years.

5. Project manager or engineer of record for the closure of 75 acres of landfill cells and three waste impoundments at Chemical Waste Management's Emelle, Alabama hazardous waste facility.

6. Project manager for landfill design and RCRA Part B permit document preparation for the 125-acre expansion of Chemical Waste Management's Adams Center hazardous waste facility near Ft. Wayne, Indiana. In addition to landfill design, Mr. Feeney directed the preparation of a master plan for development of the expansion area and the completion of a surface water control plan and associated designs.

7. Project manager for landfill cell construction and hydrogeologic evaluations at Chemical Waste Management's hazardous waste facility near Wichita, Kansas. Work included quality assurance services for construction of a new 4-acre landfill cell, inspection of the completed closure covers of three landfill cells, and preparation of semi-annual and annual reports on the performance and effectiveness of the groundwater remediation system at the facility.

8. Project manager for completion of a site acceptability study and a design and operation plan for a 10-acre private industrial waste landfill in central Georgia.

9. Technical expert responsible for conceptual design of a geomembrane liner for the 200-foot high vertical face of a rock quarry in the United Kingdom. The quarry was being permitted for eventual use as a sanitary landfill.

10. Project manager for identification, evaluation, ranking, and conceptual design of sanitary landfill sites in the southeastern United States for a privately-owned disposal company. Project results used to identify landfill sites prior to negotiations with property owners and to prepare bids for landfill construction and operation.

11. Project manager for preparation of design and construction documents for a closure cover, including a geomembrane liner and over 15 acres of radioactive waste landfill cells in Barnwell, South Carolina. This project was the first use of geomembrane liners at this facility, and the project included presentations and meetings with the client and South Carolina regulatory officials.

12. Project manager for feasibility review of a 200-acre sanitary landfill located in a former coal mining area near Oak Ridge, Tennessee.

13. Technical consultant for various sanitary and hazardous waste landfill design and construction projects in New York, Pennsylvania, Ohio, Louisiana, Virginia, and North Carolina.

14. Project manager for the remedial investigation (RI) of a CERCLA site near Columbia, South Carolina. The project involved preparation of work plans, investigations to assess the vertical and horizontal extent of soil and groundwater contamination, determination of direction and rates of migration, and evaluation of likely remedial measures. Sampling and testing of contaminated materials was completed, including a field pumping test of contaminated groundwater. Presented project findings to the Environmental Protection Agency and Department of Health and Environmental Control regulators as well as to PRP representatives.

15. Project manager of an extensive effort to define the extent of soil contamination resulting from operations at an industrial facility. The project was conducted under the terms of a Consent Agreement with regulatory authorities, and assistance in negotiation of the terms of the Agreement was provided. The work involved extensive soil sampling and analysis and included the use of a field chemical laboratory. The final report met all regulatory requirements and determined that no further investigation, monitoring, or containment measures were necessary.

16. Engineer for field investigations and embankment instrumentation of B.E. Jordan Dam in Moncure, North Carolina. The work resulted from high porewater pressures observed in the dam's foundation and included a pump test.

17. Engineer for detailed foundation investigations and dam selection studies for a large, multipurpose reservoir in Randleman, North Carolina.

18. Engineer for remedial design of dredge disposal areas along the Cape Fear River at Surry Point, North Carolina. The work evaluated the extent of salt water contamination in the surficial aquifer and the effectiveness of various remedial measures.

19. Resident engineer during construction of a 1-mile-long, 50-foot-high dam forming a coal mine tailings impoundment. Project challenges included fill placement over mine spoil and tailings and an accelerated, two-shift construction schedule. Also served as resident engineer during the later construction of a drainage blanket and stability berm to remediate a concentrated 100-gpm seep through the mine spoil foundation.

20. Geotechnical engineer for testing of subgrade under taxiways and/or parking aprons at Naval Air Station, Marietta, Georgia.

21. Technical review of organic content in fill under airport, Florida.

22. Project manager for the clean closure of two Resource Conservation and Recovery Act (RCRA) surface impoundments at a hazardous waste facility. Work included the removal of all waste materials from the impoundment and removal of soil affected by impounded waste. The cleaned impoundment was sampled in accordance with RCRA protocols to document the removal of all waste constituents. A documentation

report for the closure was prepared, submitted to, and accepted by state and federal regulatory agencies, Chemical Waste Management, Emelle, Alabama.

23. Project manager for the in-place closure of a Resource Conservation and Recovery Act surface impoundment. The impoundment contained sludges from metal plating operations. Project activities included the characterization of the chemical and engineering characteristics of the waste, installation of a groundwater monitoring network around the impoundment, and evaluation of groundwater quality. The closure cover was designed to accommodate the effects of the low shear strength and high compressibility of the impounded sludge. Construction of the closure cover was completed successfully, Huntsville, Alabama.

24. Engineer-of-record and project manager for landfill design and permitting at Chemical Waste Management's hazardous waste disposal facility in Emelle, Alabama. This facility has over 275 acres of existing or permitted landfill cells. Completed design of new landfills in response to regulatory and technology developments over a period of 13 years. Responsibilities included technical design of landfill components, including riser pipes leachate collection systems, slope stability analyses, run-on/run-off analyses, and preparation of landfill design report, specifications, and construction quality assurance plan.

25. Project manager for design of new hazardous waste landfill cells for a proposed site in the midwestern United States. Responsibilities included the optimization of landfill airspace by considering landfill height, perimeter berm height, slope angles, and cut/fill balance. A complete landfill design report, drawing package, and construction quality assurance plan was prepared for inclusion in a Part B Permit Application.

26. Completed hydrogeologic and contamination assessments at RCRA facilities in response to detected constituents in monitoring wells. Assessments included source characterization to discriminate between multiple potential sources, evaluation of flow through fractured media, solute transport modeling, and time of travel computations. Work elements included field tracer tests and field hydraulic conductivity tests in fractured and/or low permeability strata.

27. Project manager for the hydrogeologic characterization of municipal solid waste landfill sites in Georgia. Directed all phases of the field investigation and testing, analysis, and report preparation. The characterization report was prepared in accordance with EPD criteria and submitted for review. All of the sites have received regulatory approval and been issued a Letter of Site Acceptability.

28. Prepared groundwater and/or methane monitoring plans for numerous municipal solid waste landfills. Plan preparation required completion of site characterization; preparation of site hydrogeologic model; location of monitoring well locations; and description of well installation, sampling, and reporting procedures. Also negotiated with regulatory authorities regarding the number and location of proposed monitoring wells.

29. Directed the operation of two landfill gas extraction and flare systems closed municipal solid waste landfills in Georgia. Responsible for all aspects of system operation, adjustment, monitoring, maintenance, and repair. Submitted operations reports to landfill owner and monitoring reports to regulatory authorities.

30. Project manager for the installation of groundwater and methane monitoring wells at a number of solid and hazardous waste landfills and at RCRA hazardous waste management facilities. Work elements included well installations in soil, fractured rock, and sedimentary rocks; well development; and sampling. Also directed the installation of double-cased monitoring wells to permit monitoring below zones of known contamination.

31. Project manager for the closure of two RCRA solvent recycling facilities. The project required the removal of underground storage tanks, decontamination of container storage areas, characterization and disposal of contaminated soils, and confirmation sampling of the completed tank excavation and cleaned storage areas. Early stages of the project involved preparation of closure, post-closure, and contingent post-closure plans.

32. Project manager for installation and operation of a groundwater corrective action system for an RCRA facility. Corrective action required the installation of groundwater recovery wells, an underground double-contained discharge line, and discharge to the sanitary sewer. Secured an industrial discharge permit for discharge. System operation requires periodic sampling of the discharge and of groundwater monitoring wells, verification of adequate well capture zones, and routine maintenance of mechanical equipment.

33. Project manager for an RFI at an RCRA solvent-recycling facility. Directed the installation of groundwater monitoring wells, soil and groundwater sampling and analysis, and the preparation of the RFI report to be submitted to regulatory authorities. Project also involved negotiations with landowners for access to adjacent properties.

34. Conducted methane gas migration assessments at a number of solid waste landfills. Evaluated the extent and significance of the migration. Prepared corrective action plans for submittal to regulatory authorities. Directed modifications to methane monitoring systems in response to gas migration.

35. Completed stability analyses at numerous solid and hazardous waste landfills. Analyses have been completed to evaluate both static and seismic conditions. The stability of containment systems, berms, and waste masses has been evaluated to ensure effective landfill performance.

36. Prepared designs for alternative liner systems at numerous municipal solid waste landfills, some with waste heights up to 275 feet. The designs incorporated geosynthetic clay liners as low permeability components. Specific regulatory concerns regarding equivalency with compacted clay and intimate contact with geomembrane components were addressed. Stability analyses, leakage computations, and groundwater modeling were completed as part of the design and equivalency demonstration.

37. Designed an enhanced closure cover for a municipal solid waste landfill in Georgia. The enhanced cover, for an older, unlined facility, consisted of a geosynthetic clay liner to restrict infiltration into landfill and reduce the leaching of contaminants to groundwater. The project also required the design of a gas venting system, and a geotextile venting layer was included. Secured Hazardous Waste Trust Fund grants for construction of the enhanced cover and for assessment monitoring costs.

38. Project manager for the construction and then closure of a 4-acre hazardous waste landfill to accept wastes resulting from the closure of Chemical Waste Management's facility in Wichita, Kansas. The landfill was filled and closed within 6 months of construction. The landfill closure consisted of a geomembrane liner and drain, while the bottom was covered with a double liner and leachate collection system.

39. Completed routine semi-annual inspections of the closure covers of four closed landfills at Chemical Waste Management's facility in Wichita, Kansas. Over the course of 3 years, semi-annual closure inspection reports were prepared evaluating the performance of the landfill covers and the effectiveness of the groundwater remediation system at the facility.

40. Project manager for the expansion of a landfill gas extraction system at a closed landfill. The expansion involved the installation of additional wells and piping to remediate gas migration, Fayette County, Georgia.

41. Project manager for the emergency assessment of off-site migration of landfill gas. The project involved daily monitoring and reporting for up to 74 monitoring stations and personal involvement with the client, regulatory authorities, and the public, Fulton County, Georgia.

42. Project manager for the rehabilitation of an aging landfill gas extraction system. The project involved the complete replacement of all piping connecting the landfill gas extraction wells and the flare. JJG provided full-time on-site inspection during construction of these improvements, Fulton County, Georgia.

43. Project manager for design and construction of active landfill gas systems at several municipal landfills. Projects include NSPS/EG designs for entire facilities, additions to existing systems, construction services, and Title V permitting.

44. Directed landfill gas sampling and Tier 2 evaluations at several municipal solid waste landfills. Prepared reports to regulatory agencies. On each project, the evaluation resulted in a significant reduction in calculated NMOC emissions.

45. Project manager for major modification and lateral expansion of a 350-acre Subtitle D landfill in metropolitan Atlanta, Georgia. Responsible for all technical and financial aspects of project. Directed conceptual design, environmental permitting, landfill design and permitting, and coordinated with regulatory agencies and client.

46. Project manager for minor modification of C&D landfill design to accommodate adjacent residential area. Project involved noise studies and evaluations, design of screening berms, provision of landscape features, and incorporation of other aesthetic features. Also prepared displays for use in meetings with adjacent residential owners.

47. Engineer of record for construction of numerous Subtitle D MSW landfill and construction/demolition landfills. Responsibilities included insuring project was constructed in accordance with approved design plans, making field adjustments to the design to accommodate site-specific conditions, and preparing certifications to state regulatory agencies.

48. Project manager responsible for identifying solutions to diminishing airspace at an MSW landfill in Mississippi. Evaluated innovative designs for expansion into adjacent areas previously thought unusable and for optimizing the existing cover design to increase the disposal capacity. The project included careful geotechnical evaluations involving wick drains, preloading, and mechanically stabilized embankments. The client implemented these measures to increase airspace and continue operation until local approval of a lateral expansion could be obtained.

49. Technical Director and engineer of record for design and permitting of a new 1,100 acre landfill site in Perry County, Alabama. Landfill development included liner and cover system design, leachate conveyance and storage systems, airspace evaluation, cut/fill analysis, and ecological and cultural resources studies. Landfill footprint included 418 acres consisting of three separate tracts with multiple cells in each tract with a total site life of 120 yrs. Completed all permit requirements to construct and operate the landfill for Alabama Department of Environmental Management review.

50. Project Director for the renewal of the RCRA Part B Permit Application for Chemical Waste Management's Emelle, Alabama hazardous waste facility. The permit renewal for this facility, of the largest hazardous waste treatment, storage, and disposal facilities in the world, required extensive revisions to reflect changes in facility operations and planning. Considerable effort in compiling historic documents and preparing a comprehensive file of electronic permit documents and drawings was required. The permit application was provided to the client on an interactive compact disk that was searchable and utilized an extensive indexing and keyword system. The resulting electronic application was much more usable to the client in maintaining compliance with permit requirements.

51. Project manager for major modification and lateral expansion of a construction/demolition landfill in metropolitan Atlanta, Georgia. Responsible for all technical and financial aspects of project. Directed conceptual design, site characterization, landfill design and permitting, and coordinated with regulatory agencies and client.

52. Project manager for a RCRA Facility Investigation conducted at a large hazardous waste facility. The RFI involved the evaluation of eight solid waste management units. Responsible for all aspects of scope development, budgeting, execution and reporting. The completed RFI report was accepted with minimal comment from the regulatory agency.

53. Project Manager for a fast-tracked site remediation for a 20-acre institutional development. Responsible for project definition, budgeting, technical direction, scheduling and interaction with regulatory and legal personnel. Aggressive scheduling and coordination met key client deadlines, thereby avoiding a one-year delay. Remediation work involved characterization of the type and extent of waste, a groundwater investigation, complete removal of waste from some portions of the development and encapsulation of waste in other areas.

54. Project Director for the remediation of a solid waste landfill in the path of planned expressway. Responsible for all technical, financial and scheduling aspects of the site characterization and remediation design. Remediation involved the complete removal of wastes from the proposed right-of-way while maintaining the stability of the remaining waste mass. Wastes were removed from above and below the water table. Backfill was placed and densified both above and below the water table.

55. Project manager for the remediation of wastes improperly disposed of at a construction demolition waste landfill. Remediation involved the location of the disallowed wastes within a large waste mass, then removal of wastes to an approved disposal site. The project required on-site supervision and quality control for the removal of over 50,000 tons of waste materials. A certification report was provided to state regulatory authorities at the completion of the project. Close coordination with the landfill operator was required to allow this active landfill to remain in business during the remediation effort.

# *Leo F. Gentile, P.G.*

**Title:**
Service Leader

**Years of Experience:** 23

**Education:**
M.B.A., Georgia State University, 2003

M.S., Geology, Oklahoma State University, 1984

B.S., Geology, Ohio State University, 1982

University of California at Berkeley-Extension: Environmental Studies; Arizona State University: Graduate Study, Water Resources Engineering

**Professional Registration:**
Professional Geologist in Alabama, California, Florida, Georgia, Mississippi, North Carolina, South Carolina, Tennessee, and Puerto Rico

**Office Location:**
Atlanta, Georgia

## Professional Experience:

Mr. Gentile leads JJG's Tunnels and Geotechnics Service Area. His background includes over 23 years of experience in applying geology and hydrogeology to soil and groundwater contamination assessment, hazardous waste remediation, landfill siting studies, facility closure, and expert testimony. Mr. Gentile has performed groundwater monitoring for over 20 landfills in Georgia; completed six Assessments of Corrective Measures (ACM) studies for monitored natural attenuation at landfills; and authored 10 site suitability studies for new and expanding landfills. Mr. Gentile's professional experience includes technical support and management on a broad range of projects including remedial investigations and feasibility studies (RI/FS) at CERCLA sites, Resource Conservation and Recovery Act (RCRA) facility investigation and closures, siting studies and contamination assessment at solid waste landfills, investigation and remediation of agricultural chemical sites, assessments and reclamation for mining and petroleum related sites, and water resources development.

Specific project experience includes:

**Solid Waste**

- Project Manager for an Assessment of Corrective Measures (ACM) study for the Button Gwinnett MSW Landfill, Lawrenceville, Georgia. The study included detailed geochemical analysis of leachate, groundwater, and landfill gas to characterize the source of the groundwater impacts. The proposed corrective measures (capping and landfill gas extraction) have been accepted by the responsible regulatory agency.

- Project Manager for an ACM study at a MSW Landfill, Buford, Georgia. This project had been completed in phases beginning with a preliminary source characterization study, interim corrective measures (leachate collection system modifications and landfill gas extraction), assessment groundwater monitoring, and the assessment of corrective measures.

- Project Manager for an ACM study for a C&D Landfill in Lithonia, Georgia. The results of assessment monitoring has triggered an initial phase of source characterization and investigation of the extent of groundwater impacts.

- Project Manager for an Alternative Source Demonstration at a MSW Landfill in Atlanta, Georgia. This project involved detailed evaluation of historical groundwater, leachate, surface water sampling data, and geochemical analyses and comparisons of the data. The results of the study demonstrated that other sources than the landfill are contributing to groundwater contamination in this historically industrialized area. The

report was accepted by the responsible regulatory agency, and an assessment of corrective measures study was therefore not required. The landfill expansion has proceeded.

- Project Manager for a special waste characterization and disposal suitability project at a C&D landfill in Fulton County, Georgia. A small amount of special waste was inadvertently accepted at the C&D facility. The operator notified the State of Georgia and retained JJG to perform a fast-track characterization of the special waste. The results of the report showed that the waste was appropriate for disposal in a C&D landfill, but was removed by the operator.

- Project Manager for multi-site groundwater and methane monitoring program for a national solid waste management company. Prepared semi-annual reports for active landfills in Georgia. Responsible for submitting reports to Georgia EPD.

- Project Manager and responsible for professional for hydrogeological study of a C&D landfill in Brunswick, Georgia. Installed monitoring wells, sampled and analyzed soil to assess characteristics of Satilla (surficial) aquifer. Prepared report for submittal to Georgia EPD.

- Project Manager of a hydrogeologic study for a proposed regional municipal solid waste landfill and composting facility in southern Puerto Rico. The facility will be the first privately developed Subtitle D landfill in Puerto Rico. An existing regional numerical groundwater flow model developed by the USGS for the south coastal aquifer was used to characterize hydrogeologic conditions at the site and the relationship of the local hydrogeology to the regional system. Also provided expert testimony during numerous public hearings and in meetings with regulatory agencies.

- Task Manager and Certifying Geologist for the hydrogeological investigation for a proposed municipal solid waste landfill in Indiana. The investigation was performed in support of the landfill permit application that was the first under Indiana's revised and more stringent solid waste permitting requirements. The application, which was called the most thorough application ever received, was approved by the State of Indiana.

- Project Hydrogeologist for a hydrogeologic investigation for a municipal solid waste landfill expansion in Anne Arundel County, Maryland. The investigation included interpreting hydrogeologic conditions in a multi-layered aquifer system and assessing impacts to ground-water quality.

**Comprehensive Environmental Response Liability Act (CERCLA)**

- Prepared corrective action work plans and reviewed hydrogeologic information for the design of a 2.5 million cubic yard low-level radioactive

waste on-site disposal facility at the Department of Energy (DOE) Fernald Environmental Management Project, Cincinnati, Ohio. Worked as an integrated team member in client's offices for 3 months on site. Plans included environmental monitoring, impacted materials placement, traffic, borrow area management, health & safety, stormwater management, and CQA/CQC. Also performed laboratory work for and co-authored a report on a leachate liner compatibility to evaluate the effects of low-level radioactivity on the liner system components for the Fernald on-site disposal facility.

- Project Hydrogeologist for groundwater quality assessment at the Beacon Heights Landfill Superfund Site in Beacon Falls, Connecticut. The results of the assessment showed that a deeper fractured bedrock groundwater system had been impacted and that nearby supply wells could be affected. The project included an evaluation of potential remedial solutions for the groundwater. The project included preparing and implementing a post-closure monitoring plan for groundwater, surface water, and sediment.

- Co-authored a Focused Feasibility Study (FFS) Report in support of a revised remedy for the Bailey Superfund Site, Texas. The revised remedy included hot spot removal of contaminated waste and marsh sediments, in place solidification, and design of a light weight capping system to contain the remaining wastes in place. The revised remedy design was reviewed and approved by the U.S. Environmental Protection Agency (USEPA) and Texas Natural Resource Conservation Commission (TNRCC). Implementation of the remedy is ongoing.

- Project Geologist for the characterization of metals contamination at a wood treating plant in Stockton, California. Residential development around the facility was potentially impacted by metals transported in storm water runoff. Shallow ground water still used by some residents was also affected by site operations. Responsibilities included collection of soil samples, site safety officer, supervising contractors, client interface, and reporting.

- Project Manager for the investigation of heavy metals and chlorinated solvent contamination at an industrial water purification system manufacturing plant. Responsible for all aspects of the project including preparing work scope and cost estimates, budgeting, staffing, implementation of field investigation, data analysis, reporting and client and regulatory interface.

- Assistant Project Manager of a RI/FS for an electronics manufacturing facility at a former NIKE missile site near Livermore, California. Responsibilities included coordinating field personnel and subcontractors, contracts, hydrogeological data analysis, and reporting. Conducted prelimi-

nary feasibility study for selection of an interim remedial measure for ground-water contamination.

- Geology Task Leader of field investigation and remedial action order for an aerospace research and manufacturing facility in Cupertino, California. The site had contributed to a regional chlorinated solvent plume in ground water and investigation and quarterly ground-water monitoring reports. Conducted preliminary feasibility study for groundwater remediation alternatives.

**Resource Conservation and Recovery Act (RCRA)**

- Project Manager for RCRA facility investigation (RFI) of Launch Complex 37 at the Cape Canaveral Air Station, Florida. The LC-37 complex was used for the Saturn rocket testing for the Apollo space program and is being re-activated by the U.S. Air Force for the Evolved Expendable Launch Vehicle (EELV) program. The RFI included fast-track Interim Measures for mitigation of over 10,000 cubic yards of polychlorinated biphenyls (PCB)-contaminated soil to allow EELV construction to begin on schedule. Also reviewed various work plans and reports for RFI activities at other Kennedy Space Center facilities.

- Project Geologist for investigation and permitting of a RCRA hazardous waste management facility in central California. Tasks included well site geologist and supervision for installation of deep monitoring wells in a bedrock aquifer, analysis of hydrogeological and hydrochemical data for evaluating extent of ground water contamination at the facility, supervision of field activities, and reporting.

- Project Manager for closure of a RCRA hazardous waste management unit at a musical instrument manufacturing facility in southern Arizona. Managed remediation (pump and treat) phase of project. Responsible for all aspects of project including preparing work scope and cost estimates, budgeting, staffing, implementation of field investigation, data analysis, reporting, and client and regulatory interface.

**Water Resources**

- Project Manager for public involvement portion of a Water Conservation and Regional Reservoir Program Plan for the Georgia Department of Natural Resources. The project entailed defining water supply needs and location of new sources for 44 counties located in northern Georgia. This project was conducted in two phases and comprised stakeholder outreach through electronic mail and public meetings. A series of six stakeholder meetings were conducted for each of the two phases, reaching about a thousand interested parties.

- Project Manager for Communications support to the Georgia Department of Natural Resources State Water Conservation Program. The project included developing communications materials in a variety of media (print, web site development, and other electronic media) to support the State Water Conservation coordinator. The project also involved coordinating subconsultants working on behalf of the Water Conservation program.

**Agricultural Chemical Sites**

- Project Manager for soil and groundwater site investigation and remediation at an agricultural chemical research facility in Modesto, California. Responsible for all aspects of the project including budget tracking, staffing, client and regulatory agency interface, regulatory compliance, supervision of field investigation, data analysis, and report preparation. Remediation included excavation and off-site disposal and in situ treatment of pesticide contaminated soil and closure of 14 underground sumps used for pesticide waste disposal. The investigation of pesticide contamination included radionuclide labeled compounds. Site closure approval was received from the California Regional Water Quality Control Board. The client is currently evaluating redevelopment options for the site.

- Project Manager for site investigations at agricultural chemical formulating and distribution facilities throughout California. Tasks include site reconnaissance, preparation of work plans and cost estimates, supervision of field and office project staff, budget tracking, reporting and client/regulatory interface. Remediation included excavation/off-site disposal and in situ treatment/capping. Successfully negotiated reduced soil clean up levels for nitrate.

- Site Geologist for an investigation of dibromochloropropane contamination in ground water for a southern California water district. Investigation activities included dual-tube reverse circulation air rotary rig drilling to depths of up to 300 feet in fractured bedrock.

**Mining/Petroleum**

- Project Manager for a hydrogeologic investigation and preparation of a corrective action plan for the reclamation of a coal mine in Illinois. The hydrogeologic investigation included geochemical, ground water flow, and infiltration modeling to characterize hydrogeologic conditions at the site and to develop a plan to mitigate acid mine drainage impacts to ground water. The corrective action plan included design of an enhanced reclamation cover for 200 acres of coal refuse and a ground-water extraction system. The plan has been approved by the Illinois Office of Mines and Minerals and is being reviewed by Illinois EPA.

- Prepared water resources baseline analysis and impacts studies for an Environmental Impact Statement for a proposed open pit gold mine in north

central Nevada. Potential water resources impacts due to a proposed high-volume (30,000 gpm) dewatering of the deep (800 ft.) open pit. Evaluated technical reports prepared by the applicant's consultants to assess the affects of the proposed dewatering system on surface-water and ground-water resources.

- Project Manager for characterization and remediation of hydrocarbon contaminated soil and groundwater at a bus maintenance facility. Characterization activities included extensive use of cone penetrometer testing and multi-level direct-push technology sampling due to the urban setting. The sampling was used to assess the extent of diesel and gasoline contamination in a submerged sand dune with tidal effects. Remediation involved vapor extraction, air sparging and pump and treat. Successfully negotiated alternative clean-up levels with the City and County of San Francisco.

- Project Geologist responsible for evaluation of potential impacts to water resources and hazardous waste remediation projects for a refinery expansion Environmental Impact Report. Focus of water resources portion of the report was assessing potential impacts to groundwater and surface water resources in an area adjacent to San Francisco Bay.

**Presentations**

Gentile, Leo F., Haas, David, Duffy, Peggy H., and Hagerty, Joseph D., *"Riverbank Filtration as a Regioanl Supply Option for the United States,"* Riverbank Filtration Conference. September 2003.

Gentile, Leo F., *Alternative Groundwater Protection Standards,* Solid Waste Association of North America – Tri-State Conference. April 2002.

Gentile, Leo F., *Post-Closure Care Monitoring – When Does It Really End?*, Solid Waste Association of North America – Georgia Chapter. Fall 2000 Meeting. November 2000.

Gentile, Leo F., *Identifying Landfill Gas Impacts to Groundwater*, Solid Waste Association of North America – Georgia Chapter. Spring 1999 Meeting. April 1999.

Gentile, L.F., Cargill, K.W., and McGarvie, S.D., *"Enhanced Cover Methods for Surface Coal Refuse Reclamation,"* American Society for Surface Mining and Reclamation, Vision 2000 - Proceedings of the 14th Annual National Meeting, 1997.

**Publications**

Harold A. Tuchfield, P.G., Julia Schulten, Ph.D., Joe Voor, Thomas A. Peel, Ph.D., and Leo Gentile, P.G., *"Evaluation of the Uncertainties Associated with the Preliminary Ecological Risk Assessment Process: Case Study at the Cape Canaveral Air Station"*, 1998.

Simmons, S.P., Gentile, L.F., and McGarvie, S.D., *"Geochemical Forecast of Acid Rock Drainage to Evaluate Corrective Action Plans for Mine Reclamation."* American Society for Surface Mining and Reclamation, Vision 2000 - Proceedings for the 14th Annual National Meeting, 1997.

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Finney, S.C., Gentile, L., and Asbery, R., *"Viola Springs Formation – A haven for Graptolites,"* Oklahoma Geology Notes, V. 44, No. 4, 1984.

1. Project Manager of a hydrogeologic study for a proposed regional municipal solid waste landfill and composting facility in southern Puerto Rico. The facility will be the first privately developed Subtitle D landfill in Puerto Rico. Also provided expert testimony during public hearings and in meetings with regulatory agencies.

2. Task Manager and Certifying Geologist for the hydrogeological investigation for a proposed municipal solid waste landfill in Indiana. The investigation was performed in support of the landfill permit application which was the first under Indiana's revised and more stringent solid waste permitting requirements. The application, which was called the most thorough application ever received, is under review by the State of Indiana.

3. Project Hydrogeologist for a hydrogeologic investigation for a municipal solid waste landfill expansion in Anne Arundel County, Maryland. The investigation included interpreting hydrogeologic conditions in a multi-layered aquifer system and assessing impacts to ground-water quality.

4. Prepared corrective action work plans and reviewed hydrogeologic information for the design of a 2.5 million cubic yard low-level radioactive waste on-site disposal facility at the DOE Fernald Environmental Management Project, Cincinnati, Ohio. Worked as an integrated team member in client's offices for 3 months on site. Plans included environmental monitoring, impacted materials placement, traffic, borrow area management, health & safety, stormwater management, and CQA/CQC. Also performed laboratory work for and co-authored a report on a leachate liner compatibility to evaluate the effects of low-level radioactivity on the liner system components for the Fernald on-site disposal facility.

5. Project Hydrogeologist for groundwater quality assessment at the Beacon Heights Landfill Superfund Site in Beacon Falls, Connecticut. The results of the assessment showed that a deeper fractured bedrock groundwater system had been impacted and that nearby supply wells could be affected. The project included an evaluation of potential remedial solutions for the groundwater. The project included preparing and implementing a post-closure monitoring plan for groundwater, surface water, and sediment.

6. Co-authored a Focused Feasibility Study (FFS) Report in support of a revised remedy for the Bailey Superfund Site, Texas. The revised remedy included hot spot removal of contaminated waste and marsh sediments, in place solidification, and design of a light weight capping system to contain the remaining wastes in place. The revised remedy design was reviewed and approved by the USEPA and TNRCC. Implementation of the remedy is ongoing.

7. Project Geologist for the characterization of metals contamination at a wood treating plant in Stockton, California. Residential development around the facility was potentially impacted by metals transported in storm water runoff. Shallow ground water still used by some residents was also affected by site operations. Responsibilities included collection of soil samples, site safety officer, supervising contractors, client interface, and reporting.

8. Project Manager for the investigation of heavy metals and chlorinated solvent contamination at an industrial water purification system manufacturing plant. Responsible for all aspects of the project including preparing work scope and cost estimates, budgeting, staffing, implementation of field investigation, data analysis, reporting and client and regulatory interface.

9. Assistant Project Manager of a RI/FS for an electronics manufacturing facility at a former NIKE missile site near Livermore, California. Responsibilities included coordinating field personnel and subcontractors, con-

tracts, hydrogeological data analysis, and reporting. Conducted preliminary feasibility study for selection of an interim remedial measure for ground-water contamination.

10. Geology Task Leader of field investigation and remedial action order for an aerospace research and manufacturing facility in Cupertino, California. The site had contributed to a regional chlorinated solvent plume in ground water and investigation and quarterly ground-water monitoring reports. Conducted preliminary feasibility study for groundwater remediation alternatives.

11. Project Manager for RCRA facility investigation (RFI) of Launch Complex 37 at the Cape Canaveral Air Station, Florida. The LC-37 complex was used for the Saturn rocket testing for the Apollo space program and is being re-activated by the U.S. Air Force for the Evolved Expendable Launch Vehicle (EELV) program. The RFI included fast-track Interim Measures for mitigation of over 10,000 cubic yards of PCB-contaminated soil to allow EELV construction to begin on schedule. Also reviewed various work plans and reports for RFIs activities at other Kennedy Space Center facilities.

12. Project Geologist for investigation and permitting of a RCRA hazardous waste management facility in central California. Tasks included well site geologist and supervision for installation of deep monitoring wells in a bedrock aquifer, analysis of hydrogeological and hydrochemical data for evaluating extent of ground water contamination at the facility, supervision of field activities, and reporting.

13. Project Manager for closure of a RCRA hazardous waste management unit at a musical instrument manufacturing facility in southern Arizona. Managed remediation (pump and treat) phase of project. Responsible for all aspects of project including preparing work scope and cost estimates, budgeting, staffing, implementation of field investigation, data analysis, reporting, and client and regulatory interface.

14. Project Manager for soil and groundwater site investigation and remediation at an agricultural chemical research facility in Modesto, California. Responsible for all aspects of the project including budget tracking, staffing, client and regulatory agency interface, regulatory compliance, supervision of field investigation, data analysis, and report preparation. Remediation included excavation and off-site disposal and in situ treatment of pesticide contaminated soil and closure of 14 underground sumps used for pesticide waste disposal. The investigation of pesticide contamination included radionuclide labeled compounds. Site closure approval was received from the California Regional Water Quality Control Board. The client is currently evaluating redevelopment options for the site.

15. Project Manager for site investigations at agricultural chemical formulating and distribution facilities throughout California. Tasks include site reconnaissance, preparation of work plans and cost estimates, supervision of field and office project staff, budget tracking, reporting and client/regulatory interface. Remediation included excavation/off-site disposal and in situ treatment/capping. Successfully negotiated reduced soil clean up levels for nitrate.

16. Site Geologist for an investigation of dibromochloropropane contamination in ground water for a southern California water district. Investigation activities included dual-tube reverse circulation air rotary rig drilling to depths of up to 300 feet in fractured bedrock.

17. Project Manager for a hydrogeologic investigation and preparation of a corrective action plan for the reclamation of a coal mine in Illinois. The hydrogeologic investigation included geochemical, ground water flow, and infiltration modeling to characterize hydrogeologic conditions at the site and to develop a plan to mitigate acid mine drainage impacts to ground water. The corrective action plan included design of an enhanced reclama-

tion cover for 200 acres of coal refuse and a ground-water extraction system. The plan has been approved by the Illinois Office of Mines and Minerals and is being reviewed by Illinois EPA.

18. Prepared water resources baseline analysis and impacts studies for an Environmental Impact Statement for a proposed open pit gold mine in north central Nevada. Potential water resources impacts due to a proposed high-volume (30,000 gpm) dewatering of the deep (800 ft.) open pit. Evaluated technical reports prepared by the applicant's consultants to assess the affects of the proposed dewatering system on surface-water and ground-water resources.

19. Project Manager for characterization and remediation of hydrocarbon contaminated soil and groundwater at a bus maintenance facility. Characterization activities included extensive use of cone penetrometer testing and multi-level direct-push technology sampling due to the urban setting. The sampling was used to assess the extent of diesel and gasoline contamination in a submerged sand dune with tidal effects. Remediation involved vapor extraction, air sparging and pump and treat. Successfully negotiated alternative clean-up levels with the City and County of San Francisco.

20. Project Geologist responsible for evaluation of potential impacts to water resources and hazardous waste remediation projects for a refinery expansion Environmental Impact Report. Focus of water resources portion of the report was assessing potential impacts to groundwater and surface water resources in an area adjacent to San Francisco Bay.

21. Project Manager for an Assessment of Corrective Measures (ACM) study for the Button Gwinnett MSW Landfill, Lawrenceville, Georgia. The study included detailed geochemical analysis of leachate, groundwater, and landfill gas to characterize the source of the groundwater impacts. The proposed corrective measures (capping and landfill gas extraction) have been accepted by the responsible regulatory agency.

22. Project Manager for an ACM study at the UWL/Richland Creek Road MSW Landfill, Buford, Georgia. This project had been completed in phases beginning with a preliminary source characterization study, interim corrective measures (leachate collection system modifications and landfill gas extraction), assessment groundwater monitoring, and the assessment of corrective measures.

23. Project Manager for an ACM study at the East DeKalb C&D Landfill, Lithonia, Georgia. The results of assessment monitoring has triggered an initial phase of source characterization and investigation of the extent of groundwater impacts.

24. Project Manager for an Alternative Source Demonstration at the Bolton Road Landfills, Atlanta, Georgia. This project involved detailed evaluation of historical groundwater, leachate, surface water sampling data, and geochemical analyses and comparisons of the data. The results of the study demonstrated that other sources than the landfill are contributing to groundwater contamination in this historically industrialized area. If accepted by the responsible regulatory agency, an assessment of corrective measures study may not be required and the landfill expansion may proceed.

25. Project Manager for a special waste characterization and disposal suitability project at a C&D landfill in Fulton County, Georgia. A small amount of special waste was inadvertently accepted at the C&D facility. The operator notified the State of Georgia and retained JJG to perform a fast-track characterization of the special waste. The results of the report showed that the waste was appropriate for disposal in a C&D landfill, but was removed by the operator.

26. Project Manager for multi-site groundwater monitoring program for a national solid waste management company. Prepared semi-annual reports for active landfills in Georgia. Responsible for submitting reports to Georgia EPD.

27. Project Manager and responsible for professional for hydrogeological study of a C&D landfill in Brunswick, Georgia. Installed monitoring wells, sampled and analyzed soil to assess characteristics of Satilla (surficial) aquifer. Prepared report for submittal to Georgia EPD.

28. Project Geologist for remedial investigation/feasibility study of the LCP Chemicals site in Brunswick, Georgia. Responsible for soil characterization study of PCBS. Study also included pumping tests on deep monitoring wells to evaluate groundwater impacts.

# *Todd Tharpe*

**Title:**
Geologist

**Years of Experience:** 9

**Education:**
B.S. Geology, State University of West Georgia, 1996

**Office Location:**
Atlanta, Georgia

## Professional Experience:

Mr. Tharpe is a geologist with JJG working in areas of groundwater resources investigations, Piedmont and Coastal Plain Province hydrogeology, groundwater contamination, borehole and surface geophysical surveys, and subsurface characterizations. Additionally, Mr. Tharpe has experience in geotechnical ground assessments for tunnel designs and experience in planning, managing, and reporting geologic and geotechnical investigations. Mr. Tharpe was previously employed by the U.S. Geological Survey, Water Resources Division, and worked on various groundwater resources projects.

Specific project experience includes:

- ***West Area CSO Storage Tunnel, Atlanta, Georgia.*** Assisted with geotechnical analysis and investigations for 8.5-mile long, 27-foot diameter hard-rock tunnel in Atlanta.
  - Borehole Geophysics: Performed geophysical logging 70 boreholes in fractured bedrock using acoustic televiewer, gamma ray, and electric logs. Used results to orient core and develop statistical description of fracture patterns. Fracture statistics used to estimate TBM boreability and key block wedge analysis.

- ***Nancy Creek Tunnel Project, Atlanta, Georgia.*** Assisted with geotechnical analysis and field investigations for 8.5-mile long, 18-foot diameter hard-rock sewer tunnel in Atlanta.
  - Mr. Tharpe handled groundwater-related issues that arose during construction. He assisted with the geotechnical mapping program and groundwater monitoring program for the Nancy Creek Tunnel.

- ***Chattahoochee Tunnel Project, Atlanta, Georgia.*** Performed groundwater monitoring for a 9.5-mile long, 18-foot diameter hard-rock tunnel in Metro Atlanta. Responsible for collecting groundwater level data, handled groundwater related issues that arose during tunnel construction, and performed geotechnical mapping of the tunnel.

- ***Project Geologist, Louisville Water Company Riverbank Infiltration Project.*** Responsibilities included conducting subsurface investigations for the characterization of groundwater resources adjacent to the Ohio River near Louisville, Kentucky. Project involved aquifer testing, rock coring, and data review and analysis. The subsurface data will be used for the design of a 4,500-foot long bedrock tunnel designed to collect water from a series of vertical connector wells.

- ***Project Geologist, Coastal Plain Groundwater Resources Project, Savannah, Georgia.*** Responsibilities included performing a geophysical survey of a complex aquifer system, aquifer testing, and data analysis.

Project involved characterizing groundwater resources for a proposed residential housing development.

- ***Project Geologist, Coastal Plain Aquifer Storage Capacity Project, Hilton Head Island, South Carolina.*** Responsibilities included performing an aquifer test and data analysis. Project involved determining the storage capacity of the local aquifer system for groundwater storage.

- ***Project Geologist, Large Scale RFI Investigation, DuPont Chattanooga Plant, Chattanooga, Tennessee.*** Project involved performing a subsurface characterization at a 550-acre industrial facility. Surface geophysics, borehole geophysics, lineament analyses, dye tracer studies, bedrock well installation, and groundwater sampling were used to conduct the investigation. Project received DuPont CRG Level 1 safety excellence award.

- ***Assistant Project Manager, RFI Development, DuPont Chattanooga Plant, Chattanooga, Tennessee.*** Assisted in development of RFI and hydrogeologic investigation strategy. Project required close interaction with client and project manager for prioritization of strategy development, scheduling, and annual forecasting.

- ***Project Geologist and Field Team Leader, CSR Delineation Activities, DuPont McClusky Farms, Dacula, Georgia.*** Project required close interaction with client and project manager for field sampling strategy and methodology. Responsible for site coordination and subcontractor supervision.

- ***Geologist, Groundwater Resources Investigation, Lawrenceville, Georgia.*** Project involved characterization of a complex, highly fractured crystalline-rock aquifer. Many innovative and experimental technologies were used to conduct the study. Borehole geophysical technologies utilized: borehole radar, tomography, acoustic televiewer, as well as other tradition borehole geophysical devices. Project also involved field mapping, rock coring, groundwater age dating, water level analyses, discreet interval packer testing, and aquifer testing.

- ***Geologist, Subsurface Characterization of a Complex, Highly Fractured Crystalline-rock Aquifer, Dobbins AFB, Marrietta, Georgia.*** Project involved subsurface characterization for the purposes of understanding contaminant transport in a fractured rock crystalline-aquifer. Project involved surface and subsurface geophysical investigations, discreet interval packer testing, and water level monitoring.

**Continuing Education**

USGS Training Course in Advanced Borehole Geophysics
USGS Training Course in Basic Data Recorder Systems
OSHA 40-hour Hazardous Site Training
Site Safety Audit Training

**Publications**

Chapman, Melinda J., Crawford, Thomas J., **Tharpe, W. Todd** - Geology and ground-water resources of the Lawrenceville area, Georgia (January 1, 1999)

**Tharpe, W. Todd**, Peak, Michael F., Chapman, Melinda J. - Analysis of ground-water withdrawals from crystalline-rock aquifer near Lawrenceville, Georgia (March 20, 1997)

Chapman, Melinda J., Hicks, David W., Peck, Michael F., **Tharpe, W. Todd** - Characterization of a crystalline-rock aquifer near Lawrenceville, Georgia; application of advances in borehole and surface geophysical methods (March 20, 1997)

# TABLES

# Table 1
## Summary of Wetland Classifications

| System | Class | Subclass | Water Regime | Wetland Drainage Criteria | Wetland Drainage Association | Dominant Plant Species |
|---|---|---|---|---|---|---|
| **Wetland 1 (A)** | | | | | | |
| Palustrine | Forested | Broad-leaved deciduous | Semi-permanent * beaver influenced | Above the headwaters | Tayloe Branch | *Juncus effusus, Chasmanthium latifolia, Carex* spp., *Cephalanthus occidentalis, Fraxinus pennsylvanica, Celtis laevivata, Quercus nigra* |
| **Wetland 2 (B)** | | | | | | |
| Palustrine | Forested | Broad-leaved deciduous | Seasonally flooded | Above the headwaters | Tayloe Branch | *Quercus nigra, Arundinaria gigantea, Fraxinus pennsylvanica, Carex* spp., *Campsis radicans, Celtis laevigata, Liquidambar styraciflua* |
| **Wetland 3 (C)** | | | | | | |
| Palustrine | Forested | Broad-leaved deciduous | Seasonally Flooded | Below the headwaters | Tayloe Creek | *Arundinaria gigantea, Fraxinus pennsylvanica, Acer negundo,* |
| **Wetland 4 (D)** | | | | | | |
| Palustrine | Forested | Broad-leaved deciduous | Seasonally flooded | Above the headwaters | Side tributary to Tayloe Creek | *Fraxinus pennsylvanica, Campsis radicans, Celtis laevigata, Toxicodendron radicans, Carex* spp., *Aesculus sylvatica* |
| **Wetland 5 (E)** | | | | | | |
| Palustrine | Forested | Broad-leaved deciduous | Seasonally flooded | Above the headwaters | Side tributary to Tayloe Creek | *Quercus nigra, Chasmanthium latifolia, Toxicodendron radicans, Campsis radicans, Arundinaria gigantea, Fraxinus pennsylvanica, Celtis laevigata, Carex* spp. |
| **Wetland 6 (F)** | | | | | | |
| Palustrine | Forested | Broad-leaved deciduous | Seasonally flooded | Above the headwaters | Side tributary to Tayloe Creek | *Fraxinus pennsylvanica, Celtis laevigata, Toxicodendron radicans* |
| **Wetland 7 (G)** | | | | | | |
| Palustrine | Forested | Broad-leaved deciduous | Seasonally flooded *beaver influenced | Above the headwaters | Side tributary to Tayloe Creek | *Celtis laevigata, Ulmus americana, Fraxinus pennsylvanica* |
| **Wetland 8 (H)** | | | | | | |
| Palustrine | Forested/ scrub-shrub | Broad-leaved deciduous | Seasonally flooded * beaver influenced | Above the headwaters | Side tributary to Tayloe Creek | *Salix nigra, Typha latifolia, Pluchea camphorata, Polyganum* spp. , *Eupatorium perfoliatum* |

## Table 1
## Summary of Wetland Classifications – (continued)

| System | Class | Subclass | Water Regime | Wetland Drainage Criteria | Wetland Drainage Association | Dominant Plant Species |
|---|---|---|---|---|---|---|
| **Wetland 9 (I)** | | | | | | |
| Palustrine | Forested | Broad-leaved deciduous | Seasonally flooded | Above the headwaters | Side tributary to Tayloe Creek | *Celtis laevigata, Ulmus americana, Fraxinus pennsylvanica* |
| **Wetland 10 (J)** | | | | | | |
| Palustrine | Forested | Broad-leaved deciduous | Seasonally flooded *beaver influenced | Above the headwaters | Side tributary to Tayloe Creek | *Salix nigra, Cornus amomum, Toxicodendron radicans, Fraxinus pennsylvanica* |
| **Wetland 11 (K)** | | | | | | |
| Palustrine | Forested/ emergent | Broad-leaved deciduous/ persistent | Seasonally flooded | Above the headwaters | Side tributary to Tayloe Creek | *Salix nigra, Carex* spp., *Pluchea camphorata, Populis deltoides, Fraxinus pennsylvanica* |
| **Wetland 12 (L)** | | | | | | |
| Palustrine | Forested | Broad-leaved deciduous | Seasonally flooded | Above the headwaters | Side tributary to Tayloe Creek | *Salix nigra, Festuca spp., Populis deltoides, Fraxinus pennsylvanica, Toxicodendron radicans* |
| **Wetland 13 (M)** | | | | | | |
| Palustrine | Emergent | Persistent | Seasonally flooded | Below the headwaters ? | Tayloe Creek | *Juncus effusus, Boehlmaria cylindrica* |
| **Wetland 14 (N)** | | | | | | |
| Palustrine | Emergent | Persistent | Seasonally flooded | Below the headwaters ? | Tayloe Creek | *Mikania scandens, Leersia virginica, Juncus effusus, Carex* spp. |
| **Wetland 15 (O)** | | | | | | |
| Palustrine | Emergent | Persistent | Seasonally flooded | Below the headwaters | Tayloe Creek | *Juncus effusus, Passiflora lutea, Biden laevis* |
| **Wetland 16 (P)** | | | | | | |
| Palustrine | Forested/ Emergent | Broad-leaved deciduous/ Persistent | Seasonally flooded | Above the headwaters | Side tributary to Tayloe Creek | *Boehlmaria cylindrica, Populis deltoides, Salix nigra, Campsis radicans, Acer negundo, Fraxinus pennsylvanica, Lonicera japonica* |

## Table 2
## Summary of Waters of the United States Classifications

| Water | System | Subsystem | Class | Subclass | Wetland Drainage Association |
|---|---|---|---|---|---|
| 1 | Riverine | Lower Perennial | Unconsolidated Bottom | Cobble-gravel, sand, mud | Tayloe Creek |
| 2 | Riverine | Intermittent | Streambed | Sand, mud | Tayloe Creek |
| 3 | Riverine | Intermittent | Streambed | Sand, mud | Tayloe Creek |
| 4 | Riverine | Intermittent | Streambed | Sand, mud | Tayloe Creek |
| 5 | Riverine | Intermittent | Streambed | Sand, mud | Tayloe Creek |
| 6 | Riverine | Intermittent | Streambed | Sand, mud | Tayloe Creek |
| 7 | Riverine | Intermittent | Streambed | Sand, mud | Tayloe Creek |
| 8 | Riverine | Intermittent | Streambed | Sand, mud | Tayloe Creek |
| 9 | Riverine | Intermittent | Streambed | Sand, mud | Tayloe Creek |
| 10 | Riverine | Intermittent | Streambed | Sand, mud | Tayloe Creek |
| 11 | Riverine | Intermittent | Streambed | Sand, mud | Tayloe Creek |
| 12 | Riverine | Intermittent | Streambed | Sand, mud | Tayloe Creek |
| 13 | Riverine | Intermittent | Streambed | Sand, mud | Tayloe Creek |
| 14 | Riverine | Intermittent | Streambed | Sand, mud | Tayloe Creek |
| 15 | Riverine | Intermittent | Streambed | Sand, mud | Tayloe Creek |
| 16 | Riverine | Intermittent | Streambed | Sand, mud | Tayloe Creek |
| 17 | Riverine | Intermittent | Streambed | Sand, mud | Tayloe Creek |
| 18 | Palustrine | Open water | Unknown bottom | | Tayloe Creek |
| 19 | Palustrine | Open water | Unknown bottom | | Tayloe Creek |
| 20 | Palustrine | Open water | Unknown bottom | | Tayloe Creek |
| 21 | Palustrine | Open water | Unknown bottom | | Tayloe Creek |
| 22 | Palustrine | Open water | Unknown bottom | | Tayloe Creek |
| 23 | Riverine | Intermittent | Streambed | Sand, mud | Tayloe Creek |
| 24 | Riverine | Intermittent | Streambed | Sand, mud | Tayloe Branch |
| 25 | Riverine | Intermittent | Streambed | Sand, mud | Tayloe Creek |

Table 5
Groundwater Flow Calculations

JORDAN JONES & GOULDING

| | | | | | |
|---|---|---|---|---|---|
| PROJECT NUMBER: | 4305.001 | | | PAGE: | 1 OF 1 |
| PROJECT NAME: | PCA Landfill | BY: | JR | DATE: | June 8, 2001 |
| SUBJECT: | Design Calculations | CHK'D: | L.M. | DATE: | 6-14-01 |

# CALCULATED GROUNDWATER FLOW RATE

## Equation

$V = k\,{}^{i}/_{n_e}$

where: V = ground water velocity
k = hydraulic conductivity
$^{i}$ = hydraulic gradient
$n_e$ = effective porosity

| | ft./day | |
|---|---|---|
| k = | 0.03 | DW-1 |
| k = | 0.03 | DW-2 |
| k = | 0.06 | DW-3 |
| k = | 0.04 | ave. |

| Assumptions | | | Reference |
|---|---|---|---|
| ( k ) = the site average hydraulic conductivity (using average k for DW-1, DW-2, and DW-3) | = | 0.04 ft./day | (Ref. 1) |
| ( i ) = dh/dl (Estimated Potentiometric Surface Eutaw aquifer) | = | 0.006 ft./ft. | (Figure 9) |
| ( $n_e$ ) range | = | 10% 0.1<br>20% 0.2<br>30% 0.3 | (Ref. 2) |

## Calculation

V = 4 ft./day ( 0.006 ft./ft./ (10, 20, or 30%))

| | Velocity (ft./day) | Velocity (ft./year) |
|---|---|---|
| For $n_e$ = 10% | 2.5E-03 | 0.9 |
| For $n_e$ = 20% | 1.3E-03 | 0.4 |
| For $n_e$ = 30% | 8.5E-04 | 0.3 |

Notes
(1) Site investigation for proposed Perry County Associates Landfill, JJ&G, June 2001
(2) Freeze and Cherry, Groundwater, Prentice-Hall, Inc., 1979.

# Water Wells and Construction Details

| Number | Owner | Driller | Year Completed | Depth of Well (feet) | Diameter of Well (inches) | Water Bearing Unit | Altitude of Land Surface (feet) | Water Level | | Method of Lift | Use of Water | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Above (+) or Below Land Surface (feet) | Date of Measurement | | | |
| V-1 | C. Yelverton | | 1918 | 550 | 4 | Ke | 212 | 44.4 | 2/9/68 | J | S | |
| V-2 | City of Uniontown | Layne-Central | 1949 | 915 | 12.6 | Ke | 263 | 98<br>99 | 1949<br>10/10/49 | T | P | Casing: 12-in from surface to 850 ft; 6 in. from 770 to 855 ft; screen from 855 to 875 ft; 6-in casing from 875 to 895 ft; screen from 895 to 915 ft; Reported drawdown 30 ft while pumping 275 gpm in 1949. Driller's log in Table 6. |
| V-3 | City of Uniontown | Unknown | 1902 | 1,300(?) | 6 | Ke(?) | 255 | 96.5 | 12/12/67 | N | N | U.S. Geol. Survey observation well. |
| V-4 | J.C. Well | F.C. Null | 1936 | 950 | 6 | Ke | | 135 | 1936(?) | N | N | |
| V-5 | City of Uniontown | Layne-Central | 1954 | 935 | 16.8 | Ke | 287 | 1331 | 1954 | T | P | Casing: 16-in from surface to 850 ft; 8 in. from 768 to 855 ft; screen from 855 to 935 ft. Reported drawdown 67 ft. after 12 hrs pumping 510 gpm in 1954. Driller's log in Table 6. |
| V-6 | M. & T. Cheese | Layne-Central | 1946 | 908 | 12.6 | Kr | 240 | 76<br>76 | 1946<br>1950 | T | Ind | Casing: 12-in from surface to 312 ft; 6-in. from 272 to 868 ft; screen from 868 to 908 ft. Reported drawdown 13 ft. after 8 hrs. pumping 100 gpm in 1946. Driller's log in Table 6. |
| V-7 | J. Goodsen, Sr. | Radford Drillir | 1957 | 530 | 5 | Ke | 212 | 42 | 1957 | J | S | Casing: 5-in from surface to 22 ft; none below. Supplies as many as many as 200 cattle. |
| V-8 | N.B. Mayton | | 1965 | 850 | 4 | Ke | 259 | 114.3 | 3/12/68 | S | D | Casing: 4-in from surface to 20 ft; none below. |
| V-9 | A.P. Woodfin | F.C. Null | 1960 | 900 | 5 | Ke | 273 | 114.2 | 3/12/68 | S | D, S | Casing: 5 in from surface to 900 ft; perforated from 820 to 900 ft. Supplies 4 families, fish pond and 200 cattle. |
| W-1 | R. Flowers | Redford Drillir | 1968 | 720 | 4 | Ke | 273 | 129.6 | 7/24/68 | S | D | Casing: 4 in from surface to 24 ft; 2-in from surface to 720 ft; perforated from 615 to 720 ft. |
| W-2 | J.W. Tarter | | 1963 | 880 | 4 | Ke | 251 | 140 | 1963 | S | D | Casing: 4 in from surface to 30 ft; none below. |
| W-3 | W. Early | Brady Well & Supply Co. | 1962 | 940 | 4 | Ke | 251 | | | P | D | |

Reference: GSA Map 127

# Groundwater Levels and Elevations

| Observation Well ID | Total Depth | Datum Elev. | Static Groundwater | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Feb. 14, 2001 | | Feb. 28, 2001 | | Mar. 15, 2001 | | Mar. 31, 2001 | | Apr. 16, 2001 | | Apr. 30, 2001 | | May 9, 2001 | | 27-Jul-01 | |
| | | | Depth | Elev. | Depth | Elev. | Depth | Elev. | Depth | Elev. | Depth | Elev. | Depth | Elev. | Depth | Elev. | Depth | Elev. |
| DW1 | 600 | 282.28 | -- | -- | -- | -- | 175.67 | 106.61 | 175.24 | 107.04 | 175.00 | 107.28 | 174.22 | 108.06 | 173.69 | 108.59 | 171.12 | 111.16 |
| DW2 | 560 | 265.45 | 151.60 | 113.85 | 149.00 | 116.45 | 148.60 | 116.85 | 149.68 | 115.77 | 149.30 | 116.15 | 149.01 | 116.44 | 149.01 | 116.44 | 147.85 | 117.60 |
| DW3 | 535 | 229.31 | 115.10 | 114.21 | 112.00 | 117.31 | 111.13 | 118.18 | 112.10 | 117.21 | 112.70 | 116.61 | 112.58 | 116.73 | 113.72 | 115.59 | 111.90 | 117.41 |
| SW1 | 60 | 294.08 | 57.83 | 236.25 | 57.83 | 236.25 | 58.00 | 236.08 | 58.50 | 235.58 | 61.00 | Dry | 61.00 | Dry | Dry | Dry | Dry | Dry |
| SW2 | 60 | 287.08 | 57.80 | 229.28 | 57.83 | 229.25 | 57.67 | 229.41 | 57.34 | 229.74 | 57.80 | Dry | 60.50 | Dry | 56.91 | 230.17 | 53.15 | 233.93 |
| P-1 | 60 | 283.53 | -- | -- | -- | -- | -- | -- | -- | -- | -- | Dry | Dry | Dry | Dry | Dry | 59.35 | 224.18 |
| P-2 | 60 | 283.91 | -- | -- | -- | -- | -- | -- | -- | -- | -- | Dry | Dry | Dry | Dry | Dry | Dry | Dry |
| P-3 | 60 | 221.59 | -- | -- | -- | -- | -- | -- | -- | -- | -- | Dry | Dry | Dry | Dry | Dry | 30.30 | 191.29 |

| Observation Well ID | Total Depth | Datum Elev. | Static Groundwater | | | |
|---|---|---|---|---|---|---|
| | | | Jan. 20, 2005 | | May 19, 2005 | |
| | | | Depth | Elev. | Depth | Elev. |
| DW1 | 600 | 282.28 | 156.40 | 125.88 | 155.54 | 126.74 |
| DW2 | 560 | 265.45 | 134.55 | 130.90 | 134.64 | 130.81 |
| DW3 | 535 | 229.31 | 99.17 | 130.14 | 99.09 | 130.22 |
| SW1 | 60 | 294.08 | -- | -- | -- | -- |
| SW2 | 60 | 287.08 | -- | -- | -- | -- |
| P-1 | 60 | 283.53 | Dry | Dry | 20.53 | 263.00 |
| P-2 | 60 | 283.91 | 10.65 | 273.26 | 11.50 | 272.41 |
| P-3 | 60 | 221.59 | 17.80 | 203.79 | 10.91 | 210.68 |

Notes:

Observation wells drilled and installed by Allen & Willis February 8, 2001 except DW1 installed February 15, 2001.

Piezometers P-1, P-2 and P-3 installed May 1 and 2, 2001.

Water level measurements for February 14 and 28, and March 15, 2001 performed by Integrated Science & Engineering, Griffin, Georgia.

Water level measurements for March 31, April 16, and April 30 performed by Jordan, Jones & Goulding, Norcross, Georgia.

Fluid levels in SW-1 and SW-2 characterized as wet cuttings or drilling fluid,remanants - not believed to be representative of natural saturated conditions.

Well locations surveyed to State Plane - Alabama West Zone - North American Datum 1983 (NAD83) by JJ&G.

# Summary of Soil Test Results

| Boring No. | Depth | Sample Type | Atterberg Limit ASTM D422 | | | Natural Moisture Content ASTM D2216 | Amount of Fines ASTM D422 | Unified Soil Classification ASTM D2487 | Specific Gravity ASTM D854 | Organic Content ASTM D2974 | Cation Exchange Capacity | Dry Bulk Density | Vertical Permeability ASTM D5084 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | LL | PL | PI | | | | | | | | |
| | | | % | % | % | % | % | | Gs | % | Meq/100 ML | PCF | CM / SEC |
| P-1 | 38.5'-40' | UD | 56 | 26 | 30 | 19.8 | 96 | CH | 2.669 | 2.05 | 14.1 | 85.5 | 2.60E-08 |
| P-2 | 28.5'-30' | UD | 59 | 21 | 38 | 13.1 | 94 | CH | 2.673 | 1.44 | 16.4 | 105.9 | 4.60E-08 |
| P-3 | 38.5'-40' | UD | 58 | 21 | 37 | 24.8 | 86 | CH | 2.669 | 2.48 | 18 | 94.8 | 7.30E-09 |
| | | | | | | | | | | | | | |
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| | | | | | | | | | | | | | |

Notes:
Samples collected May 1 and 2, 2001 by JJ&G.
See Figure 2 for boring locations.
Laboratory Report provided in Appendix J.

# Table 5
## Groundwater Flow Calculations

JORDAN JONES & GOULDING

| | | | | | |
|---|---|---|---|---|---|
| PROJECT NUMBER: | 4305.001 | | | PAGE: | 1 OF 1 |
| PROJECT NAME: | PCA Landfill | BY: | JR | DATE: | June 8, 2001 |
| SUBJECT: | Design Calculations | CHK'D: | | DATE: | 6-14-01 |

## CALCULATED GROUNDWATER FLOW RATE

### Equation

$V = k\,i/n_e$ where: V = ground water velocity
k = hydraulic conductivity
i = hydraulic gradient
$n_e$ = effective porosity

| | ft./day | |
|---|---|---|
| k = | 0.03 | DW-1 |
| k = | 0.03 | DW-2 |
| k = | 0.06 | DW-3 |
| k = | 0.04 | ave. |

| Assumptions | | | Reference |
|---|---|---|---|
| ( k ) = the site average hydraulic conductivity (using average k for DW-1, DW-2, and DW-3) | = | 0.04 ft./day | (Ref. 1) |
| ( i ) = dh/dl (Estimated Potentiometric Surface Eutaw aquifer) | = | 0.006 ft./ft. | (Figure 9) |
| ( $n_e$ ) range | = | 10% 0.1<br>20% 0.2<br>30% 0.3 | (Ref. 2) |

### Calculation

V = 4 ft./day ( 0.006 ft./ft./ (10, 20, or 30%))

| | Velocity (ft./day) | Velocity (ft./year) |
|---|---|---|
| For $n_e$ = 10% | 2.5E-03 | 0.9 |
| For $n_e$ = 20% | 1.3E-03 | 0.4 |
| For $n_e$ = 30% | 8.5E-04 | 0.3 |

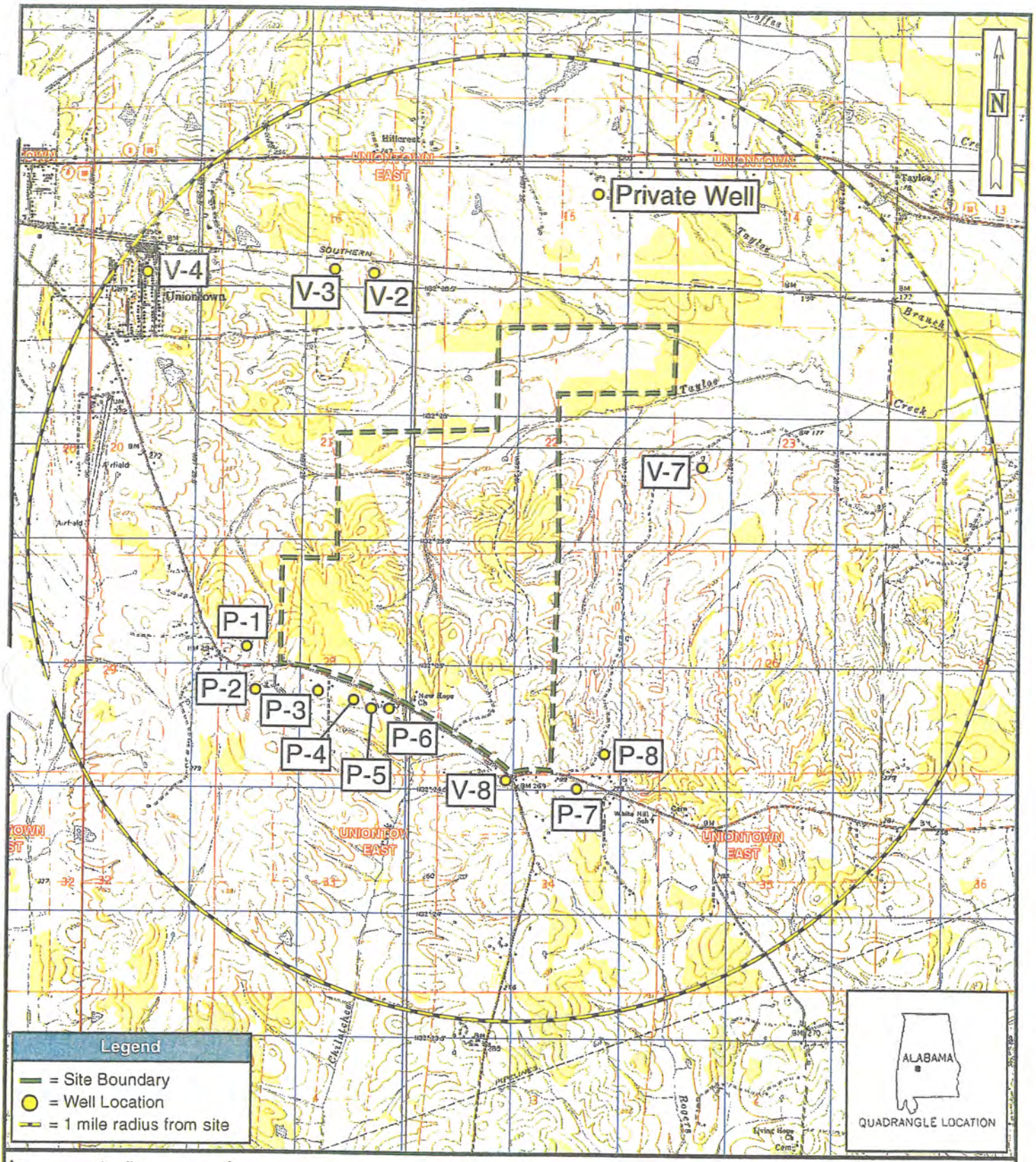
Notes
(1) Site investigation for proposed Perry County Associates Landfill, JJ&G, June 2001
(2) Freeze and Cherry, Groundwater, Prentice-Hall, Inc., 1979.

# Water Wells and Construction Details

| Number | Owner | Driller | Year Completed | Depth of Well (feet) | Diameter of Well (inches) | Water Bearing Unit | Altitude of Land Surface (feet) | Water Level | | Method of Lift | Use of Water | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Above (+) or Below Land Surface (feet) | Date of Measurement | | | |
| V-1 | C. Yelverton | | 1918 | 550 | 4 | Ke | 212 | 44.4 | 2/9/1968 | J | S | |
| V-2 | City of Uniontown | Layne-Central | 1949 | 915 | 12.6 | Ke | 263 | 98<br>99 | 1949<br>10/10/1949 | T | P | Casing: 12-in from surface to 850 ft; 6 in. from 770 to 855 ft; screen from 855 to 875 ft; 6-in casing from 875 to 895 ft; screen from 895 to 915 ft; Reported drawdown 30 ft while pumping 275 gpm in 1949. Driller's log in Table 6. |
| V-3 | City of Uniontown | Unknown | 1902 | 1,300(?) | 6 | Ke(?) | 255 | 96.5 | 12/12/1967 | N | N | U.S. Geol. Survey observation well. |
| V-4 | J.C. Well | F.C. Null | 1936 | 950 | 6 | Ke | | 135 | 1936(?) | N | N | |
| V-5 | City of Uniontown | Layne-Central | 1954 | 935 | 16.8 | Ke | 287 | 1331 | 1954 | T | P | Casing: 16-in from surface to 850 ft; 8 in. from 768 to 855 ft; screen from 855 to 935 ft. Reported drawdown 67 ft. after 12 hrs pumping 510 gpm in 1954. Driller's log in Table 6. |
| V-6 | M. & T. Cheese | Layne-Central | 1946 | 908 | 12.6- | Kr | 240 | 76<br>76 | 1946<br>1950 | T | Ind | Casing: 12-in from surface to 312 ft; 6-in. from 272 to 868 ft; screen from 868 to 908 ft. Reported drawdown 13 ft. after 8 hrs. pumping 100 gpm in 1946. Driller's log in Table 6. |
| V-7 | J. Goodsen, Sr. | Radford Drillir | 1957 | 530 | 5 | Ke | 212 | 42 | 1957 | J | S | Casing: 5-in from surface to 22 ft; none below. Supplies as many as many as 200 cattle. |
| V-8 | N.B. Mayton | | 1965 | 850 | 4 | Ke | 259 | 114.3 | 3/12/1968 | S | D | Casing: 4-in from surface to 20 ft; none below. |
| V-9 | A.P. Woodfin | F.C. Null | 1960 | 900 | 5 | Ke | 273 | 114.2 | 3/12/1968 | S | D, S | Casing: 5 in from surface to 900 ft; perforated from 820 to 900 ft. Supplies 4 families, fish pond and 200 cattle. |
| W-1 | R. Flowers | Redford Drillir | 1968 | 720 | 4 | Ke | 273 | 129.6 | 7/24/1968 | S | D | Casing: 4 in from surface to 24 ft; 2-in from surface to 720 ft; perforated from 615 to 720 ft. |
| W-2 | J.W. Tarter | | 1963 | 880 | 4 | Ke | 251 | 140 | 1963 | S | D | Casing: 4 in from surface to 30 ft; none below. |
| W-3 | W. Early | Brady Well & Supply Co. | 1962 | 940 | 4 | Ke | 251 | | | P | D | |

Reference: GSA Map 127

# FIGURES




*Ref. USGS - Uniontown East, Alabama*

JORDAN JONES & GOULDING

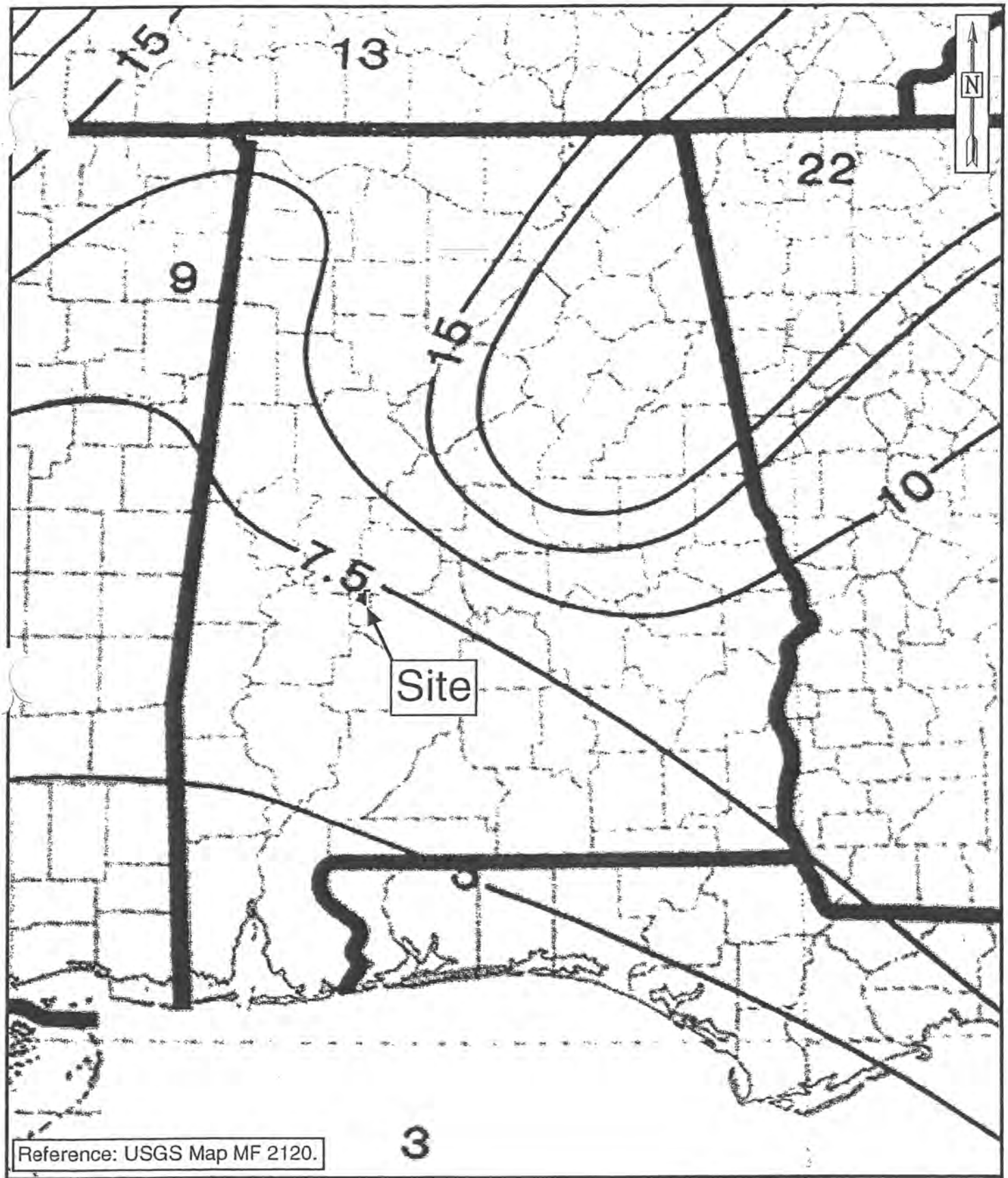
Perry County Associates Landfill

**Water Supply Well Locations**

| | |
|---|---|
| Date: | June 2005 |
| Scale: | As Shown |
| Job No.: | 4305.001 |

**Figure 10**
*- Revised -*

4305_001 radius.fh11 pt




Reference: USGS Map MF 2120.

JORDAN JONES & GOULDING

Perry County Associates Landfill

Seismicity Map

Date: June 2005
Scale: N.T.S.
Job No.: 4305.001

Figure 4

4305.001Figure1.fh11

| Syst- | Series | Geologic unit | | Thickness (feet) | Lithology | Water-bearing characteristics | Quality water |
|---|---|---|---|---|---|---|---|
| Quaternary | Holocene and Pleistocene | Low-terrace deposits and alluvium | | 0-50 | Sand, light-gray and yellowish-orange, fine- to coarse-grained, gravelly in part; gray sandy clay. | Will yield 10 gpm or more where sands and gravels are of sufficient saturated thickness. Potential source of larger supplies where hydraulically connected to the Cahaba River and Oakmulgee Creek. | Water is generally soft. |
| | | High-terrace deposits | | 0-40 | Sand, reddish-brown and reddish-gray, very fine to coarse-grained, gravelly in part; gray sandy clay. | Will yield 10 gpm where sands and gravels are of sufficient saturated thickness. | Water is probably soft; may have an iron content that exceeds 0.3 mg/l. |
| Cretaceous | Upper Cretaceous | Selma Group | Ripley Formation | 0-40 | Clay, sandy, fossiliferous, very micaceous, weathers yellowish brown and greenish gray; dark gray fine- to medium-grained sand, weathers moderate reddish brown; yellowish-brown fine-grained glauconitic sandstone. | Will yield less than 10 gpm. | No information. |
| | | | Demopolis Chalk | 0-400 | Chalk, light-gray, argillaceous, fossiliferous; light-gray and gray sandy calcareous clay, weathering in part to dusky yellow and medium reddish brown. | Relatively impermeable; not a source of water. | |
| | | | Mooreville Chalk | 0-400 | Chalk, light-gray, argillaceous, fossiliferous; light-gray and gray sandy calcareous clay. Upper 20 to 30 feet consists of very pale orange indurated limestone ledges which form persistent ridges and hills. | Relatively impermeable; not a source of water. | |
| | | Eutaw Formation | | 0-420 | Sand, light-brown and reddish-brown, fine- to coarse-grained, micaceous, crossbedded and scattered chert and quartz pebbles in lower 30 feet; light-gray and olive-gray thin-bedded glauconitic carbonaceous clay. | Will yield 0.5 to 1 mgd per well in the southeastern, central, and west-central parts of the county and 1 to 2 mgd in the southwestern part. | Water is generally soft except in west-central and south-central parts of the county it is moderately hard to hard. Iron content exceeds 0.3 mg/l in the central part of the county. Fluoride content may be objectionable south of Uniontown. |
| | | Tuscaloosa Group | Gordo Formation | 0-400 | Sand, reddish-brown and yellowish-orange, very fine to coarse-grained, gravelly in basal part; light-gray, grayish-yellow, and light-brown, partly carbonaceous sandy clay. | Will yield 0.5 to 1 mgd per well in the northern half of the county and 1 mgd or more in the southern half. | Water is generally soft, but locally in the northern part of the county may be moderately hard. Iron content generally exceeds 0.3 mg/l in the northern half of the county but generally is less than 0.3 mg/l in the southern half. Dissolved solids may exceed 1,000 mg/l south of Uniontown. |
| | | | Coker Formation | 400-700 | Sand, reddish-brown and yellowish-orange, very fine to coarse-grained; basal sand 100 to 200 feet thick and is generally gravelly. Light-gray, olive-gray, yellowish-gray, and moderate brown, partly carbonaceous sandy clay. | Will yield 0.5 to 1 mgd per well in the northern half of the county and 1 mgd or more in the southern half. | Water is soft to hard. Generally contains iron in excess of 0.3 mg/l in northern half of the county. Dissolved solids may exceed 1,000 mg/l south of Uniontown. |

Reference: Geological Survey of Alabama, Map 127.

JORDAN JONES & GOULDING

Perry County Associates Landfill

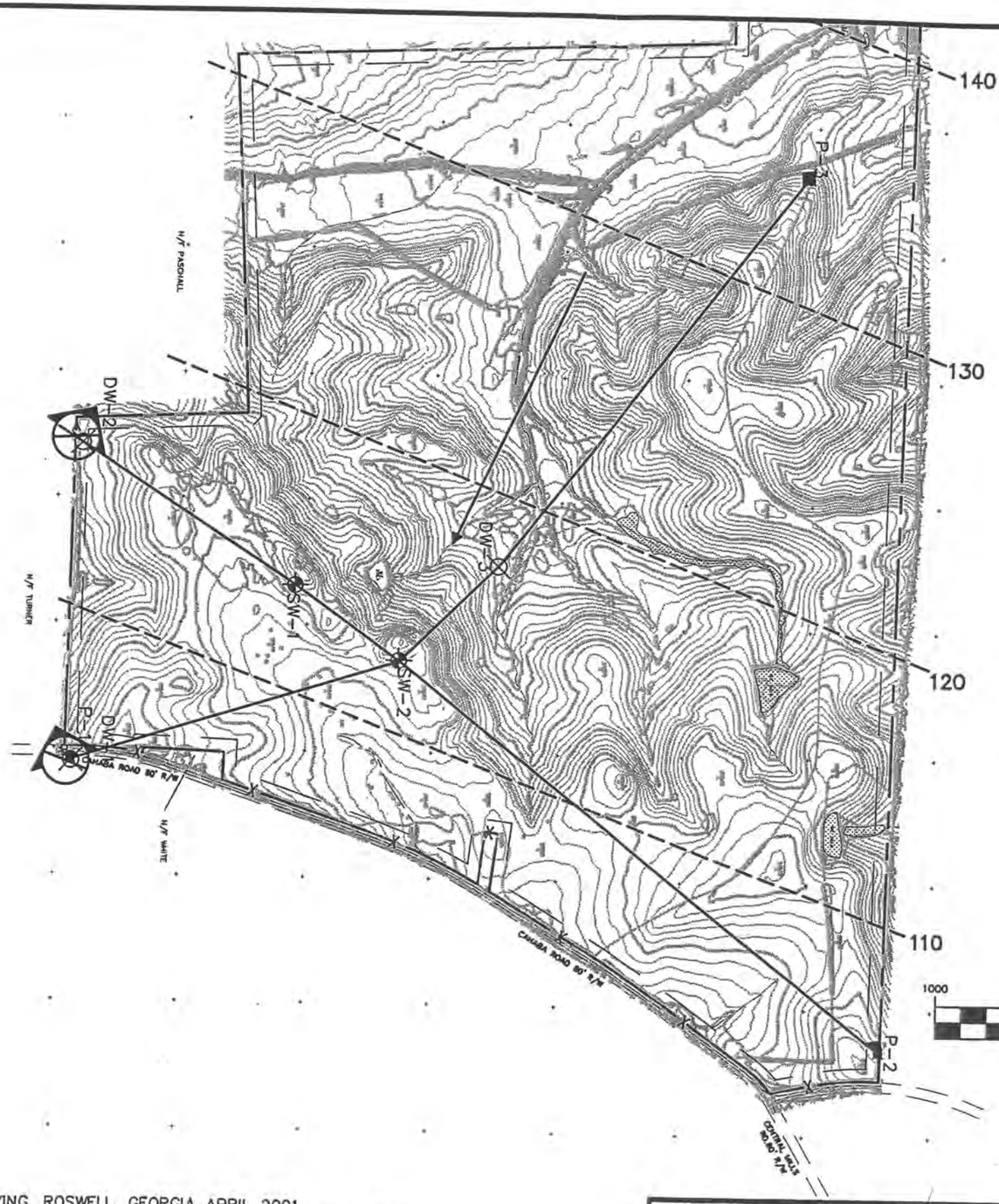
Date: June 2005
Scale: N.T.S.
Job No.: 4305.001

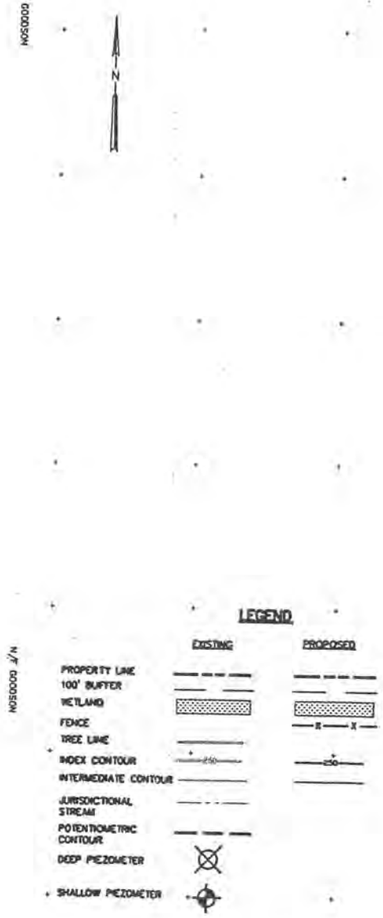
**Geologic Units Present in Perry County and Water-Bearing Characteristics**

**Figure 5**

4305.001Figure1.fh11

int001CP03.dwg 5:23, 6/5




GRAPHIC SCALE

1000 0 500 1000 2000 4000

( IN FEET )

NOTES

1. TOPOGRAPHIC SURVEY BY LANDAIR SURVEYING, ROSWELL, GEORGIA APRIL 2001.
   BOUNDARY AND WELL LOCATIONS BY JORDAN, JONES & GOULDING, INC. (APRIL–MAY 2001).
2. ELEVATIONS ARE FEET ABOVE MEAN SEA LEVEL NAD – 1983

Jordan Jones & Goulding

LANDFILL SITE ANALYSIS
PERRY COUNTY ASSOCIATES

LOCATION OF PIEZOMETERS AND CROSS SECTIONS

DATE : JUNE 2001
SCALE : AS SHOWN
JOB NO.: 4305.001

FIGURE 6

int001CS04.dgn 09.23.05

PL DW-2 SW-1 SW-2 P-2 PL

300
200
100
0
-100
-200
-300
-400

ELEVATION (FEET, MSL)

DRY DRY DRY

(DEPTH INFERRED FROM SECTION B-B')

(DEPTH INFERRED FROM POTENTIOMETRIC SURFACE MAP)

SELMA GROUP

DEMOPOLIS AND MOOREVILLE CHALKS
LIGHT GRAY TO MEDIUM YELLOWISH GRAY
FOSSILIFEROUS CHALKY, CHALKY MARL,
AND CLAYEY CHALK.

SAND

SAND/GRAVEL

EUTAW FM.

LIGHT-GREENISH GRAY TO YELLOWISH GRAY
WELL SORTED, CROSS-BEDDED, FINE TO MEDIUM-
GRAINED GLAUCONITIC MICACEOUS SAND.

*DATUM ELEV*
*-500.00*

0+00 6+00 12+00 18+00 24+00 30+00 36+00 42+00 48+00 54+00 60+00 66+00 72+00 78+00

LEGEND

BORING WELL CASING
WELL SCREEN
GROUND SURFACE
GEOLOGIC CONTACT
DASHED WHERE INFERRED
POTENTIOMETRIC SURFACE

SCALE

HORIZONTAL: 1" = 600'
VERTICAL: 1" = 100'

TJIANG

Jordan Jones & Goulding

LANDFILL SITE ANALYSIS
PERRY COUNTY ASSOCIATES

CROSS SECTION A - A

DATE : JUNE 2005
SCALE : AS SHOWN
JOB NO.: 4305.001

FIGURE 7

int001CS05.d
09.23.05

PL DW-1 P-1 SW-2 DW-3 P-3 PL

300
200
100
0
-100
-200
-300
-400

ELEVATION (FEET, MSL)

DRY
DRY
DRY

(DEPTH INFERRED FROM POTENTIOMETRIC SURFACE MAP)

SELMA GROUP

DEMOPOLIS AND MOOREVILLE CHALKS
LIGHT GRAY TO MEDIUM YELLOWISH GRAY
FOSSILIFEROUS CHALKY, CHALKY MARL,
AND CLAYEY CHALK.

CLAYEY SAND, GRAVEL

SAND

EUTAW FM.

LIGHT-GREENISH GRAY TO YELLOWISH GRAY
WELL SORTED, CROSS-BEDDED, FINE TO MEDIUM-
GRAINED GLAUCONITIC MICACEOUS SAND.

*DATUM ELEV*
*-500.00*

0+00 6+00 12+00 18+00 24+00 30+00 36+00 42+00 48+00 54+00 60+00 66+00 72+00 78+00

LEGEND

BORING
WELL CASING
WELL
SCREEN

GROUND SURFACE
GEOLOGIC CONTACT
DASHED WHERE INFERRED
POTENTIOMETRIC SURFACE

SCALE

HORIZONTAL: 1" = 600'
VERTICAL: 1" = 100'

Jordan Jones & Goulding

LANDFILL SITE ANALYSIS
PERRY COUNTY ASSOCIATES

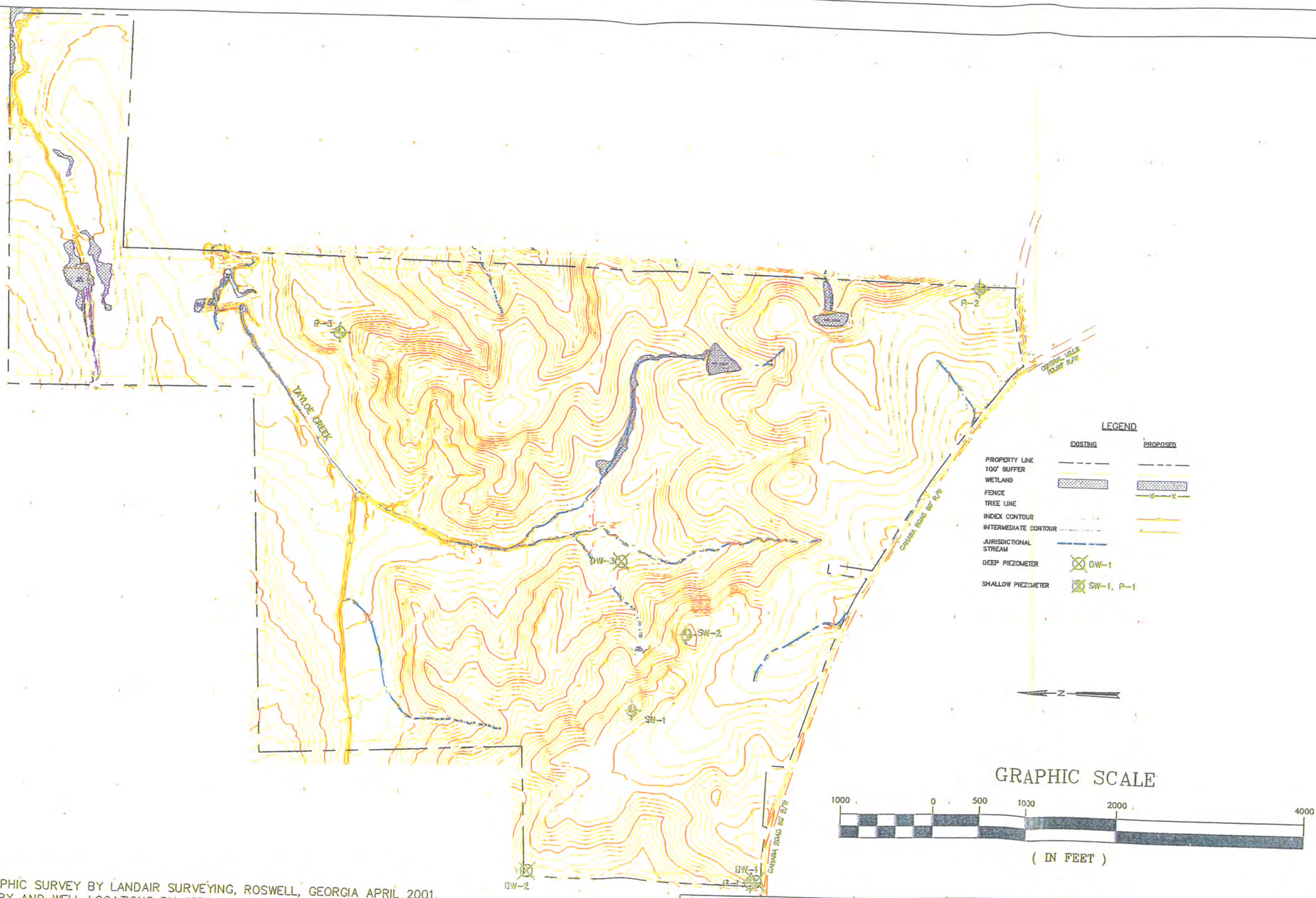
CROSS SECTION B – B

DATE : JUNE 2005
SCALE : AS SHOWN
JOB NO.: 4305.001

FIGURE 8

THANG

INT001CP04.DWG
06.13.01




LEGEND

| | EXISTING | PROPOSED |
|---|---|---|
| PROPERTY LINE<br>100' BUFFER | | |
| WETLAND | | |
| FENCE | | |
| TREE LINE | | |
| INDEX CONTOUR | | |
| INTERMEDIATE CONTOUR | | |
| JURISDICTIONAL STREAM | | |
| DEEP PIEZOMETER | DW-1 | |
| SHALLOW PIEZOMETER | SW-1, P-1 | |

N

GRAPHIC SCALE

1000 0 500 1000 2000 4000

( IN FEET )

NOTES

1. TOPOGRAPHIC SURVEY BY LANDAIR SURVEYING, ROSWELL, GEORGIA APRIL 2001.
   BOUNDARY AND WELL LOCATIONS BY JORDAN, JONES & GOULDING, INC. (APRIL–MAY 2001).
2. ELEVATIONS ARE FEET ABOVE MEAN SEA LEVEL NAD – 1983
3. LOCATION OF JURISDICTIONAL WATERS AND WETLANDS IDENTIFIED BY JJ&G APRIL 2001.
4. JURISDICTIONAL AREAS SHOWN FOR PCA LANDFILL PROPERTY ONLY.

CDIMGBA

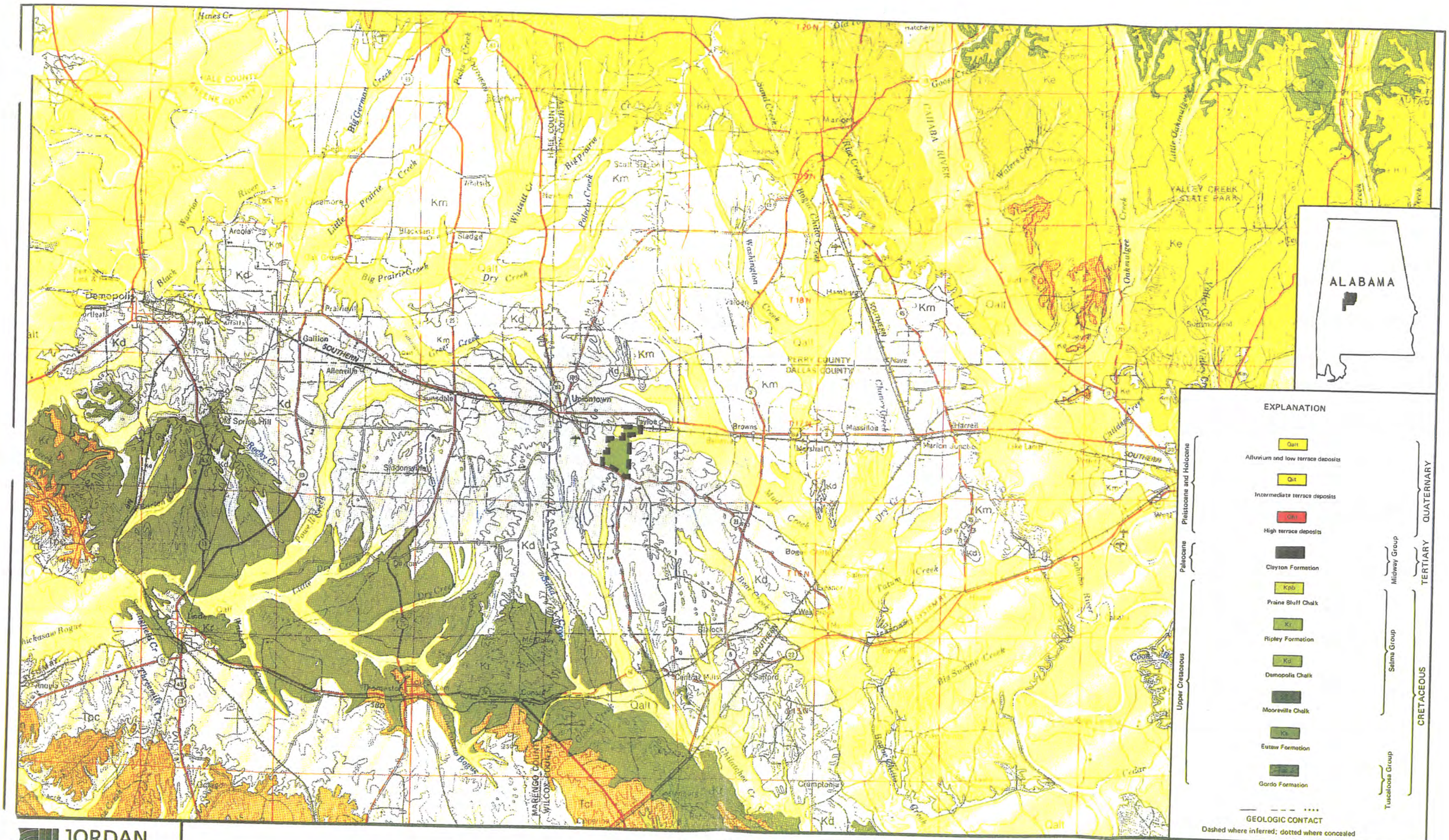
Jordan Jones & Goulding

LANDFILL SITE ANALYSIS
PERRY COUNTY ASSOCIATES

SITE CONDITIONS

DATE : JUNE 2001
SCALE : AS SHOWN
JOB NO.: 4305.001

FIGURE 2




JORDAN JONES & GOULDING

Perry County Associates Landfill

Regional Geologic Map

Date: June 2005
Scale: 1"= 4 miles
Job No.: 4305.001

Figure 3

4305.001Figure1.dv11

JORDAN
JONES &
GOULDING

# Appendix A
# Local Zoning Approval
# And
# Statement of Consistency

STATE OF ALABAMA )

PERRY COUNTY )

## RESOLUTION

**WHEREAS**, Perry County (the "County") has recently adopted its Local Solid Waste Management Plan (the "Plan"); and,

**WHEREAS**, Perry County Associates, LLC ("PCA") has applied to the County for approval of a Subtitle D solid waste disposal site (the "Site") and a related contract (the "Contract"); and

**WHEREAS**, after the requisite public notice was provided, a public hearing was held on the 8th day of August, 2005 regarding the Site and the Contract; and

**WHEREAS**, PCA and its principals, designees, transferees and/or assignees have experience in the construction, management and operation of municipal waste disposal facilities; and

**WHEREAS**, among other things, the Contract provides that for a period of (3) three years, PCA agrees not to charge the County for in-county generated waste including in Marion and Uniontown, Alabama, brought to the proposed landfill by the County, its employees, and contractual privies operating for the County immediately following the effective date of the operation of said Site; and

**WHEREAS**, PCA has agreed that the service area will include Delaware, Florida, Georgia, Kentucky, Louisiana, Mississippi, New York, New Jersey, North Carolina, Pennsylvania, Rhode Island, South Carolina, Tennessee, Virginia, and West Virginia; and

**WHEREAS**, PCA has agreed that the maximum daily deposit shall not exceed 7500 tons; and

**WHEREAS**, PCA has freely and voluntarily agreed to pay the County inclusive of all required payments, fees or charges for deposits placed in the Landfill the sum of One Dollar ($1.00) per ton on all deposits per day; and

**WHEREAS**, PCA has agreed to establish a dedicated escrow account in which PCA will pay five cents ($0.05) per ton deposited at the Site for the road maintenance; and

**WHEREAS**, PCA has agreed that within six months of operations it will pay to the County, the City of Marion and the town of Uniontown a total of $120,000.00 ($40,000.00 to each entity) as set out in the Contract; and

**WHEREAS**, PCA shall provide to the County a landscape plan which will provide buffer areas and an entrance to the Site that are aesthetically pleasing and complementary to the

surroundings, and PCA shall implement said landscape plan after making all reasonable changes thereto requested by the County; and

**WHEREAS,** PCA has committed that the Site will not cause any degradation of water quality through the discharge of pollutants, dredge or fill material into the waters of the State of Alabama in violation of the Clean Water Act or the Alabama Water Pollution Control Act; and

**WHEREAS,** the terms of the Contract will be binding upon any purchaser of the Site; and

**WHEREAS,** the County, in its best judgment, has considered the regional planning and development commission's statement of consistency; and

**WHEREAS,** the County has evaluated PCA's proposal using the current regional solid waste management needs assessment and in particular has evaluated the proposal as it relates to available existing capacity within the region and the projected lifetime of such capacity; and.

**WHEREAS,** the County has not considered or made any determination regarding whether the Site meets appropriate geological, environmental, design or other scientific or engineering standards established by federal or state agencies charged with approving, permitting, or monitoring solid waste disposal sites; and'

**WHEREAS,** the County has also given due consideration to the following:

a) The consistency of the Site with the solid waste management needs identified in the County's Plan;

b) The relationship of the Site to local planned or existing development or the absence thereof, to major transportation arteries and to existing state primary and secondary roads;

c) The location of the Site in relationship to existing industries in the state that generate large volumes of solid waste, or the relationship to the areas projected for development of industries that will generate solid waste;

d) The costs and availability of public services, facilities, and improvements required to support the Site and to protect health, safety and the environment;

e) The impact of the Site on public safety and provisions made to minimize the impact on public health and safety;

f) The social and economic impacts of the Site on the affected community including changes in property values, and social or community perception; and

g) The comments made at the public hearing on the 8th day of August, 2005 and at regular County Commission meetings, and the responses thereto by PCA.

**THEREFORE**, after due consideration of the above referenced facts and matters, a motion was made by Commissioner Turner to approve the Site and the Contract, the motion was seconded by Commissioner Sanders, and the motion was duly approved by fair favorable votes, one abstention by Commissioner Miller and no opposing votes of the County Commission.

**ACCORDINGLY, BE IT RESOLVED:**

That the approval required by Alabama Code Section 22-27-48(a), together with any other necessary or required approval, for the Site and the Contract is hereby granted by the County Commission; and

The Chairman of the County Commission is hereby given authority to execute the Contract, together with any necessary related agreements or documents.

DATED this the 13th day of September 2005.

**PERRY COUNTY COMMISSION**

**BY:** Johnny Flowers
**JOHNNY FLOWERS, CHAIRMAN**

**ATTEST:**

Walta Mae Kennie
**WALTA MAE KENNIE, CLERK**

ALABAMA-TOMBIGBEE REGIONAL COMMISSION
107 Broad Street
Camden, Alabama 36726

(334) 682-4234
Fax
(334) 682-4205

JOHN CLYDE RIGGS
Executive Director

June 23, 2005

Mr. Leo F. Gentile, P.G.
Service Leader
Jordan, Jones & Goulding
6801 governors Lake Parkway
Building 200
Norcross, Georgia 30071

Dear Mr. Gentile:

Enclosed as per your request is the Statement of Consistency for the Perry County landfill development project.

If you should have any further questions, please do not hesitate to call.

Sincerely,

ALABAMA-TOMBIGBEE REGIONAL COMMISSION

John Clyde Riggs
Executive Director

JCR:lsc

cc: Chairman Johnny Flowers
Perry County Commission

Statement of Consistency

The Alabama-Tombigbee Regional Commission (ATRC) is in receipt of a request for a "Statement of Consistency" regarding a Solid Waste Permit Application being updated for a landfill development project in Perry County, Alabama. This request is being made by Perry County Associates (PCA).

The Alabama-Tombigbee Regional Commission is in receipt of Perry County's Solid Waste Management Plan (SWMP) which was approved by the Alabama Department of Environmental Management (ADEM) on April 8, 2005. The SWMP was prepared by Volkert and Associates and the Alabama-Tombigbee Regional Commission has reviewed the plan. ATRC was not involved in the preparation of this plan and does not certify to the accuracy or validity of information contained therein.

Based on the information contained in the Regional Solid Waste Needs Assessment which does not verify the origin and destination of all solid waste coming in or going out of the ATRC region and based upon the recommendations contained in Perry County's Solid Waste Management Plan, it appears that the proposal is consistent with information contained in the Regional Solid Waste Needs Assessment and the County's Solid Waste Management Plan.

June 23, 2005
Date

John Clyde Riggs
Signature of Authorizing Official
Executive Director
Alabama-Tombigbee Regional Commission

Sherry Woodard
Signature of Notary Public

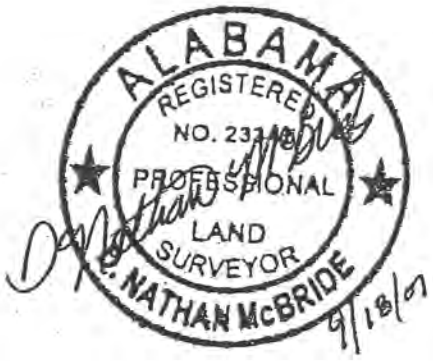
# APPENDIX B
## Legal Property Description

Perry County Associates - Landfill Boundary Legal

All that tract or parcel of land lying within Sections 21, 22, 27, & 28, Township 17 North, Range 6 East, Perry County, Alabama, and being more particularly described as follows:

Beginning at a drive shaft found at the Northeast section corner of Section 22 and being the TRUE POINT OF BEGINNING; from said TRUE POINT OF BEGINNING thus established; THENCE South 00 degrees 01 minutes 00 seconds West for a distance of 1323.74 feet to a ½" rebar and cap set; THENCE South 89 degrees 52 minutes 33 seconds West for a distance of 1831.69 feet to a calculated point along a fence; THENCE South 80 degrees 44 minutes 42 seconds West for a distance of 138.69 feet to a calculated point along a fence; THENCE South 85 degrees 22 minutes 54 seconds West for a distance of 339.64 feet to a calculated point along a fence; THENCE South 50 degrees 50 minutes 57 seconds West for a distance of 210.66 feet to a calculated point along a fence; THENCE South 35 degrees 41 minutes 03 seconds West for a distance of 106.07 feet to a calculated point along a fence; THENCE South 25 degrees 42 minutes 41 seconds West for a distance of 70.78 feet to a calculated point along a fence; THENCE South 02 degrees 08 minutes 47 seconds East for a distance of 3658.48 feet to a ½" rebar and cap set; THENCE South 02 degrees 38 minutes 46 seconds West for a distance of 5581.55 feet to a ½" rebar and cap set; THENCE along a curve to the left having a radius of 2265.00 feet and an arc length of 588.57 feet, being subtended by a chord bearing of South 85 degrees 25 minutes 35 seconds West for a distance of 586.91 feet to a ½" rebar and cap set; THENCE South 77 degrees 58 minutes 56 seconds West for a distance of 275.30 feet to a ½" rebar and cap set; THENCE along a curve to the left having a radius of 745.00 feet and an arc length of 258.62 feet, being subtended by a chord bearing of North 44 degrees 16 minutes 00 seconds West for a distance of 257.33 feet to a ½" rebar and cap set; THENCE North 54 degrees 12 minutes 42 seconds West for a distance of 609.21 feet to a ½" rebar and cap set; THENCE along a curve to the left having a radius of 13040.00 feet and an arc length of 945.79 feet, being subtended by a chord bearing of North 56 degrees 17 minutes 22 seconds West for a distance of 945.58 feet to a ½" rebar and cap set; THENCE North 58 degrees 22 minutes 02 seconds West for a distance of 1007.19 feet to a ½" rebar and cap set; THENCE along a curve to the left having a radius of 4358.00 feet and an arc length of 111.48 feet, being subtended by a chord bearing of North 59 degrees 06 minutes 00 seconds West for a distance of 111.48 feet to a ½" rebar and cap set; THENCE North 26 degrees 17 minutes 48 seconds East for a distance of 227.16 feet to a ½" rebar and cap set; THENCE North 85 degrees 11 minutes 24 seconds West for a distance of 152.24 feet to a ½" rebar and cap set; THENCE South 15 degrees 49 minutes 38 seconds West for a distance of 168.10 feet to a ½" rebar and cap set; THENCE along a curve to the left having a radius of 4358.00 feet and an arc length of 770.58 feet, being subtended by a chord bearing of North 66 degrees 21 minutes 41 seconds West for a distance of 769.57 feet to a ½" rebar and cap set; THENCE North 71 degrees 25 minutes 37 seconds West for a distance of 1236.54 feet to a ½" rebar and cap set; THENCE North 01 degrees 38 minutes 48 seconds West for a distance of 225.19 feet to a flat iron found; THENCE North 87 degrees 41 minutes 17 seconds West for a distance of 637.54 feet to a concrete right of way monument found; THENCE South 05 degrees 04 minutes 35 seconds East for a distance of 45.35 feet to a ½" rebar and cap set; THENCE along a curve to the left having a radius of 1960.00 feet and an arc length of 445.19 feet, being subtended by a chord bearing of North 83 degrees 21 minutes 01 seconds West for a distance of 444.23 feet to a ½" rebar and cap set; THENCE North 89 degrees 51 minutes 26 seconds West for a distance of 195.21 feet to a ½" rebar and cap set; THENCE North 02 degrees 00 minutes 11 seconds East for a distance of 939.53 feet to a ½" rebar and cap set; THENCE North 03 degrees 42 minutes 04 seconds East for a distance of 555.03 feet to a ½" rebar and cap set; THENCE North 01 degrees

03 minutes 06 seconds West for a distance of 1116.92 feet to a ½" rebar and cap set; THENCE North 87 degrees 39 minutes 54 seconds East for a distance of 1367.80 feet to a ½" rebar and cap set; THENCE North 02 degrees 41 minutes 46 seconds West for a distance of 2834.53 feet to a ½" rebar and cap set; THENCE North 87 degrees 42 minutes 00 seconds East for a distance of 3950.24 feet to a ½" rebar and cap set; THENCE North 00 degrees 30 minutes 37 seconds West for a distance of 2615.62 feet to a drive shaft found; THENCE North 89 degrees 08 minutes 40 seconds East for a distance of 3997.16 feet to a drive shaft found, said drive shaft found being the TRUE POINT OF BEGINNING.
Said property contains 1113.6 acres more or less as shown on, and described according to a plat of survey prepared by Jordan, Jones and Goulding, Inc., for Perry County Associates, dated August 9, 2001, and bearing the seal and certification of D. Nathan McBride, Alabama Registered Land Surveyor No. 23345.



Tract1
Being more particularly described as follows:

Commencing at a drive shaft marking the Northeast corner of section 22, Township-17-North, Range-6-East, Perry County, Alabama.

THENCE South 21 degrees 09 minutes 38 seconds West for a distance of 9902.32' to the TRUE POINT OF BEGINNING;

THENCE South 00 degrees 35 minutes 26 seconds West for a distance of 350.02 feet to a point;

THENCE North 90 degrees 00 minutes 00 seconds East for a distance of 229.33 feet to a point;

THENCE South 00 degrees 18 minutes 04 seconds West for a distance of 969.67 feet to a point;

THENCE North 89 degrees 12 minutes 24 seconds West for a distance of 472.69 feet to a point;

THENCE North 54 degrees 09 minutes 22 seconds West for a distance of 593.28 feet to a point;

THENCE North 57 degrees 25 minutes 15 seconds West for a distance of 1061.62 feet to a point;

THENCE North 01 degrees 35 minutes 09 seconds East for a distance of 394.20 feet to a point;

THENCE North 90 degrees 00 minutes 00 seconds East for a distance of 1616.61 feet to a point, said point being the TRUE POINT OF BEGINNING.

Said property contains 39.068 acres more or less.

Tract 2

Being more particularly described as follows:

Commencing at a drive shaft marking the Northeast corner of section 22, Township-17-North, Range-6-East, Perry County, Alabama.

THENCE South 52 degrees 32 minutes 53 seconds West for a distance of 7271.79' to the TRUE POINT OF BEGINNING.

THENCE South 03 degrees 15 minutes 02 seconds West for a distance of 1699.83 feet to a point;

THENCE South 56 degrees 31 minutes 43 seconds West for a distance of 871.51 feet to a point;

THENCE North 58 degrees 01 minutes 34 seconds West for a distance of 577.98 feet to a point;

THENCE North 90 degrees 00 minutes 00 seconds West for a distance of 562.13 feet to a point;

THENCE South 00 degrees 01 minutes 16 seconds West for a distance of 1738.44 feet to a point;

THENCE North 89 degrees 58 minutes 54 seconds West for a distance of 1147.26 feet to a point;

THENCE North 01 degrees 03 minutes 51 seconds East for a distance of 2177.51 feet to a point;

THENCE North 87 degrees 44 minutes 46 seconds East for a distance of 1244.58 feet to a point;

THENCE North 08 degrees 28 minutes 14 seconds East for a distance of 1370.72 feet to a point;

THENCE North 88 degrees 57 minutes 33 seconds East for a distance of 1537.98 feet to a point, said point being the TRUE POINT OF BEGINNING.

Said property contains 129.964 acres more or less.

Tract 3

Being more particularly described as follows:

Commencing at a drive shaft marking the Northeast corner of section 22, Township-17-North, Range-6-East, Perry County, Alabama.

THENCE South 31 degrees 51 minutes 51 seconds West for a distance of 5116.95' to the TRUE POINT OF BEGINNING.

THENCE South 01 degrees 09 minutes 22 seconds West for a distance of 2098.09 feet to a point;

THENCE North 89 degrees 22 minutes 57 seconds West for a distance of 1763.46 feet to a point;

THENCE North 01 degrees 19 minutes 13 seconds West for a distance of 2099.20 feet to a point;

THENCE South 89 degrees 22 minutes 57 seconds East for a distance of 1854.17 feet to a point, said point being the TRUE POINT OF BEGINNING.

Said property contains 87.119 acres more or less.

Jordan Jones & Goulding INCORPORATED

# APPENDIX C
## Flood Plain Study

JORDAN JONES & GOULDING

# TECHNICAL MEMORANDUM

**DATE:** June 12, 2001

**PREPARED FOR:** Perry County Associates, Inc.

**PREPARED BY:** Jody Hughey, E.I.T.

**REVIEWED BY:** David Briglio, P.E. DB

**SUBJECT:** Perry County Landfill
Floodplain Study

**PROJECT:** 4305.001

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This technical memorandum was written to address possible floodplain encroachment by a proposed landfill in Perry County, Alabama. The landfill is located immediately southeast of Uniontown, Alabama.

The headwaters of Tayloe Creek run through the project site. Tayloe Creek and the proposed landfill are not in a regulated floodplain. A floodplain is a "normally dry area adjoining rivers, streams, lakes, bays, or oceans that is inundated during flood events"1. Additionally, the site is not in a low-lying area. Therefore, no regulated floodplain concerns have been identified. A hydraulic analysis and evaluation was performed to demonstrate the PCA landfill will not be adversely impacted by the 100-year flood event. The PCA landfill will not restrict the flow of the 100-year flood or reduce temporary water storage capacity of the floodplain. Additionally, the 100-year flood event will not result in a washout of solid waste because the landfill does not encroach on the 100-year floodplain.

Aerial survey that provided 2-foot (ft) contours, along with a site inspection, was utilized to develop stream cross-sections, assume Manning's-n values, and determine current land use for the model. The USGS Rural Regression Equations for Region 3 (Alabama) were used to calculate the 100-year peak flows. The model was divided into ten sub-basins and appropriate flows assigned to cross-sections in each sub-basin. Peak 100-year flows ranged from 78 cubic feet per second (cfs) at the headwaters to 1618 cfs just downstream of the property line. Manning's n values were based on Chow (1952) and a visual inspection of the stream channels and surrounding areas. These values can be found in the attached HEC-RAS output.

An evaluation of the results of hydraulic analysis shows that the 100-year storm would be contained within the channel banks. Additionally, the analysis shows that backwater caused by

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1 "Applied Hydrology", Chow/Maidment/Hayes, 1988

Tayloe Creek downstream of the property line would not cause the 100-year storm to "exceed" or "breech" the channel banks on the project site. The proposed project design includes maintaining a minimum distance of 200 feet from Tayloe Creek and its onsite ephemeral drainages. Therefore, the proposed project will not be adversely affected by the 100-year flood event, and no adverse effect to human health and the environment are anticipated by the proposed project from the 100-year flood event.

Attachments:

Calculated Peak Flow
Peak Flow Calculation Data
HEC-RAS Output

## LEGEND

TOPOGRAPHIC CONTOUR

SURVEYED STREAM

SECTION LINE

## GRAPHIC SCALE

1000 2000 4000

( IN FEET )

| | |
|---|---|
| ITE ANALYSIS<br>ITY ASSOCIATES | DATE : JUNE 2005<br>SCALE : AS SHOWN<br>JOB NO.: 4305.001 |
| IN ANALYSIS | FIGURE 1 |

# Calculated Peak Flow

USGS Rural Regression Peak Flows

**Note** The regression equations are not accurate for basins with areas less than 0.44 square miles. Therefore, flows for subbasins with areas less than 0.44 square miles were prorated from the flow of their main basin and based on the percent area of the main basin.

| Basin | Area ($mi^2$) | 100-yr (cfs) | 500-yr (cfs) |
|---|---|---|---|
| A | 1.9429 | 1618.0 | 2078.0 |
| A1 | 1.6947 | 1475.0 | 1888.0 |
| A1-1 | 1.0449 | 1063.0 | 1343.0 |
| A1-1a | 0.9604 | 1004.0 | 1265.0 |
| A1-2 | 0.6498 | 771.0 | 961.0 |
| A1-2a | 0.0659 | 78.2 | 97.5 |
| A1-2b | 0.1120 | 132.9 | 165.6 |
| A1-2c | 0.1006 | 119.4 | 148.8 |
| A1-2d | 0.1515 | 179.8 | 224.1 |
| A1-2e | 0.0752 | 89.3 | 111.3 |

# Peak Flow Calculation Data

# Flood Calculation Accuracy and Limitations for Rural Streams

GLS regression analysis was applied to the four flood regions identified earlier with contributing drainage area being the only explanatory variable used in the analysis. Stedi Tasker (1985, 1986) have shown that GLS regression analysis can provide more accurate estimates of regression coefficients, better estimates of the accuracy of the regression coef and better estimates of the regression model error than OLS regression analysis. OLS reg analysis does not account for the errors associated with estimates of flood magnitude vary the length of observed record, nor does it account for the cross-correlation of concurrent discharge data between sites. GLS regression analysis accounts for these errors by using weighting matrix so that sites are weighted proportionally according to the standard errors cross-correlation of the peak discharge estimates. The flood-frequency relations for the fo regions are summarized in table 2.

Table 2.--Regional flood-frequency relations for rural streams in Alabama

[Note: Associated standard errors of prediction and equivalent years of record are listed in Q, flood discharge in cubic feet per second; A, contributing drainage area in square miles]

| Recurrence interval (years) | Regression equations for the indicated flood regions where A is the drainage are in square miles | | | |
|---|---|---|---|---|
| | Region 1 | Region 2 | Region 3 | Region 4 |

| | | | | |
|---|---|---|---|---|
| 2 | $Q = 227\ A^{0.672}$ | $Q = 163\ A^{0.664}$ | $Q = 347\ A^{0.573}$ | $Q = 169\ A^{0.61}$ |
| 5 | $Q = 374\ A^{0.669}$ | $Q = 295\ A^{0.654}$ | $Q = 517\ A^{0.607}$ | $Q = 313\ A^{0.60}$ |
| 10 | $Q = 482\ A^{0.669}$ | $Q = 406\ A^{0.648}$ | $Q = 638\ A^{0.626}$ | $Q = 444\ A^{0.60}$ |
| 25 | $Q = 627\ A^{0.668}$ | $Q = 573\ A^{0.640}$ | $Q = 796\ A^{0.648}$ | $Q = 650\ A^{0.59}$ |
| 50 | $Q = 739\ A^{0.667}$ | $Q = 716\ A^{0.634}$ | $Q = 914\ A^{0.663}$ | $Q = 831\ A^{0.58}$ |
| 100 | $Q = 855\ A^{0.667}$ | $Q = 877\ A^{0.628}$ | $Q = 1{,}032\ A^{0.677}$ | $Q = 1{,}035\ A^{0.51}$ |
| 200 | $Q = 974\ A^{0.666}$ | $Q = 1{,}057\ A^{0.622}$ | $Q = 1{,}148\ A^{0.689}$ | $Q = 1{,}262\ A^{0.5}$ |
| 500 | $Q = 1{,}135\ A^{0.666}$ | $Q = 1{,}327\ A^{0.614}$ | $Q = 1{,}302\ A^{0.704}$ | $Q = 1{,}601\ A^{0.5}$ |

The accuracy of a flood-frequency relation can be expressed in two ways: the standard prediction, or as equivalent years of record. The standard error of prediction is a measure well the regression relation will estimate flood magnitudes when applied to ungaged basi standard errors of prediction ranged from a minimum of 33 percent (regions 3 and 4) to a maximum of 52 percent (region 4). The standard error of prediction can also be expresse equivalent years of record (Hardison, 1971). These equivalent years of record represent t number of years of peak-discharge record necessary to provide a flood estimate with acc equal to that of the regression relation flood estimate. For example, the 100-year flood es from the region 1 regression relation could be estimated with same degree of accuracy a:

which could be obtained from 8 years of actual peak-discharge record. The standard erro prediction and the equivalent years of record for the regression relations are listed in tab

Table 3.--Accuracy of regional flood-frequency relations for rural streams in Alabama

| Recurrence interval (years) | Region 1 | | Region 2 | | Region 3 | | Re |
|---|---|---|---|---|---|---|---|
| | Standard error of prediction (percent) | Equivalent years of record | Standard error of prediction (percent) | Equivalent years of record | Standard error of prediction (percent) | Equivalent years of record | Standard error of prediction (percent) |
| 2 | 35 | 3 | 40 | 3 | 37 | 3 | 38 |
| 5 | 34 | 4 | 36 | 4 | 35 | 5 | 33 |
| 10 | 35 | 5 | 35 | 6 | 34 | 7 | 33 |
| 25 | 37 | 7 | 35 | 9 | 33 | 10 | 35 |
| 50 | 39 | 7 | 36 | 10 | 33 | 12 | 38 |
| 100 | 41 | 8 | 37 | 11 | 33 | 15 | 42 |
| 200 | 43 | 9 | 39 | 12 | 34 | 17 | 46 |
| 500 | 46 | 9 | 43 | 12 | 35 | 18 | 52 |

## Accuracy and Limitations of Flood-Frequency Estimates

The regression relations are valid for ungaged basins where the drainage area is wit minimum and maximum drainage areas used in the regression analysis. The range of ap drainage areas for each flood region are as follows:

| | |
|---|---|
| Flood region 1 | 0.44 to 1,027 $mi^2$ |
| Flood region 2 | 0.13 to 831 $mi^2$ |
| Flood region 3 | 0.44 to 1,097 $mi^2$ |
| Flood region 4 | 1.44 to 1,344 $mi^2$ |

The regression relations should not be used where dams, flood-detention structures, channelization have a significant effect on peak discharges nor should they be used for s urban areas unless the effects of urbanization are insignificant (for sites in urban areas, methods described by Olin and Bingham [1982]). Reliability of the regression relations drainage areas outside the flood region limits is unknown.

back

You have chosen region 3 with a return period of 100 years. For an area of 1.9429 square miles, the flow is 1618 cubic ft/s. The peak flow estimate for this scenario is based on the following regression equation: Q=1032A^0.677 (Reference:"Magnitude and Frequency of Floods in Alabama", By J.B. Atkins, USGS, WRIR 95-4199, 1996).

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**You can click on the reload button to enter in another area value for the same region and return period.**

**Click here to input a new set of values, or return to the Auburn Hydrology and Highway Engineering home page.**

You have chosen region 3 with a return period of 100 years. For an area of 1.6947 square miles, the flow is 1475 cubic ft/s. The peak flow estimate for this scenario is based on the following regression equation: Q=1032A^0.677 (Reference:"Magnitude and Frequency of Floods in Alabama", By J.B. Atkins, USGS, WRIR 95-4199, 1996).

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You can click on the reload button to enter in another area value for the same region and return period.

Click here to input a new set of values, or return to the Auburn Hydrology and Highway Engineering home page.

You have chosen region 3 with a return period of 100 years. For an area of 1.0449 square miles, the flow is 1063 cubic ft/s. The peak flow estimate for this scenario is based on the following regression equation: Q=1032A^0.677 (Reference:"Magnitude and Frequency of Floods in Alabama", By J.B. Atkins, USGS, WRIR 95-4199, 1996).

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**You can click on the reload button to enter in another area value for the same region and return period.**

**Click here to input a new set of values, or return to the Auburn Hydrology and Highway Engineering home page.**

You have chosen region 3 with a return period of 100 years. For an area of .9604 square miles, the flow is 1004 cubic ft/s. The peak flow estimate for this scenario is based on the following regression equation: Q=1032A^0.677 (Reference:"Magnitude and Frequency of Floods in Alabama", By J.B. Atkins, USGS, WRIR 95-4199, 1996).

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**You can click on the reload button to enter in another area value for the same region and return period.**

**Click here to input a new set of values, or return to the Auburn Hydrology and Highway Engineering home page.**

You have chosen region 3 with a return period of 100 years. For an area of .6498 square miles, the flow is 771 cubic ft/s. The peak flow estimate for this scenario is based on the following regression equation: Q=1032A^0.677 (Reference:"Magnitude and Frequency of Floods in Alabama", By J.B. Atkins, USGS, WRIR 95-4199, 1996).

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**You can click on the reload button to enter in another area value for the same region and return period.**

**Click here to input a new set of values, or return to the Auburn Hydrology and Highway Engineering home page.**

# HEC-RAS Output

HEC-RAS Version 3.0.1 Mar 2001
U.S. Army Corp of Engineers
Hydrologic Engineering Center
609 Second Street, Suite D
Davis, California 95616-4687
(916) 756-1104

```
X     X  XXXXXX    XXXX         XXXX        XX       XXXX
X     X  X        X    X       X   X      X  X     X
X     X  X        X            X   X     X    X    X
XXXXXXX  XXXX     X       XXX  XXXX      XXXXXX     XXXX
X     X  X        X            X  X      X    X         X
X     X  X        X    X       X   X     X    X         X
X     X  XXXXXX    XXXX        X    X    X    X    XXXXX
```

**********

PROJECT DATA
Project Title: Perry County Landfill Floodplain Study
Project File : PCLFLOOD.prj
Run Date and Time: 4/30/01 10:23:28 AM

Project in English units

Project Description:
The project consist of a landfill that will be constructed in Union Town in Perry County, Alabama. The site is composed mostly of what appears to be an old Christmas tree farm. So the vegetation is mostly grasslands with rows of trees. Much of the site is wetlands as the streams run directly through the property. This floodplain study is done for the purpose of telling the landfill designers approximately where the 100-yr floodplain lies so that they can determine if the landfill will be placed on the property and where to place it. ******* Autodesk, Inc. HEC-2 Input Data file ********

********** Minimum Data Input **********

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******* Autodesk,
Inc. HEC-2 Input Data file ********
********** Minimum Data Input
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******* Autodesk, Inc. HEC-2 Input Data file ********
**********
Minimum Data Input **********

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******* Autodesk,
Inc. HEC-2 Input Data file ********
********** Minimum Data Input
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PLAN DATA

Plan Title: 100-yr and 500-yr Floodplain Study
Plan File : p:\4305-001\Design\Floodplain\HECRAS\PCLFLOOD.p03

Geometry Title: Final Geometry
Geometry File : p:\4305-001\Design\Floodplain\HECRAS\PCLFLOOD.g04

Flow Title : Alabama Rural Regression Equation Flows
Flow File : p:\4305-001\Design\Floodplain\HECRAS\PCLFLOOD.f03

Plan Summary Information:
Number of: Cross Sections = 148 Mulitple Openings = 0
Culverts = 0 Inline Weirs = 0
Bridges = 0

Computational Information
Water surface calculation tolerance = 0.003
Critical depth calculaton tolerance = 0.003
Maximum number of interations = 20
Maximum difference tolerance = 0.1
Flow tolerance factor = 0.001

Computation Options
Critical depth computed at all cross sections
Conveyance Calculation Method: At breaks in n values only
Friction Slope Method: Average Conveyance
Computational Flow Regime: Mixed Flow

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FLOW DATA

Flow Title: Alabama Rural Regression Equation Flows
Flow File : p:\4305-001\Design\Floodplain\HECRAS\PCLFLOOD.f03

Flow Data (cfs)

| River | Reach | RS | 100-yr | 500-yr |
|---|---|---|---|---|
| RIVER-1 | Reach-1 | 2497 | 119.4 | 148.8 |
| RIVER-1 | Reach-1 | 0 | 119.4 | 148.8 |
| Main | A1-1 | 5787 | 1004 | 1265 |
| Main | A1-1 | 4369 | 1063 | 1343 |
| Main | A1-1 | 3230 | 1063 | 1343 |
| Main | Start to A1 | 2894 | 1475 | 1888 |
| Main | Start to A1 | 1156 | 1618 | 2078 |
| Main | Start to A1 | 0 | 1618 | 2078 |
| Tributary A1-2e | A1-2e | 2091 | 89.3 | 111.3 |
| Tributary A1-2e | A1-2e | 0 | 89.3 | 111.3 |
| Tributary A1-2d | A1-2d | 3628 | 179.8 | 224.1 |
| Tributary A1-2d | A1-2d | 0 | 179.8 | 224.1 |
| Tributary A1-2a | A1-2a | 1321 | 78.2 | 97.5 |
| Tributary A1-2a | A1-2a | 0 | 78.2 | 97.5 |
| Tributary A1-2b | A1-2b | 2423 | 132.9 | 165.6 |
| Tributary A1-2b | A1-2b | 550 | 132.9 | 165.6 |
| Tributary A1-2 | 2d to 2b | 5832 | 252.3 | 314.4 |

| | | | | | |
|---|---|---|---|---|---|
| * Tributary A1-2 | 2e to 2d | 4814 | * | 510.3 | 636 * |
| * Tributary A1-2 | A1 to 2e | 4164 | * | 599.6 | 747.3 * |

Boundary Conditions

| * River | Reach | Profile | * | Upstream | Downstream * |
|---|---|---|---|---|---|
| * RIVER-1 | Reach-1 | 100-yr | * | Normal S = .0298 | |
| * RIVER-1 | Reach-1 | 500-yr | * | Normal S = .0298 | |
| * Main | A1-1 | 100-yr | * | Normal S = .0324 | |
| * Main | A1-1 | 500-yr | * | Normal S = .0324 | |
| * Main | Start to A1 | 100-yr | * | | Normal S = .0042 * |
| * Main | Start to A1 | 500-yr | * | | Normal S = .0042 * |
| * Tributary A1-2e | A1-2e | 100-yr | * | Normal S = .0421 | |
| * Tributary A1-2e | A1-2e | 500-yr | * | Normal S = .0421 | |
| * Tributary A1-2d | A1-2d | 100-yr | * | Normal S = .0353 | |
| * Tributary A1-2d | A1-2d | 500-yr | * | Normal S = .0353 | |
| * Tributary A1-2a | A1-2a | 100-yr | * | Normal S = .0446 | |
| * Tributary A1-2a | A1-2a | 500-yr | * | Normal S = .0446 | |
| * Tributary A1-2b | A1-2b | 100-yr | * | Normal S = .0291 | |
| * Tributary A1-2b | A1-2b | 500-yr | * | Normal S = .0291 | |

SUMMARY OF MANNING'S N VALUES

River:RIVER-1

| * Reach | * River Sta. | * n1 | * n2 | * n3 * |
|---|---|---|---|---|
| *Reach-1 | * 2497 | * .08* | .045* | .08* |
| *Reach-1 | * 2403** | * .08* | .045* | .08* |
| *Reach-1 | * 2309** | * .08* | .045* | .08* |
| *Reach-1 | * 2215** | * .08* | .045* | .08* |
| *Reach-1 | * 2121** | * .08* | .045* | .08* |
| *Reach-1 | * 2026** | * .08* | .045* | .08* |
| *Reach-1 | * 1932** | * .08* | .045* | .08* |
| *Reach-1 | * 1838** | * .08* | .045* | .08* |
| *Reach-1 | * 1744** | * .08* | .045* | .08* |
| *Reach-1 | * 1650** | * .08* | .045* | .08* |
| *Reach-1 | * 1556** | * .08* | .045* | .08* |
| *Reach-1 | * 1462** | * .08* | .045* | .08* |
| *Reach-1 | * 1368** | * .08* | .045* | .08* |
| *Reach-1 | * 1273** | * .08* | .045* | .08* |
| *Reach-1 | * 1179** | * .08* | .045* | .08* |
| *Reach-1 | * 1085** | * .08* | .045* | .08* |
| *Reach-1 | * 991** | * .08* | .045* | .08* |
| *Reach-1 | * 897 | * .08* | .045* | .08* |
| *Reach-1 | * 807** | * .08* | .045* | .08* |
| *Reach-1 | * 718** | * .08* | .045* | .08* |
| *Reach-1 | * 628** | * .08* | .045* | .08* |
| *Reach-1 | * 538** | * .08* | .045* | .08* |
| *Reach-1 | * 448** | * .08* | .045* | .08* |
| *Reach-1 | * 359** | * .08* | .045* | .08* |
| *Reach-1 | * 269** | * .08* | .045* | .08* |
| *Reach-1 | * 179** | * .08* | .045* | .08* |
| *Reach-1 | * 90** | * .08* | .045* | .08* |

| | | | | |
|---|---|---|---|---|
| *Reach-1 | 0 | .08* | .045* | .08* |

River:Main

| Reach | River Sta. | n1 | n2 | n3 |
|---|---|---|---|---|
| *A1-1 | 5787 | .08* | .045* | .08* |
| *A1-1 | 4369 | .08* | .045* | .08* |
| *A1-1 | 3867 | .08* | .045* | .08* |
| *A1-1 | 3230 | .08* | .045* | .08* |
| *Start to A1 | 2894 | .08* | .045* | .08* |
| *Start to A1 | 1156 | .08* | .045* | .08* |
| *Start to A1 | 0 | .08* | .045* | .08* |

River:Tributary A1-2e

| Reach | River Sta. | n1 | n2 | n3 |
|---|---|---|---|---|
| *A1-2e | 2091 | .08* | .045* | .08* |
| *A1-2e | 1998** | .08* | .045* | .08* |
| *A1-2e | 1904** | .08* | .045* | .08* |
| *A1-2e | 1811** | .08* | .045* | .08* |
| *A1-2e | 1718** | .08* | .045* | .08* |
| *A1-2e | 1625** | .08* | .045* | .08* |
| *A1-2e | 1531** | .08* | .045* | .08* |
| *A1-2e | 1438** | .08* | .045* | .08* |
| *A1-2e | 1345** | .08* | .045* | .08* |
| *A1-2e | 1252** | .08* | .045* | .08* |
| *A1-2e | 1158** | .08* | .045* | .08* |
| *A1-2e | 1065 | .08* | .045* | .08* |
| *A1-2e | 980** | .08* | .045* | .08* |
| *A1-2e | 895** | .08* | .045* | .08* |
| *A1-2e | 810** | .08* | .045* | .08* |
| *A1-2e | 725** | .08* | .045* | .08* |
| *A1-2e | 640** | .08* | .045* | .08* |
| *A1-2e | 555** | .08* | .045* | .08* |
| *A1-2e | 470** | .08* | .045* | .08* |
| *A1-2e | 385** | .08* | .045* | .08* |
| *A1-2e | 300 | .08* | .045* | .08* |
| *A1-2e | 200** | .08* | .045* | .08* |
| *A1-2e | 100** | .08* | .045* | .08* |
| *A1-2e | 0 | .08* | .045* | .08* |

River:Tributary A1-2d

| Reach | River Sta. | n1 | n2 | n3 |
|---|---|---|---|---|
| *A1-2d | 3628 | .08* | .045* | .08* |
| *A1-2d | 3535** | .08* | .045* | .08* |
| *A1-2d | 3441** | .08* | .045* | .08* |
| *A1-2d | 3348** | .08* | .045* | .08* |
| *A1-2d | 3255** | .08* | .045* | .08* |
| *A1-2d | 3161** | .08* | .045* | .08* |
| *A1-2d | 3068** | .08* | .045* | .08* |
| *A1-2d | 2975** | .08* | .045* | .08* |
| *A1-2d | 2882** | .08* | .045* | .08* |

| | | | | | |
|---|---|---|---|---|---|
| *A1-2d | 2788** | .08* | .045* | .08* |
| *A1-2d | 2695** | .08* | .045* | .08* |
| *A1-2d | 2602** | .08* | .045* | .08* |
| *A1-2d | 2508** | .08* | .045* | .08* |
| *A1-2d | 2415** | .08* | .045* | .08* |
| *A1-2d | 2322** | .08* | .045* | .08* |
| *A1-2d | 2229** | .08* | .045* | .08* |
| *A1-2d | 2135** | .08* | .045* | .08* |
| *A1-2d | 2042 | .08* | .045* | .08* |
| *A1-2d | 1949** | .08* | .045* | .08* |
| *A1-2d | 1856** | .08* | .045* | .08* |
| *A1-2d | 1764** | .08* | .045* | .08* |
| *A1-2d | 1671** | .08* | .045* | .08* |
| *A1-2d | 1578** | .08* | .045* | .08* |
| *A1-2d | 1485** | .08* | .045* | .08* |
| *A1-2d | 1392** | .08* | .045* | .08* |
| *A1-2d | 1300** | .08* | .045* | .08* |
| *A1-2d | 1207** | .08* | .045* | .08* |
| *A1-2d | 1114 | .08* | .045* | .08* |
| *A1-2d | 1021** | .08* | .045* | .08* |
| *A1-2d | 928** | .08* | .045* | .08* |
| *A1-2d | 835** | .08* | .045* | .08* |
| *A1-2d | 743** | .08* | .045* | .08* |
| *A1-2d | 650** | .08* | .045* | .08* |
| *A1-2d | 557** | .08* | .045* | .08* |
| *A1-2d | 464** | .08* | .045* | .08* |
| *A1-2d | 371** | .08* | .045* | .08* |
| *A1-2d | 278** | .08* | .045* | .08* |
| *A1-2d | 186** | .08* | .045* | .08* |
| *A1-2d | 93** | .08* | .045* | .08* |
| *A1-2d | 0 | .08* | .045* | .08* |

River:Tributary A1-2a

| Reach | River Sta. | n1 | n2 | n3 |
|---|---|---|---|---|
| *A1-2a | 1321 | .08* | .045* | .08* |
| *A1-2a | 1230** | .08* | .045* | .08* |
| *A1-2a | 1139** | .08* | .045* | .08* |
| *A1-2a | 1047** | .08* | .045* | .08* |
| *A1-2a | 956** | .08* | .045* | .08* |
| *A1-2a | 865** | .08* | .045* | .08* |
| *A1-2a | 774** | .08* | .045* | .08* |
| *A1-2a | 682** | .08* | .045* | .08* |
| *A1-2a | 591** | .08* | .045* | .08* |
| *A1-2a | 500 | .08* | .045* | .08* |
| *A1-2a | 400** | .08* | .045* | .08* |
| *A1-2a | 300** | .08* | .045* | .08* |
| *A1-2a | 200** | .08* | .045* | .08* |
| *A1-2a | 100** | .08* | .045* | .08* |
| *A1-2a | 0 | .08* | .045* | .08* |

River:Tributary A1-2b

| Reach | River Sta. | n1 | n2 | n3 |
|---|---|---|---|---|
| *A1-2b | 2423 | .08* | .045* | .08* |

| Reach | River Sta. | n1 | n2 | n3 |
|---|---|---|---|---|
| A1-2b | 2336.5 | .08 | .045 | .08 |
| A1-2b | 2250. | .08 | .045 | .08 |
| A1-2b | 2163.5 | .08 | .045 | .08 |
| A1-2b | 2077. | .08 | .045 | .08 |
| A1-2b | 1990.5 | .08 | .045 | .08 |
| A1-2b | 1904. | .08 | .045 | .08 |
| A1-2b | 1817.5 | .08 | .045 | .08 |
| A1-2b | 1731. | .08 | .045 | .08 |
| A1-2b | 1644.5 | .08 | .045 | .08 |
| A1-2b | 1558 | .08 | .045 | .08 |
| A1-2b | 1466.36 | .08 | .045 | .08 |
| A1-2b | 1374.72 | .08 | .045 | .08 |
| A1-2b | 1283.09 | .08 | .045 | .08 |
| A1-2b | 1191.45 | .08 | .045 | .08 |
| A1-2b | 1099.81 | .08 | .045 | .08 |
| A1-2b | 1008.18 | .08 | .045 | .08 |
| A1-2b | 916.545 | .08 | .045 | .08 |
| A1-2b | 824.909 | .08 | .045 | .08 |
| A1-2b | 733.272 | .08 | .045 | .08 |
| A1-2b | 641.636 | .08 | .045 | .08 |
| A1-2b | 550 | .08 | .045 | .08 |
| A1-2b | 458.333 | .08 | .045 | .08 |
| A1-2b | 366.666 | .08 | .045 | .08 |
| A1-2b | 275. | .08 | .045 | .08 |
| A1-2b | 183.333 | .08 | .045 | .08 |
| A1-2b | 91.6666 | .08 | .045 | .08 |
| A1-2b | 0 | .08 | .045 | .08 |

River:Tributary A1-2

| Reach | River Sta. | n1 | n2 | n3 |
|---|---|---|---|---|
| 2d to 2b | 5832 | .08 | .045 | .08 |
| 2d to 2b | 5732 | .08 | .045 | .08 |
| 2e to 2d | 4814 | .08 | .045 | .08 |
| 2e to 2d | 4714 | .08 | .045 | .08 |
| A1 to 2e | 4164 | .08 | .045 | .08 |
| A1 to 2e | 4064 | .08 | .045 | .08 |

SUMMARY OF REACH LENGTHS

River: RIVER-1

| Reach | River Sta. | Left | Channel | Right |
|---|---|---|---|---|
| Reach-1 | 2497 | 94.12 | 94.12 | 94.12 |
| Reach-1 | 2403** | 94.12 | 94.12 | 94.12 |
| Reach-1 | 2309** | 94.12 | 94.12 | 94.12 |
| Reach-1 | 2215** | 94.12 | 94.12 | 94.12 |
| Reach-1 | 2121** | 94.12 | 94.12 | 94.12 |
| Reach-1 | 2026** | 94.12 | 94.12 | 94.12 |
| Reach-1 | 1932** | 94.12 | 94.12 | 94.12 |
| Reach-1 | 1838** | 94.12 | 94.12 | 94.12 |
| Reach-1 | 1744** | 94.12 | 94.12 | 94.12 |
| Reach-1 | 1650** | 94.12 | 94.12 | 94.12 |

| | | | | |
|---|---|---|---|---|
| *Reach-1 | 1556** | 94.12* | 94.12* | 94.12* |
| *Reach-1 | 1462** | 94.12* | 94.12* | 94.12* |
| *Reach-1 | 1368** | 94.12* | 94.12* | 94.12* |
| *Reach-1 | 1273** | 94.12* | 94.12* | 94.12* |
| *Reach-1 | 1179** | 94.12* | 94.12* | 94.12* |
| *Reach-1 | 1085** | 94.12* | 94.12* | 94.12* |
| *Reach-1 | 991** | 94.12* | 94.12* | 94.12* |
| *Reach-1 | 897 | 89.7* | 89.7* | 89.7* |
| *Reach-1 | 807** | 89.7* | 89.7* | 89.7* |
| *Reach-1 | 718** | 89.7* | 89.7* | 89.7* |
| *Reach-1 | 628** | 89.7* | 89.7* | 89.7* |
| *Reach-1 | 538** | 89.7* | 89.7* | 89.7* |
| *Reach-1 | 448** | 89.7* | 89.7* | 89.7* |
| *Reach-1 | 359** | 89.7* | 89.7* | 89.7* |
| *Reach-1 | 269** | 89.7* | 89.7* | 89.7* |
| *Reach-1 | 179** | 89.7* | 89.7* | 89.7* |
| *Reach-1 | 90** | 89.7* | 89.7* | 89.7* |
| *Reach-1 | 0 | 0* | 0* | 0* |

River: Main

| Reach | River Sta. | Left | Channel | Right |
|---|---|---|---|---|
| *A1-1 | 5787 | 1418* | 1418* | 1418* |
| *A1-1 | 4369 | 630.41* | 502.41* | 375.3* |
| *A1-1 | 3867 | 867.49* | 636.75* | 411.77* |
| *A1-1 | 3230 | * | * | * |
| *Start to A1 | 2894 | 1738* | 1738* | 1738* |
| *Start to A1 | 1156 | 1156* | 1156* | 1156* |
| *Start to A1 | 0 | 0* | 0* | 0* |

River: Tributary A1-2e

| Reach | River Sta. | Left | Channel | Right |
|---|---|---|---|---|
| *A1-2e | 2091 | 93.27* | 93.27* | 93.27* |
| *A1-2e | 1998** | 93.27* | 93.27* | 93.27* |
| *A1-2e | 1904** | 93.27* | 93.27* | 93.27* |
| *A1-2e | 1811** | 93.27* | 93.27* | 93.27* |
| *A1-2e | 1718** | 93.27* | 93.27* | 93.27* |
| *A1-2e | 1625** | 93.27* | 93.27* | 93.27* |
| *A1-2e | 1531** | 93.27* | 93.27* | 93.27* |
| *A1-2e | 1438** | 93.27* | 93.27* | 93.27* |
| *A1-2e | 1345** | 93.27* | 93.27* | 93.27* |
| *A1-2e | 1252** | 93.27* | 93.27* | 93.27* |
| *A1-2e | 1158** | 93.27* | 93.27* | 93.27* |
| *A1-2e | 1065 | 85* | 85* | 85* |
| *A1-2e | 980** | 85* | 85* | 85* |
| *A1-2e | 895** | 85* | 85* | 85* |
| *A1-2e | 810** | 85* | 85* | 85* |
| *A1-2e | 725** | 85* | 85* | 85* |
| *A1-2e | 640** | 85* | 85* | 85* |
| *A1-2e | 555** | 85* | 85* | 85* |
| *A1-2e | 470** | 85* | 85* | 85* |
| *A1-2e | 385** | 85* | 85* | 85* |
| *A1-2e | 300 | 100* | 100* | 100* |
| *A1-2e | 200** | 100* | 100* | 100* |

| | | | | |
|---|---|---|---|---|
| *A1-2e | 100** | 100* | 100* | 100* |
| *A1-2e | 0 | * | * | * |

River: Tributary A1-2d

| Reach | River Sta. | Left | Channel | Right |
|---|---|---|---|---|
| *A1-2d | 3628 | 93.29* | 93.29* | 93.29* |
| *A1-2d | 3535** | 93.29* | 93.29* | 93.29* |
| *A1-2d | 3441** | 93.29* | 93.29* | 93.29* |
| *A1-2d | 3348** | 93.29* | 93.29* | 93.29* |
| *A1-2d | 3255** | 93.29* | 93.29* | 93.29* |
| *A1-2d | 3161** | 93.29* | 93.29* | 93.29* |
| *A1-2d | 3068** | 93.29* | 93.29* | 93.29* |
| *A1-2d | 2975** | 93.29* | 93.29* | 93.29* |
| *A1-2d | 2882** | 93.29* | 93.29* | 93.29* |
| *A1-2d | 2788** | 93.29* | 93.29* | 93.29* |
| *A1-2d | 2695** | 93.29* | 93.29* | 93.29* |
| *A1-2d | 2602** | 93.29* | 93.29* | 93.29* |
| *A1-2d | 2508** | 93.29* | 93.29* | 93.29* |
| *A1-2d | 2415** | 93.29* | 93.29* | 93.29* |
| *A1-2d | 2322** | 93.29* | 93.29* | 93.29* |
| *A1-2d | 2229** | 93.29* | 93.29* | 93.29* |
| *A1-2d | 2135** | 93.29* | 93.29* | 93.29* |
| *A1-2d | 2042 | 92.8* | 92.8* | 92.8* |
| *A1-2d | 1949** | 92.8* | 92.8* | 92.8* |
| *A1-2d | 1856** | 92.8* | 92.8* | 92.8* |
| *A1-2d | 1764** | 92.8* | 92.8* | 92.8* |
| *A1-2d | 1671** | 92.8* | 92.8* | 92.8* |
| *A1-2d | 1578** | 92.8* | 92.8* | 92.8* |
| *A1-2d | 1485** | 92.8* | 92.8* | 92.8* |
| *A1-2d | 1392** | 92.8* | 92.8* | 92.8* |
| *A1-2d | 1300** | 92.8* | 92.8* | 92.8* |
| *A1-2d | 1207** | 92.8* | 92.8* | 92.8* |
| *A1-2d | 1114 | 92.83* | 92.83* | 92.83* |
| *A1-2d | 1021** | 92.83* | 92.83* | 92.83* |
| *A1-2d | 928** | 92.83* | 92.83* | 92.83* |
| *A1-2d | 835** | 92.83* | 92.83* | 92.83* |
| *A1-2d | 743** | 92.83* | 92.83* | 92.83* |
| *A1-2d | 650** | 92.83* | 92.83* | 92.83* |
| *A1-2d | 557** | 92.83* | 92.83* | 92.83* |
| *A1-2d | 464** | 92.83* | 92.83* | 92.83* |
| *A1-2d | 371** | 92.83* | 92.83* | 92.83* |
| *A1-2d | 278** | 92.83* | 92.83* | 92.83* |
| *A1-2d | 186** | 92.83* | 92.83* | 92.83* |
| *A1-2d | 93** | 92.83* | 92.83* | 92.83* |
| *A1-2d | 0 | 0* | 0* | 0* |

River: Tributary A1-2a

| Reach | River Sta. | Left | Channel | Right |
|---|---|---|---|---|
| *A1-2a | 1321 | 91.22* | 91.22* | 91.22* |
| *A1-2a | 1230** | 91.22* | 91.22* | 91.22* |
| *A1-2a | 1139** | 91.22* | 91.22* | 91.22* |
| *A1-2a | 1047** | 91.22* | 91.22* | 91.22* |
| *A1-2a | 956** | 91.22* | 91.22* | 91.22* |

| | | | | |
|---|---|---|---|---|
| *A1-2a | 865** | 91.22* | 91.22* | 91.22* |
| *A1-2a | 774** | 91.22* | 91.22* | 91.22* |
| *A1-2a | 682** | 91.22* | 91.22* | 91.22* |
| *A1-2a | 591** | 91.22* | 91.22* | 91.22* |
| *A1-2a | 500 | 100* | 100* | 100* |
| *A1-2a | 400** | 100* | 100* | 100* |
| *A1-2a | 300** | 100* | 100* | 100* |
| *A1-2a | 200** | 100* | 100* | 100* |
| *A1-2a | 100** | 100* | 100* | 100* |
| *A1-2a | 0 | * | * | * |

River: Tributary A1-2b

| Reach | River Sta. | Left | Channel | Right |
|---|---|---|---|---|
| *A1-2b | 2423 | 86.5* | 86.5* | 86.5* |
| *A1-2b | 2336.5* | 86.5* | 86.5* | 86.5* |
| *A1-2b | 2250.* | 86.5* | 86.5* | 86.5* |
| *A1-2b | 2163.5* | 86.5* | 86.5* | 86.5* |
| *A1-2b | 2077.* | 86.5* | 86.5* | 86.5* |
| *A1-2b | 1990.5* | 86.5* | 86.5* | 86.5* |
| *A1-2b | 1904.* | 86.5* | 86.5* | 86.5* |
| *A1-2b | 1817.5* | 86.5* | 86.5* | 86.5* |
| *A1-2b | 1731.* | 86.5* | 86.5* | 86.5* |
| *A1-2b | 1644.5* | 86.5* | 86.5* | 86.5* |
| *A1-2b | 1558 | 91.64* | 91.64* | 91.64* |
| *A1-2b | 1466.36* | 91.64* | 91.64* | 91.64* |
| *A1-2b | 1374.72* | 91.64* | 91.64* | 91.64* |
| *A1-2b | 1283.09* | 91.64* | 91.64* | 91.64* |
| *A1-2b | 1191.45* | 91.64* | 91.64* | 91.64* |
| *A1-2b | 1099.81* | 91.64* | 91.64* | 91.64* |
| *A1-2b | 1008.18* | 91.64* | 91.64* | 91.64* |
| *A1-2b | 916.545* | 91.64* | 91.64* | 91.64* |
| *A1-2b | 824.909* | 91.64* | 91.64* | 91.64* |
| *A1-2b | 733.272* | 91.64* | 91.64* | 91.64* |
| *A1-2b | 641.636* | 91.64* | 91.64* | 91.64* |
| *A1-2b | 550 | 91.67* | 91.67* | 91.67* |
| *A1-2b | 458.333* | 91.67* | 91.67* | 91.67* |
| *A1-2b | 366.666* | 91.67* | 91.67* | 91.67* |
| *A1-2b | 275.* | 91.67* | 91.67* | 91.67* |
| *A1-2b | 183.333* | 91.67* | 91.67* | 91.67* |
| *A1-2b | 91.6666* | 91.66* | 91.66* | 91.66* |
| *A1-2b | 0 | 550* | 550* | 550* |

River: Tributary A1-2

| Reach | River Sta. | Left | Channel | Right |
|---|---|---|---|---|
| *2d to 2b | 5832 | 100* | 100* | 100* |
| *2d to 2b | 5732 | * | * | * |
| *2e to 2d | 4814 | 100* | 100* | 100* |
| *2e to 2d | 4714 | * | * | * |
| *A1 to 2e | 4164 | 100* | 100* | 100* |
| *A1 to 2e | 4064 | * | * | * |

Profile Output Table - Standard Table 1

| River | Reach | River Sta | Q Total (cfs) | Min Ch El (ft) | W.S. Elev (ft) | Crit W.S. (ft) | E.G. Elev (ft) | E.G. Slope (ft/ft) | Vel Chnl (ft/s) | Flow Area (sq ft) | Top Width (ft) | Froude # Chl |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Tributary A1-2* | 2d to 2b | 5832 | 252.30 | 216.80 | 219.56 | 218.94 | 219.64 | 0.005237 | 3.95 | 148.26 | 123.68 | 0.44 |
| Tributary A1-2* | 2d to 2b | 5732 | 252.30 | 216.30 | 218.79 | 218.44 | 218.93 | 0.009904 | 5.04 | 116.79 | 113.14 | 0.60 |
| Tributary A1-2* | 2e to 2d | 4814 | 510.30 | 207.96 | 212.51 | 211.74 | 212.74 | 0.005702 | 5.64 | 211.45 | 146.19 | 0.48 |
| Tributary A1-2* | 2e to 2d | 4714 | 510.30 | 207.46 | 211.47 | 211.24 | 211.92 | 0.011980 | 7.46 | 145.32 | 98.43 | 0.69 |
| Tributary A1-2* | A1 to 2e | 4164 | 599.60 | 202.56 | 207.48 | 206.52 | 207.81 | 0.005307 | 6.03 | 181.37 | 73.35 | 0.52 |
| Tributary A1-2* | A1 to 2e | 4064 | 599.60 | 202.06 | 206.02 | 206.02 | 206.87 | 0.017599 | 9.21 | 115.10 | 64.57 | 0.91 |
| Tributary A1-2b* | A1-2b | 2423 | 132.90 | 259.60 | 261.61 | 261.52 | 261.85 | 0.022913 | 6.46 | 48.71 | 64.13 | 0.86 |
| Tributary A1-2b* | A1-2b | 2336.5* | 132.90 | 257.56 | 259.66 | 259.58 | 259.91 | 0.021768 | 6.54 | 48.84 | 64.11 | 0.85 |
| Tributary A1-2b* | A1-2b | 2250.* | 132.90 | 255.52 | 257.67 | 257.64 | 257.97 | 0.022960 | 6.88 | 46.85 | 62.72 | 0.88 |
| Tributary A1-2b* | A1-2b | 2163.5* | 132.90 | 253.48 | 255.72 | 255.69 | 256.03 | 0.021831 | 6.92 | 46.79 | 62.30 | 0.86 |
| Tributary A1-2b* | A1-2b | 2077.* | 132.90 | 251.44 | 253.72 | 253.72 | 254.09 | 0.023093 | 7.23 | 44.24 | 58.90 | 0.89 |
| Tributary A1-2b* | A1-2b | 1990.5* | 132.90 | 249.40 | 251.76 | 251.75 | 252.14 | 0.021445 | 7.15 | 44.33 | 57.66 | 0.86 |
| Tributary A1-2b* | A1-2b | 1904.* | 132.90 | 247.37 | 249.72 | 249.72 | 250.17 | 0.023928 | 7.55 | 40.22 | 50.96 | 0.91 |
| Tributary A1-2b* | A1-2b | 1817.5* | 132.90 | 245.33 | 247.77 | 247.77 | 248.21 | 0.021535 | 7.35 | 40.89 | 50.17 | 0.87 |
| Tributary A1-2b* | A1-2b | 1731.* | 132.90 | 243.29 | 245.75 | 245.82 | 246.26 | 0.023534 | 7.69 | 38.12 | 47.49 | 0.90 |
| Tributary A1-2b* | A1-2b | 1644.5* | 132.90 | 241.25 | 243.78 | 243.84 | 244.29 | 0.022015 | 7.58 | 38.16 | 46.74 | 0.88 |
| Tributary A1-2b* | A1-2b | 1558 | 132.90 | 239.21 | 241.98 | 241.88 | 242.32 | 0.013449 | 6.30 | 46.59 | 50.48 | 0.69 |
| Tributary A1-2b* | A1-2b | 1466.36* | 132.90 | 237.96 | 240.75 | 240.64 | 241.08 | 0.013457 | 6.27 | 48.21 | 54.71 | 0.69 |
| Tributary A1-2b* | A1-2b | 1374.72* | 132.90 | 236.72 | 239.53 | 239.38 | 239.84 | 0.013514 | 6.23 | 50.09 | 59.82 | 0.68 |
| Tributary A1-2b* | A1-2b | 1283.09* | 132.90 | 235.47 | 238.30 | 238.09 | 238.59 | 0.013571 | 6.18 | 52.10 | 64.97 | 0.67 |
| Tributary A1-2b* | A1-2b | 1191.45* | 132.90 | 234.22 | 237.06 | 236.86 | 237.34 | 0.013671 | 6.13 | 54.11 | 69.95 | 0.67 |
| Tributary A1-2b* | A1-2b | 1099.81* | 132.90 | 232.98 | 235.82 | 235.62 | 236.08 | 0.013728 | 6.03 | 56.05 | 74.24 | 0.66 |
| Tributary A1-2b* | A1-2b | 1008.18* | 132.90 | 231.73 | 234.57 | 234.45 | 234.81 | 0.013762 | 5.93 | 57.77 | 78.13 | 0.65 |
| Tributary A1-2b* | A1-2b | 916.545* | 132.90 | 230.49 | 233.32 | 233.20 | 233.54 | 0.013892 | 5.81 | 59.29 | 81.09 | 0.63 |
| Tributary A1-2b* | A1-2b | 824.909* | 132.90 | 229.24 | 232.07 | 231.94 | 232.27 | 0.013653 | 5.63 | 61.62 | 85.45 | 0.61 |
| Tributary A1-2b* | A1-2b | 733.272* | 132.90 | 227.99 | 230.81 | 230.65 | 230.99 | 0.014214 | 5.58 | 62.34 | 88.41 | 0.61 |
| Tributary A1-2b* | A1-2b | 641.636* | 132.90 | 226.75 | 229.57 | 229.39 | 229.72 | 0.013257 | 5.24 | 66.30 | 94.26 | 0.57 |
| Tributary A1-2b* | A1-2b | 550 | 132.90 | 225.50 | 228.27 | 228.12 | 228.43 | 0.015157 | 5.36 | 64.27 | 94.94 | 0.59 |
| Tributary A1-2b* | A1-2b | 458.333* | 132.90 | 224.08 | 226.72 | 226.62 | 226.91 | 0.018017 | 5.83 | 59.64 | 90.99 | 0.66 |
| Tributary A1-2b* | A1-2b | 366.666* | 132.90 | 222.67 | 225.30 | 225.12 | 225.45 | 0.014040 | 5.32 | 66.64 | 97.34 | 0.60 |
| Tributary A1-2b* | A1-2b | 275.* | 132.90 | 221.25 | 223.70 | 223.63 | 223.91 | 0.020137 | 6.24 | 56.97 | 88.86 | 0.73 |
| Tributary A1-2b* | A1-2b | 183.333* | 132.90 | 219.83 | 222.35 | 222.13 | 222.48 | 0.012117 | 5.08 | 71.25 | 101.46 | 0.58 |
| Tributary A1-2b* | A1-2b | 91.6666* | 132.90 | 218.42 | 220.64 | 220.64 | 220.90 | 0.025705 | 6.90 | 51.61 | 84.10 | 0.84 |
| Tributary A1-2b* | A1-2b | 0 | 132.90 | 217.00 | 219.86 | 219.12 | 219.88 | 0.002713 | 2.69 | 132.96 | 142.88 | 0.28 |
| Tributary A1-2a* | A1-2a | 1321 | 78.20 | 246.59 | 248.14 | 248.28 | 248.62 | 0.044671 | 7.83 | 23.20 | 45.60 | 1.18 |
| Tributary A1-2a* | A1-2a | 1230** | 78.20 | 244.16 | 245.86 | 245.86 | 246.13 | 0.022144 | 5.97 | 30.69 | 53.00 | 0.85 |
| Tributary A1-2a* | A1-2a | 1139** | 78.20 | 241.73 | 243.33 | 243.44 | 243.74 | 0.031160 | 6.84 | 25.67 | 49.15 | 1.02 |
| Tributary A1-2a* | A1-2a | 1047** | 78.20 | 239.30 | 240.96 | 241.01 | 241.29 | 0.022975 | 6.07 | 28.78 | 52.94 | 0.88 |
| Tributary A1-2a* | A1-2a | 956** | 78.20 | 236.87 | 238.45 | 238.58 | 238.90 | 0.029837 | 6.71 | 24.71 | 49.46 | 1.00 |
| Tributary A1-2a* | A1-2a | 865** | 78.20 | 234.43 | 236.06 | 236.15 | 236.44 | 0.024040 | 6.15 | 26.58 | 51.94 | 0.91 |
| Tributary A1-2a* | A1-2a | 774** | 78.20 | 232.00 | 233.57 | 233.70 | 234.04 | 0.028693 | 6.55 | 23.56 | 48.97 | 0.99 |
| Tributary A1-2a* | A1-2a | 682** | 78.20 | 229.57 | 231.16 | 231.27 | 231.59 | 0.024955 | 6.18 | 24.54 | 50.58 | 0.93 |
| Tributary A1-2a* | A1-2a | 591** | 78.20 | 227.14 | 228.69 | 228.83 | 229.18 | 0.027888 | 6.40 | 22.33 | 48.13 | 0.98 |
| Tributary A1-2a* | A1-2a | 500 | 78.20 | 224.71 | 226.27 | 226.40 | 226.73 | 0.025653 | 6.16 | 22.58 | 48.85 | 0.94 |
| Tributary A1-2a* | A1-2a | 400** | 78.20 | 223.11 | 224.80 | 224.80 | 225.09 | 0.015721 | 5.13 | 29.49 | 57.51 | 0.75 |
| Tributary A1-2a* | A1-2a | 300** | 78.20 | 221.51 | 223.19 | 223.20 | 223.49 | 0.016215 | 5.19 | 29.00 | 56.92 | 0.76 |
| Tributary A1-2a* | A1-2a | 200** | 78.20 | 219.91 | 221.60 | 221.60 | 221.89 | 0.015754 | 5.13 | 29.45 | 57.47 | 0.75 |
| Tributary A1-2a* | A1-2a | 100** | 78.20 | 218.31 | 219.99 | 220.00 | 220.29 | 0.016182 | 5.19 | 29.04 | 56.96 | 0.76 |
| Tributary A1-2a* | A1-2a | 0 | 78.20 | 216.71 | 218.39 | 218.40 | 218.69 | 0.015844 | 5.14 | 29.36 | 57.36 | 0.75 |
| Tributary A1-2d* | A1-2d | 3628 | 179.80 | 260.91 | 262.96 | 262.71 | 263.09 | 0.017263 | 6.09 | 83.61 | 111.72 | 0.77 |
| Tributary A1-2d* | A1-2d | 3535** | 179.80 | 259.30 | 261.36 | 261.11 | 261.48 | 0.017214 | 6.00 | 84.24 | 113.07 | 0.75 |
| Tributary A1-2d* | A1-2d | 3441** | 179.80 | 257.69 | 259.75 | 259.50 | 259.87 | 0.017309 | 5.90 | 84.63 | 114.22 | 0.74 |
| Tributary A1-2d* | A1-2d | 3348** | 179.80 | 256.08 | 258.15 | 257.88 | 258.25 | 0.017196 | 5.78 | 85.19 | 114.94 | 0.73 |
| Tributary A1-2d* | A1-2d | 3255** | 179.80 | 254.47 | 256.54 | 256.27 | 256.64 | 0.017289 | 5.66 | 85.72 | 116.55 | 0.71 |
| Tributary A1-2d* | A1-2d | 3161** | 179.80 | 252.86 | 254.93 | 254.65 | 255.03 | 0.017244 | 5.54 | 86.29 | 117.73 | 0.70 |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Tributary A1-2d | A1-2d | 3068** | 179.80 | 251.25 | 253.33 | 253.04 | 253.42 | 0.017259 | 5.44 | 86.74 | 118.95 | 0.69 |
| Tributary A1-2d | A1-2d | 2975** | 179.80 | 249.64 | 251.72 | 251.42 | 251.81 | 0.017212 | 5.29 | 87.46 | 120.61 | 0.67 |
| Tributary A1-2d | A1-2d | 2882** | 179.80 | 248.03 | 250.11 | 249.80 | 250.20 | 0.017285 | 5.19 | 87.75 | 121.56 | 0.66 |
| Tributary A1-2d | A1-2d | 2788** | 179.80 | 246.43 | 248.51 | 248.19 | 248.59 | 0.017144 | 5.04 | 88.60 | 123.22 | 0.64 |
| Tributary A1-2d | A1-2d | 2695** | 179.80 | 244.82 | 246.89 | 246.58 | 246.97 | 0.017516 | 4.96 | 88.29 | 123.78 | 0.63 |
| Tributary A1-2d | A1-2d | 2602** | 179.80 | 243.21 | 245.30 | 244.96 | 245.37 | 0.016813 | 4.72 | 90.14 | 125.80 | 0.60 |
| Tributary A1-2d | A1-2d | 2508** | 179.80 | 241.60 | 243.67 | 243.35 | 243.75 | 0.018037 | 4.74 | 88.20 | 125.52 | 0.61 |
| Tributary A1-2d | A1-2d | 2415** | 179.80 | 239.99 | 242.09 | 241.73 | 242.16 | 0.015951 | 4.38 | 92.87 | 129.72 | 0.56 |
| Tributary A1-2d | A1-2d | 2322** | 179.80 | 238.38 | 240.42 | 240.12 | 240.50 | 0.019876 | 4.62 | 85.86 | 125.70 | 0.60 |
| Tributary A1-2d | A1-2d | 2229** | 179.80 | 236.77 | 238.91 | 238.50 | 238.97 | 0.013665 | 3.83 | 99.36 | 135.85 | 0.49 |
| Tributary A1-2d | A1-2d | 2135** | 179.80 | 235.16 | 237.13 | 236.89 | 237.23 | 0.027084 | 4.87 | 77.10 | 121.09 | 0.65 |
| Tributary A1-2d | A1-2d | 2042 | 179.80 | 233.55 | 235.81 | 235.27 | 235.85 | 0.009092 | 3.02 | 116.50 | 147.93 | 0.38 |
| Tributary A1-2d | A1-2d | 1949** | 179.80 | 232.69 | 234.96 | 234.46 | 235.00 | 0.009095 | 3.40 | 116.00 | 147.83 | 0.42 |
| Tributary A1-2d | A1-2d | 1856** | 179.80 | 231.84 | 234.11 | 233.64 | 234.16 | 0.009113 | 3.69 | 115.11 | 146.90 | 0.45 |
| Tributary A1-2d | A1-2d | 1764** | 179.80 | 230.98 | 233.26 | 232.83 | 233.31 | 0.009090 | 3.92 | 114.41 | 146.43 | 0.47 |
| Tributary A1-2d | A1-2d | 1671** | 179.80 | 230.13 | 232.41 | 232.00 | 232.47 | 0.009134 | 4.12 | 113.14 | 145.25 | 0.50 |
| Tributary A1-2d | A1-2d | 1578** | 179.80 | 229.27 | 231.55 | 231.17 | 231.62 | 0.009166 | 4.28 | 112.00 | 144.49 | 0.51 |
| Tributary A1-2d | A1-2d | 1485** | 179.80 | 228.41 | 230.70 | 230.35 | 230.77 | 0.009110 | 4.40 | 111.01 | 143.27 | 0.52 |
| Tributary A1-2d | A1-2d | 1392** | 179.80 | 227.56 | 229.85 | 229.51 | 229.93 | 0.009116 | 4.51 | 109.91 | 142.56 | 0.54 |
| Tributary A1-2d | A1-2d | 1300** | 179.80 | 226.70 | 228.99 | 228.68 | 229.08 | 0.009180 | 4.62 | 108.32 | 141.30 | 0.55 |
| Tributary A1-2d | A1-2d | 1207** | 179.80 | 225.85 | 228.15 | 227.84 | 228.24 | 0.008818 | 4.63 | 109.24 | 142.87 | 0.55 |
| Tributary A1-2d | A1-2d | 1114 | 179.80 | 224.99 | 227.25 | 227.00 | 227.36 | 0.010091 | 4.96 | 102.35 | 138.75 | 0.59 |
| Tributary A1-2d | A1-2d | 1021** | 179.80 | 223.94 | 226.28 | 226.07 | 226.42 | 0.010134 | 5.17 | 99.48 | 136.69 | 0.61 |
| Tributary A1-2d | A1-2d | 928** | 179.80 | 222.89 | 225.31 | 225.12 | 225.48 | 0.010165 | 5.31 | 96.10 | 132.85 | 0.62 |
| Tributary A1-2d | A1-2d | 835** | 179.80 | 221.83 | 224.33 | 224.16 | 224.52 | 0.010337 | 5.44 | 91.52 | 126.24 | 0.61 |
| Tributary A1-2d | A1-2d | 743** | 179.80 | 220.78 | 223.34 | 223.18 | 223.56 | 0.010338 | 5.52 | 87.34 | 118.88 | 0.64 |
| Tributary A1-2d | A1-2d | 650** | 179.80 | 219.73 | 222.33 | 222.18 | 222.58 | 0.010678 | 5.64 | 81.74 | 109.56 | 0.65 |
| Tributary A1-2d | A1-2d | 557** | 179.80 | 218.68 | 221.32 | 221.11 | 221.59 | 0.010603 | 5.65 | 77.28 | 99.52 | 0.65 |
| Tributary A1-2d | A1-2d | 464** | 179.80 | 217.62 | 220.27 | 220.14 | 220.57 | 0.011310 | 5.80 | 70.13 | 85.85 | 0.67 |
| Tributary A1-2d | A1-2d | 371** | 179.80 | 216.57 | 219.29 | 219.13 | 219.58 | 0.010055 | 5.55 | 71.26 | 84.44 | 0.63 |
| Tributary A1-2d | A1-2d | 278** | 179.80 | 215.52 | 218.18 | 218.11 | 218.55 | 0.012110 | 5.97 | 62.29 | 76.21 | 0.69 |
| Tributary A1-2d | A1-2d | 186** | 179.80 | 214.46 | 217.27 | 217.06 | 217.56 | 0.008970 | 5.33 | 69.50 | 79.55 | 0.60 |
| Tributary A1-2d | A1-2d | 93** | 179.80 | 213.41 | 216.02 | 216.02 | 216.50 | 0.014475 | 6.38 | 51.80 | 65.07 | 0.75 |
| Tributary A1-2d | A1-2d | 0 | 179.80 | 212.36 | 215.63 | 214.99 | 215.77 | 0.003668 | 3.79 | 100.78 | 120.40 | 0.39 |
| Tributary A1-2e | A1-2e | 2091 | 89.30 | 251.78 | 253.08 | 252.95 | 253.20 | 0.028125 | 5.39 | 40.10 | 74.60 | 0.91 |
| Tributary A1-2e | A1-2e | 1998** | 89.30 | 249.18 | 250.53 | 250.40 | 250.66 | 0.026527 | 5.46 | 40.80 | 75.32 | 0.90 |
| Tributary A1-2e | A1-2e | 1904** | 89.30 | 246.59 | 247.96 | 247.85 | 248.10 | 0.028382 | 5.79 | 39.44 | 73.75 | 0.94 |
| Tributary A1-2e | A1-2e | 1811** | 89.30 | 243.99 | 245.40 | 245.30 | 245.55 | 0.026348 | 5.80 | 40.17 | 73.75 | 0.92 |
| Tributary A1-2e | A1-2e | 1718** | 89.30 | 241.40 | 242.82 | 242.74 | 242.98 | 0.028689 | 6.16 | 38.30 | 70.80 | 0.97 |
| Tributary A1-2e | A1-2e | 1625** | 89.30 | 238.80 | 240.26 | 240.18 | 240.43 | 0.026132 | 6.07 | 39.19 | 70.50 | 0.93 |
| Tributary A1-2e | A1-2e | 1531** | 89.30 | 236.21 | 237.67 | 237.62 | 237.86 | 0.028907 | 6.45 | 37.26 | 68.18 | 0.98 |
| Tributary A1-2e | A1-2e | 1438** | 89.30 | 233.61 | 235.12 | 235.06 | 235.31 | 0.025974 | 6.30 | 38.36 | 68.16 | 0.94 |
| Tributary A1-2e | A1-2e | 1345** | 89.30 | 231.02 | 232.52 | 232.50 | 232.74 | 0.029091 | 6.70 | 36.23 | 65.61 | 0.99 |
| Tributary A1-2e | A1-2e | 1252** | 89.30 | 228.42 | 229.97 | 229.94 | 230.18 | 0.025900 | 6.50 | 37.53 | 65.97 | 0.94 |
| Tributary A1-2e | A1-2e | 1158** | 89.30 | 225.83 | 227.37 | 227.37 | 227.61 | 0.029263 | 6.88 | 35.33 | 63.41 | 0.99 |
| Tributary A1-2e | A1-2e | 1065 | 89.30 | 223.23 | 224.93 | 224.80 | 225.08 | 0.016157 | 5.49 | 44.53 | 70.37 | 0.75 |
| Tributary A1-2e | A1-2e | 980** | 89.30 | 221.87 | 223.53 | 223.42 | 223.68 | 0.016640 | 5.44 | 45.02 | 76.77 | 0.76 |
| Tributary A1-2e | A1-2e | 895** | 89.30 | 220.51 | 222.15 | 222.06 | 222.30 | 0.015735 | 5.23 | 47.20 | 85.48 | 0.74 |
| Tributary A1-2e | A1-2e | 810** | 89.30 | 219.15 | 220.76 | 220.70 | 220.92 | 0.016757 | 5.26 | 47.15 | 93.14 | 0.76 |
| Tributary A1-2e | A1-2e | 725** | 89.30 | 217.79 | 219.41 | 219.34 | 219.56 | 0.015204 | 4.99 | 51.42 | 111.41 | 0.73 |
| Tributary A1-2e | A1-2e | 640** | 89.30 | 216.44 | 218.02 | 217.97 | 218.19 | 0.017035 | 5.14 | 52.59 | 137.26 | 0.77 |
| Tributary A1-2e | A1-2e | 555** | 89.30 | 215.08 | 216.64 | 216.63 | 216.80 | 0.015722 | 4.85 | 56.10 | 153.08 | 0.73 |
| Tributary A1-2e | A1-2e | 470** | 89.30 | 213.72 | 215.23 | 215.23 | 215.39 | 0.017336 | 4.90 | 54.18 | 156.01 | 0.76 |
| Tributary A1-2e | A1-2e | 385** | 89.30 | 212.36 | 213.82 | 213.81 | 213.93 | 0.014064 | 4.25 | 73.15 | 325.66 | 0.68 |
| Tributary A1-2e | A1-2e | 300 | 89.30 | 211.00 | 212.41 | 212.41 | 212.56 | 0.018515 | 4.67 | 52.62 | 455.83 | 0.77 |
| Tributary A1-2e | A1-2e | 200** | 89.30 | 209.75 | 211.02 | 210.95 | 211.06 | 0.009189 | 3.01 | 101.77 | 374.63 | 0.53 |
| Tributary A1-2e | A1-2e | 100** | 89.30 | 208.50 | 209.70 | 209.70 | 209.78 | 0.018805 | 4.10 | 76.25 | 337.33 | 0.75 |
| Tributary A1-2e | A1-2e | 0 | 89.30 | 207.25 | 208.70 | 208.45 | 208.71 | 0.002146 | 1.63 | 180.88 | 484.87 | 0.26 |
| Main | A1-1 | 5787 | 1004.00 | 204.00 | 211.47 | 210.03 | 212.45 | 0.005983 | 8.76 | 167.23 | 41.38 | 0.59 |

| River | Reach | River Sta | E.G. Elev (ft) | W.S. Elev (ft) | Vel Head (ft) | Frctn Loss (ft) | C & E Loss (ft) | Q Left (cfs) | Q Channel (cfs) | Q Right (cfs) | Top Width (ft) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Main | A1-1 | 4369 | 1063.00 | 198.00 | 205.19 | 203.29 | 205.61 | 0.003841 | 5.23 | 208.73 | 59.31 | 0.45 |
| Main | A1-1 | 3867 | 1063.00 | 196.00 | 203.24 | 201.10 | 203.71 | 0.003720 | 5.48 | 197.35 | 47.67 | 0.45 |
| Main | A1-1 | 3230 | 1063.00 | 194.00 | 201.68 | 198.60 | 201.93 | 0.002028 | 4.01 | 265.26 | 91.01 | 0.33 |
| Main | Start to A1 | 2894 | 1475.00 | 192.00 | 201.08 | 196.68 | 201.34 | 0.001575 | 4.14 | 355.86 | 59.05 | 0.30 |
| Main | Start to A1 | 1156 | 1618.00 | 190.00 | 194.11 | 191.48 | 195.12 | 0.011854 | 8.09 | 200.10 | 60.43 | 0.76 |
| Main | Start to A1 | 0 | 1618.00 | 182.00 | 186.95 | 185.71 | 187.29 | 0.004201 | 4.88 | 428.17 | 224.37 | 0.46 |
| RIVER-1 | Reach-1 | 2497 | 119.40 | 265.84 | 267.05 | 266.94 | 267.28 | 0.017593 | 4.79 | 43.75 | 66.35 | 0.79 |
| RIVER-1 | Reach-1 | 2403** | 119.40 | 264.19 | 265.40 | 265.29 | 265.62 | 0.017597 | 4.79 | 45.05 | 69.55 | 0.79 |
| RIVER-1 | Reach-1 | 2309** | 119.40 | 262.53 | 263.75 | 263.64 | 263.96 | 0.017585 | 4.79 | 46.32 | 72.58 | 0.79 |
| RIVER-1 | Reach-1 | 2215** | 119.40 | 260.88 | 262.10 | 261.98 | 262.31 | 0.017548 | 4.79 | 47.69 | 75.83 | 0.79 |
| RIVER-1 | Reach-1 | 2121** | 119.40 | 259.23 | 260.45 | 260.34 | 260.65 | 0.017647 | 4.80 | 48.80 | 78.69 | 0.79 |
| RIVER-1 | Reach-1 | 2026** | 119.40 | 257.58 | 258.80 | 258.68 | 258.99 | 0.017544 | 4.79 | 50.22 | 81.72 | 0.79 |
| RIVER-1 | Reach-1 | 1932** | 119.40 | 255.92 | 257.15 | 257.03 | 257.33 | 0.017621 | 4.81 | 51.28 | 84.50 | 0.79 |
| RIVER-1 | Reach-1 | 1838** | 119.40 | 254.27 | 255.50 | 255.37 | 255.68 | 0.017543 | 4.81 | 52.62 | 87.57 | 0.79 |
| RIVER-1 | Reach-1 | 1744** | 119.40 | 252.62 | 253.85 | 253.71 | 254.02 | 0.017678 | 4.82 | 53.59 | 89.73 | 0.79 |
| RIVER-1 | Reach-1 | 1650** | 119.40 | 250.96 | 252.20 | 252.05 | 252.36 | 0.017425 | 4.81 | 55.18 | 93.27 | 0.79 |
| RIVER-1 | Reach-1 | 1556** | 119.40 | 249.31 | 250.54 | 250.40 | 250.70 | 0.017852 | 4.85 | 55.69 | 94.89 | 0.80 |
| RIVER-1 | Reach-1 | 1462** | 119.40 | 247.66 | 248.90 | 248.73 | 249.04 | 0.017219 | 4.80 | 57.77 | 98.67 | 0.78 |
| RIVER-1 | Reach-1 | 1368** | 119.40 | 246.00 | 247.24 | 247.08 | 247.38 | 0.018184 | 4.91 | 57.52 | 99.54 | 0.80 |
| RIVER-1 | Reach-1 | 1273** | 119.40 | 244.35 | 245.60 | 245.41 | 245.73 | 0.016809 | 4.78 | 60.45 | 103.36 | 0.77 |
| RIVER-1 | Reach-1 | 1179** | 119.40 | 242.70 | 243.93 | 243.75 | 244.06 | 0.018745 | 4.99 | 58.99 | 103.72 | 0.81 |
| RIVER-1 | Reach-1 | 1085** | 119.40 | 241.05 | 242.31 | 242.11 | 242.42 | 0.016067 | 4.73 | 63.91 | 109.63 | 0.76 |
| RIVER-1 | Reach-1 | 991** | 119.40 | 239.39 | 240.61 | 240.44 | 240.73 | 0.020205 | 5.15 | 59.28 | 106.35 | 0.83 |
| RIVER-1 | Reach-1 | 897 | 119.40 | 237.74 | 239.04 | 238.77 | 239.12 | 0.014481 | 4.44 | 69.37 | 117.83 | 0.69 |
| RIVER-1 | Reach-1 | 807** | 119.40 | 236.39 | 237.73 | 237.52 | 237.84 | 0.014047 | 4.54 | 66.32 | 113.61 | 0.71 |
| RIVER-1 | Reach-1 | 718** | 119.40 | 235.04 | 236.39 | 236.23 | 236.53 | 0.014902 | 4.64 | 60.96 | 106.71 | 0.73 |
| RIVER-1 | Reach-1 | 628** | 119.40 | 233.70 | 235.09 | 234.94 | 235.25 | 0.013731 | 4.49 | 59.30 | 103.65 | 0.71 |
| RIVER-1 | Reach-1 | 538** | 119.40 | 232.35 | 233.73 | 233.61 | 233.93 | 0.015590 | 4.69 | 52.11 | 93.74 | 0.75 |
| RIVER-1 | Reach-1 | 448** | 119.40 | 231.00 | 232.44 | 232.29 | 232.64 | 0.013393 | 4.42 | 51.76 | 90.67 | 0.70 |
| RIVER-1 | Reach-1 | 359** | 119.40 | 229.65 | 231.03 | 230.94 | 231.28 | 0.016890 | 4.73 | 42.66 | 71.86 | 0.77 |
| RIVER-1 | Reach-1 | 269** | 119.40 | 228.30 | 229.76 | 229.59 | 229.97 | 0.012501 | 4.21 | 45.42 | 70.37 | 0.67 |
| RIVER-1 | Reach-1 | 179** | 119.40 | 226.96 | 228.29 | 228.23 | 228.59 | 0.019387 | 4.79 | 35.29 | 56.92 | 0.82 |
| RIVER-1 | Reach-1 | 90** | 119.40 | 225.61 | 227.10 | 226.86 | 227.29 | 0.010678 | 3.86 | 43.39 | 60.80 | 0.62 |
| RIVER-1 | Reach-1 | 0 | 119.40 | 224.26 | 225.50 | 225.50 | 225.86 | 0.025564 | 5.03 | 28.97 | 47.36 | 0.92 |

Profile Output Table - Standard Table 2

| River | Reach | River Sta | E.G. Elev (ft) | W.S. Elev (ft) | Vel Head (ft) | Frctn Loss (ft) | C & E Loss (ft) | Q Left (cfs) | Q Channel (cfs) | Q Right (cfs) | Top Width (ft) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Tributary A1-2 | 2d to 2b | 5832 | 219.64 | 219.56 | 0.08 | 0.70 | 0.01 | 110.97 | 56.07 | 85.26 | 123.68 |
| Tributary A1-2 | 2d to 2b | 5732 | 218.93 | 218.79 | 0.14 | 6.18 | 0.01 | 105.76 | 63.77 | 82.78 | 113.14 |
| Tributary A1-2 | 2e to 2d | 4814 | 212.74 | 212.51 | 0.23 | 0.80 | 0.02 | 125.48 | 197.72 | 187.10 | 146.19 |
| Tributary A1-2 | 2e to 2d | 4714 | 211.92 | 211.47 | 0.44 | 4.08 | 0.03 | 106.51 | 228.15 | 175.64 | 98.43 |
| Tributary A1-2 | A1 to 2e | 4164 | 207.81 | 207.48 | 0.33 | 0.88 | 0.05 | 251.09 | 306.50 | 42.01 | 73.35 |
| Tributary A1-2 | A1 to 2e | 4064 | 206.87 | 206.02 | 0.85 | 2.90 | 0.18 | 207.80 | 359.72 | 32.09 | 64.57 |
| Tributary A1-2b | A1-2b | 2423 | 261.85 | 261.61 | 0.24 | 1.93 | 0.00 | 51.58 | 37.25 | 44.06 | 64.13 |
| Tributary A1-2b | A1-2b | 2336.5 | 259.91 | 259.66 | 0.25 | 1.93 | 0.00 | 49.43 | 40.77 | 42.70 | 64.11 |
| Tributary A1-2b | A1-2b | 2250. | 257.97 | 257.67 | 0.30 | 1.94 | 0.00 | 46.58 | 45.45 | 40.86 | 62.72 |
| Tributary A1-2b | A1-2b | 2163.5 | 256.03 | 255.72 | 0.32 | 1.94 | 0.01 | 44.33 | 49.05 | 39.53 | 62.30 |
| Tributary A1-2b | A1-2b | 2077. | 254.09 | 253.72 | 0.37 | 1.92 | 0.00 | 40.96 | 53.64 | 38.30 | 58.90 |
| Tributary A1-2b | A1-2b | 1990.5 | 252.14 | 251.76 | 0.38 | 1.96 | 0.01 | 38.60 | 56.66 | 37.64 | 57.66 |
| Tributary A1-2b | A1-2b | 1904. | 250.17 | 249.72 | 0.45 | 1.96 | 0.00 | 34.74 | 61.30 | 36.87 | 50.96 |
| Tributary A1-2b | A1-2b | 1817.5 | 248.21 | 247.77 | 0.44 | 1.96 | 0.00 | 32.84 | 63.60 | 36.46 | 50.17 |
| Tributary A1-2b | A1-2b | 1731. | 246.26 | 245.75 | 0.51 | 1.95 | 0.01 | 28.90 | 68.76 | 35.25 | 47.49 |
| Tributary A1-2b | A1-2b | 1644.5 | 244.29 | 243.78 | 0.51 | 1.97 | 0.00 | 26.64 | 71.52 | 34.74 | 46.74 |
| Tributary A1-2b | A1-2b | 1558 | 242.32 | 241.98 | 0.34 | 1.23 | 0.00 | 29.26 | 67.12 | 36.52 | 50.48 |
| Tributary A1-2b | A1-2b | 1466.36 | 241.08 | 240.75 | 0.33 | 1.24 | 0.00 | 30.10 | 65.24 | 37.57 | 54.71 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Tributary A1-2b | A1-2b | 1374.72 | | 239.84 | 239.53 | 0.31 | 1.24 | 0.00 | 31.32 | 62.99 | 38.59 | 59.82 |
| Tributary A1-2b | A1-2b | 1283.09 | | 238.59 | 238.30 | 0.30 | 1.25 | 0.00 | 33.51 | 60.82 | 38.57 | 64.97 |
| Tributary A1-2b | A1-2b | 1191.45 | | 237.34 | 237.06 | 0.28 | 1.26 | 0.01 | 36.09 | 58.34 | 38.47 | 69.95 |
| Tributary A1-2b | A1-2b | 1099.81 | | 236.08 | 235.82 | 0.26 | 1.26 | 0.01 | 38.64 | 55.31 | 38.94 | 74.24 |
| Tributary A1-2b | A1-2b | 1008.18 | | 234.81 | 234.57 | 0.24 | 1.27 | 0.01 | 40.52 | 52.64 | 39.74 | 78.13 |
| Tributary A1-2b | A1-2b | 916.545 | | 233.54 | 233.32 | 0.22 | 1.26 | 0.01 | 42.92 | 49.29 | 40.69 | 81.09 |
| Tributary A1-2b | A1-2b | 824.909 | | 232.27 | 232.07 | 0.20 | 1.28 | 0.00 | 44.63 | 45.91 | 42.36 | 85.45 |
| Tributary A1-2b | A1-2b | 733.272 | | 230.99 | 230.81 | 0.19 | 1.26 | 0.01 | 46.25 | 43.12 | 43.53 | 88.41 |
| Tributary A1-2b | A1-2b | 641.636 | | 229.72 | 229.57 | 0.15 | 1.30 | 0.00 | 48.01 | 38.86 | 46.03 | 94.26 |
| Tributary A1-2b | A1-2b | 550 | | 228.43 | 228.27 | 0.16 | 1.51 | 0.00 | 48.79 | 37.11 | 47.00 | 94.94 |
| Tributary A1-2b | A1-2b | 458.333 | | 226.91 | 226.72 | 0.19 | 1.45 | 0.01 | 48.53 | 38.42 | 45.94 | 90.99 |
| Tributary A1-2b | A1-2b | 366.666 | | 225.45 | 225.30 | 0.15 | 1.53 | 0.01 | 49.59 | 35.07 | 48.23 | 97.34 |
| Tributary A1-2b | A1-2b | 275 | | 223.91 | 223.70 | 0.21 | 1.41 | 0.03 | 48.79 | 38.38 | 45.73 | 88.86 |
| Tributary A1-2b | A1-2b | 183.333 | | 222.48 | 222.35 | 0.13 | 1.56 | 0.01 | 50.49 | 32.53 | 49.88 | 101.46 |
| Tributary A1-2b | A1-2b | 91.6666 | | 220.90 | 220.64 | 0.26 | 0.57 | 0.07 | 48.91 | 39.18 | 44.81 | 84.10 |
| Tributary A1-2b | A1-2b | 0 | | 219.88 | 219.86 | 0.03 | 0.24 | 0.01 | 53.42 | 20.21 | 59.27 | 142.88 |
| Tributary A1-2a | A1-2a | 1321 | | 248.62 | 248.14 | 0.48 | | | 22.53 | 35.97 | 19.71 | 45.60 |
| Tributary A1-2a | A1-2a | 1230** | | 246.13 | 245.86 | 0.27 | 1.93 | 0.00 | 23.08 | 34.42 | 20.70 | 53.00 |
| Tributary A1-2a | A1-2a | 1139** | | 243.74 | 243.33 | 0.41 | 2.38 | 0.01 | 19.38 | 41.00 | 17.81 | 49.15 |
| Tributary A1-2a | A1-2a | 1047** | | 241.29 | 240.96 | 0.33 | 2.43 | 0.02 | 18.69 | 41.80 | 17.71 | 52.94 |
| Tributary A1-2a | A1-2a | 956** | | 238.90 | 238.45 | 0.44 | 2.38 | 0.01 | 15.46 | 47.70 | 15.04 | 49.46 |
| Tributary A1-2a | A1-2a | 865** | | 236.44 | 236.06 | 0.38 | 2.44 | 0.02 | 14.50 | 49.02 | 14.68 | 51.94 |
| Tributary A1-2a | A1-2a | 774** | | 234.04 | 233.57 | 0.47 | 2.39 | 0.01 | 11.84 | 53.92 | 12.44 | 48.97 |
| Tributary A1-2a | A1-2a | 682** | | 231.59 | 231.16 | 0.43 | 2.44 | 0.01 | 10.91 | 55.35 | 11.94 | 50.58 |
| Tributary A1-2a | A1-2a | 591** | | 229.18 | 228.69 | 0.49 | 2.40 | 0.01 | 8.77 | 59.35 | 10.09 | 48.13 |
| Tributary A1-2a | A1-2a | 500 | | 226.73 | 226.27 | 0.47 | 2.44 | 0.01 | 7.79 | 61.11 | 9.30 | 48.85 |
| Tributary A1-2a | A1-2a | 400** | | 225.09 | 224.80 | 0.30 | 1.57 | 0.00 | 10.43 | 55.81 | 11.96 | 57.51 |
| Tributary A1-2a | A1-2a | 300** | | 223.49 | 223.19 | 0.31 | 1.60 | 0.00 | 10.27 | 56.14 | 11.80 | 56.92 |
| Tributary A1-2a | A1-2a | 200** | | 221.89 | 221.60 | 0.30 | 1.60 | 0.00 | 10.42 | 55.83 | 11.95 | 57.47 |
| Tributary A1-2a | A1-2a | 100** | | 220.29 | 219.99 | 0.31 | 1.60 | 0.00 | 10.28 | 56.11 | 11.81 | 56.96 |
| Tributary A1-2a | A1-2a | 0 | | 218.69 | 218.39 | 0.30 | 1.60 | 0.00 | 10.39 | 55.89 | 11.92 | 57.36 |
| Tributary A1-2d | A1-2d | 3628 | | 263.09 | 262.96 | 0.12 | 1.61 | 0.00 | 101.90 | 21.45 | 56.45 | 111.72 |
| Tributary A1-2d | A1-2d | 3535** | | 261.48 | 261.36 | 0.12 | 1.61 | 0.00 | 100.11 | 20.62 | 59.07 | 113.07 |
| Tributary A1-2d | A1-2d | 3441** | | 259.87 | 259.75 | 0.11 | 1.61 | 0.00 | 98.44 | 19.63 | 61.73 | 114.22 |
| Tributary A1-2d | A1-2d | 3348** | | 258.25 | 258.15 | 0.11 | 1.61 | 0.00 | 96.64 | 18.66 | 64.50 | 114.94 |
| Tributary A1-2d | A1-2d | 3255** | | 256.64 | 256.54 | 0.10 | 1.61 | 0.00 | 94.90 | 17.68 | 67.22 | 116.55 |
| Tributary A1-2d | A1-2d | 3161** | | 255.03 | 254.93 | 0.10 | 1.61 | 0.00 | 92.87 | 16.81 | 70.12 | 117.73 |
| Tributary A1-2d | A1-2d | 3068** | | 253.42 | 253.33 | 0.10 | 1.61 | 0.00 | 90.80 | 16.06 | 72.94 | 118.95 |
| Tributary A1-2d | A1-2d | 2975** | | 251.81 | 251.72 | 0.09 | 1.61 | 0.00 | 88.72 | 15.06 | 76.02 | 120.61 |
| Tributary A1-2d | A1-2d | 2882** | | 250.20 | 250.11 | 0.09 | 1.61 | 0.00 | 86.62 | 14.29 | 78.89 | 121.56 |
| Tributary A1-2d | A1-2d | 2788** | | 248.59 | 248.51 | 0.08 | 1.62 | 0.00 | 84.53 | 13.24 | 82.02 | 123.22 |
| Tributary A1-2d | A1-2d | 2695** | | 246.97 | 246.89 | 0.08 | 1.60 | 0.00 | 82.18 | 12.56 | 85.06 | 123.78 |
| Tributary A1-2d | A1-2d | 2602** | | 245.37 | 245.30 | 0.08 | 1.62 | 0.00 | 80.40 | 11.51 | 87.89 | 125.80 |
| Tributary A1-2d | A1-2d | 2508** | | 243.75 | 243.67 | 0.08 | 1.58 | 0.00 | 77.49 | 11.03 | 91.28 | 125.52 |
| Tributary A1-2d | A1-2d | 2415** | | 242.16 | 242.09 | 0.07 | 1.66 | 0.00 | 75.85 | 9.97 | 93.98 | 129.72 |
| Tributary A1-2d | A1-2d | 2322** | | 240.50 | 240.42 | 0.08 | 1.52 | 0.01 | 72.32 | 9.72 | 97.76 | 125.70 |
| Tributary A1-2d | A1-2d | 2229** | | 238.97 | 238.91 | 0.06 | 1.74 | 0.00 | 72.35 | 8.10 | 99.35 | 135.85 |
| Tributary A1-2d | A1-2d | 2135** | | 237.23 | 237.13 | 0.10 | 1.36 | 0.02 | 65.45 | 8.86 | 105.49 | 121.09 |
| Tributary A1-2d | A1-2d | 2042 | | 235.85 | 235.81 | 0.04 | 0.84 | 0.00 | 70.34 | 6.13 | 103.33 | 147.93 |
| Tributary A1-2d | A1-2d | 1949** | | 235.00 | 234.96 | 0.04 | 0.84 | 0.00 | 72.89 | 9.21 | 97.70 | 147.83 |
| Tributary A1-2d | A1-2d | 1856** | | 234.16 | 234.11 | 0.05 | 0.84 | 0.00 | 75.47 | 12.34 | 91.99 | 146.90 |
| Tributary A1-2d | A1-2d | 1764** | | 233.31 | 233.26 | 0.05 | 0.85 | 0.00 | 77.64 | 15.76 | 86.39 | 146.43 |
| Tributary A1-2d | A1-2d | 1671** | | 232.47 | 232.41 | 0.06 | 0.85 | 0.00 | 79.28 | 19.20 | 81.31 | 145.25 |
| Tributary A1-2d | A1-2d | 1578** | | 231.62 | 231.55 | 0.07 | 0.85 | 0.00 | 81.38 | 22.87 | 75.55 | 144.49 |
| Tributary A1-2d | A1-2d | 1485** | | 230.77 | 230.70 | 0.07 | 0.85 | 0.00 | 83.46 | 26.47 | 69.87 | 143.27 |
| Tributary A1-2d | A1-2d | 1392** | | 229.93 | 229.85 | 0.08 | 0.85 | 0.00 | 84.93 | 30.00 | 64.87 | 142.56 |
| Tributary A1-2d | A1-2d | 1300** | | 229.08 | 228.99 | 0.09 | 0.83 | 0.00 | 86.19 | 33.85 | 59.76 | 141.30 |
| Tributary A1-2d | A1-2d | 1207** | | 228.24 | 228.15 | 0.09 | 0.87 | 0.00 | 87.72 | 37.04 | 55.04 | 142.87 |
| Tributary A1-2d | A1-2d | 1114 | | 227.36 | 227.25 | 0.12 | 0.94 | 0.00 | 87.77 | 42.29 | 49.75 | 138.75 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Tributary A1-2d | A1-2d | 1021** | 226.42 | 226.28 | 0.14 | 0.94 | 0.00 | 79.88 | 50.28 | 49.64 | 136.69 | |
| Tributary A1-2d | A1-2d | 928** | 225.48 | 225.31 | 0.16 | 0.95 | 0.00 | 72.53 | 58.44 | 48.83 | 132.85 | |
| Tributary A1-2d | A1-2d | 835** | 224.52 | 224.33 | 0.19 | 0.96 | 0.00 | 65.17 | 66.95 | 47.67 | 126.24 | |
| Tributary A1-2d | A1-2d | 743** | 223.56 | 223.34 | 0.22 | 0.98 | 0.00 | 58.68 | 75.11 | 46.01 | 118.88 | |
| Tributary A1-2d | A1-2d | 650** | 222.58 | 222.33 | 0.25 | 0.99 | 0.00 | 52.30 | 83.69 | 43.82 | 109.56 | |
| Tributary A1-2d | A1-2d | 557** | 221.59 | 221.32 | 0.27 | 1.02 | 0.00 | 47.01 | 91.19 | 41.60 | 99.52 | |
| Tributary A1-2d | A1-2d | 464** | 220.57 | 220.27 | 0.30 | 0.99 | 0.00 | 42.89 | 99.32 | 37.58 | 85.85 | |
| Tributary A1-2d | A1-2d | 371** | 219.58 | 219.29 | 0.29 | 1.02 | 0.01 | 40.16 | 103.74 | 35.91 | 84.44 | |
| Tributary A1-2d | A1-2d | 278** | 218.55 | 218.18 | 0.37 | 0.96 | 0.02 | 33.84 | 115.00 | 30.96 | 76.21 | |
| Tributary A1-2d | A1-2d | 186** | 217.56 | 217.27 | 0.29 | 1.04 | 0.02 | 33.34 | 114.85 | 31.62 | 79.55 | |
| Tributary A1-2d | A1-2d | 93** | 216.50 | 216.02 | 0.48 | 0.60 | 0.10 | 24.05 | 133.22 | 22.53 | 65.07 | |
| Tributary A1-2d | A1-2d | 0 | 215.77 | 215.63 | 0.14 | 3.02 | 0.01 | 36.74 | 106.91 | 36.15 | 120.40 | |
| Tributary A1-2e | A1-2e | 2091 | 253.20 | 253.08 | 0.12 | 2.55 | 0.00 | 27.79 | 13.18 | 48.33 | 74.60 | |
| Tributary A1-2e | A1-2e | 1998** | 250.66 | 250.53 | 0.12 | 2.56 | 0.00 | 28.53 | 14.13 | 46.64 | 75.32 | |
| Tributary A1-2e | A1-2e | 1904** | 248.10 | 247.96 | 0.14 | 2.55 | 0.00 | 29.35 | 15.36 | 44.59 | 73.75 | |
| Tributary A1-2e | A1-2e | 1811** | 245.55 | 245.40 | 0.14 | 2.56 | 0.00 | 30.10 | 16.15 | 43.05 | 73.75 | |
| Tributary A1-2e | A1-2e | 1718** | 242.98 | 242.82 | 0.17 | 2.55 | 0.00 | 30.69 | 17.39 | 41.23 | 70.80 | |
| Tributary A1-2e | A1-2e | 1625** | 240.43 | 240.26 | 0.16 | 2.56 | 0.00 | 31.40 | 18.04 | 39.86 | 70.50 | |
| Tributary A1-2e | A1-2e | 1531** | 237.86 | 237.67 | 0.19 | 2.55 | 0.00 | 31.95 | 19.44 | 37.90 | 68.18 | |
| Tributary A1-2e | A1-2e | 1438** | 235.31 | 235.12 | 0.18 | 2.56 | 0.00 | 32.74 | 19.96 | 36.60 | 68.16 | |
| Tributary A1-2e | A1-2e | 1345** | 232.74 | 232.52 | 0.22 | 2.56 | 0.00 | 33.39 | 21.45 | 34.46 | 65.61 | |
| Tributary A1-2e | A1-2e | 1252** | 230.18 | 229.97 | 0.21 | 2.57 | 0.00 | 34.18 | 21.72 | 33.41 | 65.97 | |
| Tributary A1-2e | A1-2e | 1158** | 227.61 | 227.37 | 0.24 | 1.98 | 0.03 | 35.01 | 23.20 | 31.09 | 63.41 | |
| Tributary A1-2e | A1-2e | 1065 | 225.08 | 224.93 | 0.14 | 1.39 | 0.00 | 36.08 | 20.88 | 32.34 | 70.37 | |
| Tributary A1-2e | A1-2e | 980** | 223.68 | 223.53 | 0.15 | 1.38 | 0.00 | 34.86 | 23.98 | 30.45 | 76.77 | |
| Tributary A1-2e | A1-2e | 895** | 222.30 | 222.15 | 0.15 | 1.38 | 0.00 | 33.00 | 26.38 | 29.92 | 85.48 | |
| Tributary A1-2e | A1-2e | 810** | 220.92 | 220.76 | 0.16 | 1.36 | 0.00 | 30.72 | 29.27 | 29.31 | 93.14 | |
| Tributary A1-2e | A1-2e | 725** | 219.56 | 219.41 | 0.15 | 1.37 | 0.00 | 28.67 | 31.11 | 29.52 | 111.41 | |
| Tributary A1-2e | A1-2e | 640** | 218.19 | 218.02 | 0.17 | 1.39 | 0.01 | 25.60 | 34.31 | 29.39 | 137.26 | |
| Tributary A1-2e | A1-2e | 555** | 216.80 | 216.64 | 0.15 | 1.40 | 0.00 | 20.34 | 34.67 | 34.28 | 153.08 | |
| Tributary A1-2e | A1-2e | 470** | 215.39 | 215.23 | 0.16 | 1.32 | 0.02 | 14.63 | 36.18 | 38.49 | 156.01 | |
| Tributary A1-2e | A1-2e | 385** | 213.93 | 213.82 | 0.11 | 1.37 | 0.00 | 19.09 | 32.31 | 37.91 | 325.66 | |
| Tributary A1-2e | A1-2e | 300 | 212.56 | 212.41 | 0.15 | | | 5.84 | 35.94 | 47.52 | 455.83 | |
| Tributary A1-2e | A1-2e | 200** | 211.06 | 211.02 | 0.04 | 1.27 | 0.00 | 51.67 | 20.30 | 17.33 | 374.63 | |
| Tributary A1-2e | A1-2e | 100** | 209.78 | 209.70 | 0.08 | 0.48 | 0.02 | 47.82 | 25.65 | 15.82 | 337.33 | |
| Tributary A1-2e | A1-2e | 0 | 208.71 | 208.70 | 0.01 | 0.87 | 0.03 | 57.15 | 13.04 | 19.11 | 484.87 | |
| Main | A1-1 | 5787 | 212.45 | 211.47 | 0.97 | 6.67 | 0.17 | 68.59 | 802.69 | 132.71 | 41.38 | |
| Main | A1-1 | 4369 | 205.61 | 205.19 | 0.42 | 1.90 | 0.00 | 3.60 | 1057.82 | 1.58 | 59.31 | |
| Main | A1-1 | 3867 | 203.71 | 203.24 | 0.47 | 1.71 | 0.06 | 1.57 | 1059.77 | 1.67 | 47.67 | |
| Main | A1-1 | 3230 | 201.93 | 201.68 | 0.25 | 0.59 | 0.00 | 0.12 | 1062.88 | 0.00 | 91.01 | |
| Main | Start to A1 | 2894 | 201.34 | 201.08 | 0.27 | 6.14 | 0.07 | | 1475.00 | | 59.05 | |
| Main | Start to A1 | 1156 | 195.12 | 194.11 | 1.02 | 7.63 | 0.20 | 0.00 | 1617.96 | 0.04 | 60.43 | |
| Main | Start to A1 | 0 | 187.29 | 186.95 | 0.34 | | | 20.73 | 1474.29 | 122.98 | 224.37 | |
| RIVER-1 | Reach-1 | 2497 | 267.28 | 267.05 | 0.23 | 1.66 | 0.00 | 25.95 | 72.93 | 20.51 | 66.35 | |
| RIVER-1 | Reach-1 | 2403** | 265.62 | 265.40 | 0.23 | 1.66 | 0.00 | 25.61 | 69.86 | 23.93 | 69.55 | |
| RIVER-1 | Reach-1 | 2309** | 263.96 | 263.75 | 0.22 | 1.65 | 0.00 | 25.25 | 66.78 | 27.37 | 72.58 | |
| RIVER-1 | Reach-1 | 2215** | 262.31 | 262.10 | 0.21 | 1.66 | 0.00 | 24.99 | 63.57 | 30.84 | 75.83 | |
| RIVER-1 | Reach-1 | 2121** | 260.65 | 260.45 | 0.20 | 1.66 | 0.00 | 24.72 | 60.60 | 34.07 | 78.69 | |
| RIVER-1 | Reach-1 | 2026** | 258.99 | 258.80 | 0.19 | 1.65 | 0.00 | 24.55 | 57.25 | 37.60 | 81.72 | |
| RIVER-1 | Reach-1 | 1932** | 257.33 | 257.15 | 0.19 | 1.65 | 0.00 | 24.06 | 54.49 | 40.85 | 84.50 | |
| RIVER-1 | Reach-1 | 1838** | 255.68 | 255.50 | 0.18 | 1.66 | 0.00 | 23.80 | 51.41 | 44.19 | 87.57 | |
| RIVER-1 | Reach-1 | 1744** | 254.02 | 253.85 | 0.17 | 1.65 | 0.00 | 23.39 | 48.27 | 47.74 | 89.73 | |
| RIVER-1 | Reach-1 | 1650** | 252.36 | 252.20 | 0.16 | 1.66 | 0.00 | 23.04 | 45.22 | 51.14 | 93.27 | |
| RIVER-1 | Reach-1 | 1556** | 250.70 | 250.54 | 0.16 | 1.65 | 0.00 | 22.61 | 42.34 | 54.45 | 94.89 | |
| RIVER-1 | Reach-1 | 1462** | 249.04 | 248.90 | 0.14 | 1.67 | 0.00 | 22.39 | 39.08 | 57.93 | 98.67 | |
| RIVER-1 | Reach-1 | 1368** | 247.38 | 247.24 | 0.14 | 1.64 | 0.00 | 21.74 | 36.37 | 61.29 | 99.54 | |
| RIVER-1 | Reach-1 | 1273** | 245.73 | 245.60 | 0.13 | 1.67 | 0.00 | 21.67 | 32.86 | 64.87 | 103.36 | |
| RIVER-1 | Reach-1 | 1179** | 244.06 | 243.93 | 0.13 | 1.63 | 0.01 | 21.02 | 30.57 | 67.81 | 103.72 | |
| RIVER-1 | Reach-1 | 1085** | 242.42 | 242.31 | 0.11 | 1.69 | 0.00 | 21.12 | 26.74 | 71.54 | 109.63 | |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| * RIVER-1 | * Reach-1 | * 991** | * | 240.73 * | 240.61 * | 0.12 * | 1.60 * | 0.01 * | 20.10 * | 24.85 * | 74.46 * | 106.35 * |
| * RIVER-1 | * Reach-1 | * 897 | * | 239.12 * | 239.04 * | 0.08 * | 1.28 * | 0.00 * | 20.69 * | 19.94 * | 78.76 * | 117.83 * |
| * RIVER-1 | * Reach-1 | * 807** | * | 237.84 * | 237.73 * | 0.11 * | 1.30 * | 0.00 * | 19.82 * | 31.54 * | 68.04 * | 113.61 * |
| * RIVER-1 | * Reach-1 | * 718** | * | 236.53 * | 236.39 * | 0.14 * | 1.28 * | 0.00 * | 17.73 * | 43.12 * | 58.55 * | 106.71 * |
| * RIVER-1 | * Reach-1 | * 628** | * | 235.25 * | 235.09 * | 0.16 * | 1.31 * | 0.00 * | 15.87 * | 53.38 * | 50.15 * | 103.65 * |
| * RIVER-1 | * Reach-1 | * 538** | * | 233.93 * | 233.73 * | 0.20 * | 1.29 * | 0.00 * | 12.61 * | 65.44 * | 41.35 * | 93.74 * |
| * RIVER-1 | * Reach-1 | * 448** | * | 232.64 * | 232.44 * | 0.20 * | 1.34 * | 0.01 * | 10.85 * | 74.14 * | 34.41 * | 90.67 * |
| * RIVER-1 | * Reach-1 | * 359** | * | 231.28 * | 231.03 * | 0.26 * | 1.30 * | 0.01 * | 9.00 * | 84.78 * | 25.62 * | 71.86 * |
| * RIVER-1 | * Reach-1 | * 269** | * | 229.97 * | 229.76 * | 0.21 * | 1.38 * | 0.01 * | 8.53 * | 89.67 * | 21.20 * | 70.37 * |
| * RIVER-1 | * Reach-1 | * 179** | * | 228.59 * | 228.29 * | 0.30 * | 1.26 * | 0.03 * | 6.92 * | 99.45 * | 13.03 * | 56.92 * |
| * RIVER-1 | * Reach-1 | * 90** | * | 227.29 * | 227.10 * | 0.20 * | 1.41 * | 0.02 * | 7.51 * | 99.79 * | 12.10 * | 60.80 * |
| * RIVER-1 | * Reach-1 | * 0 | * | 225.86 * | 225.50 * | 0.36 * | 3.47 * | 0.09 * | 4.27 * | 110.00 * | 5.13 * | 47.36 * |

**********

ERRORS WARNINGS AND NOTES
Errors Warnings and Notes for Plan : Floodplain

River: RIVER-1 Reach: Reach-1 RS: 2497 Profile: 100-yr
Warning:The energy loss was greater than 1.0 ft (0.3 m), between the current and previous cross section. This may indicate the need for additional cross sections.

River: RIVER-1 Reach: Reach-1 RS: 2403** Profile: 100-yr
Warning:The energy loss was greater than 1.0 ft (0.3 m), between the current and previous cross section. This may indicate the need for additional cross sections.

River: RIVER-1 Reach: Reach-1 RS: 2309** Profile: 100-yr
Warning:The energy loss was greater than 1.0 ft (0.3 m), between the current and previous cross section. This may indicate the need for additional cross sections.

River: RIVER-1 Reach: Reach-1 RS: 2215** Profile: 100-yr
Warning:The energy loss was greater than 1.0 ft (0.3 m), between the current and previous cross section. This may indicate the need for additional cross sections.

River: RIVER-1 Reach: Reach-1 RS: 2121** Profile: 100-yr
Warning:The energy loss was greater than 1.0 ft (0.3 m), between the current and previous cross section. This may indicate the need for additional cross sections.

River: RIVER-1 Reach: Reach-1 RS: 2026** Profile: 100-yr
Warning:The energy loss was greater than 1.0 ft (0.3 m), between the current and previous cross section. This may indicate the need for additional cross sections.

River: RIVER-1 Reach: Reach-1 RS: 1932** Profile: 100-yr
Warning:The energy loss was greater than 1.0 ft (0.3 m), between the current and previous cross section. This may indicate the need for additional cross sections.

River: RIVER-1 Reach: Reach-1 RS: 1838** Profile: 100-yr
Warning:The energy loss was greater than 1.0 ft (0.3 m), between the current and previous cross section. This may indicate the need for additional cross sections.

River: RIVER-1 Reach: Reach-1 RS: 1744** Profile: 100-yr
Warning:The energy loss was greater than 1.0 ft (0.3 m), between the current and previous cross section. This may indicate the need for additional cross sections.

River: RIVER-1 Reach: Reach-1 RS: 1650** Profile: 100-yr
Warning:The energy loss was greater than 1.0 ft (0.3 m), between the current and previous cross section. This may indicate the need for additional cross sections.

River: RIVER-1 Reach: Reach-1 RS: 1556** Profile: 100-yr
Warning:The energy loss was greater than 1.0 ft (0.3 m), between the current and previous cross section. This may indicate the need for additional cross sections.

River: RIVER-1 Reach: Reach-1 RS: 1462** Profile: 100-yr
Warning:The energy loss was greater than 1.0 ft (0.3 m), between the current and previous cross section. This may indicate the need for additional cross sections.

River: RIVER-1 Reach: Reach-1 RS: 1368** Profile: 100-yr
Warning:The energy loss was greater than 1.0 ft (0.3 m), between the current and previous cross section. This may indicate the need for additional cross sections.

River: RIVER-1 Reach: Reach-1 RS: 1273** Profile: 100-yr

Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate the need for additional cross sections.

River: RIVER-1 Reach: Reach-1 RS: 1179** Profile: 100-yr

Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate the need for additional cross sections.

River: RIVER-1 Reach: Reach-1 RS: 1085** Profile: 100-yr

Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate the need for additional cross sections.

River: RIVER-1 Reach: Reach-1 RS: 991** Profile: 100-yr

Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate the need for additional cross sections.

River: RIVER-1 Reach: Reach-1 RS: 897 Profile: 100-yr

Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate the need for additional cross sections.

River: RIVER-1 Reach: Reach-1 RS: 807** Profile: 100-yr

Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate the need for additional cross sections.

River: RIVER-1 Reach: Reach-1 RS: 718** Profile: 100-yr

Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate the need for additional cross sections.

River: RIVER-1 Reach: Reach-1 RS: 628** Profile: 100-yr

Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate the need for additional cross sections.

River: RIVER-1 Reach: Reach-1 RS: 538** Profile: 100-yr

Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate the need for additional cross sections.

River: RIVER-1 Reach: Reach-1 RS: 448** Profile: 100-yr

Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate the need for additional cross sections.

River: RIVER-1 Reach: Reach-1 RS: 359** Profile: 100-yr

Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate the need for additional cross sections.

River: RIVER-1 Reach: Reach-1 RS: 269** Profile: 100-yr

Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate the need for additional cross sections.

River: RIVER-1 Reach: Reach-1 RS: 179** Profile: 100-yr

Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate the need for additional cross sections.

River: RIVER-1 Reach: Reach-1 RS: 90** Profile: 100-yr

Warning: The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4. This may indicate the need for additional cross sections.

Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate the need for additional cross sections.

River: RIVER-1 Reach: Reach-1 RS: 0 Profile: 100-yr

Warning: The energy equation could not be balanced within the specified number of iterations. The program used critical depth for the water surface and continued on with the calculations.

Warning: The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4. This may indicate the need for additional cross sections.

Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate the need for additional cross sections.

Warning: During the standard step iterations, when the assumed water surface was set equal to critical depth, the calculated water surface came back below critical depth. This indicates that there is not a valid subcritical answer. The program defaulted to critical depth.

River: Main Reach: A1-1 RS: 5787 Profile: 100-yr

Warning: The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for additional cross sections.

Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate the need for additional cross sections.

River: Main Reach: A1-1 RS: 4369 Profile: 100-yr

Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate

the need for additional cross sections.
River: Main Reach: A1-1 RS: 3867 Profile: 100-yr
Warning:The energy loss was greater than 1.0 ft (0.3 m) between the current and previous cross section. This may indicate the need for additional cross sections.
River: Main Reach: A1-1 RS: 3230 Profile: 100-yr
Warning:Divided flow computed for this cross-section.
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4. This may indicate the need for additional cross sections.
River: Main Reach: Start to A1 RS: 2894 Profile: 100-yr
Warning:The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for additional cross sections.
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4. This may indicate the need for additional cross sections.
Warning:The energy loss was greater than 1.0 ft (0.3 m), between the current and previous cross section. This may indicate the need for additional cross sections.
River: Main Reach: Start to A1 RS: 1156 Profile: 100-yr
Warning:The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for additional cross sections.
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4. This may indicate the need for additional cross sections.
Warning:The energy loss was greater than 1.0 ft (0.3 m), between the current and previous cross section. This may indicate the need for additional cross sections.
River: Tributary A1-2e Reach: A1-2e RS: 2091 Profile: 100-yr
Warning:The energy loss was greater than 1.0 ft (0.3 m), between the current and previous cross section. This may indicate the need for additional cross sections.
River: Tributary A1-2e Reach: A1-2e RS: 1998** Profile: 100-yr
Warning:The energy loss was greater than 1.0 ft (0.3 m), between the current and previous cross section. This may indicate the need for additional cross sections.
River: Tributary A1-2e Reach: A1-2e RS: 1904** Profile: 100-yr
Warning:The energy loss was greater than 1.0 ft (0.3 m), between the current and previous cross section. This may indicate the need for additional cross sections.
River: Tributary A1-2e Reach: A1-2e RS: 1811** Profile: 100-yr
Warning:The energy loss was greater than 1.0 ft (0.3 m), between the current and previous cross section. This may indicate the need for additional cross sections.
River: Tributary A1-2e Reach: A1-2e RS: 1718** Profile: 100-yr
Warning:The energy loss was greater than 1.0 ft (0.3 m), between the current and previous cross section. This may indicate the need for additional cross sections.
River: Tributary A1-2e Reach: A1-2e RS: 1625** Profile: 100-yr
Warning:The energy loss was greater than 1.0 ft (0.3 m), between the current and previous cross section. This may indicate the need for additional cross sections.
River: Tributary A1-2e Reach: A1-2e RS: 1531** Profile: 100-yr
Warning:The energy loss was greater than 1.0 ft (0.3 m), between the current and previous cross section. This may indicate the need for additional cross sections.
River: Tributary A1-2e Reach: A1-2e RS: 1438** Profile: 100-yr
Warning:The energy loss was greater than 1.0 ft (0.3 m), between the current and previous cross section. This may indicate the need for additional cross sections.
River: Tributary A1-2e Reach: A1-2e RS: 1345** Profile: 100-yr
Warning:The energy loss was greater than 1.0 ft (0.3 m), between the current and previous cross section. This may indicate the need for additional cross sections.
River: Tributary A1-2e Reach: A1-2e RS: 1252** Profile: 100-yr
Warning:The energy loss was greater than 1.0 ft (0.3 m), between the current and previous cross section. This may indicate the need for additional cross sections.
River: Tributary A1-2e Reach: A1-2e RS: 1158** Profile: 100-yr
Warning:The energy equation could not be balanced within the specified number of iterations. The program used critical depth for the water surface and continued on with the calculations.
Warning:The energy loss was greater than 1.0 ft (0.3 m), between the current and previous cross section. This may indicate the need for additional cross sections.
Warning:During the standard step iterations, when the assumed water surface was set equal to critical depth, the calculated water surface came back below critical depth. This indicates that there is not a valid subcritical answer. The program defaulted to critical depth.
River: Tributary A1-2e Reach: A1-2e RS: 1065 Profile: 100-yr

Warning: The energy loss was greater than 1.0 ft (0.3 m), between the current and previous cross section. This may indicate the need for additional cross sections.

River: Tributary A1-2e Reach: A1-2e RS: 980** Profile: 100-yr

Warning: The energy loss was greater than 1.0 ft (0.3 m), between the current and previous cross section. This may indicate the need for additional cross sections.

River: Tributary A1-2e Reach: A1-2e RS: 895** Profile: 100-yr

Warning: The energy loss was greater than 1.0 ft (0.3 m), between the current and previous cross section. This may indicate the need for additional cross sections.

River: Tributary A1-2e Reach: A1-2e RS: 810** Profile: 100-yr

Warning: The energy loss was greater than 1.0 ft (0.3 m), between the current and previous cross section. This may indicate the need for additional cross sections.

River: Tributary A1-2e Reach: A1-2e RS: 725** Profile: 100-yr

Warning: The energy loss was greater than 1.0 ft (0.3 m), between the current and previous cross section. This may indicate the need for additional cross sections.

River: Tributary A1-2e Reach: A1-2e RS: 640** Profile: 100-yr

Warning: The energy loss was greater than 1.0 ft (0.3 m), between the current and previous cross section. This may indicate the need for additional cross sections.

River: Tributary A1-2e Reach: A1-2e RS: 555** Profile: 100-yr

Warning: The energy loss was greater than 1.0 ft (0.3 m), between the current and previous cross section. This may indicate the need for additional cross sections.

River: Tributary A1-2e Reach: A1-2e RS: 470** Profile: 100-yr

Warning: The energy equation could not be balanced within the specified number of iterations. The program used critical depth for the water surface and continued on with the calculations.

Warning: The energy loss was greater than 1.0 ft (0.3 m), between the current and previous cross section. This may indicate the need for additional cross sections.

Warning: During the standard step iterations, when the assumed water surface was set equal to critical depth, the calculated water surface came back below critical depth. This indicates that there is not a valid subcritical answer. The program defaulted to critical depth.

River: Tributary A1-2e Reach: A1-2e RS: 385** Profile: 100-yr

Warning: Divided flow computed for this cross-section.

Warning: The energy loss was greater than 1.0 ft (0.3 m), between the current and previous cross section. This may indicate the need for additional cross sections.

River: Tributary A1-2e Reach: A1-2e RS: 300 Profile: 100-yr

Warning: The energy equation could not be balanced within the specified number of iterations. The program used critical depth for the water surface and continued on with the calculations.

Warning: Divided flow computed for this cross-section.

Warning: The energy loss was greater than 1.0 ft (0.3 m), between the current and previous cross section. This may indicate the need for additional cross sections.

Warning: The parabolic search method failed to converge on critical depth. The program will try the cross section slice/secant method to find critical depth.

Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid, water surface was used.

River: Tributary A1-2e Reach: A1-2e RS: 200** Profile: 100-yr

Warning: Divided flow computed for this cross-section.

Warning: The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4. This may indicate the need for additional cross sections.

Warning: The energy loss was greater than 1.0 ft (0.3 m), between the current and previous cross section. This may indicate the need for additional cross sections.

River: Tributary A1-2e Reach: A1-2e RS: 100** Profile: 100-yr

Warning: The energy equation could not be balanced within the specified number of iterations. The program used critical depth for the water surface and continued on with the calculations.

Warning: Divided flow computed for this cross-section.

Warning: The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4. This may indicate the need for additional cross sections.

Warning: The energy loss was greater than 1.0 ft (0.3 m), between the current and previous cross section. This may indicate the need for additional cross sections.

Warning: During the standard step iterations, when the assumed water surface was set equal to critical depth, the calculated water surface came back below critical depth. This indicates that there is not a valid subcritical answer. The program defaulted to critical depth.

```
River: Tributary A1-2e  Reach: A1-2e     RS: 0     Profile: 100-yr
     Warning:Divided flow computed for this cross-section.
     Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
             This may indicate the need for additional cross sections.
River: Tributary A1-2d  Reach: A1-2d     RS: 3628     Profile: 100-yr
     Warning:The energy loss was greater than 1.0 ft (0.3 m), between the current and previous cross section.  This may indicate
             the need for additional cross sections.
River: Tributary A1-2d  Reach: A1-2d     RS: 3535**     Profile: 100-yr
     Warning:The energy loss was greater than 1.0 ft (0.3 m), between the current and previous cross section.  This may indicate
             the need for additional cross sections.
River: Tributary A1-2d  Reach: A1-2d     RS: 3441**     Profile: 100-yr
     Warning:The energy loss was greater than 1.0 ft (0.3 m), between the current and previous cross section.  This may indicate
             the need for additional cross sections.
River: Tributary A1-2d  Reach: A1-2d     RS: 3348**     Profile: 100-yr
     Warning:The energy loss was greater than 1.0 ft (0.3 m), between the current and previous cross section.  This may indicate
             the need for additional cross sections.
River: Tributary A1-2d  Reach: A1-2d     RS: 3255**     Profile: 100-yr
     Warning:The energy loss was greater than 1.0 ft (0.3 m), between the current and previous cross section.  This may indicate
             the need for additional cross sections.
River: Tributary A1-2d  Reach: A1-2d     RS: 3161**     Profile: 100-yr
     Warning:The energy loss was greater than 1.0 ft (0.3 m), between the current and previous cross section.  This may indicate
             the need for additional cross sections.
River: Tributary A1-2d  Reach: A1-2d     RS: 3068**     Profile: 100-yr
     Warning:The energy loss was greater than 1.0 ft (0.3 m), between the current and previous cross section.  This may indicate
             the need for additional cross sections.
River: Tributary A1-2d  Reach: A1-2d     RS: 2975**     Profile: 100-yr
     Warning:The energy loss was greater than 1.0 ft (0.3 m), between the current and previous cross section.  This may indicate
             the need for additional cross sections.
River: Tributary A1-2d  Reach: A1-2d     RS: 2882**     Profile: 100-yr
     Warning:The energy loss was greater than 1.0 ft (0.3 m), between the current and previous cross section.  This may indicate
             the need for additional cross sections.
River: Tributary A1-2d  Reach: A1-2d     RS: 2788**     Profile: 100-yr
     Warning:The energy loss was greater than 1.0 ft (0.3 m), between the current and previous cross section.  This may indicate
             the need for additional cross sections.
River: Tributary A1-2d  Reach: A1-2d     RS: 2695**     Profile: 100-yr
     Warning:The energy loss was greater than 1.0 ft (0.3 m), between the current and previous cross section.  This may indicate
             the need for additional cross sections.
River: Tributary A1-2d  Reach: A1-2d     RS: 2602**     Profile: 100-yr
     Warning:The energy loss was greater than 1.0 ft (0.3 m), between the current and previous cross section.  This may indicate
             the need for additional cross sections.
River: Tributary A1-2d  Reach: A1-2d     RS: 2508**     Profile: 100-yr
     Warning:The energy loss was greater than 1.0 ft (0.3 m), between the current and previous cross section.  This may indicate
             the need for additional cross sections.
River: Tributary A1-2d  Reach: A1-2d     RS: 2415**     Profile: 100-yr
     Warning:The energy loss was greater than 1.0 ft (0.3 m), between the current and previous cross section.  This may indicate
             the need for additional cross sections.
River: Tributary A1-2d  Reach: A1-2d     RS: 2322**     Profile: 100-yr
     Warning:The energy loss was greater than 1.0 ft (0.3 m), between the current and previous cross section.  This may indicate
             the need for additional cross sections.
River: Tributary A1-2d  Reach: A1-2d     RS: 2229**     Profile: 100-yr
     Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
             This may indicate the need for additional cross sections.
     Warning:The energy loss was greater than 1.0 ft (0.3 m), between the current and previous cross section.  This may indicate
             the need for additional cross sections.
River: Tributary A1-2d  Reach: A1-2d     RS: 2135**     Profile: 100-yr
     Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
             This may indicate the need for additional cross sections.
     Warning:The energy loss was greater than 1.0 ft (0.3 m), between the current and previous cross section.  This may indicate
             the need for additional cross sections.
```

River: Tributary A1-2d Reach: A1-2d RS: 557** Profile: 100-yr
Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate the need for additional cross sections.
River: Tributary A1-2d Reach: A1-2d RS: 371** Profile: 100-yr
Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate the need for additional cross sections.
River: Tributary A1-2d Reach: A1-2d RS: 186** Profile: 100-yr
Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate the need for additional cross sections.
River: Tributary A1-2d Reach: A1-2d RS: 93** Profile: 100-yr
Warning: The energy equation could not be balanced within the specified number of iterations. The program selected the water surface that had the least amount of error between computed and assumed values.
Warning: The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4. This may indicate the need for additional cross sections.
Warning: During the standard step iterations, when the assumed water surface was set equal to critical depth, the calculated water surface came back below critical depth. This indicates that there is not a valid subcritical answer. The program defaulted to critical depth.
River: Tributary A1-2d Reach: A1-2d RS: 0 Profile: 100-yr
Warning: Divided flow computed for this cross-section.
Warning: The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4. This may indicate the need for additional cross sections.
Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate the need for additional cross sections.
River: Tributary A1-2a Reach: A1-2a RS: 1230** Profile: 100-yr
Warning: The energy equation could not be balanced within the specified number of iterations. The program used critical depth for the water surface and continued on with the calculations.
Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate the need for additional cross sections.
Warning: During the standard step iterations, when the assumed water surface was set equal to critical depth, the calculated water surface came back below critical depth. This indicates that there is not a valid subcritical answer. The program defaulted to critical depth.
River: Tributary A1-2a Reach: A1-2a RS: 1139** Profile: 100-yr
Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate the need for additional cross sections.
River: Tributary A1-2a Reach: A1-2a RS: 1047** Profile: 100-yr
Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate the need for additional cross sections.
River: Tributary A1-2a Reach: A1-2a RS: 956** Profile: 100-yr
Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate the need for additional cross sections.
River: Tributary A1-2a Reach: A1-2a RS: 865** Profile: 100-yr
Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate the need for additional cross sections.
River: Tributary A1-2a Reach: A1-2a RS: 774** Profile: 100-yr
Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate the need for additional cross sections.
River: Tributary A1-2a Reach: A1-2a RS: 682** Profile: 100-yr
Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate the need for additional cross sections.
River: Tributary A1-2a Reach: A1-2a RS: 591** Profile: 100-yr
Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate the need for additional cross sections.
River: Tributary A1-2a Reach: A1-2a RS: 500 Profile: 100-yr
Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate the need for additional cross sections.
River: Tributary A1-2a Reach: A1-2a RS: 400** Profile: 100-yr
Warning: The energy equation could not be balanced within the specified number of iterations. The program selected the water surface that had the least amount of error between computed and assumed values.
Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate

the need for additional cross sections.
Warning: During the standard step iterations, when the assumed water surface was set equal to critical depth, the calculated water surface came back below critical depth. This indicates that there is not a valid subcritical answer. The program defaulted to critical depth.
River: Tributary A1-2a Reach: A1-2a RS: 300** Profile: 100-yr
Warning: The energy loss was greater than 1.0 ft (0.3 m), between the current and previous cross section. This may indicate the need for additional cross sections.
River: Tributary A1-2a Reach: A1-2a RS: 200** Profile: 100-yr
Warning: The energy loss was greater than 1.0 ft (0.3 m), between the current and previous cross section. This may indicate the need for additional cross sections.
River: Tributary A1-2a Reach: A1-2a RS: 100** Profile: 100-yr
Warning: The energy loss was greater than 1.0 ft (0.3 m), between the current and previous cross section. This may indicate the need for additional cross sections.
River: Tributary A1-2a Reach: A1-2a RS: 0 Profile: 100-yr
Warning: The energy loss was greater than 1.0 ft (0.3 m), between the current and previous cross section. This may indicate the need for additional cross sections.
River: Tributary A1-2b Reach: A1-2b RS: 2423 Profile: 100-yr
Warning: The energy loss was greater than 1.0 ft (0.3 m), between the current and previous cross section. This may indicate the need for additional cross sections.
River: Tributary A1-2b Reach: A1-2b RS: 2336.5* Profile: 100-yr
Warning: The energy loss was greater than 1.0 ft (0.3 m), between the current and previous cross section. This may indicate the need for additional cross sections.
River: Tributary A1-2b Reach: A1-2b RS: 2250.* Profile: 100-yr
Warning: The energy loss was greater than 1.0 ft (0.3 m), between the current and previous cross section. This may indicate the need for additional cross sections.
River: Tributary A1-2b Reach: A1-2b RS: 2163.5* Profile: 100-yr
Warning: The energy loss was greater than 1.0 ft (0.3 m), between the current and previous cross section. This may indicate the need for additional cross sections.
River: Tributary A1-2b Reach: A1-2b RS: 2077.* Profile: 100-yr
Warning: The energy equation could not be balanced within the specified number of iterations. The program selected the water surface that had the least amount of error between computed and assumed values.
Warning: The energy loss was greater than 1.0 ft (0.3 m), between the current and previous cross section. This may indicate the need for additional cross sections.
Warning: During the standard step iterations, when the assumed water surface was set equal to critical depth, the calculated water surface came back below critical depth. This indicates that there is not a valid subcritical answer. The program defaulted to critical depth.
River: Tributary A1-2b Reach: A1-2b RS: 1990.5* Profile: 100-yr
Warning: The energy loss was greater than 1.0 ft (0.3 m), between the current and previous cross section. This may indicate the need for additional cross sections.
River: Tributary A1-2b Reach: A1-2b RS: 1904.* Profile: 100-yr
Warning: The energy equation could not be balanced within the specified number of iterations. The program selected the water surface that had the least amount of error between computed and assumed values.
Warning: The energy loss was greater than 1.0 ft (0.3 m), between the current and previous cross section. This may indicate the need for additional cross sections.
Warning: During the standard step iterations, when the assumed water surface was set equal to critical depth, the calculated water surface came back below critical depth. This indicates that there is not a valid subcritical answer. The program defaulted to critical depth.
River: Tributary A1-2b Reach: A1-2b RS: 1817.5* Profile: 100-yr
Warning: The energy loss was greater than 1.0 ft (0.3 m), between the current and previous cross section. This may indicate the need for additional cross sections.
Note: Program found supercritical flow starting at this cross section.
River: Tributary A1-2b Reach: A1-2b RS: 1731.* Profile: 100-yr
Warning: The energy loss was greater than 1.0 ft (0.3 m), between the current and previous cross section. This may indicate the need for additional cross sections.
River: Tributary A1-2b Reach: A1-2b RS: 1644.5* Profile: 100-yr
Warning: The energy loss was greater than 1.0 ft (0.3 m), between the current and previous cross section. This may indicate the need for additional cross sections.
River: Tributary A1-2b Reach: A1-2b RS: 1558 Profile: 100-yr
Warning: The energy loss was greater than 1.0 ft (0.3 m), between the current and previous cross section. This may indicate

the need for additional cross sections.
Note: Hydraulic jump has occurred between this cross section and the previous upstream section.
River: Tributary A1-2b Reach: A1-2b RS: 1466.36* Profile: 100-yr
Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate the need for additional cross sections.
River: Tributary A1-2b Reach: A1-2b RS: 1374.72* Profile: 100-yr
Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate the need for additional cross sections.
River: Tributary A1-2b Reach: A1-2b RS: 1283.09* Profile: 100-yr
Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate the need for additional cross sections.
River: Tributary A1-2b Reach: A1-2b RS: 1191.45* Profile: 100-yr
Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate the need for additional cross sections.
River: Tributary A1-2b Reach: A1-2b RS: 1099.81* Profile: 100-yr
Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate the need for additional cross sections.
River: Tributary A1-2b Reach: A1-2b RS: 1008.18* Profile: 100-yr
Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate the need for additional cross sections.
River: Tributary A1-2b Reach: A1-2b RS: 916.545* Profile: 100-yr
Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate the need for additional cross sections.
River: Tributary A1-2b Reach: A1-2b RS: 824.909* Profile: 100-yr
Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate the need for additional cross sections.
River: Tributary A1-2b Reach: A1-2b RS: 733.272* Profile: 100-yr
Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate the need for additional cross sections.
River: Tributary A1-2b Reach: A1-2b RS: 641.636* Profile: 100-yr
Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate the need for additional cross sections.
River: Tributary A1-2b Reach: A1-2b RS: 550 Profile: 100-yr
Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate the need for additional cross sections.
River: Tributary A1-2b Reach: A1-2b RS: 458.333* Profile: 100-yr
Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate the need for additional cross sections.
River: Tributary A1-2b Reach: A1-2b RS: 366.666* Profile: 100-yr
Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate the need for additional cross sections.
River: Tributary A1-2b Reach: A1-2b RS: 275.* Profile: 100-yr
Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate the need for additional cross sections.
River: Tributary A1-2b Reach: A1-2b RS: 183.333* Profile: 100-yr
Warning: The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4. This may indicate the need for additional cross sections.
Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate the need for additional cross sections.
River: Tributary A1-2b Reach: A1-2b RS: 91.6666* Profile: 100-yr
Warning: The energy equation could not be balanced within the specified number of iterations. The program used critical depth for the water surface and continued on with the calculations.
Warning: The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4. This may indicate the need for additional cross sections.
Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate the need for additional cross sections.
Warning: During the standard step iterations, when the assumed water surface was set equal to critical depth, the calculated water surface came back below critical depth. This indicates that there is not a valid subcritical answer. The program defaulted to critical depth.

River: Tributary A1-2 Reach: 2d to 2b RS: 5732 Profile: 100-yr
Warning: The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4. This may indicate the need for additional cross sections.
Warning: The energy loss was greater than 1.0 ft (0.3 m), between the current and previous cross section. This may indicate the need for additional cross sections.
River: Tributary A1-2 Reach: 2e to 2d RS: 4814 Profile: 100-yr
Warning: The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4. This may indicate the need for additional cross sections.
River: Tributary A1-2 Reach: 2e to 2d RS: 4714 Profile: 100-yr
Warning: The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4. This may indicate the need for additional cross sections.
Warning: The energy loss was greater than 1.0 ft (0.3 m), between the current and previous cross section. This may indicate the need for additional cross sections.
River: Tributary A1-2 Reach: A1 to 2e RS: 4164 Profile: 100-yr
Warning: The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for additional cross sections.
Warning: The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4. This may indicate the need for additional cross sections.
River: Tributary A1-2 Reach: A1 to 2e RS: 4064 Profile: 100-yr
Warning: The energy equation could not be balanced within the specified number of iterations. The program used critical depth for the water surface and continued on with the calculations.
Warning: The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for additional cross sections.
Warning: The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4. This may indicate the need for additional cross sections.
Warning: The energy loss was greater than 1.0 ft (0.3 m), between the current and previous cross section. This may indicate the need for additional cross sections.
Warning: During the standard step iterations, when the assumed water surface was set equal to critical depth, the calculated water surface came back below critical depth. This indicates that there is not a valid subcritical answer. The program defaulted to critical depth.

Jordan Jones & Goulding INCORPORATED

# APPENDIX D

## Ecological Studies Report

# ECOLOGICAL STUDIES REPORT

## Perry County Disposal Facility

Uniontown, Alabama

**Prepared For:**
Perry County Associates, LLC

**Prepared By:**

**Ecological Solutions, Inc.**

Ecological Solutions

**Jordan, Jones & Goulding, Inc.**

Jordan Jones & Goulding

June 2001

# Table of Contents


Page

EXECUTIVE SUMMARY

SECTION 1 - INTRODUCTION

Site Location ..... 1-1

SECTION 2 - THREATENED AND ENDANGERED SPECIES

Endangered Species Compliance – General Condition 11 ..... 2-1
Office Review Methodology ..... 2-1
Protected Species Conclusion ..... 2-2

SECTION 3 - JURISDICTIONAL STUDIES

Wetland Methodologies and Parameter Evaluations ..... 3-1
Vegetation ..... 3-2
Soils ..... 3-3
Non-Sandy Soils ..... 3-3
Sandy Soils ..... 3-5
Hydrology ..... 3-6
Study Results ..... 3-7
Wetland Vegetation Communities ..... 3-10
Jurisdictional Waters ..... 3-22
Potential Jurisdictional Impacts ..... 3-23

SECTION 4 - PERMIT CONSIDERATIONS

Section 404 Overview ..... 4-1
Anticipated Project Permit Requirements ..... 4-2


## List of Tables


Table 1 – Protected Fauna in the Vicinity of Perry County ..... 2-1
Table 2 – Plant Indicator Status Categories ..... 3-2
Table 3 – Hydrologic Zones – Non-Tidal Areas ..... 3-7
Table 4 – Summary of Wetland Classifications and Acreages ..... 3-8
Table 5 – Summary of Waters of the United States Classifications ..... 3-10

## List of Figures

Figure 1 – Vicinity Map
Figure 2 –USGS Topographical Map and Location of Jurisdictional Waters and Wetlands

## List of Appendices

APPENDIX A – Wetland Data Sheets

# Executive Summary

Ecological Solutions, Inc. and Jordan, Jones & Goulding, Inc. (JJ&G) and were contracted by Perry County Associates, LLC to perform ecological studies for a 1,600-acre parcel east of Uniontown, Alabama, in Perry County, Alabama. The ecological studies included identification of Section 404 jurisdictional boundaries following the accepted methodology of the Department of the Army Corps of Engineers (ACOE). Office and field reviews were conducted for animal and plant species listed under the protection of the Endangered Species Act. This report includes a site description, study methodologies, results of field surveys, an overview of Section 404 permit requirements, and anticipated permit requirements.

Field studies identified the presence of 16 jurisdictional wetlands and 25 jurisdictional waters in the study corridor. The jurisdictional wetlands were classified as palustrine forested, emergent, and scrub/shrub systems. The jurisdictional waters were classified as lower perennial and intermittent systems. Please refer to the Jurisdictional Studies section of this report for more information pertaining to the type and the location of jurisdictional areas within the study corridor.

During field studies, no observations were made of any protected species known to occur in Perry County. A detailed discussion of methodologies and protected species requirements is included in the Threatened and Endangered Species section of this report.

Construction of the Perry County Disposal Facility, as currently proposed, would not impact areas within the jurisdiction of the ACOE; therefore, no Section 404 permit is required for the project. The project are was specifically designed to eliminate impacts to jurisdictional areas.

# SECTION 1
# Introduction

Ecological Solutions, Inc and Jordan, Jones, & Goulding, Inc. (JJ&G) were contracted by Perry County Associates, LLC to perform ecological studies within a 1,600-acre tract in Perry County, Alabama (Figure 1). Field studies consisted of jurisdictional delineations and threatened and endangered species surveys. All jurisdictional wetlands and waters of the United States were identified following guidelines promulgated in the United States Army Corps of Engineers (ACOE) *Wetland Delineation Manual T-87-1* (ACOE, 1987).

Field studies were conducted during September 1999. After a field review by qualified biologists, the vegetation communities were determined to be upland or wetland and then were classified by dominant vegetation.

## Site Location

The site is located within a large agricultural tract of land that currently is utilized for cattle farming and as a hunting preserve. The cattle farming operation is comprised of approximately 600 acres and generally is described as rolling pastureland with primarily forested stream buffer corridors. The hunting preserve is comprised of approximately 1,000 acres and generally is described as rolling hills with a scrubby early pioneer vegetation with some large areas in mixed pine/hardwood forest.

# SECTION 2
# Threatened and Endangered Species

## Endangered Species Compliance — General Condition 11

Under terms of Section 7 of the Endangered Species Act, federal agencies shall *"ensure that any action authorized, funded or carried out by such agency is not likely to jeopardize the continued existence of any endangered species or threatened species or result in the destruction or adverse modification of habitat of such species which is determined by the Secretary to be critical...". The* ACOE requires protected species surveys for potential impact areas that must be permitted under Section 404 of the Clean Water Act.

### Office Review Methodology

An office review of available literature sources was conducted to develop a preliminary list of threatened and endangered species for Perry County in the vicinity of Uniontown, Alabama. The primary source of information on listed species of possible occurrence was the federal "Red Book" - Region 4 and the U.S. Fish and Wildlife Service (USFWS) county database.

A current list (January 1999) of federally threatened and endangered species was obtained from the USFWS office in Daphne, Alabama, for review and comments. Field personnel to readily evaluate habitats for the possible occurrence of protected species generated a species/habitat matrix (Table 1).

**Table 1**
**Protected Fauna in the Vicinity of Perry County**

| Species | Common name | Federal Status | State Distribution | Habitat |
|---|---|---|---|---|
| *Haliaeetus leucocephalus* | southern bald eagle | T | entire state | lakes, rivers, sea coasts |
| *Picoides borealis* | red-cockaded woodpecker | E | entire state | open pine woods, pine savannahs |
| *Notropis cahabae* | Cahaba shiner | E | main channel of Cahaba River | large shoals with sandy substrate scattered over gravel beds |

T = Federal Threatened
E = Federal Endangered

Biologists surveyed the entire 1,600-acre study area to identify potential habitats for federal-listed threatened and endangered (T&E) species. Upon completion of field studies and literature review, biologists have concluded that the proposed Perry County Disposal Facility is "not likely to adversely affect" any of the species listed for Perry County. Below is a brief discussion of each federal-listed T&E species identified for this project area.

The **red-cockaded woodpecker** (*Picoides borealis*) has a range that historically covered the Southeast. Populations of the bird now are fragmented throughout its former range. Red-cockaded woodpeckers primarily use live pine trees to excavate a nesting cavity. The birds live in clans of two to five individuals and require a wide area of habitat for nesting cavities, roost holes, and foraging. Specific habitat requirements are 50 hectares (125 acres) of contiguous pine with little to no developed understory. Nesting habitat should have live pines greater than 60 years of age; foraging habitat should have pine and hardwood trees greater than 30 years of age. No habitat for the red-cockaded woodpecker was observed during field studies.

The **bald eagle** (*Haliaeetus leucocephalus*) prefers primarily riparian habitats associated with coastal waters, rivers and lakes, and usually nests near bodies of water where foraging habitat occurs. No rivers, coastal waters, or large lakes are within the vicinity of the project.

The **Cahaba shiner** (*Notropis cahabae*) is endemic to the main channel of the Cahaba River. Preferred habitat is 0.30 to 0.49 meters (1 to 1.6 feet) of deep large shoals with sandy substrate scattered over gravel beds. The Cahaba shiner is known from portions of the Cahaba River in Perry County. The Cahaba River is not within the project area; therefore, the habitat of the Cahaba shiner will not be impacted by construction of the proposed Perry County Disposal Facility.

**Protected Species Conclusion**

No federally protected or state protected species were observed within the proposed 1,600-acre parcel during the field studies. Habitat was not observed for any protected species of potential occurrence within the study corridor. Aquatic sampling was not conducted in the study; however, it is unlikely that protected aquatic species would be found in the study area, because suitable habitat was not encountered. Construction of this project would not have an impact on the federal and state protected species.

# SECTION 3
# Jurisdictional Studies

The proposed project corridor was surveyed with respect to jurisdictional wetlands, as required by the provisions of Executive Order 11990 and subsequent federal regulations. Jurisdictional areas are those that satisfy the criteria of a wetland, including:

- Prevalence of hydrophytic vegetation
- Hydric soils
- Permanent or periodic inundation or saturation

## Wetland Methodologies and Parameter Evaluations

Evaluation of a habitat to determine whether it meets the criteria defining a jurisdictional wetland is accomplished using one of three methods outlined in the *Corps of Engineers Wetlands Delineation Manual (1987 Federal Manual).* All three methods take into account site soils, vegetation, and hydrology parameters to determine whether a habitat should be classified as a jurisdictional wetland.

The most common method for performing a jurisdictional assessment is the Routine Determination. This method evaluates each parameter and involves a qualitative collection of data. Prior to performing field studies, resources such as U.S. Geological Survey (USGS) topographical maps, aerial photography, and county soil survey information are reviewed to identify the potential areas of jurisdictional wetlands and to delineate the extent of the systems. The 1987 ACOE Data Forms are completed for each community type within each wetland system.

A Comprehensive Determination is a methodology that involves collecting quantitative data for complex sites or when intensive documentation of a site is necessary. In certain cases, only one parameter may require Comprehensive Determination; while the assessment of the remaining parameters follows the Routine Determination.

The third method of performing jurisdictional assessments is the Atypical Situation method. This method is recommended in the *1987 Federal Manual* when one of the parameters for identifying jurisdictional wetlands (soils, vegetation, or hydrology) is not present or discernible because of recent human activities or natural events. Part C of this method applies to wetlands that were purposely or incidentally created by human activities but lack one or more of the parameters. Subsection 4 under Atypical Situation presents examples of man-induced hydrology for wetlands and describes these areas as usually lacking indicators of hydric soils. Hydric soils

can require long periods of time to develop the normal characteristics indicative of wetland hydrology and subsurface anaerobic conditions.

For this project, the Routine Determination methodology was followed during the identification of jurisdictional areas within the study area. Based on this methodology, each wetland parameter was evaluated to make the wetland determination. Below is a brief discussion of each parameter.

## Vegetation

In both the Routine and Comprehensive Determinations, all dominant plants are identified to species. The vegetation parameter is a strong and reliable parameter in undisturbed wetland communities. Following identification, the *National List of Plant Species that Occur in Wetlands - Southeast Region* (Reed, 1988) is consulted to determine the wetland indicator status of each species. The indicator status of a plant may fall into one of the categories listed in Table 2.

**Table 2**
**Plant Indicator Status Categories (adopted from the *Federal Manual*)***

| Indicator Category | Indicator Symbol | Definition |
|---|---|---|
| Obligate Wetland Plants | OBL | Plants that occur almost always (estimated probability > 99%) in wetlands under natural conditions but also may rarely occur (estimated probability < 1%) in non-wetlands. Examples: *Spartina alterniflora, Taxodium distichum.* |
| Facultative Wetland Plants | FACW | Plants that usually occur (estimated probability > 67% to 99%) in wetlands but also occur (estimated probability 1% to 33%) in non-wetlands. Examples: *Fraxinus pennsylvanica, Cornus foemnia.* |
| Facultative Plants | FAC | Plants with a similar probability (estimated probability 33% to 67%) of occurring in both wetlands and non-wetlands. Examples: *Acer rubrum, Smilax rotundifolia.* |
| Facultative Upland Plants | FACU | Plants that occur sometimes (estimated probability 1% to > 33%) in wetlands but occur more often (estimated probability > 67% to > 99%) in non-wetlands. Examples: *Quercus rubra, Potentilla arguta.* |
| Obligate Upland Plants | UPL | Plants that rarely occur (estimated probability < 1%) in wetlands but almost always occur (estimated probability > 99%) in non-wetlands under natural conditions. Examples: *Pinus echinata, Bromus mollis.* |

* Categories were developed originally and defined by the USFWS National Wetlands Inventory and subsequently modified by the National Plant List Panel. The three facultative categories are subdivided by (+) and (-) modifiers.

Analysis of the vegetation parameter in a Comprehensive Determination involves detailed sampling of various strata to establish plant dominance. In a Routine Determination, dominance may be based on visual observations of each strata. For the vegetation parameter to be satisfied, a plant community should have greater than 50 percent of the dominant species with a rating of facultative, facultative wetland, or obligate wetland. An alternative to the 50-percent dominance criteria is the facultative-neutral option. This option may be used when a district questions the indicator status of a dominant species. When dominant species with an indicator of facultative

occur, with facultative upland or facultative wetland dominant plant species, the facultative species may be considered neutral; therefore, the jurisdictional status of the parameter would be based on the greater number of facultative wetland species versus facultative upland species. Should the facultative wetland dominant species equal the facultative upland species, then associate species are considered. Should the number still be equal, the jurisdictional status is determined by the soil and hydrology parameters. The final step within the vegetation parameter is to identify the type of vegetation community and wetland system following the *Classification of Wetlands and Deepwater Habitats* (Cowardin *et al.*, 1989).

## Soils

The next parameter reviewed is the soil parameter. The soil parameter is the pell great groups of vertisols that are:

- Somewhat poorly drained and have a water table less than 0.5 feet from the surface for a significant period (usually a week or more) during the growing season; or

- Poorly drained or very poorly drained and have either:

  - A water table at less than 1.0 feet from the surface for a significant period (usually a week or more) during the growing season if permeability is less than 6 inches in any layer within 20 inches; or

  - A water table at less than 1.5 feet from the surface for a significant period (usually a week or more) during the growing season if permeability is less than 6 inches in any layer within 20 inches; or

- Soils that are ponded for a long or very long duration during the growing season; or

- Soils that frequently are flooded for a long duration or very long duration during the growing season.

Soils may be determined to be hydric by using regional indicators in addition to referencing the 1991 *Hydric Soils of the United States.* Several criteria are listed in the 1987 *Federal Manual,* each of which indicates the presence of hydric soils.

### Non-Sandy Soils

- ***Organic soils (histosols)*** - Organic soils are saturated for long periods of time and commonly are called muck. Soils are determined to be organic if more than 50 percent of the upper 12 inches of soil is composed of organic material or if organic material lies directly over bedrock.

- ***Histic epipedons*** - Histic epipedons are soils with an 8- to 16-inch layer of soil that is sufficiently saturated to prevent aerobic decomposition of the organic surface. Histic epipedons must be saturated for 30 consecutive days or more for soils containing a minimum of 20-percent organic matter when no clay is present or a minimum of 30-percent organic matter when the clay content is 60 percent or higher.

- ***Sulfidic material*** - Sulfidic material is determined to be present within the soils when waterlogged, permanently saturated soils emit an odor of rotten eggs. This odor is an indication of the presence of hydrogen sulfide created from a reducing environment.

- ***Aquic or peraquic moisture regime*** - An aquic moisture regime essentially is free of dissolved oxygen due to strong reducing conditions. The soil is saturated by groundwater, and dissolved oxygen is removed from the soil by soil fauna and root systems. The soil temperature must be above 5 degrees Celsius (°C) at some point while the soil is saturated. A peraquic soil regime requires the presence of groundwater always at or near the soil surface.

- ***Reducing soil conditions*** - During periods of prolonged inundation or saturation, soils will begin to undergo reducing conditions. These conditions result in iron being reduced from the ferric state to the ferrous state. In the field, this can be confirmed by a qualitative test using alpha, alpha dipyridil, a chemical reagent. If the iron in the soil has been reduced, a pink color would occur when the alpha, alpha dipyridil is added to the soil sample.

- ***Soil colors*** - When anaerobic conditions result in soil reduction, mineral soils often will produce gray or very dark colors. These colors are a direct result of the reduction of iron, manganese, and other elements in the soil. Soils that are saturated for a long duration usually exhibit bluish to greenish-gray colors. This effect is referred to as gleying. The Munsell Color Charts can be used to determine gleyed soils. Mineral soils that are saturated (but not for prolonged periods) will develop a low chroma matrix that may or may not contain mottles. Under these conditions, the mottles often will be "bright" Munsell colors. As a general rule, mineral hydric soils will exhibit one of the following conditions: 1) matrix chroma of 2 or less in mottled soils; or 2) matrix color of 1 or less in unmottled soils.

- ***Soil appearing on hydric soils list*** - The National Technical Committee for Hydric Soils maintains an updated list of soil types that are known to be hydric or to have hydric inclusions. This list can be referenced to determine whether a soil type is hydric. Many National Resources Conservation Service (NRCS) offices also maintain a list of known hydric soils that can be more beneficial on a regional basis.

**Sandy Soils**

- ***High organic matter content in surface horizon*** - Sandy soils that are inundated or saturated for prolonged periods usually develop a layer of organic matter near the surface horizon. This can be attributed to anaerobic conditions that greatly reduce decomposition of the organic matter.

- ***Streaking of subsurface horizons by organic matter*** - As the water table fluctuates in sandy soils, organic material is carried through the soil profile. The movement of the organics through the soil profile often results in organic streaking in certain portions of the soil profile that are subject to water table fluctuation. Areas of organic streaking can be observed visually with the assistance of a sharpshooter shovel.

- ***Organic pans*** - As stated above, organic material moves within the soil profile as the water table fluctuates. The organics have a tendency to accumulate in the area that represents the average depth of the water table. The presence of elemental aluminum can result in the soils becoming hardened at the average depth of groundwater. This hardened layer often is referred to as a spodic horizon. Soil pits must be excavated to determine if spodic horizons are present.

Along with the 1987 *Federal Manual*, several other publications are available that provide guidance in the identification of hydric soils. These publications are available for use at both the regional and national levels. Examples include *Redoximorphic Features for Identifying Aquic Conditions* (North Carolina Agricultural Research Service, 1995) and *Field Indicators of Hydric Soils in the United States* (United States Department of Agriculture, 1995). These resources often provide detailed information on the identification of hydric soils. The ACOE district in which the work would be performed should be contacted to ensure that the usage of hydric soil indicators other than those in the 1987 *Federal Manual* are acceptable.

Field soil samples were taken to a minimum depth of 12 inches. The soils were studied for examples of hydric properties (i.e., oxidized rhizospheres, mottling, low chroma, concretions, and water saturation). *Munsell Soil Color Charts* (Kollmorgen Instruments Corporation, 1994) were used to determine hue, value, and chroma of both the matrix and the mottle colors of each horizon. Hue indicates the relationship to the primary colors in the spectrum of white light; value indicates the lightness of the color; and chroma represents the strength. A low-chroma soil with bright mottles or gleyed soil indicates a hydric soil, if the low-chroma is a result of a reducing environment rather than natural color or parent materials. A low chroma soil generally has a matrix chroma of 2 or less in mottled soils or a matrix chroma of 1 or less in unmottled soils.

The local soil survey data was reviewed to determine soils likely to be encountered during field review of the property. The following soils were identified as occurring on the site.

- Appling sandy clay loam, severely eroded rolling phase, 6- to 10-percent slopes (Ad) - This is a well-drained to somewhat excessively drained soil in which the surface layer has been removed by severe erosion. This soil is not listed as hydric in the *Hydric Soils of the United States.*

- Appling sandy loam, eroded undulating phase, 2- to 6-percent slopes (Ag) - This is a well drained to somewhat excessively drained soil in which the surface layer has been removed by severe erosion. This soil is not listed as hydric in the *Hydric Soils of the United States.*

- Cecil sandy loam, eroded hilly phase, 10- to 15-percent slopes (Ck) - This is a somewhat excessively drained soil of which only 25 to 75 percent of the surface layer remains. It is not listed as hydric in the *Hydric Soils of the United States.*

- Cecil sandy loam, eroded rolling phase, 6- to 10-percent slopes (Cg) - This is a well-drained to somewhat excessively drained soil that occurs on broad, moderately smooth interstream divides and gradual slopes toward drainageways. It is not listed as hydric in the *Hydric Soils of the United States.*

- Lloyd sandy loam, eroded rolling phase, 6- to 10-percent slopes (Lg) - This is a well-drained to somewhat excessively drained soil that occurs on fairly smooth interstream ridges and moderate slopes toward drainageways. This soil is not listed as hydric in the *Hydric Soils of the United States.*

- Lloyd sandy loam, eroded undulating phase, 2- to 6-percent slopes (Le) - This is a well-drained soil that occurs on smooth inter-stream ridges and mild slopes toward drainageways. This soil is not listed as hydric in the *Hydric Soils of the United States.*

- Seneca fine sandy loam, undulating phase, 2- to 6-percent slopes (Sb) - This well-drained soil is found on foot slopes along drainageways. This soil is not listed in the *Hydric Soils of the United States.*

**Hydrology**

Hydrology is the driving force for the creation of hydric soils and the development of hydrophytic vegetative communities; observing field indicators can assess it. Research suggests that the most influential factor for plant community development is the duration of soil saturation or inundation, rather than the frequency of the event. In addition, it is essential that wetland hydrology be present during the growing season. The growing season is defined as the period in which soil temperatures are above 5°C (41.5°F) or as the period between the last frost of spring and the first frost of winter.

A classification system of wetland hydrology for non-tidal areas, developed by the Department of the Army Waterways Experiment Station, is presented in Table 3 (*Federal Manual, 1987).*

**Table 3**
**Hydrologic Zones* - Non-Tidal Areas**

| Zone | Name | Duration** | Comments |
|---|---|---|---|
| I† | Permanently inundated | 0% | Inundation > 6.6 feet mean water depth |
| II | Semi-permanently to nearly permanently inundated or saturated | > 75% - < 0% | Inundation defined as ≤ 6.6 feet mean water depth |
| III | Regularly inundated or saturated | > 25% - 75% | |
| IV | Seasonally inundated or saturated | > 12.5% - 25% | |
| V | Irregularly inundated or saturated | ≤ 5% - 12.5% | Many areas having these hydrologic characteristics are not wetlands |
| VI | Intermittently or never inundated or saturated | < 5% | Areas with these hydrologic characteristics are not wetlands |

* Zones adapted from Clark and Benforado (1981).
** Refers to duration of inundation and/or soil saturation during the growing season.
† This defines an aquatic habitat zone.

Analysis of the hydrology parameter for a Routine Determination involves reviewing a study area for indicators of extended periods of hydrology. Some indicators of wetland hydrology are identified in the 1987 *Federal Manual.* These indicators include recorded data, visual observation of inundation, visual observation of soil saturation, watermarks, drift lines, sediment deposits, drainage patterns within the wetlands, oxidized rhizospheres by live roots within the soil profile, and water-stained leaves. In addition, the presence of wetland hydrology may be inferred from certain morphological, physiological, and reproductive adaptations of plants to an anaerobic environment. Only the morphological adaptations can be determined in the field. Examples of morphological adaptations include buttressed tree trunks, pneumatophores, adventitious roots, shallow root systems, inflated vegetative structures, polymorphic leaves, floating leaves and stems, hypertrophied lenticels, and multi-trunks or stooling. The facultative-neutral option also can be used as a secondary indicator of wetland hydrology.

## Study Results

For the proposed Perry County Disposal Facility project, field delineations were conducted throughout the entire study corridor. Qualified biologists conducted all jurisdictional studies in September 1999.

During the field studies, the presence of 16 jurisdictional wetlands (Jurisdictional Wetland A - Jurisdictional Wetland P) and 25 jurisdictional waters; (Jw1–Jw25) were identified. The approximate locations of jurisdictional areas within the study area are shown on Figure 2. The jurisdictional wetlands were classified as palustrine emergent, palustrine scrub/shrub, and palustrine forested systems. The jurisdictional waters were classified as riverine lower perennial and intermittent systems. Tables 4 and 5 provide summaries of the wetland and water classifications for those systems occurring within the study area.

**Table 4**

**Summary of Wetland Classifications and Acreages**

| System | Class | Subclass | Water Regime | Acreage | Wetland Drainage Association | Dominant Plant Species |
|---|---|---|---|---|---|---|
| **Wetland 1 (A)** | | | | | | |
| Palustrine | Forested | Broad-leaved deciduous | Semi-permanent * beaver influenced | | Tayloe Branch | *Juncus effusus, Chasmanthium latifolia, Carex* spp., *Cephalanthus occidentalis, Fraxinus pennsylvanica, Celtis laevivata, Quercus nigra* |
| **Wetland 2 (B)** | | | | | | |
| Palustrine | Forested | Broad-leaved deciduous | Seasonally flooded | | Tayloe Branch | *Quercus nigra, Arundinaria gigantea, Fraxinus pennsylvanica, Carex* spp., *Campsis radicans, Celtis laevigata, Liquidambar styraciflua* |
| **Wetland 3 (C)** | | | | | | |
| Palustrine | Forested | Broad-leaved deciduous | Seasonally Flooded | | Tayloe Creek | *Arundinaria gigantea, Fraxinus pennsylvanica, Acer negundo,* |
| **Wetland 4 (D)** | | | | | | |
| Palustrine | Forested | Broad-leaved deciduous | Seasonally flooded | | Side tributary to Tayloe Creek | *Fraxinus pennsylvanica, Campsis radicans, Celtis laevigata, Toxicodendron radicans, Carex* spp., *Aesculus sylvatica* |
| **Wetland 5 (E)** | | | | | | |
| Palustrine | Forested | Broad-leaved deciduous | Seasonally flooded | | Side tributary to Tayloe Creek | *Quercus nigra, Chasmanthium latifolia, Toxicodendron radicans, Campsis radicans, Arundinaria gigantea, Fraxinus pennsylvanica, Celtis laevigata, Carex* spp. |
| **Wetland 6 (F)** | | | | | | |
| Palustrine | Forested | Broad-leaved deciduous | Seasonally flooded | | Side tributary to Tayloe Creek | *Fraxinus pennsylvanica, Celtis laevigata, Toxicodendron radicans* |
| **Wetland 7 (G)** | | | | | | |
| Palustrine | Forested | Broad-leaved deciduous | Seasonally flooded *beaver influenced | | Side tributary to Tayloe Creek | *Celtis laevigata, Ulmus americana, Fraxinus pennsylvanica* |
| **Wetland 8 (H)** | | | | | | |
| Palustrine | Forested/ scrub-shrub | Broad-leaved deciduous | Seasonally flooded * beaver influenced | | Side tributary to Tayloe Creek | *Salix nigra, Typha latifolia, Pluchea camphorata, Polyganum* spp. , *Eupatorium perfoliatum* |

**Table 4**
**Summary of Wetland Classifications and Acreages – (continued)**

| System | Class | Subclass | Water Regime | Acreage | Wetland Drainage Association | Dominant Plant Species |
|---|---|---|---|---|---|---|
| **Wetland 9 (I)** | | | | | | |
| Palustrine | Forested | Broad-leaved deciduous | Seasonally flooded | | Side tributary to Tayloe Creek | *Celtis laevigata, Ulmus americana, Fraxinus pennsylvanica* |
| **Wetland 10 (J)** | | | | | | |
| Palustrine | Forested | Broad-leaved deciduous | Seasonally flooded *beaver influenced | | Side tributary to Tayloe Creek | *Salix nigra, Cornus amomum, Toxicodendron radicans, Fraxinus pennsylvanica* |
| **Wetland 11 (K)** | | | | | | |
| Palustrine | Forested/ emergent | Broad-leaved deciduous/ persistent | Seasonally flooded | | Side tributary to Tayloe Creek | *Salix nigra, Carex* spp., *Pluchea camphorata, Populis deltoides, Fraxinus pennsylvanica* |
| **Wetland 12 (L)** | | | | | | |
| Palustrine | Forested | Broad-leaved deciduous | Seasonally flooded | | Side tributary to Tayloe Creek | *Salix nigra, Festuca spp., Populis deltoides, Fraxinus pennsylvanica, Toxicodendron radicans* |
| **Wetland 13 (M)** | | | | | | |
| Palustrine | Emergent | Persistent | Seasonally flooded | | Tayloe Creek | *Juncus effusus, Boehlmaria cylindrica* |
| **Wetland 14 (N)** | | | | | | |
| Palustrine | Emergent | Persistent | Seasonally flooded | | Tayloe Creek | *Mikania scandens, Leersia virginica, Juncus effusus, Carex* spp. |
| **Wetland 15 (O)** | | | | | | |
| Palustrine | Emergent | Persistent | Seasonally flooded | | Tayloe Creek | *Juncus effusus, Passiflora lutea, Biden laevis* |
| **Wetland 16 (P)** | | | | | | |
| Palustrine | Forested/ Emergent | Broad-leaved deciduous/ Persistent | Seasonally flooded | | Side tributary to Tayloe Creek | *Boehlmaria cylindrica, Populis deltoides, Salix nigra, Campsis radicans, Acer negundo, Fraxinus pennsylvanica, Lonicera japonica* |

**Table 5**
**Summary of Waters of the United States Classifications**

| Water | System | Subsystem | Class | Subclass | Wetland Drainage Association |
|---|---|---|---|---|---|
| 1 | Riverine | Lower Perennial | Unconsolidated Bottom | Cobble-gravel, sand, mud | Tayloe Creek |
| 2 | Riverine | Intermittent | Streambed | Sand, mud | Tayloe Creek |
| 3 | Riverine | Intermittent | Streambed | Sand, mud | Tayloe Creek |
| 4 | Riverine | Intermittent | Streambed | Sand, mud | Tayloe Creek |
| 5 | Riverine | Intermittent | Streambed | Sand, mud | Tayloe Creek |
| 6 | Riverine | Intermittent | Streambed | Sand, mud | Tayloe Creek |
| 7 | Riverine | Intermittent | Streambed | Sand, mud | Tayloe Creek |
| 8 | Riverine | Intermittent | Streambed | Sand, mud | Tayloe Creek |
| 9 | Riverine | Intermittent | Streambed | Sand, mud | Tayloe Creek |
| 10 | Riverine | Intermittent | Streambed | Sand, mud | Tayloe Creek |
| 11 | Riverine | Intermittent | Streambed | Sand, mud | Tayloe Creek |
| 12 | Riverine | Intermittent | Streambed | Sand, mud | Tayloe Creek |
| 13 | Riverine | Intermittent | Streambed | Sand, mud | Tayloe Creek |
| 14 | Riverine | Intermittent | Streambed | Sand, mud | Tayloe Creek |
| 15 | Riverine | Intermittent | Streambed | Sand, mud | Tayloe Creek |
| 16 | Riverine | Intermittent | Streambed | Sand, mud | Tayloe Creek |
| 17 | Riverine | Intermittent | Streambed | Sand, mud | Tayloe Creek |
| 18 | Palustrine | Open water | Unknown bottom | | Tayloe Creek |
| 19 | Palustrine | Open water | Unknown bottom | | Tayloe Creek |
| 20 | Palustrine | Open water | Unknown bottom | | Tayloe Creek |
| 21 | Palustrine | Open water | Unknown bottom | | Tayloe Creek |
| 22 | Palustrine | Open water | Unknown bottom | | Tayloe Creek |
| 23 | Riverine | Intermittent | Streambed | Sand, mud | Tayloe Creek |
| 24 | Riverine | Intermittent | Streambed | Sand, mud | Tayloe Branch |
| 25 | Riverine | Intermittent | Streambed | Sand, mud | Tayloe Creek |

## Wetland Vegetation Communities

Wetland communities identified in this report are those that meet the ACOE three-parameter definition of a wetland. Within the project area, wetland systems encountered were classified as either mixed hardwood or emergent/scrub shrub wetlands. To further classify the types of wetland systems within the project corridor, the Cowardin Classification System was used to identify each wetland system. Please refer to the jurisdictional studies section of this report for a detailed classification of each wetland system. Each community type is discussed below.

**Emergent/Scrub-shrub (EM/SS)** — Emergent/Scrub-shrub wetlands are those systems that are dominated by herbaceous species and woody shrubs or saplings. These wetlands usually are characterized by saturated to inundated soil conditions throughout the year. Within the project area, dominant species within this community include black willow (*Salix nigra*), camphor weed (*Pluchea camphorata*), smartweed (*Polyganum* spp.), boneset (*Eupatorium perfoliatum*), softrush (*Juncus effusus*), false nettle (*Boehmaria cylindrica*), climbing hempweed (*Mikania scandens*), rice cut grass (*Leersia virginica*), and various sedges (*Carex* spp.). Surface hydrology within this community type varies from non-existent during dry periods and from 6 inches to 6 feet during wet periods. This community provides habitat for waterfowl and wading birds. The wetland areas are located adjacent to and within the floodplain of streams. The wetlands are supported hydrologically primarily by direct

rainfall, overbank flooding, poor drainage, runoff from surrounding terrain, and ongoing beaver activity.

**Mixed Hardwood (MH)** — Forested wetlands are characterized by hardwood species that range from 20 to 60+ years of growth. This community type offers good wildlife habitat, particularly for waterfowl and wading birds. Dominant plants found within the forested wetland areas are black willow (*Salix nigra*), Eastern cottonwood (*Populus deltoides*), sweet gum (*Liquidambar styraciflua*), hackberry (*Celtis laevigata*), box elder (*Acer negundo*), silky dogwood (*Cornus amomum*), green ash (*Fraxinus pennsylvanica*), buttonbush (*Cephalanthus occidentalis*), water oak (*Quercus nigra*), giant cane (*Arundinaria gigantea*), poison ivy (*Toxicodendron radicans*), trumpet vine (*Campsis radicans*), upland sea oats (*Chasmanthium latifolia*), and various sedges (*Carex* spp.). The wetland areas are located adjacent to and within the floodplain of streams. The wetlands are supported hydrologically primarily by direct rainfall, overbank flooding, poor drainage, runoff from surrounding terrain, and ongoing beaver activity.

The approximate boundaries of all jurisdictional areas were recorded on field maps. A brief description of all jurisdictional waters and wetlands identified within the study area is given below. Data sheets for the wetland and upland data points are included in the Appendix.

**Jurisdictional Wetland 1(A)**

Jurisdictional Wetland 1 consists of a palustrine forested, broad-leaved deciduous system with a semi-permanently flooded hydrologic regime (PFO1Fb) and a palustrine emergent, persistent, semi-permanently flooded hydrologic regime (PEM1Fb). The wetland is located within and adjacent to Jurisdictional Water 24 (Tayloe Branch) immediately downstream of the railroad tracks. Ongoing beaver activity was identified within the wetland. Two wetland data points were taken within Jurisdictional Wetland 1. Wetland data point 1 was taken within the emergent and scrub/shrub portion of Jurisdictional Wetland 1. Wetland data point 2 was taken within the forested portion of Jurisdictional Wetland 1.

*Wetland Data Point 1*

Within the wetland data point, dominant vegetation included soft rush (*Juncus effusus*), upland sea oats (*Chasmanthium latifolia*), buttonbush (*Cephalanthus occidentalis*), green ash (*Fraxinus pennsylvanica*), hackberry (*Celtis laevigata*), water oak (*Quercus nigra*) and various sedges (*Carex* spp.). Indicators of wetland hydrology included water marks, sediment deposits, and drainage patterns in the wetland. These are primary indicators of wetland hydrology and satisfy the hydrology criterion. Soil samples were taken from a depth of 0 to 12 inches. Soils from a depth of 0 to 4 inches had a matrix color of 10YR 5/2 with distinct mottles of 5YR 5/8. Soils from a depth of 4 to 8 inches had a matrix color of 10Y 6/1 with distinct mottles of 5YR 5/8. Soils from a depth of 8 to 12 inches had a matrix color of 10Y 4/1 with no mottles. The profile had a clay texture. Hydric soil indicators included reducing conditions and low chroma, all of which satisfy the criterion for wetland soils. The wetland is located within and adjacent to Jurisdictional Water 24 (Tayloe Branch).

*Wetland Data Point 2*

Within the wetland data point, dominant vegetation included soft rush (*Juncus effusus*), upland sea oats (*Chasmanthium latifolia*), buttonbush (*Cephalanthus occidentalis*), green ash (*Fraxinus pennsylvanica*), hackberry (*Celtis laevigata*), possumhaw (*Ilex decidua*), water oak (*Quercus nigra*) and various sedges (*Carex* spp.). Indicators of wetland hydrology included water marks, sediment deposits, and drainage patterns in the wetland. These are primary indicators of wetland hydrology and satisfy the hydrology criterion. Soil samples were taken from a depth of 0 to 12 inches. Soils from a depth of 0 to 12 inches had a matrix color of 10YR 4/2 with no mottles. The profile had a clay texture. Hydric soil indicators included low chroma, which satisfies the criterion for wetland soils. The wetland is located within and adjacent to Jurisdictional Water 24 (Tayloe Branch).

*Upland Data Point*

Within the upland data point, dominant vegetation included trumpet vine (*Campsis radicans*), honey suckle (*Lonicera japonica*), serrate-leaf blackberry (*Rubus argutus*), green ash (*Fraxinus pennsylvanica*), water oak (*Quercus nigra*, facultative), and box elder (*Acer negundo*). No indicators of wetland hydrology were observed at this data point. Soil samples were taken from a depth of 0 to 12 inches. The entire soil profile had a matrix color of 10YR 6/6 with no mottles. The profile had a clay texture. There were no hydric soil indicators.

**Jurisdictional Wetland 2(B)**

Jurisdictional Wetland 2 consists of a palustrine forested, broad-leaved deciduous wetland with a seasonally flooded hydrologic regime (PFO1C) located on the south side of Jurisdictional Water 24 (Tayloe Branch). The wetland is located on the south side of the railroad tracks and to the east of the catfish ponds. One wetland data point was taken within Jurisdictional Wetland 2.

*Wetland Data Point 1*

Within the wetland data point, dominant vegetation included water oak (*Quercus nigra*), giant cane (*Arundinaria gigantea*), green ash (*Fraxinus pennsylvanica*) trumpet vine (*Campsis radicans*), hackberry (*Celtis laevigata*), various sedges (*Carex* spp.) and sweetgum *(Liquidambar styraciflua*). Indicators of wetland hydrology included soil saturation to the surface and drainage patterns in the wetland. These are primary indicators of wetland hydrology and satisfy the hydrology criterion. Soil samples were taken from a depth of 0 to 12 inches. Soils from a depth of 0 to 2 inches had a matrix color of 7.5YR 5/8 and no mottles with a clay texture. Soils from a depth of 2 to 12 inches had a matrix color of 7.5YR 6/1 with distinct 7.5 YR 5/8 mottles with a clay texture. Hydric soil indicators included low chroma and reducing conditions, both of which satisfy the criterion for wetland soils.

*Upland Data Point*

Within the upland data point, dominant vegetation included poison ivy (*Toxicodendron radicans*), sweetgum (*Liquidambar styraciflua*), Eastern red cedar (*Juniperus virginiana*), wax myrtle (*Myrica cerifera*), trumpet vine (*Campsis radicans*), and various sedges (*Carex* spp.). Soil samples were taken from a depth of 0 to 12 inches. Soils from 0 to 8 inches had a matrix color of 7.5YR 6/1 with few 7.5 YR 7/8 mottles. Soils from 8 to 12 inches had a matrix color of 2.5Y 7/1 with few 7.5 YR 5/8 mottles. The profile had a clay texture. There were no hydric soil indicators.

**Jurisdictional Wetland 3(C)**

Jurisdictional Wetland 3 consists of a palustrine forested, broad-leaved deciduous system with a seasonally flooded hydrologic regime (PFO1C). The wetland is located adjacent to Jurisdictional Water 1 (Tayloe Creek) immediately downstream of Tayloe Creek and a large side tributary. One wetland data point was taken within Jurisdictional Wetland 3.

*Wetland Data Point*

Within the wetland data point, dominant vegetation included giant cane (*Arundinaria gigantea*), green ash (*Fraxinus pennsylvanica*), box elder (*Acer negundo*), and saplings of green *ash (Fraxinus pennsylvanica*). Indicators of wetland hydrology included water marks and drainage patterns in the wetland. These are primary indicators of wetland hydrology and satisfy the hydrology criterion. Soil samples were taken from a depth of 0 to 12 inches. Soils from a depth of 0 to 12 inches had a matrix color of 10YR 4/2 with no mottles. The profile had a clay texture. Hydric soil indicators included low chroma, which satisfies the criterion for wetland soils. The wetland is located adjacent to Jurisdictional Water 1.

*Upland Data Point*

Within the upland data point, dominant vegetation included cultivated soy bean (*Glycine max*). No indicators of wetland hydrology were observed at this data point. Soil samples were taken from a depth of 0 to 12 inches. The entire soil profile had a matrix color of 10YR 4/2 with no mottles. The profile had a clay texture. Hydric soil indicators included low chroma, which satisfies the criterion for wetland soils.

**Jurisdictional Wetland 4(D)**

Jurisdictional Wetland 4 consists of a palustrine forested, broad-leaved deciduous system with a seasonally flooded hydrologic regime (PFO1C). The wetland is located adjacent to Jurisdictional Water 2. One wetland data point was taken within Jurisdictional Wetland 4.

*Wetland Data Point*

Within the wetland data point, dominant vegetation included green ash (*Fraxinus pennsylvanica*), buckeye (*Aesculus sylvatica*), trumpet vine (*Campsis radicans*), hackberry (*Celtis laevigata*),

poison ivy (*Toxicodendron radicans*), and various sedges (*Carex* spp.). Indicators of wetland hydrology included water marks and drainage patterns in the wetland. These are primary indicators of wetland hydrology and satisfy the hydrology criterion. Soil samples were taken from a depth of 0 to 12 inches. Soils from a depth of 0 to 12 inches had a matrix color of 10YR 4/3 with faint mottles of 10 YR 4/6. Soils from a depth of 4 to 8 inches had a matrix color of 10Y 6/1 with distinct mottles of 5 YR 5/8. The profile had a clay texture. Hydric soil indicators included low chroma, which satisfies the criterion for wetland soils. The wetland is located adjacent to Jurisdictional Water 2.

*Upland Data Point*

Within the upland data point, dominant vegetation included green ash (*Fraxinus pennsylvanica*), Eastern red cedar (*Juniperus virginiana*), hackberry (*Celtis laevigaeta*), and trumpet vine (*Campsis radicans*). No indicators of wetland hydrology were observed at this data point. Soil samples were taken from a depth of 0 to 12 inches. The entire soil profile had a matrix color of 2.5YR 4/4 with no mottles. The profile had a clay texture. There were no hydric soil indicators.

**Jurisdictional Wetland 5(E)**

Jurisdictional Wetland 5 consists of a palustrine forested, broad-leaved deciduous system with a seasonally flooded hydrologic regime (PFO1C). The wetland is located adjacent to Jurisdictional Water 5. One wetland data point was taken within Jurisdictional Wetland 5.

*Wetland Data Point*

Within the wetland data point, dominant vegetation included water oak (*Quercus nigra*), upland sea oats (*Chasmanthium latifolia*), poison ivy (*Toxicodendron radicans*), trumpet vine (*Campsis radicans*), giant cane (*Arundinaria gigantea*), green ash (*Fraxinus pennsylvanica*), and various sedges (*Carex* spp.). Indicators of wetland hydrology included water marks and drainage patterns in the wetland. These are primary indicators of wetland hydrology and satisfy the hydrology criterion. Soil samples were taken from a depth of 0 to 12 inches. Soils from a depth of 0 to 12 inches had a matrix color of 2.5 YR 4/3 with faint mottles of 10 YR 5/6. The profile had a clay texture. Hydric soil indicators included reducing conditions and low chroma, all of which satisfy the criterion for wetland soils. The wetland is located adjacent to Jurisdictional Water 5.

*Upland Data Point*

Within the upland data point, dominant vegetation included green ash (*Fraxinus pennsylcanica*), hackberry (*Celtis laevigata*), and poison ivy (*Toxicodendron radicans*). No indicators of wetland hydrology were observed at this data point. Soil samples were taken from a depth of 0 to 12 inches. The entire soil profile had a matrix color of 10YR 4/4 with no mottles. The profile had a sandy texture. There were no hydric soil indicators.

**Jurisdictional Wetland 6(F)**

Jurisdictional Wetland 6 consists of a palustrine forested, broad-leaved deciduous system with a seasonally flooded hydrologic regime (PFO1C). The wetland is located adjacent to Jurisdictional Water 5. One wetland data point was taken within Jurisdictional Wetland 6.

*Wetland Data Point*

Within the wetland data point, dominant vegetation included green ash (*Fraxinus pennsylvanica*), hackberry (*Celtis laevigata*), and poison ivy (*Toxicodendron radicans*). Indicators of wetland hydrology included water marks and drainage patterns in the wetland. These are primary indicators of wetland hydrology and satisfy the hydrology criterion. Soil samples were taken from a depth of 0 to 12 inches. Soils from a depth of 0 to 6 inches had a matrix color of 10YR 4/2 with no mottles. Soils from a depth of 6 to 12 inches had a matrix color of 10YR 4/2 with distinct mottles of 7.5 YR 5/8. The profile had a clay texture. Hydric soil indicators included reducing conditions and low chroma, all of which satisfy the criterion for wetland soils. The wetland is located adjacent to Jurisdictional Water 5.

*Upland Data Point*

Within the upland data point, dominant vegetation included persimmon (*Diospyros virginiana*), Eastern red cedar (*Juniperus virginiana*), poison ivy (*Toxicodendron radicans*), and green ash (*Fraxinus pennsylvanica*). No indicators of wetland hydrology were observed at this data point. Soil samples were taken from a depth of 0 to 12 inches. The entire soil profile had a matrix color of 10YR 5/4 with no mottles. The profile had a clay texture. There were no hydric soil indicators.

**Jurisdictional Wetland 7(G)**

Jurisdictional Wetland 7 consists of a palustrine forested, broad-leaved deciduous system with a seasonally flooded hydrologic regime (PFO1C). The wetland is located adjacent to Jurisdictional Water 2. A remnant beaver dam was identified within the wetland. One wetland data point was taken within Jurisdictional Wetland 7.

*Wetland Data Point*

Within the wetland data point, dominant vegetation included hackberry (*Celtis laevigata*), American elm (*Ulmus americana*), and green ash (*Fraxinus pennsylvanica*). Indicators of wetland hydrology included water marks and drainage patterns in the wetland. These are primary indicators of wetland hydrology and satisfy the hydrology criterion. Soil samples were taken from a depth of 0 to 12 inches. Soils from a depth of 0 to 6 inches had a matrix color of 10YR 4/2 with no mottles. Soils from a depth of 6 to 12 inches had a matrix color of 10YR 4/2 with faint mottles of 7.5 YR 4/6. The profile had a clay texture. Hydric soil indicators included reducing conditions and low chroma, all of which satisfy the criterion for wetland soils. The wetland is located adjacent to Jurisdictional Water 2.

*Upland Data Point*

Within the upland data point, dominant vegetation included persimmon (*Diospyros virginiana*), Eastern red cedar (*Juniperus virginiana*), greenbrier (*Smilax rotundifolia*), poison ivy (*Toxicodendron radicans*), and hackberry (*Celtis laevigata*). No indicators of wetland hydrology were observed at this data point. Soil samples were taken from a depth of 0 to 12 inches. The entire soil profile had a matrix color of 10YR 5/6 with no mottles. The profile had a clay texture. There were no hydric soil indicators.

**Jurisdictional Wetland 8(H)**

Jurisdictional Wetland 8 consists of a palustrine, emergent, persistent system with a semi-permanently flooded hydrologic regime (PEM1F) and palustrine, scrub/shrub broad-leaved deciduous system with a semi-permanently flooded hydrologic regime (PSS1F). The wetland is located within and adjacent to Jurisdictional Water 5. Ongoing beaver activity was identified within the wetland. One wetland data point was taken within Jurisdictional Wetland 8.

*Wetland Data Point*

Within the wetland data point, dominant vegetation included black willow (*Salix nigra*), cattail (*Typha latifolia*), camphor weed (*Pluchea camphorata*), smartweed (*Polyganum* spp.), and boneset (*Eupatorium perfoliatum*). Indicators of wetland hydrology included water marks, sediment deposits, and drainage patterns in the wetland. These are primary indicators of wetland hydrology and satisfy the hydrology criterion. Soil samples were taken from a depth of 0 to 12 inches. Soils from a depth of 0 to 2 inches had a matrix color of 2.5YR 5/3 with no mottles. Soils from a depth of 2 to 12 inches had a matrix color of 2.5 YR 4/2 with faint mottles of 7.5 YR 5/8. The profile had a clay texture. Hydric soil indicators included reducing conditions and low chroma, all of which satisfy the criterion for wetland soils. The wetland is located within and adjacent to Jurisdictional Water 5.

*Upland Data Point*

Within the upland data point, dominant vegetation included persimmon (*Diospyros virginiana*), Eastern red cedar (*Juniperus virginiana*), poison ivy (*Toxicodendron radicans*), boneset (*Eupatorium perfoliatum*), and green ash (*Fraxinus pennsylvanica*). No indicators of wetland hydrology were observed at this data point. Soil samples were taken from a depth of 0 to 12 inches. The entire soil profile had a matrix color of 10YR 4/4 with no mottles. The profile had a clay texture. There were no hydric soil indicators.

**Jurisdictional Wetland 9(I)**

Jurisdictional Wetland 9 consists of a palustrine forested, broad-leaved deciduous system with a seasonally flooded hydrologic regime (PFO1Fb). The wetland is located within and adjacent to Jurisdictional Water 24 (Tayloe Branch) immediately downstream of the railroad tracks. Ongoing beaver activity was identified within the wetland. One wetland data point was taken within Jurisdictional Wetland 9.

*Wetland Data Point*

Within the wetland data point, dominant vegetation included hackberry (*Celtis laevigata*), American elm (*Ulmus americana*), and green ash (*Fraxinus pennsylvanica*). Indicators of wetland hydrology included water marks and drainage patterns in the wetland. These are primary indicators of wetland hydrology and satisfy the hydrology criterion. Soil samples were taken from a depth of 0 to 12 inches. Soils from a depth of 0 to 6 inches had a matrix color of 10YR 4/2 with no mottles. Soils from a depth of 6 to 12 inches had a matrix color of 10YR 4/2 with faint mottles of 7.5 YR 4/6. The profile had a clay texture. Hydric soil indicators included reducing conditions and low chroma, all of which satisfy the criterion for wetland soils. The wetland is located adjacent to Jurisdictional Water 2.

*Upland Data Point*

Within the upland data point, dominant vegetation included persimmon (*Diospyros virginiana*), Eastern red cedar (*Juniperus virginiana*), greenbrier (*Smilax rotundifolia*), poison ivy (*Toxicodendron radicans*), and hackberry (*Celtis laevigata*). No indicators of wetland hydrology were observed at this data point. Soil samples were taken from a depth of 0 to 12 inches. The entire soil profile had a matrix color of 10YR 5/6 with no mottles. The profile had a clay texture. There were no hydric soil indicators.

**Jurisdictional Wetland 10(J)**

Jurisdictional Wetland 10 consists of a palustrine forested, broad-leaved deciduous system with a semi-permanently flooded hydrologic regime (PFO1Fb). The wetland is located within and adjacent to Jurisdictional Water 8. Remnant beaver activity was identified within the wetland. One wetland data point was taken within Jurisdictional Wetland 10.

*Wetland Data Point*

Within the wetland data point, dominant vegetation included black willow (*Salix nigra*), silky dogwood (*Cornus amomum*), poison ivy (*Toxicodendron radicans*), and green ash (*Fraxinus pennsylvanica*). Indicators of wetland hydrology included water marks and drainage patterns in the wetland. These are primary indicators of wetland hydrology and satisfy the hydrology criterion. Soil samples were taken from a depth of 0 to 12 inches. Soils from a depth of 0 to 12 inches had a matrix color of 2.5 YR 3/2 with faint mottles of 10 YR 5/8. The profile had a

clay texture. Hydric soil indicators included reducing conditions and low chroma, all of which satisfy the criterion for wetland soils. The wetland is located within and adjacent to Jurisdictional Water 8.

*Upland Data Point*

Within the upland data point, dominant vegetation included persimmon (*Diospyros virginiana*), Eastern red cedar (*Juniperus virginiana*), poison ivy (*Toxicodendron radicans*), boneset (*Eupatorium perfoliatum*), and green ash (*Fraxinus pennsylvanica*). No indicators of wetland hydrology were observed at this data point. Soil samples were taken from a depth of 0 to 12 inches. The entire soil profile had a matrix color of 10YR 4/4 with no mottles. The profile had a clay texture. There were no hydric soil indicators.

**Jurisdictional Wetland 11(K)**

Jurisdictional Wetland 11 consists of a palustrine forested, broad-leaved deciduous system with a semi-permanently flooded hydrologic regime (PFO1F) and palustrine emergent, persistent with a semi-permanently flooded hydrologic regime (PEM1F). The wetland is located within Jurisdictional Water 18, which is described as a farm pond. One wetland data point was taken within Jurisdictional Wetland 11.

*Wetland Data Point*

Within the wetland data point, dominant vegetation included black willow (*Salix nigra*), camphor weed (*Pluchea camphorata*), Eastern cottonwood (*Populus deltoides*), green ash (*Fraxinus pennsylvanica*), and various sedges (*Carex* spp.). Indicators of wetland hydrology included water marks, sediment deposits, and drainage patterns in the wetland. These are primary indicators of wetland hydrology and satisfy the hydrology criterion. Soil samples were taken from a depth of 0 to 12 inches. Soils from a depth of 0 to 12 inches had a matrix color of 2.5 Y 4/2 with distinct mottles of 10 YR 4/6. The profile had a clay texture. Hydric soil indicators included reducing conditions and low chroma, all of which satisfy the criterion for wetland soils. The wetland is located within and adjacent to Jurisdictional Water 11.

*Upland Data Point*

Within the upland data point, dominant vegetation included Eastern red cedar (*Juniperus virginiana*), poison ivy (*Toxicodendron radicans*), fescue (*Festuca* spp.), and goldenrod (*Solidago* spp.). No indicators of wetland hydrology were observed at this data point. Soil samples were taken from a depth of 0 to 12 inches. The entire soil profile had a matrix color of 10YR 3/2 with no mottles. The profile had a clay texture. There were no hydric soil indicators.

**Jurisdictional Wetland 12(L)**

Jurisdictional Wetland 12 consists of a palustrine forested, broad-leaved deciduous system with a seasonally flooded hydrologic regime (PFO1C). The wetland is located adjacent to and within Jurisdictional Water 6. One wetland data point was taken within Jurisdictional Wetland 12.

*Wetland Data Point*

Within the wetland data point, dominant vegetation included green ash (*Fraxinus pennsylvanica*), black willow (*Salix nigra*), Eastern cottonwood (*Populus deltoides*), and poison ivy (*Toxicodendron radicans*). Indicators of wetland hydrology included drainage patterns in the wetland. These are primary indicators of wetland hydrology and satisfy the hydrology criterion. Soil samples were taken from a depth of 0 to 12 inches. Soils from a depth of 0 to 4 inches had a matrix color of 5 Y 3/2 with no mottles. Soils from a depth of 4 to 12 inches had a matrix color of 5Y 3/2 with faint mottles of 10 YR 5/8. The profile had a clay texture. Hydric soil indicators included reducing conditions and low chroma, all of which satisfy the criterion for wetland soils. The wetland is located adjacent to Jurisdictional Water 8.

*Upland Data Point*

Within the upland data point, dominant vegetation included ragweed (*Ambrosia artemesifolia*), fescue (*Festuca* spp.), Eastern red cedar (*Juniperus virginiana*), Eastern Cottonwood (*Populus deltoides*), poison ivy (*Toxicodendron radicans*), and green ash (*Fraxinus pennsylvanica*). No indicators of wetland hydrology were observed at this data point. Soil samples were taken from a depth of 0 to 12 inches. The entire soil profile had a matrix color of 5 YR 3/2 with no mottles. The profile had a clay texture. There were no hydric soil indicators.

**Jurisdictional Wetland 13(M)**

Jurisdictional Wetland 13 consists of a palustrine forested, broad-leaved deciduous system with a semi-permanently flooded hydrologic regime (PFO1F). The wetland is located within and adjacent to Jurisdictional Water 1. One wetland data point was taken within Jurisdictional Wetland 13.

*Wetland Data Point*

Within the wetland data point, dominant vegetation included soft rush (*Juncus effusus*) and clearweed (*Boehlmaria cylindrica*). Indicators of wetland hydrology included water marks and drainage patterns in the wetland. These are primary indicators of wetland hydrology and satisfy the hydrology criterion. Soil samples were taken from a depth of 0 to 12 inches. Soils from a depth of 0 to 12 inches had a matrix color of 10YR 3/2 with distinct mottles of 10 YR 5/8. The profile had a clay texture. Hydric soil indicators included reducing conditions and low chroma, all of which satisfy the criterion for wetland soils. The wetland is located within and adjacent to Jurisdictional Water 1.

*Upland Data Point*

Within the upland data point, dominant vegetation included Japanese honeysuckle (*Lonicera japonica*), Eastern red cedar (*Juniperus virginiana*), poison ivy (*Toxicodendron radicans*), and hackberry (*Celtis laevigata*). No indicators of wetland hydrology were observed at this data point. Soil samples were taken from a depth of 0 to 12 inches. The entire soil profile had a matrix color of 10YR 3/4 with no mottles. The profile had a clay texture. There were no hydric soil indicators.

**Jurisdictional Wetland 14(N)**

Jurisdictional Wetland 14 consists of a palustrine emergent, persistent system with a semi-permanently flooded hydrologic regime (PEM1F). The wetland is located within and adjacent to Jurisdictional Water 1. One wetland data point was taken within Jurisdictional Wetland 14.

*Wetland Data Point*

Within the wetland data point, dominant vegetation included climbing hempweed (*Mikania scandens*), rice cut grass (*Leersia virginica*), soft rush (*Juncus effusus*), and various sedges (*Carex* spp.). Indicators of wetland hydrology included water marks, sediment deposits and drainage patterns in wetlands. These are primary indicators of wetland hydrology and satisfy the hydrology criterion. Soil samples were taken from a depth of 0 to 12 inches. Soils from a depth of 0 to 12 inches had a matrix color of 2.5 YR 4/2 with distinct mottles of 7.5 YR 4/6. The profile had a clay texture. Hydric soil indicators included reducing conditions and low chroma, all of which satisfy the criterion for wetland soils. The wetland is located within and adjacent to Jurisdictional Water 1.

*Upland Data Point*

Within the upland data point, dominant vegetation included trumpet vine (*Campis radicans*), poison ivy (*Toxicodendron radicans*), American elm (*Ulmus americanus*), and hackberry (*Celtis laevigata*). No indicators of wetland hydrology were observed at this data point. Soil samples were taken from a depth of 0 to 12 inches. The entire soil profile had a matrix color of 10YR 3/4 with no mottles. The profile had a clay texture. There were no hydric soil indicators.

**Jurisdictional Wetland 15(O)**

Jurisdictional Wetland 15 consists of a palustrine emergent, persistent system with a semi-permanently flooded hydrologic regime (PFO1F). The wetland is located adjacent to Jurisdictional Water 5. One wetland data point was taken within Jurisdictional Wetland 15.

*Wetland Data Point*

Within the wetland data point, dominant vegetation included soft rush (*Juncus effusus*), Passion flower (*Passiflora lutea*), and beggar tick (*Biden laevis*). Indicators of wetland hydrology included sediment deposits and drainage patterns in wetlands. These are primary indicators of wetland hydrology and satisfy the hydrology criterion. Soil samples were taken from a depth of 0 to 12 inches. Soils from a depth of 0 to 12 inches had a matrix color of 2.5Y 4/2 with distinct mottles of 7.5 YR 4/6. The profile had a clay texture. Hydric soil indicators included reducing conditions and low chroma, all of which satisfy the criterion for wetland soils. The wetland is located within and adjacent to Jurisdictional Water 1.

*Upland Data Point*

Within the upland data point, dominant vegetation included trumpet vine (*Campis radicans*), poison ivy (*Toxicodendron radicans*) American elm (*Ulmus americanus*), and hackberry (*Celtis laevigata*). No indicators of wetland hydrology were observed at this data point. Soil samples were taken from a depth of 0 to 12 inches. The entire soil profile had a matrix color of 10YR 3/4 with no mottles. The profile had a clay texture. There were no hydric soil indicators.

**Jurisdictional Wetland 16(P)**

Jurisdictional Wetland 16 consists of a palustrine forested, broad-leaved deciduous system with a seasonally flooded hydrologic regime (PFO1C). The wetland is located adjacent to Jurisdictional Water 5. One wetland data point was taken within Jurisdictional Wetland 16.

*Wetland Data Point*

Within the wetland data point, dominant vegetation included clearweed (*Boehlmaria cylindrica*), Eastern cottonwood (*Populis deltoides*), black willow (*Salix nigra*), trumpet vine (*Campsis radicans*), box elder (*Acer negundo*), green ash (*Fraxinus pennsylvanica*), and Japanese honeysuckle (*Lonicera japonica*). Indicators of wetland hydrology included drainage patterns in the wetland. This is a primary indicator of wetland hydrology and satisfies the hydrology criterion. Soil samples were taken from a depth of 0 to 12 inches. Soils from a depth of 0 to 6 inches had a matrix color of 10YR 4/3 with no mottles. Soils from a depth of 6 to 12 inches had a matrix color of 10YR 432 with faint mottles of 7.5 YR 5/8. The profile had a clay texture. Hydric soil indicators included reducing conditions and low chroma, all of which satisfy the criterion for wetland soils. The wetland is located upstream of Jurisdictional Water 12.

*Upland Data Point*

Within the upland data point, dominant vegetation included persimmon (*Diospyros virginiana*), Eastern red cedar (*Juniperus virginiana*), poison ivy (*Toxicodendron radicans*), fescue (*Festuca* spp.), and goldenrod (*Solidago* spp.). No indicators of wetland hydrology were observed at this data point.

Soil samples were taken from a depth of 0 to 12 inches. The entire soil profile had a matrix color of 10YR 7/2 with no mottles. The profile had a clay texture. There were no hydric soil indicators.

**Jurisdictional Waters**

Jurisdictional Water 1 is described as a riverine, lower perennial, unconsolidated bottom with a cobble-gravel, sand, mud substrate with a semi-permanently flooded hydrologic regime (R4SB145J) and is approximately 25 feet wide. This jurisdictional water is considered to be the main branch of Tayloe Creek and is located within an agricultural and forested drainage basin. The stream is naturally meandering and was not flowing during field observations. Small pools of stagnant water were found in lower depressional areas with some aquatic life present. The stream is depicted on the USGS map as a solid blue line stream.

Jurisdictional Waters 2, 3, 4, 5, 7, 16, and 24 are described as riverine, intermittent, streambeds with a sand, mud substrate with a intermittently flooded hydrologic regime (R4SB45J) and range from approximately 6 to 15 feet wide. These waters are tributaries of Tayloe Creek and naturally meandering with no water flow observed during field studies. Small pools of stagnant water were found in lower depressional areas with some aquatic life present. These waters are depicted on the USGS map as solid blue line streams.

Jurisdictional Waters 6, 8, 9, 14, 15, and 23 are described as riverine, intermittent, streambeds with a sand, mud substrate that is intermittently flooded (R4SB45J) and is approximately 3 to 6 feet wide. These waters are tributaries of Tayloe Creek and naturally meandering with no water flow observed during field studies. These waters are depicted on the USGS map as intermittent blue line streams. No water was observed within the unvegetated stream channels during the site visit.

Jurisdictional Waters 10, 11, 12, 13, 17, and 25 are described as riverine, intermittent, streambeds with a sand, mud substrate that is intermittently flooded (R4SB45J) and is approximately 1 to 3 feet wide. These waters are tributaries of Tayloe Creek and naturally meandering with no water flow observed during field studies. These waters are depicted on the USGS map as intermittent blue line streams and, in some cases, not shown as blue line streams. No water was observed within the unvegetated stream channels during the site visit.

Jurisdictional Waters 18, 19, 20, 21, and 22 are farm ponds described as palustrine, open water with an unknown bottom that is semi-permanently flooded (POWF). These jurisdictional waters are located at the headwaters of tributaries to Tayloe Creek. These farm ponds apparently were constructed to provide water for livestock. Although an extreme drought was present within the area during the field inspection, a small pool of water remained within the interior of the small pond. Most of these waters are depicted on the USGS map as ponds, although two ponds currently are under construction. These jurisdictional waters are isolated systems.

## Potential Jurisdictional Impacts

An assessment of potential jurisdictional impacts was conducted for the project. Based on the currently proposed design plan, no jurisdictional areas would be impacted as a result of the proposed Perry County Disposal Facility project. The project has been specifically designed to eliminate impacts to jurisdictional systems.

# SECTION 4
# Permit Considerations

## Section 404 Overview

Section 404 of the Clean Water Act provides the Secretary of the Army, acting through the Chief of Engineers, the power to issue Individual Permits and to authorize the use of Nationwide Permits (NWPs) for the discharge of dredged or fill materials into the waters of the United States, including special aquatic sites and wetlands (Nation's Waters). District engineers have the authority to issue permits for activities in the Nation's Waters.

Individual Permits are required for projects having more than minimal cumulative adverse impacts on the Nation's Waters. Individual Permits involve public notification and coordination with federal and state agencies.

Regional Permits are provided by the ACOE on a local and state basis. These permits usually authorize specific minor impacts within certain geographic areas that would not satisfy the Nationwide Permit required. In the State of Alabama, Regional Permits are issued through the Mobile district office of the ACOE.

All types of permits have specific and general permit conditions. Examples of permit conditions include wetland mitigation for wetland impacts, notification of the ACOE prior to use of the permit, and notification of the ACOE if the proposed project may affect any historical properties listed (proposed for listing or thought to be eligible for listing) on the National Register of Historic Places. Projects not meeting the requirements of the Regional Permit program may be eligible for an Individual Permit or a NWP. Regional Permits may be combined with NWPs for a single project, in some cases.

NWPs have been previously established by the Chief of Engineers for projects that have minimal cumulative impacts to the Nation's Waters. Specific criteria and conditions were established that must be satisfied prior to obtaining authorization of a NWP from the ACOE.

Several scenarios may determine whether a project requires an Individual Permit or NWP. For projects that would impact a portion of a water body under the jurisdiction of the Rivers and Harbors Act, an Individual Permit is required unless exempted by a Regional Permit or authorized by a NWP.

Any project normally requiring a NWP that fails to satisfy specific permit conditions could be elevated to an Individual Permit. Examples of such conditions include projects that may jeopardize animal or plant species listed under the provisions of the Endangered Species Act or projects that potentially could impact historically or culturally significant resources. Because the

permit is a federal action, the conditional requirements must be attained not only within wetland habitats, but also throughout all areas within the project's boundaries for cultural resources or for any plant or animal that has a dependency on a wetland habitat. Finally, each ACOE District Engineer has the authority, at his/her discretion, to elevate a NWP to an Individual Permit if he/she believes that an impact is avoidable or would have a significant environmental impact.

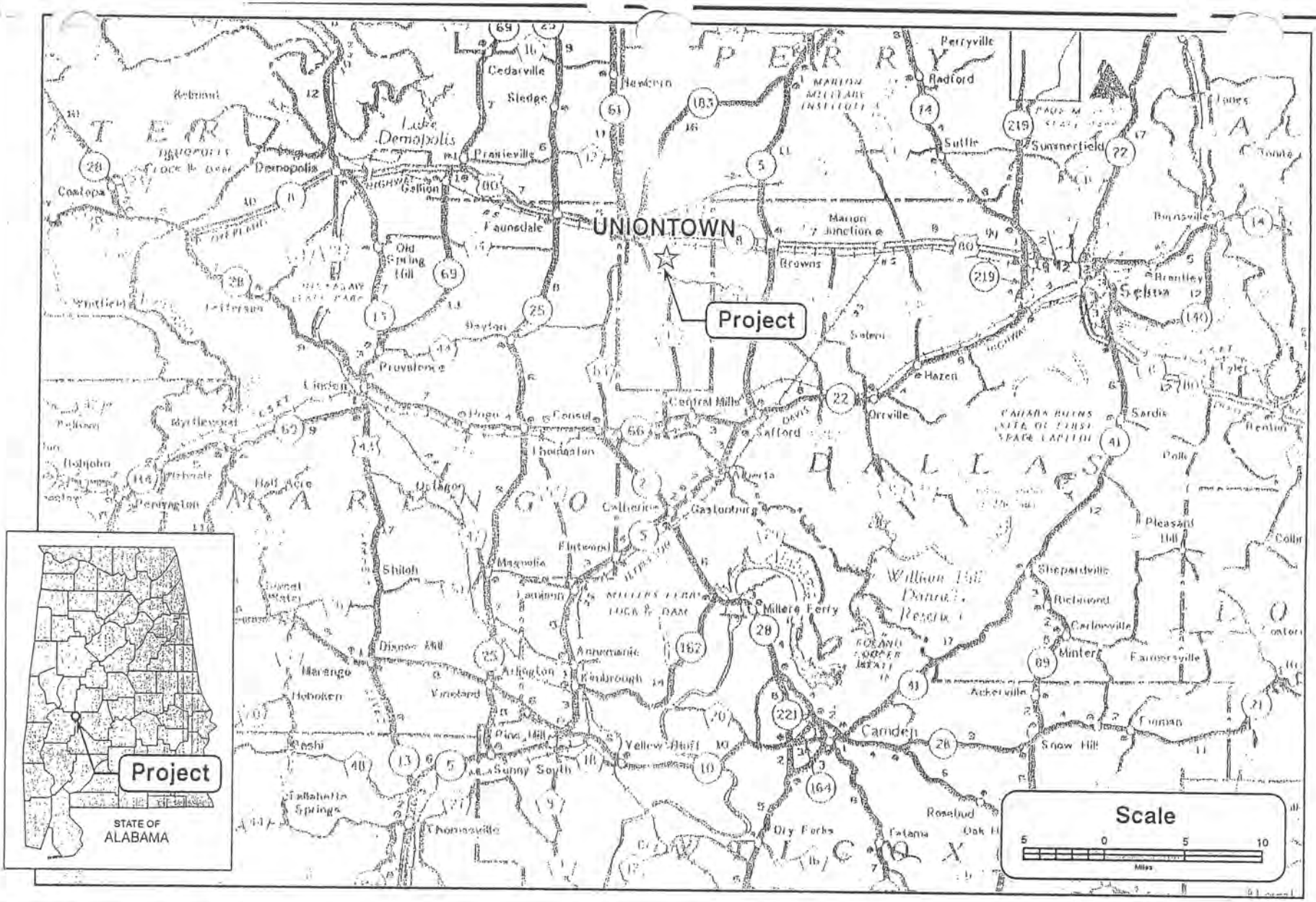
To obtain an Individual Permit, a permit application must be submitted to the applicable district office of the ACOE. The application must include a surveyed boundary of jurisdictional habitats; a description of the proposed impacts; justification of need for the project; a Section 404(b) 1 analysis; identification of adjacent landowners; and, if necessary, a conceptual mitigation plan. An Individual Permit must be advertised for public comment, with public hearings being required if substantial adverse comments are received from coordinating agencies or the public. Approximately 6 to 8 months are required to complete the process for obtaining an Individual Permit.

For many of the NWPs, a Pre-Construction Notification (PCN) must be submitted to alert the local district office of the ACOE of the intent to use a NWP. The PCN must describe the wetland system, provide specifications of the proposed project, identify the prospective permittee, and include a delineation of affected wetlands.

## Anticipated Project Permit Requirements

The current design plans for the Perry County Disposal Facility do not impact any jurisdictional areas. The project was specifically designed to eliminate impacts to jurisdictional wetlands and streams by developing cells that are not located in jurisdictional areas. Because this project does not have any jurisdictional impacts there are no ACOE permit requirements. Future development of the area that differs from the current plans will need to be evaluated for impacts to jurisdictional areas and permitted at that time.

# FIGURES




JORDAN JONES & GOULDING

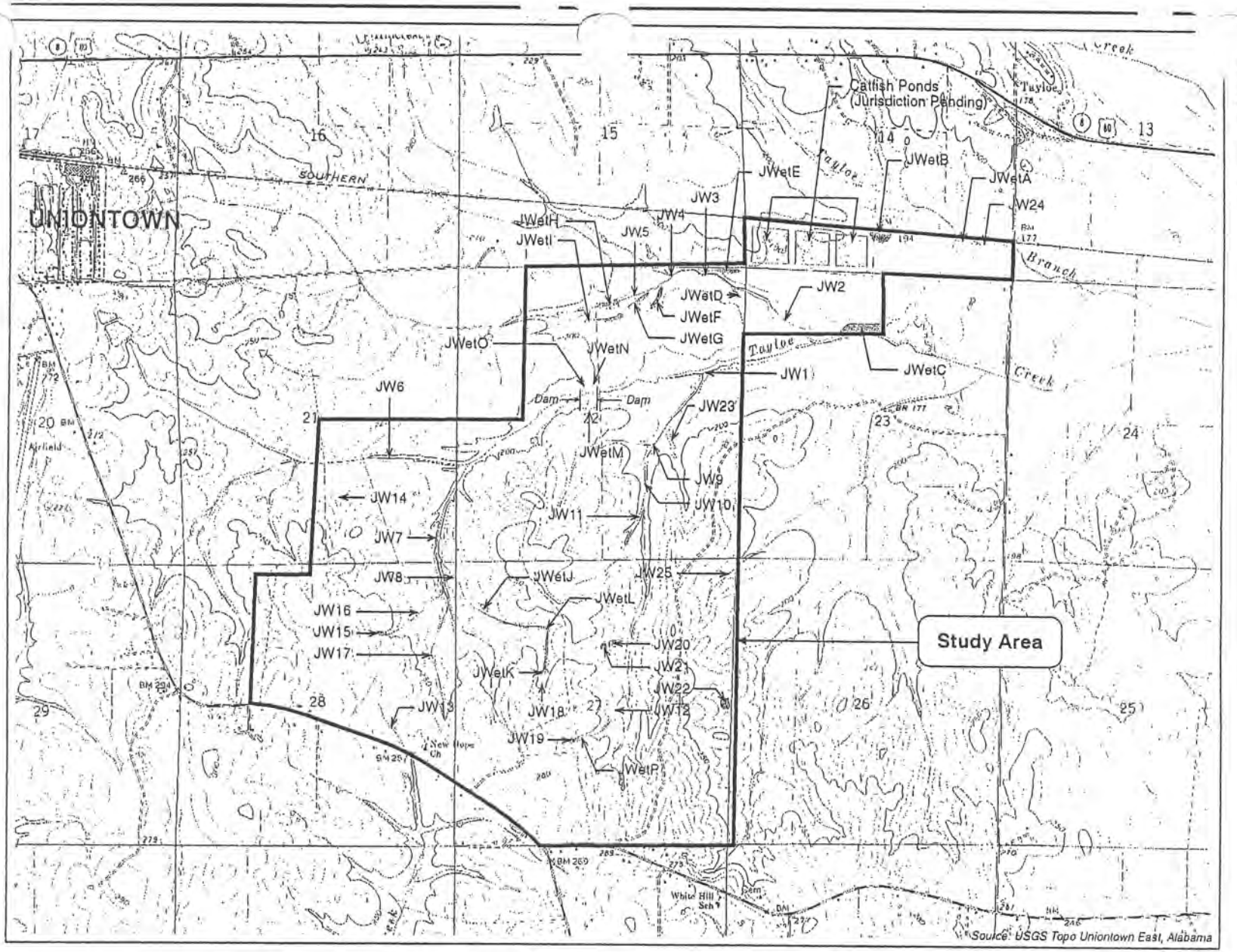
Perry County Associates Landfill
Perry County, Alabama

**Vicinity Map**

| | |
|---|---|
| Date: | June 2001 |
| Scale: | As Shown |
| Job No.: | 4305.001 |

**Figure 1**

4305_001figure1.ln9




JORDAN JONES & GOULDING

Perry County Associates Landfill
Perry County, Alabama

**Location of Jurisdictional Waters and Wetlands**

| | |
|---|---|
| Date: | June 2001 |
| Scale: | N.T.S. |
| Job No.: | 4305.001 |

**Figure 2**

4305_001figure1.ihd

# APPENDIX A
## Wetland Data Sheets

# DATA FORM
# ROUTINE WETLAND DETERMINATION
## *(1987 COE Wetlands Delineation Manual)*

| | | | |
|---|---|---|---|
| Project/Site: Uniontown Landfill | Project No: 1270.002 | Date: 14-Sep-1999 |
| Applicant/Owner: International Landfill Mngt. | | County: Perry |
| Investigators: Smith/McCleod | | State: Alabama |
| | | Plot ID: 1 |

| | | |
|---|---|---|
| Do Normal Circumstances exist on the site? | (Yes) No | Community ID: PFO1B |
| Is the site significantly disturbed (Atypical Situation:)? | Yes (No) | Transect ID: A line |
| Is the area a potential Problem Area? | Yes (No) | Field Location: |
| (If needed, explain on the reverse side) | | Jurisdictional Wetland 1 (Data Point 1) |

**VEGETATION** (USFWS Region No. 2)

| Dominant Plant Species(Latin/Common) | Stratum | Indicator | Plant Species(Latin/Common) | Stratum | Indicator |
|---|---|---|---|---|---|
| *Juncus effusus* | Herb | FACW+ | *Fraxinus pennsylvanica* | Tree | FACW |
| Rush,Soft | | | Ash,Green | | |
| *Chasmanthium latifolium* | Herb | FAC- | *Ulmus americana* | Tree | FACW |
| Sea-Oats,Indian | | | Elm,American | | |
| *Carex species (sterile)* | Herb | FAC | *Quercus nigra* | Tree | FAC |
| Sedge, sterile | | | Oak,Water | | |
| *Cephalanthus occidentalis* | Shrub | OBL | *Cephalanthus occidentalis* | Tree | OBL |
| Buttonbush,Common | | | Buttonbush,Common | | |
| | | | | | |
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| | | | | | |
| | | | | | |
| | | | | | |

Percent of Dominant Species that are OBL, FACW or FAC: (excluding FAC-) 7/8 = 87.50%

FAC Neutral: 5/5 = 100.00%
Numeric Index: 17/8 = 2.13

**Remarks:**
Alot of area is bare from being inundated. Trees are on the edge of the wet area, but canopy covers the wetland.

**HYDROLOGY**

NO Recorded Data(Describe in Remarks):
- N/A Stream, Lake or Tide Gauge
- N/A Aerial Photographs
- N/A Other

YES No Recorded Data

Field Observations

| | |
|---|---|
| Depth of Surface Water: | N/A *(in.)* |
| Depth to Free Water in Pit: | N/A *(in.)* |
| Depth to Saturated Soil: | N/A *(in.)* |

Wetland Hydrology Indicators

Primary Indicators
- NO Inundated
- NO Saturated in Upper 12 Inches
- YES Water Marks
- NO Drift Lines
- YES Sediment Deposits
- YES Drainage Patterns in Wetlands

Secondary Indicators
- NO Oxidized Root Channels in Upper 12 Inches
- NO Water-Stained Leaves
- NO Local Soil Survey Data
- NO FAC-Neutral Test
- NO Other(Explain in Remarks)

**Remarks:**
Area is induced by beaver activity. Dam causes water to leave channel and flood area seasonally. Beaver dam is present. No water observed on visit. Beavers have chewed on trees.

# DATA FORM
# ROUTINE WETLAND DETERMINATION
## *(1987 COE Wetlands Delineation Manual)*

| | | |
|---|---|---|
| Project/Site: Uniontown Landfill | Project No: 1270.002 | Date: 14-Sep-1999 |
| Applicant/Owner: International Landfill Mngt. | | County: Perry |
| Investigators: Smith/McCleod | | State: Alabama |
| | | Plot ID: 1 |

SOILS

Map Unit Name (Series and Phase): Unknown
Map Symbol: Unk Drainage Class:
Taxonomy (Subgroup):
Mapped Hydric Inclusion?
Field Observations Confirm Mapped Type? Yes (No)
Profile Description

| Depth (inches) | Horizon | Matrix Color (Munsell Moist) | Mottle Color (Munsell Moist) | Mottle Abundance/Contrast | | Texture, Concretions, Structure, etc |
|---|---|---|---|---|---|---|
| 0-4 | | 10YR5/2 | 5YR5/8 | N/A | Distinct | Clay |
| 4-8 | | 10YR6/1 | 5YR5/8 | N/A | Distinct | Clay |
| 8-12 | | 10GY4/1 | N/A | N/A | N/A | Clay |

Hydric Soil Indicators:

- NO Histosol
- NO Histic Epipedon
- NO Sulfidic Odor
- NO Aquic Moisture Regime
- YES Reducing Conditions
- YES Gleyed or Low Chroma Colors
- NO Concretions
- NO High Organic Content in Surface Layer in Sandy Soils
- NO Organic Streaking in Sandy Soils
- NO Listed on Local Hydric Soils List
- NO Listed on National Hydric Soils List
- NO Other (Explain in Remarks)

Remarks:

WETLAND DETERMINATION

| | | |
|---|---|---|
| Hydrophytic Vegetation Present? (Yes) No | Is the Sampling Point within the Wetland? (Yes) No | |
| Wetland Hydrology Present? (Yes) No | | |
| Hydric Soils Present? (Yes) No | | |

Remarks:

# DATA FORM
# ROUTINE WETLAND DETERMINATION
## *(1987 COE Wetlands Delineation Manual)*

| | | |
|---|---|---|
| **Project/Site:** Uniontown Landfill | Project No: 1270.002 | **Date:** 14-Sep-1999 |
| **Applicant/Owner:** International Landfill Mngt. | | **County:** Perry |
| **Investigators:** Smith/McCleod | | **State:** Alabama |
| | | **Plot ID:** 2 |

| | | |
|---|---|---|
| **Do Normal Circumstances exist on the site?** | (Yes) No | **Community ID:** PFO1B/PEM1B |
| **Is the site significantly disturbed (Atypical Situation:)?** | Yes (No) | **Transect ID:** A Line |
| **Is the area a potential Problem Area?** | Yes (No) | **Field Location:** |
| (If needed, explain on the reverse side) | | Jurisdictional Wetland 1 (Data Point 2) |

**VEGETATION** (USFWS Region No. 2)

| Dominant Plant Species(Latin/Common) | Stratum | Indicator | Plant Species(Latin/Common) | Stratum | Indicator |
|---|---|---|---|---|---|
| *Ilex decidua* | Shrub | FACW- | *Cephalanthus occidentalis* | Tree | OBL |
| Holly,Deciduous | | | Buttonbush,Common | | |
| *Juncus effusus* | Herb | FACW+ | *Fraxinus pennsylvanica* | Tree | FACW |
| Rush,Soft | | | Ash,Green | | |
| *Chasmanthium latifolium* | Herb | FAC- | *Ulmus americana* | Tree | FACW |
| Sea-Oats,Indian | | | Elm,American | | |
| *Carex sp. (sterile)* | Herb | NI | *Quercus nigra* | Tree | FAC |
| Sedge, sterile | | | Oak,Water | | |
| *Cephalanthus occidentalis* | Shrub | OBL | | | |
| Buttonbush,Common | | | | | |
| | | | | | |
| | | | | | |
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| | |
|---|---|
| **Percent of Dominant Species that are OBL, FACW or FAC:** (excluding FAC-) 7/8 = 87.50% | **FAC Neutral:** 6/6 = 100.00%<br>**Numeric Index:** 16/8 = 2.00 |

**Remarks:**
Beaver dam located at flag A-9. Channel runs through middle of wetland. Located 50 feet from channel of Tayloe Branch. Wetland ends where notch allows water back to Tayloe Branch.

**HYDROLOGY**

NO Recorded Data(Describe in Remarks):
- N/A Stream, Lake or Tide Gauge
- N/A Aerial Photographs
- N/A Other

YES No Recorded Data

**Field Observations**

| | |
|---|---|
| Depth of Surface Water: | N/A *(in.)* |
| Depth to Free Water in Pit: | N/A *(in.)* |
| Depth to Saturated Soil: | N/A *(in.)* |

**Wetland Hydrology Indicators**

Primary Indicators
- NO Inundated
- NO Saturated in Upper 12 Inches
- YES Water Marks
- NO Drift Lines
- YES Sediment Deposits
- YES Drainage Patterns in Wetlands

Secondary Indicators
- NO Oxidized Root Channels in Upper 12 Inches
- NO Water-Stained Leaves
- NO Local Soil Survey Data
- NO FAC-Neutral Test
- NO Other(Explain in Remarks)

**Remarks:**
Area is below beaver dam. Beaver activity floods the area.

# DATA FORM
# ROUTINE WETLAND DETERMINATION
## *(1987 COE Wetlands Delineation Manual)*

| | | | |
|---|---|---|---|
| Project/Site: Uniontown Landfill | | Project No: 1270.002 | Date: 14-Sep-1999 |
| Applicant/Owner: International Landfill Mngt. | | | County: Perry |
| Investigators: Smith/McCleod | | | State: Alabama |
| | | | Plot ID: 2 |

SOILS

Map Unit Name (Series and Phase): Unknown
Map Symbol: Unk Drainage Class:
Taxonomy (Subgroup):
Profile Description

Mapped Hydric Inclusion?
Field Observations Confirm Mapped Type? Yes (No)

| Depth (inches) | Horizon | Matrix Color (Munsell Moist) | Mottle Color (Munsell Moist) | Mottle Abundance/Contrast | | Texture, Concretions, Structure, etc |
|---|---|---|---|---|---|---|
| 0-12 | | 10YR4/2 | N/A | N/A | N/A | Clay |

Hydric Soil Indicators:

- NO Histosol
- NO Histic Epipedon
- NO Sulfidic Odor
- NO Aquic Moisture Regime
- NO Reducing Conditions
- YES Gleyed or Low Chroma Colors
- NO Concretions
- NO High Organic Content in Surface Layer in Sandy Soils
- NO Organic Streaking in Sandy Soils
- NO Listed on Local Hydric Soils List
- NO Listed on National Hydric Soils List
- NO Other (Explain in Remarks)

Remarks:

WETLAND DETERMINATION

| | | | |
|---|---|---|---|
| Hydrophytic Vegetation Present? | (Yes) No | Is the Sampling Point within the Wetland? | (Yes) No |
| Wetland Hydrology Present? | (Yes) No | | |
| Hydric Soils Present? | (Yes) No | | |

Remarks:

# DATA FORM
# ROUTINE WETLAND DETERMINATION
## *(1987 COE Wetlands Delineation Manual)*

| | | | |
|---|---|---|---|
| Project/Site: | Uniontown Landfill | Project No: 1270.002 | Date: 14-Sep-1999 |
| Applicant/Owner: | International Landfill Mngt. | | County: Perry |
| Investigators: | Smith/McCleod | | State: Alabama |
| | | | Plot ID: 3 |

| | | |
|---|---|---|
| Do Normal Circumstances exist on the site? | (Yes) No | Community ID: Upland |
| Is the site significantly disturbed (Atypical Situation:)? | Yes (No) | Transect ID: A line |
| Is the area a potential Problem Area? | Yes (No) | Field Location: |
| (If needed, explain on the reverse side) | | Jurisdictional Wetland 1 Upland Dt Pt |

VEGETATION (USFWS Region No. 2)

| Dominant Plant Species(Latin/Common) | Stratum | Indicator | Plant Species(Latin/Common) | Stratum | Indicator |
|---|---|---|---|---|---|
| *Campsis radicans* | Herb | FAC | *Quercus nigra* | Shrub | FAC |
| Trumpet-Creeper | | | Oak,Water | | |
| *Lonicera japonica* | Vine | FAC- | *Quercus nigra* | Tree | FAC |
| Honeysuckle,Japanese | | | Oak,Water | | |
| *Rubus argutus* | Herb | FACU+ | *Acer negundo* | Shrub | FACW |
| Blackberry,Serrate-Leaf | | | Box-Elder | | |
| *Fraxinus pennsylvanica* | Shrub | FACW | *Acer negundo* | Tree | FACW |
| Ash,Green | | | Box-Elder | | |
| *Fraxinus pennsylvanica* | Tree | FACW | | | |
| Ash,Green | | | | | |
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| | |
|---|---|
| Percent of Dominant Species that are OBL, FACW or FAC: (excluding FAC-) 7/9 = 77.78% | FAC Neutral: 4/5 = 80.00%<br>Numeric Index: 24/9 = 2.67 |

Remarks:
Small scrub/shrub area (approximately 50 feet wide) between wetland and agricultural field.

HYDROLOGY

NO Recorded Data(Describe in Remarks):
- N/A Stream, Lake or Tide Gauge
- N/A Aerial Photographs
- N/A Other

YES No Recorded Data

Field Observations

| | |
|---|---|
| Depth of Surface Water: | N/A *(in.)* |
| Depth to Free Water in Pit: | N/A *(in.)* |
| Depth to Saturated Soil: | N/A *(in.)* |

Wetland Hydrology Indicators

Primary Indicators
- NO Inundated
- NO Saturated in Upper 12 Inches
- NO Water Marks
- NO Drift Lines
- NO Sediment Deposits
- NO Drainage Patterns in Wetlands

Secondary Indicators
- NO Oxidized Root Channels in Upper 12 Inches
- NO Water-Stained Leaves
- NO Local Soil Survey Data
- NO FAC-Neutral Test
- NO Other(Explain in Remarks)

Remarks:
No signs of hydrology present.



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# DATA FORM
# ROUTINE WETLAND DETERMINATION
## *(1987 COE Wetlands Delineation Manual)*

| | | | |
|---|---|---|---|
| Project/Site: Uniontown Landfill | | Project No: 1270.002 | Date: 14-Sep-1999 |
| Applicant/Owner: International Landfill Mngt. | | | County: Perry |
| Investigators: Smith/McCleod | | | State: Alabama |
| | | | Plot ID: 3 |

SOILS

Map Unit Name (Series and Phase): Unknown
Map Symbol: Unk Drainage Class:
Taxonomy (Subgroup):
Profile Description

Mapped Hydric Inclusion?
Field Observations Confirm Mapped Type? Yes (No)

| Depth (inches) | Horizon | Matrix Color (Munsell Moist) | Mottle Color (Munsell Moist) | Mottle Abundance/Contrast | | Texture, Concretions, Structure, etc |
|---|---|---|---|---|---|---|
| 0-12 | | 10YR6/6 | N/A | N/A | N/A | Clay |

Hydric Soil Indicators:

- NO Histosol
- NO Histic Epipedon
- NO Sulfidic Odor
- NO Aquic Moisture Regime
- NO Reducing Conditions
- NO Gleyed or Low Chroma Colors
- NO Concretions
- NO High Organic Content in Surface Layer in Sandy Soils
- NO Organic Streaking in Sandy Soils
- NO Listed on Local Hydric Soils List
- NO Listed on National Hydric Soils List
- NO Other (Explain in Remarks)

Remarks:

WETLAND DETERMINATION

| | | |
|---|---|---|
| Hydrophytic Vegetation Present? | (Yes) No | Is the Sampling Point within the Wetland? Yes (No) |
| Wetland Hydrology Present? | Yes (No) | |
| Hydric Soils Present? | Yes (No) | |

Remarks:

# DATA FORM
# ROUTINE WETLAND DETERMINATION
## *(1987 COE Wetlands Delineation Manual)*

| | | | |
|---|---|---|---|
| Project/Site: | Uniontown Landfill | Project No: 1270.002 | Date: 14-Sep-1999 |
| Applicant/Owner: | International Landfill Mngt. | | County: Perry |
| Investigators: | Smith/McCleod | | State: Alabama |
| | | | Plot ID: 4 |

| | | |
|---|---|---|
| Do Normal Circumstances exist on the site? | (Yes) No | Community ID: PFO1B |
| Is the site significantly disturbed (Atypical Situation:)? | Yes (No) | Transect ID: B line |
| Is the area a potential Problem Area? | Yes (No) | Field Location: |
| (If needed, explain on the reverse side) | | Jurisdictional Wetland 2 |

VEGETATION (USFWS Region No. 2)

| Dominant Plant Species(Latin/Common) | Stratum | Indicator | Plant Species(Latin/Common) | Stratum | Indicator |
|---|---|---|---|---|---|
| *Quercus nigra* Oak,Water | Shrub | FAC | *Campsis radicans* Trumpet-Creeper | Vine | FAC |
| *Quercus nigra* Oak,Water | Tree | FAC | *Celtis laevigata* Sugar-Berry | Tree | FACW |
| *Arundinaria gigantea* Cane,Giant | Shrub | FACW | *Liquidambar styraciflua* Gum,Sweet | Tree | FAC+ |
| *Fraxinus pennsylvanica* Ash,Green | Tree | FACW | *Liquidambar styraciflua* Gum,Sweet | Shrub | FAC+ |
| *Carex sp. (sterile)* Sedge, sterile | Tree | NI | | | |
| | | | | | |
| | | | | | |
| | | | | | |

Percent of Dominant Species that are OBL, FACW or FAC: (excluding FAC-) 8/8 = 100.00%

FAC Neutral: 3/3 = 100.00%
Numeric Index: 21/8 = 2.63

Remarks:
Bare areas present. wetland continues between catfish ponds and railroad but was not flagged.

HYDROLOGY

NO Recorded Data(Describe in Remarks):
- N/A Stream, Lake or Tide Gauge
- N/A Aerial Photographs
- N/A Other

YES No Recorded Data

Field Observations

| | |
|---|---|
| Depth of Surface Water: | N/A *(in.)* |
| Depth to Free Water in Pit: | N/A *(in.)* |
| Depth to Saturated Soil: | N/A *(in.)* |

Wetland Hydrology Indicators

Primary Indicators
- NO Inundated
- NO Saturated in Upper 12 Inches
- YES Water Marks
- NO Drift Lines
- NO Sediment Deposits
- NO Drainage Patterns in Wetlands

Secondary Indicators
- NO Oxidized Root Channels in Upper 12 Inches
- YES Water-Stained Leaves
- NO Local Soil Survey Data
- NO FAC-Neutral Test
- NO Other(Explain in Remarks)

Remarks:
Adventitious roots and buttressing present. The site was dry during visit due to drought.

# DATA FORM
# ROUTINE WETLAND DETERMINATION
## *(1987 COE Wetlands Delineation Manual)*

| | | | |
|---|---|---|---|
| Project/Site: | Uniontown Landfill | Project No: 1270.002 | Date: 14-Sep-1999 |
| Applicant/Owner: | International Landfill Mngt. | | County: Perry |
| Investigators: | Smith/McCleod | | State: Alabama |
| | | | Plot ID: 4 |

SOILS

Map Unit Name (Series and Phase): Unknown
Map Symbol: Unk Drainage Class:
Taxonomy (Subgroup):
Mapped Hydric Inclusion?
Field Observations Confirm Mapped Type? Yes (No)

Profile Description

| Depth (inches) | Horizon | Matrix Color (Munsell Moist) | Mottle Color (Munsell Moist) | Mottle Abundance/Contrast | | Texture, Concretions, Structure, etc |
|---|---|---|---|---|---|---|
| 0-2 | | 7.5YR5/8 | N/A | N/A | N/A | Clay |
| 2-12 | | 7.5YR6/1 | 7.5YR5/8 | N/A | Distinct | Clay |

Hydric Soil Indicators:

NO Histosol
NO Histic Epipedon
NO Sulfidic Odor
NO Aquic Moisture Regime
YES Reducing Conditions
YES Gleyed or Low Chroma Colors
NO Concretions
NO High Organic Content in Surface Layer in Sandy Soils
NO Organic Streaking in Sandy Soils
NO Listed on Local Hydric Soils List
NO Listed on National Hydric Soils List
NO Other (Explain in Remarks)

Remarks:

WETLAND DETERMINATION

| | | | |
|---|---|---|---|
| Hydrophytic Vegetation Present? | (Yes) | No | Is the Sampling Point within the Wetland? (Yes) No |
| Wetland Hydrology Present? | (Yes) | No | |
| Hydric Soils Present? | (Yes) | No | |

Remarks:



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# DATA FORM
# ROUTINE WETLAND DETERMINATION
## *(1987 COE Wetlands Delineation Manual)*

| | | | |
|---|---|---|---|
| Project/Site: | Uniontown Landfill | Project No: 1270.002 | Date: 14-Sep-1999 |
| Applicant/Owner: | International Landfill Mngt. | | County: Perry |
| Investigators: | Smith/McCleod | | State: Alabama |
| | | | Plot ID: 5 |

| | | |
|---|---|---|
| Do Normal Circumstances exist on the site? | (Yes) No | Community ID: Upland |
| Is the site significantly disturbed (Atypical Situation:)? | Yes (No) | Transect ID: B line |
| Is the area a potential Problem Area? | Yes (No) | Field Location: |
| (If needed, explain on the reverse side) | | Jurisdictional Wetland 2 Upland Dt Pt |

VEGETATION (USFWS Region No. 2)

| Dominant Plant Species(Latin/Common) | Stratum | Indicator | Plant Species(Latin/Common) | Stratum | Indicator |
|---|---|---|---|---|---|
| *Toxicodendron radicans* | Herb | FAC | *Myrica cerifera* | Shrub | FAC+ |
| Ivy,Poison | | | Bayberry,Southern | | |
| *Liquidambar styraciflua* | Shrub | FAC+ | *Carex sp. (sterile)* | Herb | NI |
| Gum,Sweet | | | Sedge, sterile | | |
| *Liquidambar styraciflua* | Tree | FAC+ | *Campsis radicans* | Herb | FAC |
| Gum,Sweet | | | Trumpet-Creeper | | |
| *Juniperus virginiana* | Tree | FACU- | | | |
| Cedar,Eastern Red | | | | | |
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| | |
|---|---|
| Percent of Dominant Species that are OBL, FACW or FAC: (excluding FAC-) 5/6 = 83.33% | FAC Neutral: 0/1 = 0.00%<br>Numeric Index: 19/6 = 3.17 |

Remarks:
Definate vegetation change from wetland area.

HYDROLOGY

NO Recorded Data(Describe in Remarks):
- N/A Stream, Lake or Tide Gauge
- N/A Aerial Photographs
- N/A Other

YES No Recorded Data

Field Observations

| | |
|---|---|
| Depth of Surface Water: | N/A *(in.)* |
| Depth to Free Water in Pit: | N/A *(in.)* |
| Depth to Saturated Soil: | N/A *(in.)* |

Wetland Hydrology Indicators

Primary Indicators
- NO Inundated
- NO Saturated in Upper 12 Inches
- NO Water Marks
- NO Drift Lines
- NO Sediment Deposits
- NO Drainage Patterns in Wetlands

Secondary Indicators
- NO Oxidized Root Channels in Upper 12 Inches
- NO Water-Stained Leaves
- NO Local Soil Survey Data
- NO FAC-Neutral Test
- NO Other(Explain in Remarks)

Remarks:
No signs of hydrology.



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# DATA FORM
# ROUTINE WETLAND DETERMINATION
## *(1987 COE Wetlands Delineation Manual)*

| | | | |
|---|---|---|---|
| Project/Site: | Uniontown Landfill | Project No: 1270.002 | Date: 14-Sep-1999 |
| Applicant/Owner: | International Landfill Mngt. | | County: Perry |
| Investigators: | Smith/McCleod | | State: Alabama |
| | | | Plot ID: 5 |

SOILS

Map Unit Name (Series and Phase): Unknown
Map Symbol: Unk Drainage Class:
Taxonomy (Subgroup):
Mapped Hydric Inclusion?
Field Observations Confirm Mapped Type? Yes (No)
Profile Description

| Depth (inches) | Horizon | Matrix Color (Munsell Moist) | Mottle Color (Munsell Moist) | Mottle Abundance/Contrast | | Texture, Concretions, Structure, etc |
|---|---|---|---|---|---|---|
| 0-8 | | 7.5YR6/1 | 7.5YR7/8 | Few | N/A | Clay |
| 8-12 | | 2.5Y7/1 | 7.5YR5/8 | Few | N/A | Clay |

Hydric Soil Indicators:

| | |
|---|---|
| NO Histosol | NO Concretions |
| NO Histic Epipedon | NO High Organic Content in Surface Layer in Sandy Soils |
| NO Sulfidic Odor | NO Organic Streaking in Sandy Soils |
| NO Aquic Moisture Regime | NO Listed on Local Hydric Soils List |
| NO Reducing Conditions | NO Listed on National Hydric Soils List |
| NO Gleyed or Low Chroma Colors | NO Other (Explain in Remarks) |

Remarks:

WETLAND DETERMINATION

| | | |
|---|---|---|
| Hydrophytic Vegetation Present? | (Yes) No | Is the Sampling Point within the Wetland? Yes (No) |
| Wetland Hydrology Present? | Yes (No) | |
| Hydric Soils Present? | Yes (No) | |

Remarks:



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# DATA FORM
# ROUTINE WETLAND DETERMINATION
## *(1987 COE Wetlands Delineation Manual)*

| | | | |
|---|---|---|---|
| Project/Site: | Uniontown Landfill | Project No: 1270.002 | Date: 14-Sep-1999 |
| Applicant/Owner: | International Landfill Mngt. | | County: Perry |
| Investigators: | Smith/McCleod | | State: Alabama |
| | | | Plot ID: 6 |

| | | |
|---|---|---|
| Do Normal Circumstances exist on the site? | (Yes) No | Community ID: PFO1B |
| Is the site significantly disturbed (Atypical Situation:)? | Yes (No) | Transect ID: C line |
| Is the area a potential Problem Area? | Yes (No) | Field Location: |
| (If needed, explain on the reverse side) | | Jurisdictional Wetland 3 |

VEGETATION (USFWS Region No. 2)

| Dominant Plant Species(Latin/Common) | Stratum | Indicator | Plant Species(Latin/Common) | Stratum | Indicator |
|---|---|---|---|---|---|
| *Arundinaria gigantea* | Shrub | FACW | *Fraxinus pennsylvanica* | Tree | FACW |
| Cane,Giant | | | Ash,Green | | |
| *Fraxinus pennsylvanica* | Shrub | FACW | *Acer negundo* | Tree | FACW |
| Ash,Green | | | Box-Elder | | |
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Percent of Dominant Species that are OBL, FACW or FAC: (excluding FAC-) 4/4 = 100.00%

FAC Neutral: 4/4 = 100.00%
Numeric Index: 8/4 = 2.00

Remarks:
Wetland runs parallel to Tayloe Creek. It is separated by a berm.

HYDROLOGY

NO Recorded Data(Describe in Remarks):
- N/A Stream, Lake or Tide Gauge
- N/A Aerial Photographs
- N/A Other

YES No Recorded Data

Field Observations

| | |
|---|---|
| Depth of Surface Water: | N/A *(in.)* |
| Depth to Free Water in Pit: | N/A *(in.)* |
| Depth to Saturated Soil: | N/A *(in.)* |

Wetland Hydrology Indicators

Primary Indicators
- NO Inundated
- NO Saturated in Upper 12 Inches
- YES Water Marks
- NO Drift Lines
- NO Sediment Deposits
- YES Drainage Patterns in Wetlands

Secondary Indicators
- NO Oxidized Root Channels in Upper 12 Inches
- YES Water-Stained Leaves
- NO Local Soil Survey Data
- NO FAC-Neutral Test
- NO Other(Explain in Remarks)

Remarks:
Buttressing present. No water present during visit.



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# DATA FORM
# ROUTINE WETLAND DETERMINATION
## *(1987 COE Wetlands Delineation Manual)*

| | | | |
|---|---|---|---|
| Project/Site: | Uniontown Landfill | Project No: 1270.002 | Date: 14-Sep-1999 |
| Applicant/Owner: | International Landfill Mngt. | | County: Perry |
| Investigators: | Smith/McCleod | | State: Alabama |
| | | | Plot ID: 6 |

SOILS

Map Unit Name (Series and Phase): Unknown

Map Symbol: Unk Drainage Class:

Mapped Hydric Inclusion?

Taxonomy (Subgroup):

Field Observations Confirm Mapped Type? Yes (No)

Profile Description

| Depth (inches) | Horizon | Matrix Color (Munsell Moist) | Mottle Color (Munsell Moist) | Mottle Abundance/Contrast | | Texture, Concretions, Structure, etc |
|---|---|---|---|---|---|---|
| 0-12 | | 10YR4/2 | N/A | N/A | N/A | Clay |

Hydric Soil Indicators:

| | |
|---|---|
| NO Histosol | NO Concretions |
| NO Histic Epipedon | NO High Organic Content in Surface Layer in Sandy Soils |
| NO Sulfidic Odor | NO Organic Streaking in Sandy Soils |
| NO Aquic Moisture Regime | NO Listed on Local Hydric Soils List |
| NO Reducing Conditions | NO Listed on National Hydric Soils List |
| YES Gleyed or Low Chroma Colors | NO Other (Explain in Remarks) |

Remarks:

WETLAND DETERMINATION

| | | | |
|---|---|---|---|
| Hydrophytic Vegetation Present? | (Yes) | No | Is the Sampling Point within the Wetland? (Yes) No |
| Wetland Hydrology Present? | (Yes) | No | |
| Hydric Soils Present? | (Yes) | No | |

Remarks:



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# DATA FORM
# ROUTINE WETLAND DETERMINATION
## *(1987 COE Wetlands Delineation Manual)*

| | | | |
|---|---|---|---|
| Project/Site: | Uniontown Landfill | Project No: 1270.002 | Date: 14-Sep-1999 |
| Applicant/Owner: | International Landfill Mngt. | | County: Perry |
| Investigators: | Smith/McCleod | | State: Alabama |
| | | | Plot ID: 7 |

| | | |
|---|---|---|
| Do Normal Circumstances exist on the site? | (Yes) No | Community ID: Upland |
| Is the site significantly disturbed (Atypical Situation:)? | Yes (No) | Transect ID: C line |
| Is the area a potential Problem Area? | Yes (No) | Field Location: |
| (If needed, explain on the reverse side) | | Jurisdictional Wetland 3 Upland Dt Pt |

VEGETATION (USFWS Region No. 2)

| Dominant Plant Species(Latin/Common) | Stratum | Indicator | Plant Species(Latin/Common) | Stratum | Indicator |
|---|---|---|---|---|---|
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Percent of Dominant Species that are OBL, FACW or FAC: (excluding FAC-) 0/0 = 0.00%

FAC Neutral: 0/0 = 0.00%
Numeric Index: 0/0 = 0.00

Remarks:
Data point taken in agricultural field planted with soybean (Glycine max).

HYDROLOGY

NO Recorded Data(Describe in Remarks):
- N/A Stream, Lake or Tide Gauge
- N/A Aerial Photographs
- N/A Other

YES No Recorded Data

Field Observations

| | |
|---|---|
| Depth of Surface Water: | N/A *(in.)* |
| Depth to Free Water in Pit: | N/A *(in.)* |
| Depth to Saturated Soil: | N/A *(in.)* |

Wetland Hydrology Indicators

Primary Indicators
- NO Inundated
- NO Saturated in Upper 12 Inches
- NO Water Marks
- NO Drift Lines
- NO Sediment Deposits
- NO Drainage Patterns in Wetlands

Secondary Indicators
- NO Oxidized Root Channels in Upper 12 Inches
- NO Water-Stained Leaves
- NO Local Soil Survey Data
- NO FAC-Neutral Test
- NO Other(Explain in Remarks)

Remarks:
No signs of hydrology.



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# DATA FORM
# ROUTINE WETLAND DETERMINATION
## *(1987 COE Wetlands Delineation Manual)*

| | | | |
|---|---|---|---|
| Project/Site: Uniontown Landfill | | Project No: 1270.002 | Date: 14-Sep-1999 |
| Applicant/Owner: International Landfill Mngt. | | | County: Perry |
| Investigators: Smith/McCleod | | | State: Alabama |
| | | | Plot ID: 7 |

SOILS

Map Unit Name (Series and Phase): Unknown
Map Symbol: Unk Drainage Class:
Taxonomy (Subgroup):
Mapped Hydric Inclusion?
Field Observations Confirm Mapped Type? Yes (No)
Profile Description

| Depth (inches) | Horizon | Matrix Color (Munsell Moist) | Mottle Color (Munsell Moist) | Mottle Abundance/Contrast | | Texture, Concretions, Structure, etc |
|---|---|---|---|---|---|---|
| 0-12 | | 10YR5/4 | N/A | N/A | N/A | Clay |

Hydric Soil Indicators:

| | |
|---|---|
| NO Histosol | NO Concretions |
| NO Histic Epipedon | NO High Organic Content in Surface Layer in Sandy Soils |
| NO Sulfidic Odor | NO Organic Streaking in Sandy Soils |
| NO Aquic Moisture Regime | NO Listed on Local Hydric Soils List |
| NO Reducing Conditions | NO Listed on National Hydric Soils List |
| NO Gleyed or Low Chroma Colors | NO Other (Explain in Remarks) |

Remarks:

WETLAND DETERMINATION

| | | |
|---|---|---|
| Hydrophytic Vegetation Present? | Yes (No) | Is the Sampling Point within the Wetland? Yes (No) |
| Wetland Hydrology Present? | Yes (No) | |
| Hydric Soils Present? | Yes (No) | |

Remarks:



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# DATA FORM
# ROUTINE WETLAND DETERMINATION
## *(1987 COE Wetlands Delineation Manual)*

| | | | |
|---|---|---|---|
| Project/Site: | Uniontown Landfill | Project No: 1270.002 | Date: 15-Sep-1999 |
| Applicant/Owner: | International Landfill Mngt. | | County: Perry |
| Investigators: | Smith/McCleod | | State: Alabama |
| | | | Plot ID: 8 |

| | | | |
|---|---|---|---|
| Do Normal Circumstances exist on the site? | (Yes) | No | Community ID: PFO1B |
| Is the site significantly disturbed (Atypical Situation:)? | Yes | (No) | Transect ID: D line |
| Is the area a potential Problem Area? | Yes | (No) | Field Location: |
| (If needed, explain on the reverse side) | | | Jurisdictional Wetland 4 |

VEGETATION (USFWS Region No. 2)

| Dominant Plant Species(Latin/Common) | Stratum | Indicator | Plant Species(Latin/Common) | Stratum | Indicator |
|---|---|---|---|---|---|
| *Fraxinus pennsylvanica* | Tree | FACW | *Campsis radicans* | Herb | FAC |
| Ash,Green | | | Trumpet-Creeper | | |
| *Fraxinus pennsylvanica* | Shrub | FACW | *Celtis laevigata* | Shrub | FACW |
| Ash,Green | | | Sugar-Berry | | |
| *Aesculus pavia* | Shrub | FAC | *Toxicodendron radicans* | Herb | FAC |
| Buckeye,Red | | | Ivy,Poison | | |
| *Aesculus pavia* | Tree | FAC | *Carex sp. (sterile)* | Herb | NI |
| Buckeye,Red | | | Sedge, sterile | | |
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Percent of Dominant Species that are OBL, FACW or FAC: (excluding FAC-) 7/7 = 100.00%

FAC Neutral: 3/3 = 100.00%
Numeric Index: 18/7 = 2.57

Remarks:
Cresent shaped wetland. Mostly bare areas. Not a lot of herbaceous ground cover.

HYDROLOGY

NO Recorded Data(Describe in Remarks):
- N/A Stream, Lake or Tide Gauge
- N/A Aerial Photographs
- N/A Other

YES No Recorded Data

Field Observations

| | |
|---|---|
| Depth of Surface Water: | N/A *(in.)* |
| Depth to Free Water in Pit: | N/A *(in.)* |
| Depth to Saturated Soil: | N/A *(in.)* |

Wetland Hydrology Indicators

Primary Indicators
- NO Inundated
- NO Saturated in Upper 12 Inches
- YES Water Marks
- YES Drift Lines
- NO Sediment Deposits
- YES Drainage Patterns in Wetlands

Secondary Indicators
- NO Oxidized Root Channels in Upper 12 Inches
- YES Water-Stained Leaves
- NO Local Soil Survey Data
- NO FAC-Neutral Test
- NO Other(Explain in Remarks)

Remarks:
Buttressing present



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# DATA FORM
# ROUTINE WETLAND DETERMINATION
## *(1987 COE Wetlands Delineation Manual)*

| | | | |
|---|---|---|---|
| Project/Site: | Uniontown Landfill | Project No: 1270.002 | Date: 15-Sep-1999 |
| Applicant/Owner: | International Landfill Mngt. | | County: Perry |
| nvestigators: | Smith/McCleod | | State: Alabama |
| | | | Plot ID: 8 |

SOILS

Map Unit Name (Series and Phase): Unknown
Map Symbol: Unk Drainage Class:
Taxonomy (Subgroup):
Mapped Hydric Inclusion?
Field Observations Confirm Mapped Type? Yes (No)

Profile Description

| Depth (inches) | Horizon | Matrix Color (Munsell Moist) | Mottle Color (Munsell Moist) | Mottle Abundance/Contrast | Texture, Concretions, Structure, etc |
|---|---|---|---|---|---|
| 0-12 | | 10YR4/3 | 10YR4/6 | Few Faint | Clay |

Hydric Soil Indicators:

| | |
|---|---|
| NO Histosol | NO Concretions |
| NO Histic Epipedon | NO High Organic Content in Surface Layer in Sandy Soils |
| NO Sulfidic Odor | NO Organic Streaking in Sandy Soils |
| NO Aquic Moisture Regime | NO Listed on Local Hydric Soils List |
| YES Reducing Conditions | NO Listed on National Hydric Soils List |
| NO Gleyed or Low Chroma Colors | NO Other (Explain in Remarks) |

Remarks:

WETLAND DETERMINATION

| | | | |
|---|---|---|---|
| Hydrophytic Vegetation Present? | (Yes) | No | Is the Sampling Point within the Wetland? (Yes) No |
| Wetland Hydrology Present? | (Yes) | No | |
| Hydric Soils Present? | (Yes) | No | |

Remarks:



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# DATA FORM
# ROUTINE WETLAND DETERMINATION
## *(1987 COE Wetlands Delineation Manual)*

| | | | |
|---|---|---|---|
| Project/Site: | Uniontown Landfill | Project No: 1270.002 | Date: 15-Sep-1999 |
| Applicant/Owner: | International Landfill Mngt. | | County: Perry |
| Investigators: | Smith/McCleod | | State: Alabama |
| | | | Plot ID: 9 |

| | | |
|---|---|---|
| Do Normal Circumstances exist on the site? | (Yes) No | Community ID: Upland |
| Is the site significantly disturbed (Atypical Situation:)? | Yes (No) | Transect ID: D/E Line |
| Is the area a potential Problem Area? | Yes (No) | Field Location: |
| (If needed, explain on the reverse side) | | Jurisdictional Wetland D/E Upland Dt Pt |

VEGETATION (USFWS Region No. 2)

| Dominant Plant Species(Latin/Common) | Stratum | Indicator | Plant Species(Latin/Common) | Stratum | Indicator |
|---|---|---|---|---|---|
| *Fraxinus pennsylvanica* | Tree | FACW | *Toxicodendron radicans* | Herb | FAC |
| Ash,Green | | | Ivy,Poison | | |
| *Fraxinus pennsylvanica* | Shrub | FACW | *Celtis laevigata* | Tree | FACW |
| Ash,Green | | | Sugar-Berry | | |
| *Juniperus virginiana* | Shrub | FACU- | *Campsis radicans* | Herb | FAC |
| Cedar,Eastern Red | | | Trumpet-Creeper | | |
| *Juniperus virginiana* | Tree | FACU- | | | |
| Cedar,Eastern Red | | | | | |
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Percent of Dominant Species that are OBL, FACW or FAC: (excluding FAC-) 5/7 = 71.43%

FAC Neutral: 3/5 = 60.00%
Numeric Index: 20/7 = 2.86

Remarks:

HYDROLOGY

NO Recorded Data(Describe in Remarks):
- N/A Stream, Lake or Tide Gauge
- N/A Aerial Photographs
- N/A Other

YES No Recorded Data

Field Observations

| | |
|---|---|
| Depth of Surface Water: | N/A *(in.)* |
| Depth to Free Water in Pit: | N/A *(in.)* |
| Depth to Saturated Soil: | N/A *(in.)* |

Wetland Hydrology Indicators

Primary Indicators
- NO Inundated
- NO Saturated in Upper 12 Inches
- NO Water Marks
- NO Drift Lines
- NO Sediment Deposits
- NO Drainage Patterns in Wetlands

Secondary Indicators
- NO Oxidized Root Channels in Upper 12 Inches
- NO Water-Stained Leaves
- NO Local Soil Survey Data
- NO FAC-Neutral Test
- NO Other(Explain in Remarks)

Remarks:
No signs of hydrology.

# DATA FORM
# ROUTINE WETLAND DETERMINATION
## *(1987 COE Wetlands Delineation Manual)*

| | | | |
|---|---|---|---|
| Project/Site: | Uniontown Landfill | Project No: 1270.002 | Date: 15-Sep-1999 |
| Applicant/Owner: | International Landfill Mngt. | | County: Perry |
| Investigators: | Smith/McCleod | | State: Alabama |
| | | | Plot ID: 9 |

SOILS

Map Unit Name (Series and Phase): Unknown
Map Symbol: Unk Drainage Class:
Taxonomy (Subgroup):
Mapped Hydric Inclusion?
Field Observations Confirm Mapped Type? Yes (No)
Profile Description

| Depth (inches) | Horizon | Matrix Color (Munsell Moist) | Mottle Color (Munsell Moist) | Mottle Abundance/Contrast | | Texture, Concretions, Structure, etc |
|---|---|---|---|---|---|---|
| 0-12 | | 2.5YR4/3 | N/A | N/A | N/A | Clay |

Hydric Soil Indicators:

| | |
|---|---|
| NO Histosol | NO Concretions |
| NO Histic Epipedon | NO High Organic Content in Surface Layer in Sandy Soils |
| NO Sulfidic Odor | NO Organic Streaking in Sandy Soils |
| NO Aquic Moisture Regime | NO Listed on Local Hydric Soils List |
| NO Reducing Conditions | NO Listed on National Hydric Soils List |
| NO Gleyed or Low Chroma Colors | NO Other (Explain in Remarks) |

Remarks:

WETLAND DETERMINATION

| | | |
|---|---|---|
| Hydrophytic Vegetation Present? | (Yes) No | Is the Sampling Point within the Wetland? Yes (No) |
| Wetland Hydrology Present? | Yes (No) | |
| Hydric Soils Present? | Yes (No) | |

Remarks:



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# DATA FORM
# ROUTINE WETLAND DETERMINATION
## *(1987 COE Wetlands Delineation Manual)*

| | | | |
|---|---|---|---|
| Project/Site: | Uniontown Landfill | Project No: 1270.002 | Date: 16-Sep-1999 |
| Applicant/Owner: | International Landfill Mngt. | | County: Perry |
| Investigators: | Smith/McCleod | | State: Alabama |
| | | | Plot ID: 23 |

| | | |
|---|---|---|
| Do Normal Circumstances exist on the site? | (Yes) No | Community ID: Upland |
| Is the site significantly disturbed (Atypical Situation:)? | Yes (No) | Transect ID: L line |
| Is the area a potential Problem Area? | Yes (No) | Field Location: |
| (If needed, explain on the reverse side) | | Jurisdictional Wetland 12 Upland Dt Pt |

VEGETATION (USFWS Region No. 2)

| Dominant Plant Species(Latin/Common) | Stratum | Indicator | Plant Species(Latin/Common) | Stratum | Indicator |
|---|---|---|---|---|---|
| *Ambrosia artemisiifolia* | Herb | FACU | *Fescue sp.* | Herb | UPL |
| Ragweed,Annual | | | Fescue sp. | | |
| *Fraxinus pennsylvanica* | Tree | FACW | *Toxicodendron radicans* | Herb | FAC |
| Ash,Green | | | Ivy,Poison | | |
| *Juniperus virginiana* | Tree | FACU- | *Populus deltoides* | Tree | FAC+ |
| Cedar,Eastern Red | | | Cotton-Wood,Eastern | | |
| | | | | | |
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| | |
|---|---|
| Percent of Dominant Species that are OBL, FACW or FAC: (excluding FAC-) 3/6 = 50.00% | FAC Neutral: 1/4 = 25.00%<br>Numeric Index: 21/6 = 3.50 |

Remarks:

HYDROLOGY

NO Recorded Data(Describe in Remarks):
- N/A Stream, Lake or Tide Gauge
- N/A Aerial Photographs
- N/A Other

YES No Recorded Data

Field Observations

| | |
|---|---|
| Depth of Surface Water: | N/A *(in.)* |
| Depth to Free Water in Pit: | N/A *(in.)* |
| Depth to Saturated Soil: | N/A *(in.)* |

Wetland Hydrology Indicators

Primary Indicators
- NO Inundated
- NO Saturated in Upper 12 Inches
- NO Water Marks
- NO Drift Lines
- NO Sediment Deposits
- NO Drainage Patterns in Wetlands

Secondary Indicators
- NO Oxidized Root Channels in Upper 12 Inches
- NO Water-Stained Leaves
- NO Local Soil Survey Data
- NO FAC-Neutral Test
- NO Other(Explain in Remarks)

Remarks:
No signs of hydrology.



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# DATA FORM
# ROUTINE WETLAND DETERMINATION
## *(1987 COE Wetlands Delineation Manual)*

| | | | |
|---|---|---|---|
| Project/Site: | Uniontown Landfill | Project No: 1270.002 | Date: 16-Sep-1999 |
| Applicant/Owner: | International Landfill Mngt. | | County: Perry |
| Investigators: | Smith/McCleod | | State: Alabama |
| | | | Plot ID: 23 |

**SOILS**

Map Unit Name (Series and Phase): Unknown
Map Symbol: Unk Drainage Class:
Taxonomy (Subgroup):
Mapped Hydric Inclusion?
Field Observations Confirm Mapped Type? Yes (No)
Profile Description

| Depth (inches) | Horizon | Matrix Color (Munsell Moist) | Mottle Color (Munsell Moist) | Mottle Abundance/Contrast | | Texture, Concretions, Structure, etc |
|---|---|---|---|---|---|---|
| 0-12 | | 5Y3/2 | N/A | N/A | N/A | Clay |

Hydric Soil Indicators:

| | |
|---|---|
| NO Histosol | NO Concretions |
| NO Histic Epipedon | NO High Organic Content in Surface Layer in Sandy Soils |
| NO Sulfidic Odor | NO Organic Streaking in Sandy Soils |
| NO Aquic Moisture Regime | NO Listed on Local Hydric Soils List |
| NO Reducing Conditions | NO Listed on National Hydric Soils List |
| NO Gleyed or Low Chroma Colors | NO Other (Explain in Remarks) |

Remarks:
No mottles.

**WETLAND DETERMINATION**

| | | |
|---|---|---|
| Hydrophytic Vegetation Present? | Yes (No) | Is the Sampling Point within the Wetland? Yes (No) |
| Wetland Hydrology Present? | Yes (No) | |
| Hydric Soils Present? | Yes (No) | |

Remarks:



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# DATA FORM
# ROUTINE WETLAND DETERMINATION
## *(1987 COE Wetlands Delineation Manual)*

| | | | |
|---|---|---|---|
| Project/Site: | Uniontown Landfill | Project No: 1270.002 | Date: 17-Sep-1999 |
| Applicant/Owner: | International Landfill Mngt. | | County: Perry |
| nvestigators: | Smith/McCleod | | State: Alabama |
| | | | Plot ID: 24 |

| | | | |
|---|---|---|---|
| Do Normal Circumstances exist on the site? | (Yes) | No | Community ID: PEM1B |
| Is the site significantly disturbed (Atypical Situation:)? | Yes | (No) | Transect ID: M line |
| Is the area a potential Problem Area? | Yes | (No) | Field Location: |
| (If needed, explain on the reverse side) | | | Jurisdictional Wetland 13 |

VEGETATION (USFWS Region No. 2)

| Dominant Plant Species(Latin/Common) | Stratum | Indicator | Plant Species(Latin/Common) | Stratum | Indicator |
|---|---|---|---|---|---|
| *Juncus effusus* | Herb | FACW+ | *Boehmeria cylindrica* | Herb | FACW+ |
| Rush,Soft | | | False-Nettle,Small-Spike | | |

Percent of Dominant Species that are OBL, FACW or FAC: (excluding FAC-) 2/2 = 100.00%

FAC Neutral: 2/2 = 100.00%
Numeric Index: 4/2 = 2.00

Remarks:
On small patch of head-high black willow (Salix nigra)

HYDROLOGY

NO Recorded Data(Describe in Remarks):
- N/A Stream, Lake or Tide Gauge
- N/A Aerial Photographs
- N/A Other

YES No Recorded Data

Field Observations

| | |
|---|---|
| Depth of Surface Water: | N/A *(in.)* |
| Depth to Free Water in Pit: | N/A *(in.)* |
| Depth to Saturated Soil: | N/A *(in.)* |

Wetland Hydrology Indicators

Primary Indicators
- NO Inundated
- NO Saturated in Upper 12 Inches
- YES Water Marks
- NO Drift Lines
- NO Sediment Deposits
- YES Drainage Patterns in Wetlands

Secondary Indicators
- NO Oxidized Root Channels in Upper 12 Inches
- NO Water-Stained Leaves
- NO Local Soil Survey Data
- NO FAC-Neutral Test
- NO Other(Explain in Remarks)

Remarks:
Side finger of Tayloe creek near dam and road.



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# DATA FORM
# ROUTINE WETLAND DETERMINATION
## *(1987 COE Wetlands Delineation Manual)*

| | | | |
|---|---|---|---|
| Project/Site: | Uniontown Landfill | Project No: 1270.002 | Date: 17-Sep-1999 |
| Applicant/Owner: | International Landfill Mngt. | | County: Perry |
| Investigators: | Smith/McCleod | | State: Alabama |
| | | | Plot ID: 24 |

SOILS

Map Unit Name (Series and Phase): Unknown
Map Symbol: Unk Drainage Class:
Taxonomy (Subgroup):
Mapped Hydric Inclusion?
Field Observations Confirm Mapped Type? Yes (No)
Profile Description

| Depth (inches) | Horizon | Matrix Color (Munsell Moist) | Mottle Color (Munsell Moist) | Mottle Abundance/Contrast | Texture, Concretions, Structure, etc |
|---|---|---|---|---|---|
| 0-12 | | 10YR3/2 | 10YR5/8 | Common N/A | Clay |

Hydric Soil Indicators:

| | |
|---|---|
| NO Histosol | NO Concretions |
| NO Histic Epipedon | NO High Organic Content in Surface Layer in Sandy Soils |
| NO Sulfidic Odor | NO Organic Streaking in Sandy Soils |
| NO Aquic Moisture Regime | NO Listed on Local Hydric Soils List |
| YES Reducing Conditions | NO Listed on National Hydric Soils List |
| YES Gleyed or Low Chroma Colors | NO Other (Explain in Remarks) |

Remarks:

WETLAND DETERMINATION

| | | | |
|---|---|---|---|
| Hydrophytic Vegetation Present? | (Yes) | No | Is the Sampling Point within the Wetland? (Yes) No |
| Wetland Hydrology Present? | (Yes) | No | |
| Hydric Soils Present? | (Yes) | No | |

Remarks:



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# DATA FORM
# ROUTINE WETLAND DETERMINATION
## *(1987 COE Wetlands Delineation Manual)*

| | | | |
|---|---|---|---|
| Project/Site: | Uniontown Landfill | Project No: 1270.002 | Date: 17-Sep-1999 |
| Applicant/Owner: | International Landfill Mngt. | | County: Perry |
| Investigators: | Smith/McCleod | | State: Alabama |
| | | | Plot ID: 25 |

| | | |
|---|---|---|
| Do Normal Circumstances exist on the site? | (Yes) No | Community ID: Upland |
| Is the site significantly disturbed (Atypical Situation:)? | Yes (No) | Transect ID: M line |
| Is the area a potential Problem Area? | Yes (No) | Field Location: |
| (If needed, explain on the reverse side) | | Jurisdictional Wetland 13 Upland Dt Pt |

VEGETATION (USFWS Region No. 2)

| Dominant Plant Species(Latin/Common) | Stratum | Indicator | Plant Species(Latin/Common) | Stratum | Indicator |
|---|---|---|---|---|---|
| *Juniperus virginiana* | Tree | FACU- | *Celtis laevigata* | Tree | FACW |
| Cedar,Eastern Red | | | Sugar-Berry | | |
| *Toxicodendron radicans* | Herb | FAC | *Celtis laevigata* | Shrub | FACW |
| Ivy,Poison | | | Sugar-Berry | | |
| *Lonicera japonica* | Vine | FAC- | | | |
| Honeysuckle,Japanese | | | | | |
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| | | | | | |

Percent of Dominant Species that are OBL, FACW or FAC: (excluding FAC-) 3/5 = 60.00%

FAC Neutral: 2/3 = 66.67%
Numeric Index: 14/5 = 2.80

Remarks:

HYDROLOGY

NO Recorded Data(Describe in Remarks):
- N/A Stream, Lake or Tide Gauge
- N/A Aerial Photographs
- N/A Other

YES No Recorded Data

Field Observations

| | |
|---|---|
| Depth of Surface Water: | N/A *(in.)* |
| Depth to Free Water in Pit: | N/A *(in.)* |
| Depth to Saturated Soil: | N/A *(in.)* |

Wetland Hydrology Indicators

Primary Indicators
- NO Inundated
- NO Saturated in Upper 12 Inches
- NO Water Marks
- NO Drift Lines
- NO Sediment Deposits
- NO Drainage Patterns in Wetlands

Secondary Indicators
- NO Oxidized Root Channels in Upper 12 Inches
- NO Water-Stained Leaves
- NO Local Soil Survey Data
- NO FAC-Neutral Test
- NO Other(Explain in Remarks)

Remarks:
No signs of hydrology.



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# DATA FORM
# ROUTINE WETLAND DETERMINATION
## *(1987 COE Wetlands Delineation Manual)*

| | | | |
|---|---|---|---|
| Project/Site: | Uniontown Landfill | Project No: 1270.002 | Date: 17-Sep-1999 |
| Applicant/Owner: | International Landfill Mngt. | | County: Perry |
| Investigators: | Smith/McCleod | | State: Alabama |
| | | | Plot ID: 25 |

SOILS

Map Unit Name (Series and Phase): Unknown
Map Symbol: Unk Drainage Class:
Taxonomy (Subgroup):
Mapped Hydric Inclusion?
Field Observations Confirm Mapped Type?. Yes (No)

Profile Description

| Depth (inches) | Horizon | Matrix Color (Munsell Moist) | Mottle Color (Munsell Moist) | Mottle Abundance/Contrast | | Texture, Concretions, Structure, etc |
|---|---|---|---|---|---|---|
| 0-12 | | 10YR3/4 | N/A | N/A | N/A | Clay |

Hydric Soil Indicators:

| | |
|---|---|
| NO Histosol | NO Concretions |
| NO Histic Epipedon | NO High Organic Content in Surface Layer in Sandy Soils |
| NO Sulfidic Odor | NO Organic Streaking in Sandy Soils |
| NO Aquic Moisture Regime | NO Listed on Local Hydric Soils List |
| NO Reducing Conditions | NO Listed on National Hydric Soils List |
| NO Gleyed or Low Chroma Colors | NO Other (Explain in Remarks) |

Remarks:

WETLAND DETERMINATION

| | | |
|---|---|---|
| Hydrophytic Vegetation Present? | (Yes) No | Is the Sampling Point within the Wetland? Yes (No) |
| Wetland Hydrology Present? | Yes (No) | |
| Hydric Soils Present? | Yes (No) | |

Remarks:

# DATA FORM
# ROUTINE WETLAND DETERMINATION
## *(1987 COE Wetlands Delineation Manual)*

| | | | |
|---|---|---|---|
| Project/Site: | Uniontown Landfill | Project No: 1270.002 | Date: 17-Sep-1999 |
| Applicant/Owner: | International Landfill Mngt. | | County: Perry |
| Investigators: | Smith/McCleod | | State: Alabama |
| | | | Plot ID: 26 |

| | | |
|---|---|---|
| Do Normal Circumstances exist on the site? | (Yes) No | Community ID: PEM1B |
| Is the site significantly disturbed (Atypical Situation:)? | Yes (No) | Transect ID: N line |
| Is the area a potential Problem Area? | Yes (No) | Field Location: |
| (If needed, explain on the reverse side) | | Jurisdictional Wetland 14 |

VEGETATION (USFWS Region No. 2)

| Dominant Plant Species(Latin/Common) | Stratum | Indicator | Plant Species(Latin/Common) | Stratum | Indicator |
|---|---|---|---|---|---|
| *Mikania scandens* | Herb | FACW+ | *Juncus effusus* | Herb | FACW+ |
| Hempweed,Climbing | | | Rush,Soft | | |
| *Leersia oryzoides* | Herb | OBL | *Carex sp. (sterile)* | Herb | NI |
| Cutgrass,Rice | | | Sedge, sterile | | |
| *Sparganium sp.* | Herb | OBL | | | |
| Sparganium sp. | | | | | |
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| | |
|---|---|
| Percent of Dominant Species that are OBL, FACW or FAC: (excluding FAC-) 4/4 = 100.00% | FAC Neutral: 4/4 = 100.00%<br>Numeric Index: 6/4 = 1.50 |

Remarks:

HYDROLOGY

NO Recorded Data(Describe in Remarks):
- N/A Stream, Lake or Tide Gauge
- N/A Aerial Photographs
- N/A Other

YES No Recorded Data

Field Observations

| | |
|---|---|
| Depth of Surface Water: | N/A *(in.)* |
| Depth to Free Water in Pit: | N/A *(in.)* |
| Depth to Saturated Soil: | N/A *(in.)* |

Wetland Hydrology Indicators

Primary Indicators
- NO Inundated
- NO Saturated in Upper 12 Inches
- NO Water Marks
- NO Drift Lines
- YES Sediment Deposits
- YES Drainage Patterns in Wetlands

Secondary Indicators
- NO Oxidized Root Channels in Upper 12 Inches
- NO Water-Stained Leaves
- NO Local Soil Survey Data
- NO FAC-Neutral Test
- NO Other(Explain in Remarks)

Remarks:
Along run-around in dammed up area.



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# DATA FORM
# ROUTINE WETLAND DETERMINATION
## *(1987 COE Wetlands Delineation Manual)*

| | | | |
|---|---|---|---|
| Project/Site: | Uniontown Landfill | Project No: 1270.002 | Date: 17-Sep-1999 |
| Applicant/Owner: | International Landfill Mngt. | | County: Perry |
| Investigators: | Smith/McCleod | | State: Alabama |
| | | | Plot ID: 26 |

SOILS

Map Unit Name (Series and Phase): Unknown
Map Symbol: Unk Drainage Class:
Taxonomy (Subgroup):
Mapped Hydric Inclusion?
Field Observations Confirm Mapped Type? Yes (No)

Profile Description

| Depth (inches) | Horizon | Matrix Color (Munsell Moist) | Mottle Color (Munsell Moist) | Mottle Abundance/Contrast | | Texture, Concretions, Structure, etc |
|---|---|---|---|---|---|---|
| 0-12 | | 2.5Y4/2 | 7.5YR4/6 | Many | N/A | Clay |

Hydric Soil Indicators:

- NO Histosol
- NO Histic Epipedon
- NO Sulfidic Odor
- NO Aquic Moisture Regime
- YES Reducing Conditions
- YES Gleyed or Low Chroma Colors
- NO Concretions
- NO High Organic Content in Surface Layer in Sandy Soils
- NO Organic Streaking in Sandy Soils
- NO Listed on Local Hydric Soils List
- NO Listed on National Hydric Soils List
- NO Other (Explain in Remarks)

Remarks:
Soil was mucky.

WETLAND DETERMINATION

| | | | |
|---|---|---|---|
| Hydrophytic Vegetation Present? | (Yes) | No | Is the Sampling Point within the Wetland? (Yes) No |
| Wetland Hydrology Present? | (Yes) | No | |
| Hydric Soils Present? | (Yes) | No | |

Remarks:



WetForm™

# DATA FORM
# ROUTINE WETLAND DETERMINATION
## *(1987 COE Wetlands Delineation Manual)*

| | | | |
|---|---|---|---|
| Project/Site: | Uniontown Landfill | Project No: 1270.002 | Date: 17-Sep-1999 |
| Applicant/Owner: | International Landfill Mngt. | | County: Perry |
| Investigators: | Smith/McCleod | | State: Alabama |
| | | | Plot ID: 27 |

| | | | |
|---|---|---|---|
| Do Normal Circumstances exist on the site? | (Yes) | No | Community ID: Upland |
| Is the site significantly disturbed (Atypical Situation:)? | Yes | (No) | Transect ID: N line |
| Is the area a potential Problem Area? | Yes | (No) | Field Location: |
| (If needed, explain on the reverse side) | | | Jurisdictional Wetland 14 Upland Dt Pt |

VEGETATION (USFWS Region No. 2)

| Dominant Plant Species(Latin/Common) | Stratum | Indicator | Plant Species(Latin/Common) | Stratum | Indicator |
|---|---|---|---|---|---|
| *Toxicodendron radicans* | Herb | FAC | *Ulmus americana* | Tree | FACW |
| Ivy,Poison | | | Elm,American | | |
| *Celtis laevigata* | Tree | FACW | *Campsis radicans* | Herb | FAC |
| Sugar-Berry | | | Trumpet-Creeper | | |
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Percent of Dominant Species that are OBL, FACW or FAC: (excluding FAC-) 4/4 = 100.00%

FAC Neutral: 2/2 = 100.00%

Numeric Index: 10/4 = 2.50

Remarks:

HYDROLOGY

NO Recorded Data(Describe in Remarks):
- N/A Stream, Lake or Tide Gauge
- N/A Aerial Photographs
- N/A Other

YES No Recorded Data

Field Observations

| | |
|---|---|
| Depth of Surface Water: | N/A *(in.)* |
| Depth to Free Water in Pit: | N/A *(in.)* |
| Depth to Saturated Soil: | N/A *(in.)* |

Wetland Hydrology Indicators

Primary Indicators
- NO Inundated
- NO Saturated in Upper 12 Inches
- NO Water Marks
- NO Drift Lines
- NO Sediment Deposits
- NO Drainage Patterns in Wetlands

Secondary Indicators
- NO Oxidized Root Channels in Upper 12 Inches
- NO Water-Stained Leaves
- NO Local Soil Survey Data
- NO FAC-Neutral Test
- NO Other(Explain in Remarks)

Remarks:
No signs of hydrology.



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# DATA FORM
# ROUTINE WETLAND DETERMINATION
## *(1987 COE Wetlands Delineation Manual)*

| | | | |
|---|---|---|---|
| Project/Site: | Uniontown Landfill | Project No: 1270.002 | Date: 17-Sep-1999 |
| Applicant/Owner: | International Landfill Mngt. | | County: Perry |
| Investigators: | Smith/McCleod | | State: Alabama |
| | | | Plot ID: 27 |

SOILS

Map Unit Name (Series and Phase): Unknown
Map Symbol: Unk Drainage Class:
Taxonomy (Subgroup):
Mapped Hydric Inclusion?
Field Observations Confirm Mapped Type? Yes (No)
Profile Description

| Depth (inches) | Horizon | Matrix Color (Munsell Moist) | Mottle Color (Munsell Moist) | Mottle Abundance/Contrast | | Texture, Concretions, Structure, etc |
|---|---|---|---|---|---|---|
| 0-12 | | 10R3/4 | N/A | N/A | N/A | Clay |

Hydric Soil Indicators:

| | |
|---|---|
| NO Histosol | NO Concretions |
| NO Histic Epipedon | NO High Organic Content in Surface Layer in Sandy Soils |
| NO Sulfidic Odor | NO Organic Streaking in Sandy Soils |
| NO Aquic Moisture Regime | NO Listed on Local Hydric Soils List |
| NO Reducing Conditions | NO Listed on National Hydric Soils List |
| NO Gleyed or Low Chroma Colors | NO Other (Explain in Remarks) |

Remarks:

WETLAND DETERMINATION

| | | |
|---|---|---|
| Hydrophytic Vegetation Present? | (Yes) No | Is the Sampling Point within the Wetland? Yes (No) |
| Wetland Hydrology Present? | Yes (No) | |
| Hydric Soils Present? | Yes (No) | |

Remarks:



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# DATA FORM
# ROUTINE WETLAND DETERMINATION
## *(1987 COE Wetlands Delineation Manual)*

| | | | |
|---|---|---|---|
| Project/Site: | Uniontown Landfill | Project No: 1270.002 | Date: 17-Sep-1999 |
| Applicant/Owner: | International Landfill Mngt. | | County: Perry |
| Investigators: | Smith/McCleod | | State: Alabama |
| | | | Plot ID: 28 |

| | | |
|---|---|---|
| Do Normal Circumstances exist on the site? | (Yes) No | Community ID: PEM1B |
| Is the site significantly disturbed (Atypical Situation:)? | Yes (No) | Transect ID: O line |
| Is the area a potential Problem Area? | Yes (No) | Field Location: |
| (If needed, explain on the reverse side) | | Jurisdictional Wetland 15 |

VEGETATION (USFWS Region No. 2)

| Dominant Plant Species(Latin/Common) | Stratum | Indicator | Plant Species(Latin/Common) | Stratum | Indicator |
|---|---|---|---|---|---|
| *Juncus effusus* | Herb | FACW+ | *Cardiospermum halicacabum* | Herb | FAC |
| Rush,Soft | | | Balloonvine | | |
| *Passiflora edulis* | Herb | FACU | *Bidens aristosa* | Herb | FACW |
| Passion-Flower,Purple | | | Beggar-Ticks,Bearded | | |
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Percent of Dominant Species that are OBL, FACW or FAC: (excluding FAC-) 3/4 = 75.00%

FAC Neutral: 2/3 = 66.67%

Numeric Index: 11/4 = 2.75

Remarks:

HYDROLOGY

NO Recorded Data(Describe in Remarks):
- N/A Stream, Lake or Tide Gauge
- N/A Aerial Photographs
- N/A Other

YES No Recorded Data

Field Observations

| | |
|---|---|
| Depth of Surface Water: | N/A *(in.)* |
| Depth to Free Water in Pit: | N/A *(in.)* |
| Depth to Saturated Soil: | N/A *(in.)* |

Wetland Hydrology Indicators

Primary Indicators
- NO Inundated
- NO Saturated in Upper 12 Inches
- NO Water Marks
- NO Drift Lines
- YES Sediment Deposits
- YES Drainage Patterns in Wetlands

Secondary Indicators
- NO Oxidized Root Channels in Upper 12 Inches
- NO Water-Stained Leaves
- NO Local Soil Survey Data
- NO FAC-Neutral Test
- NO Other(Explain in Remarks)

Remarks:
Area is where cattle use to come and drink.



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# DATA FORM
# ROUTINE WETLAND DETERMINATION
## *(1987 COE Wetlands Delineation Manual)*

| | | |
|---|---|---|
| Project/Site: Uniontown Landfill | Project No: 1270.002 | Date: 17-Sep-1999 |
| Applicant/Owner: International Landfill Mngt. | | County: Perry |
| Investigators: Smith/McCleod | | State: Alabama |
| | | Plot ID: 28 |

SOILS

Map Unit Name (Series and Phase): Unknown
Map Symbol: Unk Drainage Class:
Taxonomy (Subgroup):
Mapped Hydric Inclusion?
Field Observations Confirm Mapped Type? Yes (No)
Profile Description

| Depth (inches) | Horizon | Matrix Color (Munsell Moist) | Mottle Color (Munsell Moist) | Mottle Abundance/Contrast | | Texture, Concretions, Structure, etc |
|---|---|---|---|---|---|---|
| 0-12 | | 2.5Y4/2 | 7.5YR4/6 | N/A | N/A | Clay |

Hydric Soil Indicators:

- NO Histosol
- NO Histic Epipedon
- NO Sulfidic Odor
- NO Aquic Moisture Regime
- YES Reducing Conditions
- YES Gleyed or Low Chroma Colors
- NO Concretions
- NO High Organic Content in Surface Layer in Sandy Soils
- NO Organic Streaking in Sandy Soils
- NO Listed on Local Hydric Soils List
- NO Listed on National Hydric Soils List
- NO Other (Explain in Remarks)

Remarks:
Soil was mucky.

WETLAND DETERMINATION

| | | |
|---|---|---|
| Hydrophytic Vegetation Present? (Yes) No | Is the Sampling Point within the Wetland? (Yes) No | |
| Wetland Hydrology Present? (Yes) No | | |
| Hydric Soils Present? (Yes) No | | |

Remarks:

# DATA FORM
# ROUTINE WETLAND DETERMINATION
## *(1987 COE Wetlands Delineation Manual)*

| | | | |
|---|---|---|---|
| **Project/Site:** | Uniontown Landfill | **Project No:** 1270.002 | **Date:** 17-Sep-1999 |
| **Applicant/Owner:** | International Landfill Mngt. | | **County:** Perry |
| **Investigators:** | Smith/McCleod | | **State:** Alabama |
| | | | **Plot ID:** 29 |

| | | |
|---|---|---|
| Do Normal Circumstances exist on the site? | (Yes) No | **Community ID:** Upland |
| Is the site significantly disturbed (Atypical Situation:)? | Yes (No) | **Transect ID:** O line |
| Is the area a potential Problem Area? | Yes (No) | **Field Location:** |
| (If needed, explain on the reverse side) | | Jurisdictional Wetland 15 Upland Dt Pt |

**VEGETATION** (USFWS Region No. 2)

| Dominant Plant Species(Latin/Common) | Stratum | Indicator | Plant Species(Latin/Common) | Stratum | Indicator |
|---|---|---|---|---|---|
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| | |
|---|---|
| **Percent of Dominant Species that are OBL, FACW or FAC:** (excluding FAC-) 0/0 = 0.00% | FAC Neutral: 0/0 = 0.00%<br>Numeric Index: 0/0 = 0.00 |

**Remarks:**
Same as upland data point for jurisdictional wetland N

**HYDROLOGY**

NO Recorded Data(Describe in Remarks):
- N/A Stream, Lake or Tide Gauge
- N/A Aerial Photographs
- N/A Other

YES No Recorded Data

**Field Observations**

| | |
|---|---|
| Depth of Surface Water: | N/A *(in.)* |
| Depth to Free Water in Pit: | N/A *(in.)* |
| Depth to Saturated Soil: | N/A *(in.)* |

**Wetland Hydrology Indicators**

Primary Indicators
- NO Inundated
- NO Saturated in Upper 12 Inches
- NO Water Marks
- NO Drift Lines
- NO Sediment Deposits
- NO Drainage Patterns in Wetlands

Secondary Indicators
- NO Oxidized Root Channels in Upper 12 Inches
- NO Water-Stained Leaves
- NO Local Soil Survey Data
- NO FAC-Neutral Test
- NO Other(Explain in Remarks)

**Remarks:**
Same as jurisdictional wetland N.

# DATA FORM
# ROUTINE WETLAND DETERMINATION
## *(1987 COE Wetlands Delineation Manual)*

| | | | |
|---|---|---|---|
| Project/Site: | Uniontown Landfill | Project No: 1270.002 | Date: 17-Sep-1999 |
| Applicant/Owner: | International Landfill Mngt. | | County: Perry |
| Investigators: | Smith/McCleod | | State: Alabama |
| | | | Plot ID: 29 |

**SOILS**

Map Unit Name (Series and Phase): Unknown
Map Symbol: Unk Drainage Class:
Taxonomy (Subgroup):
Mapped Hydric Inclusion?
Field Observations Confirm Mapped Type? Yes (No)
Profile Description

| Depth (inches) | Horizon | Matrix Color (Munsell Moist) | Mottle Color (Munsell Moist) | Mottle Abundance/Contrast | | Texture, Concretions, Structure, etc |
|---|---|---|---|---|---|---|
| 0-12 | | 10YR3/4 | N/A | N/A | N/A | Clay |

Hydric Soil Indicators:

| | |
|---|---|
| NO Histosol | NO Concretions |
| NO Histic Epipedon | NO High Organic Content in Surface Layer in Sandy Soils |
| NO Sulfidic Odor | NO Organic Streaking in Sandy Soils |
| NO Aquic Moisture Regime | NO Listed on Local Hydric Soils List |
| NO Reducing Conditions | NO Listed on National Hydric Soils List |
| NO Gleyed or Low Chroma Colors | NO Other (Explain in Remarks) |

Remarks:
Same as jurisdictional wetland N.

**WETLAND DETERMINATION**

| | | |
|---|---|---|
| Hydrophytic Vegetation Present? | Yes (No) | Is the Sampling Point within the Wetland? Yes (No) |
| Wetland Hydrology Present? | Yes (No) | |
| Hydric Soils Present? | Yes (No) | |

Remarks:



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# DATA FORM
# ROUTINE WETLAND DETERMINATION
## *(1987 COE Wetlands Delineation Manual)*

| | | | |
|---|---|---|---|
| Project/Site: | Uniontown Landfill | Project No: 1270.002 | Date: 17-Sep-1999 |
| Applicant/Owner: | International Landfill Mngt. | | County: Perry |
| nvestigators: | Smith/McCleod | | State: Alabama |
| | | | Plot ID: 30 |

| | | | |
|---|---|---|---|
| Do Normal Circumstances exist on the site? | (Yes) | No | Community ID: PEM1B/PFO1B |
| Is the site significantly disturbed (Atypical Situation:)? | Yes | (No) | Transect ID: P line |
| Is the area a potential Problem Area? | Yes | (No) | Field Location: |
| (If needed, explain on the reverse side) | | | Jursidictional Wetland 16 |

VEGETATION (USFWS Region No. 2)

| Dominant Plant Species(Latin/Common) | Stratum | Indicator | Plant Species(Latin/Common) | Stratum | Indicator |
|---|---|---|---|---|---|
| *Boehmeria cylindrica* | Herb | FACW+ | *Acer negundo* | Tree | FACW |
| False-Nettle,Small-Spike | | | Box-Elder | | |
| *Populus deltoides* | Tree | FAC+ | *Fraxinus pennsylvanica* | Tree | FACW |
| Cotton-Wood,Eastern | | | Ash,Green | | |
| *Salix nigra* | Tree | OBL | *Fraxinus pennsylvanica* | Shrub | FACW |
| Willow,Black | | | Ash,Green | | |
| *Campsis radicans* | Herb | FAC | *Lonicera japonica* | Herb | FAC- |
| Trumpet-Creeper | | | Honeysuckle,Japanese | | |
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| | | | | | |

Percent of Dominant Species that are OBL, FACW or FAC: (excluding FAC-) 7/8 = 87.50%

FAC Neutral: 5/5 = 100.00%
Numeric Index: 18/8 = 2.25

Remarks:

HYDROLOGY

NO Recorded Data(Describe in Remarks):
- N/A Stream, Lake or Tide Gauge
- N/A Aerial Photographs
- N/A Other

YES No Recorded Data

Field Observations

| | |
|---|---|
| Depth of Surface Water: | N/A *(in.)* |
| Depth to Free Water in Pit: | N/A *(in.)* |
| Depth to Saturated Soil: | N/A *(in.)* |

Wetland Hydrology Indicators

Primary Indicators
- NO Inundated
- NO Saturated in Upper 12 Inches
- NO Water Marks
- NO Drift Lines
- NO Sediment Deposits
- YES Drainage Patterns in Wetlands

Secondary Indicators
- NO Oxidized Root Channels in Upper 12 Inches
- NO Water-Stained Leaves
- NO Local Soil Survey Data
- NO FAC-Neutral Test
- NO Other(Explain in Remarks)

Remarks:
Soppy area below dam on farm pond. Stream channel starts just below wetland.



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# DATA FORM
# ROUTINE WETLAND DETERMINATION
## *(1987 COE Wetlands Delineation Manual)*

| | | | |
|---|---|---|---|
| Project/Site: | Uniontown Landfill | Project No: 1270.002 | Date: 17-Sep-1999 |
| Applicant/Owner: | International Landfill Mngt. | | County: Perry |
| Investigators: | Smith/McCleod | | State: Alabama |
| | | | Plot ID: 30 |

SOILS

Map Unit Name (Series and Phase): Unknown
Map Symbol: Unk Drainage Class:
Taxonomy (Subgroup):
Mapped Hydric Inclusion?
Field Observations Confirm Mapped Type? Yes (No)
Profile Description

| Depth (inches) | Horizon | Matrix Color (Munsell Moist) | Mottle Color (Munsell Moist) | Mottle Abundance/Contrast | | Texture, Concretions, Structure, etc |
|---|---|---|---|---|---|---|
| 0-6 | | 10YR4/3 | N/A | N/A | N/A | Clay |
| 6-12 | | 10YR3/2 | 7.5YR5/8 | Few | N/A | Clay |

Hydric Soil Indicators:

- NO Histosol
- NO Histic Epipedon
- NO Sulfidic Odor
- NO Aquic Moisture Regime
- YES Reducing Conditions
- YES Gleyed or Low Chroma Colors
- NO Concretions
- NO High Organic Content in Surface Layer in Sandy Soils
- NO Organic Streaking in Sandy Soils
- NO Listed on Local Hydric Soils List
- NO Listed on National Hydric Soils List
- NO Other (Explain in Remarks)

Remarks:

WETLAND DETERMINATION

| | | | |
|---|---|---|---|
| Hydrophytic Vegetation Present? | (Yes) | No | Is the Sampling Point within the Wetland? (Yes) No |
| Wetland Hydrology Present? | (Yes) | No | |
| Hydric Soils Present? | (Yes) | No | |

Remarks:

# DATA FORM
# ROUTINE WETLAND DETERMINATION
## *(1987 COE Wetlands Delineation Manual)*

| | | | |
|---|---|---|---|
| Project/Site: | Uniontown Landfill | Project No: 1270.002 | Date: 17-Sep-1999 |
| Applicant/Owner: | International Landfill Mngt. | | County: Perry |
| Investigators: | Smith/McCleod | | State: Alabama |
| | | | Plot ID: 31 |

| | | | |
|---|---|---|---|
| Do Normal Circumstances exist on the site? | (Yes) | No | Community ID: Upland |
| Is the site significantly disturbed (Atypical Situation:)? | Yes | (No) | Transect ID: P line |
| Is the area a potential Problem Area? | Yes | (No) | Field Location: |
| (If needed, explain on the reverse side) | | | Jurisdictional Wetland 16 Upland Dt Pt |

VEGETATION (USFWS Region No. 2)

| Dominant Plant Species(Latin/Common) | Stratum | Indicator | Plant Species(Latin/Common) | Stratum | Indicator |
|---|---|---|---|---|---|
| *Solidago altissima* | Herb | FACU+ | *Juniperus virginiana* | Tree | FACU- |
| Golden-Rod,Tall | | | Cedar,Eastern Red | | |
| *Fescue sp.* | Herb | UPL | *Juniperus virginiana* | Shrub | FACU- |
| Fescue sp. | | | Cedar,Eastern Red | | |
| *Diospyros virginiana* | Tree | FAC | *Toxicodendron radicans* | Herb | FAC |
| Persimmon,Common | | | Ivy,Poison | | |
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Percent of Dominant Species that are OBL, FACW or FAC: (excluding FAC-) 2/6 = 33.33%

FAC Neutral: 0/4 = 0.00%
Numeric Index: 23/6 = 3.83

Remarks:

HYDROLOGY

NO Recorded Data(Describe in Remarks):
- N/A Stream, Lake or Tide Gauge
- N/A Aerial Photographs
- N/A Other

YES No Recorded Data

Field Observations

| | |
|---|---|
| Depth of Surface Water: | N/A *(in.)* |
| Depth to Free Water in Pit: | N/A *(in.)* |
| Depth to Saturated Soil: | N/A *(in.)* |

Wetland Hydrology Indicators

Primary Indicators
- NO Inundated
- NO Saturated in Upper 12 Inches
- NO Water Marks
- NO Drift Lines
- NO Sediment Deposits
- NO Drainage Patterns in Wetlands

Secondary Indicators
- NO Oxidized Root Channels in Upper 12 Inches
- NO Water-Stained Leaves
- NO Local Soil Survey Data
- NO FAC-Neutral Test
- NO Other(Explain in Remarks)

Remarks:
No signs of hydrology.



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# DATA FORM
## ROUTINE WETLAND DETERMINATION
### *(1987 COE Wetlands Delineation Manual)*

| | | | |
|---|---|---|---|
| Project/Site: | Uniontown Landfill | Project No: 1270.002 | Date: 17-Sep-1999 |
| Applicant/Owner: | International Landfill Mngt. | | County: Perry |
| nvestigators: | Smith/McCleod | | State: Alabama |
| | | | Plot ID: 31 |

SOILS

Map Unit Name (Series and Phase): Unknown
Map Symbol: Unk Drainage Class:
Taxonomy (Subgroup):
Mapped Hydric Inclusion?
Field Observations Confirm Mapped Type? Yes (No)

Profile Description

| Depth (inches) | Horizon | Matrix Color (Munsell Moist) | Mottle Color (Munsell Moist) | Mottle Abundance/Contrast | | Texture, Concretions, Structure, etc |
|---|---|---|---|---|---|---|
| 0-12 | | 10YR7/2 | N/A | N/A | N/A | Clay |

Hydric Soil Indicators:

| | |
|---|---|
| NO Histosol | NO Concretions |
| NO Histic Epipedon | NO High Organic Content in Surface Layer in Sandy Soils |
| NO Sulfidic Odor | NO Organic Streaking in Sandy Soils |
| NO Aquic Moisture Regime | NO Listed on Local Hydric Soils List |
| NO Reducing Conditions | NO Listed on National Hydric Soils List |
| NO Gleyed or Low Chroma Colors | NO Other (Explain in Remarks) |

Remarks:

WETLAND DETERMINATION

| | | | |
|---|---|---|---|
| Hydrophytic Vegetation Present? | Yes (No) | Is the Sampling Point within the Wetland? | Yes (No) |
| Wetland Hydrology Present? | Yes (No) | | |
| Hydric Soils Present? | Yes (No) | | |

Remarks:

# APPENDIX E

## U.S. Fish and Wildlife Service Clearance

RECEIVED
JUN 15 2005

JORDAN
JONES &
GOULDING

6801 Governors Lake Parkway
Building 200
Norcross, Georgia 30071
T 770.455.8555
F 770.455.7391
www.jjg.com

June 14, 2005

Mr. Larry E. Goldman
Field Supervisor
United States Department of the Interior
Fish and Wildlife Services
P.O. Box Drawer 1190
Daphne, Alabama 36526

RE: Site Analysis Report Update
Perry County Associates MSW Landfill
Perry County, Alabama

Dear Mr. Goldman,

On behalf of Perry County Associates (PCA) Jordan, Jones & Goulding (JJG) is currently updating the Site Acceptability Report and Solid Waste Permit Application for the Perry County, Alabama landfill development project. In a letter dated October 26, 2001, the U.S. Fish and Wildlife Service (USFWS) issued a letter concurring that no threatened or endangered species occur in the project area. A copy of the letter is attached for your reference.

In June of 2003, the permitting process for the proposed Perry County MSWLF was temporarily halted. In May of 2005, the permitting process was resumed by PCA.

As part of the SAR revision process, JJG performed a review of the most current Threatened and Endangered Species (T&E) list for Perry County, Alabama. The review showed that no threatened or endangered species have been added to the T&E list since the issuance of the USFWS letter of concurrence dated October 26, 2001. Additionally, a site reconnaissance was performed by JJG on May 19, 2005. The review of the threatened and endangered species list, combined with the recent site reconnaissance, showed that the proposed facility will not impact any threatened or endangered species. It should be noted that the boundaries of the site have not been altered in any way, and a site map has been included for your review.

In an effort to ensure that the proposed site remains in compliance with USFWS guidelines, JJG is requesting a revised letter of concurrence from the U.S. Fish and Wildlife Service.

[redacted]

No listed, proposed or candidate specie

Elaine Snyder Conn

Acting U.S. Fish & Wildlife Service Field Supe

6-30-05

P:\4383-001\SiteAcceptability\ltrplan.doc

If you have any questions or need additional information, please do not hesitate to contact us.

Sincerely,

JORDAN, JONES & GOULDING, INC.

Leo F. Gentile, P.G.
Service Leader

Copy to: Larry Matthews – PCA
Mark Ballard - JJG
Project File

Jordan Jones & Goulding INCORPORATED

# Appendix F

## Letter of Concurrence Army Corps of Engineers (Wetlands)

## Alabama State Historic Preservation Office – Letter of Certification and Environmental Resources Analysis, Inc. Report

# MEMORANDUM OF AGREEMENT

**Parties Involved:**

Perry County Associates, LLC
Alabama Historical Commission

COPY

**Purpose:**

To establish that documentary research, history, and archeological investigation of certain areas of the proposed Subtitle D landfill property located in Perry County, Alabama will be completed and fulfill all the requirements specified by the Alabama Department of Environmental Management (ADEM) and the Alabama Historical Commission (AHC). In turn, AHC agrees that the landfill to be constructed as described in the Site Plan (Sheet 2 and attached to this document as Exhibit A) Design and Operations Plan Perry County Associates (PCA) Solid Waste Landfill (June 2005) meets the requirement of Alabama Solid Waste Program regulation 335-13-4 (1)(e).

**Conditions:**

PCA Agrees to:

1. Complete the documentary research and history on Rural Hill Plantation and Phase II archeological investigation in accordance with AHC Guidance. The Phase II archeological investigation will commence no later than two (2) years after landfill operation (waste acceptance) has begun. Upon receipt of an ADEM Solid Waste Disposal Facility Permit, PCA shall post a performance bond made payable to the Alabama Historical Commission in the amount required to complete the needed archeology to assure that the Phase II archeological investigation is conducted.

2. Utilize archeologists who meet the professional standards set forth in 36 CFR 57 for all field investigations.

3. Avoid and preserve the area associated with the area identified in the report entitled "Archaeological Survey and Cultural Resource Evaluation of a Proposed Landfill in Perry County, Alabama near Uniontown" (labeled as Exhibit B and attached to this document) as the Old Plantation Cemetery, delineate a 100-foot buffer zone around the cemetery, and maintain access to the area for the descendents of those interred within.

4. Avoid and preserve in perpetuity eight areas and the area reported to be a historic cemetery identified in the Phase I archeological testing until additional archeological investigations are complete and that AHC agrees that these eight sites have been characterized in accordance with AHC guidance. Protection of these areas would not be required if they are deemed not eligible for the National Register of Historic Places and agreed to by AHC, or if these areas are mitigated completely.

5. Establish a 100-foot buffer by erecting permanent fencing around of each of the eight sites and the area reported to be a historic cemetery.

6. Erect signs identifying the eight sites and the area reported to be a historic cemetery as environmentally sensitive areas that shall be avoided by construction activities, equipment storage, and traffic. Construction workers will receive awareness training as to the nature of these sites and sensitivity to not disturbing them.

7. Approval of the proposed landfill footprint as represented on the Design and Operations Plans (dated June 2005) by AHC does not constitute approval for any future modifications to the planned construction. Both ADEM and AHC approval is required for construction in such new areas of construction.

8. Comply with all the requirements of the ADEM Land Division - Solid Waste Program.

9. Record with the property deed an easement to AHC, (or a mutually-agreed third party) to protect any site identified in the Phase II investigation as being eligible for the National Register of Historic Places.

10. Distribute copies of the reports and historical documentation discovered during and generated by this investigation to libraries in Perry and Dallas Counties, Alabama. A brief educational summary will also be prepared for use by the general public and educators in these counties in their curricula. AHC shall have the opportunity to review and approve these documents prior to disseminating to the public.

11. The parties concur that the landfill footprint as shown in the Design and Operations Plan Perry County Associates (PCA) Solid Waste Landfill (June 2005) does not lie in any of the eight sites or potential cemetery, or buffers established to protect them. If artifacts or cultural remains are found during construction, work shall cease in that area and AHC shall be notified immediately. Construction will not continue in that area until AHC and PCA reach an agreement regarding the cultural significance of that area.

12. If a dispute arises out of or relates to this Memorandum, or the breach thereof, and if the dispute cannot be settled through negotiation, the Parties agree first to try in good faith to settle the dispute by mediation administered by the American Arbitration Association under its Commercial Mediation Procedures before resorting to arbitration, litigation, or some other dispute resolution procedure.

    In the event that any such dispute is not resolved through the above referenced mediation process, said such dispute relating to this Memorandum, or the breach thereof, shall be settled by arbitration administered by the American Arbitration Association under its Commercial Arbitration Rules, and judgment on the award rendered by the arbitrator(s) may be entered in any court having jurisdiction thereof.

13. This memorandum of agreement shall be null and void in the event that a solid waste disposal facility permit is not issued by ADEM to PCA, or if PCA decides to otherwise not pursue development of the property.

**Agreed to by:**

PERRY COUNTY ASSOCIATES, LLC

Larry Matthews
President

10-11-05
Date

ALABAMA HISTORICAL COMMISSION

Elizabeth Ann Brown
Deputy State Historic Preservation Officer

September 20, 2005
Date

DEPARTMENT OF THE ARMY
MOBILE DISTRICT, CORPS OF ENGINEERS
P.O. BOX 2288
MOBILE, ALABAMA 36628-0001

ECOLOGICAL SOLUTIONS, INC.
RECEIVED
MAY 16 2003

May 13, 2003

REPLY TO
ATTENTION OF:

Regulatory Branch
Operations Division

SUBJECT: Perry County Landfill Project - Jurisdictional Number ALJ03-01547-N

Ecological Solutions
Attention: Mr. David W. Smith
630 Colonial Park Drive, Suite 200
Roswell, Georgia 30075

Dear Mr. Smith:

Reference is made to your letter requesting clarification of our jurisdictional determination, ALJ01-03736-N, concerning a verification of delineated wetland boundaries and the subsequent development of the proposed Perry County Landfill in Uniontown, Perry County, Alabama.

Based upon the current "Final Grade - Site Plan" submitted to this office, we concur that the project is designed to avoid all jurisdictional waters including wetlands, (see enclosure titled "Basis for Jurisdictional Determination") at the project site. A Department of the Army permit pursuant to Section 404 of the Clean Water Act will not be required provided development of the site does not degrade or significantly destroy wetlands.

Please be advised that this jurisdictional determination reflects current policy and regulation and is valid for a period of 5 years from the date of this letter. If after the 5-year period this jurisdictional determination has not been specifically revalidated by the U.S. Army Corps of Engineers, it shall automatically expire. Should you disagree with certain terms and/or conditions of this determination, the enclosed Notification of Applicant Options outlines the steps to take to file your objection.

The statements contained herein do not convey any property rights or any exclusive privileges, and do not authorize any injury to property or obviate the requirements to obtain other local, State, or Federal assent required by law for the activities discussed above.

If the scope of work or project location changes, you are urged to contact this office for a verification of this determination. Thank you for your cooperation with our permit program. If you have any questions concerning this matter, please contact Mr. Troy L. Ephriam of the Enforcement Section at (251) 694-3783.

Sincerely,

for Ronald A. Krizman
Chief, Regulatory Branch
Operations Division

Enclosure

## NOTIFICATION OF ADMINISTRATIVE APPEAL OPTIONS AND PROCESS AND REQUEST FOR APPEAL

| Applicant: Perry County Landfill c/o Eco. Solutions | File Number:ALJ03-01547-N | Date: 13 MAY 03 |
|---|---|---|
| Attached is: | | See Section below |
| | INITIAL PROFFERED PERMIT (Standard Permit or Letter of permission) | A |
| | PROFFERED PERMIT (Standard Permit or Letter of permission) | B |
| | PERMIT DENIAL | C |
| X | APPROVED JURISDICTIONAL DETERMINATION | D |
| | PRELIMINARY JURISDICTIONAL DETERMINATION | E |

SECTION I - The following identifies your rights and options regarding an administrative appeal of the above decision. Additional information may be found at http://usace.army.mil/inet/functions/cw/cecwo/reg or Corps regulations at 33 CFR Part 331.

A: INITIAL PROFFERED PERMIT: You may accept or object to the permit.

- ACCEPT: If you received a Standard Permit, you may sign the permit document and return it to the district engineer for final authorization. If you received a Letter of Permission (LOP), you may accept the LOP and your work is authorized. Your signature on the Standard Permit or acceptance of the LOP means that you accept the permit in its entirety, and waive all rights to appeal the permit, including its terms and conditions, and approved jurisdictional determinations associated with the permit.
- OBJECT: If you object to the permit (Standard or LOP) because of certain terms and conditions therein, you may request that the permit be modified accordingly. You must complete Section II of this form and return the form to the district engineer. Your objections must be received by the district engineer within 60 days of the date of this notice, or you will forfeit your right to appeal the permit in the future. Upon receipt of your letter, the district engineer will evaluate your objections and may: (a) modify the permit to address all of your concerns, (b) modify the permit to address some of your objections, or (c) not modify the permit having determined that the permit should be issued as previously written. After evaluating your objections, the district engineer will send you a proffered permit for your reconsideration, as indicated in Section B below.

B: PROFFERED PERMIT: You may accept or appeal the permit

- ACCEPT: If you received a Standard Permit, you may sign the permit document and return it to the district engineer for final authorization. If you received a Letter of Permission (LOP), you may accept the LOP and your work is authorized. Your signature on the Standard Permit or acceptance of the LOP means that you accept the permit in its entirety, and waive all rights to appeal the permit, including its terms and conditions, and approved jurisdictional determinations associated with the permit.
- APPEAL: If you choose to decline the proffered permit (Standard or LOP) because of certain terms and conditions therein, you may appeal the declined permit under the Corps of Engineers Administrative Appeal Process by completing Section II of this form and sending the form to the division engineer. This form must be received by the division engineer within 60 days of the date of this notice.

C: PERMIT DENIAL: You may appeal the denial of a permit under the Corps of Engineers Administrative Appeal Process by completing Section II of this form and sending the form to the division engineer. This form must be received by the division engineer within 60 days of the date of this notice.

D: APPROVED JURISDICTIONAL DETERMINATION: You may accept or appeal the approved JD or provide new information.

- ACCEPT: You do not need to notify the Corps to accept an approved JD. Failure to notify the Corps within 60 days of the date of this notice, means that you accept the approved JD in its entirety, and waive all rights to appeal the approved JD.
- APPEAL: If you disagree with the approved JD, you may appeal the approved JD under the Corps of Engineers Administrative Appeal Process by completing Section II of this form and sending the form to the division engineer. This form must be received by the division engineer within 60 days of the date of this notice.

PRELIMINARY JURISDICTIONAL DETERMINATION: You do not need to respond to the Corps regarding the preliminary JD. The Preliminary JD is not appealable. If you wish, you may request an approved JD (which may be appealed), by contacting the Corps district for further instruction. Also you may provide new information for further consideration by the Corps to reevaluate the JD.

## SECTION II - REQUEST FOR APPEAL or OBJECTIONS TO AN INITIAL PROFFERED PERMIT

REASONS FOR APPEAL OR OBJECTIONS: (Describe your reasons for appealing the decision or your objections to an initial proffered permit in clear concise statements. You may attach additional information to this form to clarify where your reasons or objections are addressed in the administrative record.)

ADDITIONAL INFORMATION: The appeal is limited to a review of the administrative record, the Corps memorandum for the record of the appeal conference or meeting, and any supplemental information that the review officer has determined is needed to clarify the administrative record. Neither the appellant nor the Corps may add new information or analyses to the record. However, you may provide additional information to clarify the location of information that is already in the administrative record.

## POINT OF CONTACT FOR QUESTIONS OR INFORMATION:

| | |
|---|---|
| If you have questions regarding this decision and/or the appeal process you may contact:<br>MR. TROY EPHRIAM<br>CESAM-OP-S<br>U.S. ARMY CORPS OF ENGINEERS<br>POST OFFICE BOX 2288<br>MOBILE, ALABAMA 36628-0001<br>(334) 694-3783 | If you only have questions regarding the appeal process you may also contact:<br>MR. ARTHUR L. MIDDLETON, JR.<br>REGULATORY APPEAL REVIEW OFFICER<br>ROOM 9M15<br>60 FORSYTH STREET SOUTHWEST<br>ATLANTA, GEORGIA 30303-8801<br>(404) 562-5136 |

RIGHT OF ENTRY: Your signature below grants the right of entry to Corps of Engineers personnel, and any government consultants, to conduct investigations of the project site during the course of the appeal process. You will be provided a 15 day notice of any site investigation, and will have the opportunity to participate in all site investigations.

| | | |
|---|---|---|
| Signature of appellant or agent. | Date: | Telephone number: |

# BASIS FOR JURISDICTIONAL DETERMINATION

U.S. Army Corps of Engineers, Mobile District

APPLICANT: Perry County Landfill

PROJECT LOCATION/WATERWAY: NO WATERWAY

FILE NUMBER: MJ03-01547-N

PROJECT REVIEW COMPLETED: ☒ Office ☐ Field

Type of Waters of the United States Present on the project site:

- ☐ Waters which are currently used, or were used in the past, or may be susceptible for use to use in interstate or foreign commerce, including all waters which are subject to the ebb and flow of the tide.
- ☐ Interstate waters including interstate wetlands.
- ☒ Other waters such as intrastate lakes, rivers, streams (including intermittent streams), mudflats, sandflats, wetlands, sloughs, prairie potholes, wet meadows, playa lakes, or natural ponds, the use, degradation or destruction of which could affect interstate or foreign commerce including any such waters:
  - (i) Which are or could be used by interstate or foreign travelers for recreational or other purposes: or
  - (ii) From which fish or shellfish are or could be taken and sold in interstate or foreign commerce; or
  - (iii) Which are used or could be used for industrial purpose by industries in interstate commerce.
- ☐ Impoundments of waters otherwise defined as waters of the United States under the definition.
- ☐ Tributaries of waters defined in the four items above.
- ☐ The territorial seas.
- ☐ Wetlands adjacent to waters (other than waters that are themselves wetlands) identified in the six items above.

Summary of Indicators supporting the Corps Jurisdiction determination:

- ☒ Wetland (Corps Wetland Delineation Manual (87 Manual)):
  - ☐ Hydrology _____
  - ☐ Hydric soils _____
  - ☐ Hydrophytic Vegetation _____
- ☐ Adjacency _____
- ☐ Tributary connection _____
- ☐ Interstate or Foreign Commerce _____
- ☐ Navigation _____

Lateral Extent of Jurisdiction (33 CFR 328 and 329):

☒ Ordinary High Water Mark indicated by:
- ☐ clear, natural line impressed on the bank
- ☐ the presence of litter and debris
- ☐ changes in the character of soil
- ☐ destruction of terrestrial vegetation
- ☐ shelving
- ☐ other: _____

☐ High Tide Line indicated by:
- ☐ oil or scum line along shore objects
- ☐ fine shell or debris deposits (foreshore)
- ☐ physical markings/characteristics
- ☐ tidal gages
- ☐ other: _____

☐ Mean High Water Mark indicated by:
- ☐ survey to available datum; ☐ physical markings; ☐ vegetation lines/changes in vegetation types
- ☐ other: _____

- ☐ Within territorial sea _____
- ☐ Other indicators _____

Preparer: EPHRIAM, T. Date: 12 May 03 (Revised Jan 2002)

COPY

# ARCHAEOLOGICAL SURVEY AND CULTURAL RESOURCE EVALUATION OF A PROPOSED LANDFILL IN PERRY COUNTY, ALABAMA NEAR UNIONTOWN

PREPARED FOR:

PERRY COUNTY ASSOCIATES
2280 SATELLITE BLVD.
DULUTH, GA 30097

CONDUCTED BY:

ENVIRONMENTAL RESOURCE ANALYSTS, INC.
AUBURN TECHNOLOGY PARK
2975 BROWN COURT
AUBURN, ALABAMA 36830

Robert H. Campbell — 10/03/01

Robert H. Campbell
Archaeological Consultant

Date

REVIEWED BY:

McDonald Brooms — 10-11-01

McDonald Brooms
Consulting Archaeologist

Date

ERA REPORT NUMBER A-010903

# 1.0 INTRODUCTION

At the request of Perry County Associates an archaeological survey and cultural resource evaluation was conducted by Robert H. Campbell from May 29-August 25, 2001 at the location of a proposed landfill near Uniontown in Perry County, Alabama (Figure 1).

In compliance with current state and federal laws and regulations, this survey was conducted to identify any significant cultural resources present within the project area and evaluate the potential impact of the proposed project on those resources. The area associated with the proposed project was physically inspected by means of intensive surface survey, walked transects, and subsurface testing. An assessment of available archaeological and historical literature was conducted along with a search of the Alabama Site Survey File, the National Register of Historic Places, and the Alabama Register.

This report is submitted as an instrument for the informed management of cultural resources and a copy of this report along with any artifacts recovered in association with this survey will be curated at the Archaeological Research Center, Troy State University in Troy, Alabama. Original photography and field notes will remain at Environmental Resource Analysts, Inc. in Auburn, Alabama. When appropriate, Alabama State Site Files will be submitted to the Office of Archaeological Services, The University of Alabama, Moundville, Alabama.

An investigation of this nature requires the efforts of numerous individuals to be successful and I am most appreciative of the assistance and support given by many people over the course of this investigation. I am especially grateful for the advice and counsel kindly given by Mr. McDonald Brooms, Director of the Archaeological Research Center at Troy State University, and for his review of this report. Dr. Bill Grantham of the Archaeological Research center examined and identified bone fragments recovered during this investigation and Ms. Clarissa Eleam, also of the Archaeological Research Center, reviewed and identified numerous historic artifacts; I am thankful for the help and

expertise of both of these individuals. Commissioner Johnny Flowers provided valuable assistance of which I am most appreciative. Field assistant Myles T. Horne was instrumental in assuring that the investigation stayed on track and progressed to completion.

Mrs. Kitty Gray Long, the current owner of Pitts' Folly and a descendant of Phillip Henry Pitts and Margaret Mary Pitts (early owners of the survey tract), was most generous in providing family oral history, locating individuals who had lived on the survey tract in the past, and in providing a copy of Phillip Henry Pitts' diary and account book. I am grateful for her efforts in helping us learn about the Pitts family and their Rural Hill Plantation which was located within the study area. I also wish to thank Mr. Willie Armstrong for his assistance in providing documentary historical information on Rural Hill Plantation and the potential location of the old cemetery associated with this plantation. Mr. Winston Brown helped in locating individuals who had lived on the property and Mr. Theo Powell also provided documentary historical information. I am thankful to these individuals for their assistance.

## 1.1 PROJECT LOCATION

The survey tract encompassed an area of approximately 925 acres located in the NW ¼ of Section 27, N ½ of SW ¼ of Section 27, portions of the S ½ of SW ¼ of Section 27, NE ¼ of Section 28, portions of the E ½ of the NW ¼ of Section 28, N ½ of the NE ¼ of the SE ¼ of Section 28, portions of the S ½ of the NE ¼ of the SE ¼ of Section 28, portions of the N ½ of the NW ¼ of SE ¼ of Section 28, S ½ of the SE ¼ of Section 21, S ¼ of the N ½ of the SE ¼ of Section 21, S ½ of the SW ¼ of Section 22, and the S ¼ of the N ½ of the SW ¼ of Section 22, Township 17 N, Range 6 E (Figure 1).

## 1.2 PROJECT ENVIRONMENT AND PHYSIOGRAPHY

The tract lies within the Black Prairie physiographic district of the East Gulf Coastal Plain, an area also know as the "Black Belt" and locally as the "Cane-break " region.

This area corresponds with the outcrop of Demopolis chalk, an Upper Cretaceous deposit of fossiliferous brittle chalk, chalky marl, and calcareous clay. Consequently surface soils are weathered cretaceous chalk, marl, and clay and are usually very thin, often with chalk and clay subsoils exposed on the surface and easily eroded on slopes.

Exposed chalk is evident on many sloped areas of the tract and herbaceous prairie growth with numerous young cedars is found across most of the undulating terrain. A few groves of mature oaks, hickories, and various hardwoods are spread sparsely around the property. Selected wetland zones in the bottoms have been previously delineated. Within the Alabama River Basin, elevation within the study area ranged from 200 feet to 280 feet.

## 2.0 LITERATURE AND DOCUMENT SEARCH

In order to assist in the identification of any cultural resources within the survey area, an assessment of available records was conducted. A preliminary search of existing county records including deeds and wills was conducted at the Perry County Courthouse. Local and county histories were examined and preliminary oral history interviews were conducted with local informants. A search of the National Register of Historic Places and the Alabama Register of Landmarks and Heritage was also carried out. A search of the Alabama Site Survey and available previous archaeological survey information was also conducted. A diary and account book of one of the properties earliest owners was located and studied.

## 2.1 ALABAMA SITE SURVEY FILE

No existing archaeological sites have been recorded on or in immediate proximity to the survey tract. Four sites were recorded in the general area of the tract, all of which are considered ineligible for nomination to the National Register. 1 Pe 156 is a late 19$^{th}$-early 20$^{th}$ century house site; 1 Pe 157 is a collapsed early 20$^{th}$ century house; 1Pe 158 is

a destroyed early 20th century shed or garage; 1 Pe 161 is a bulldozed 19th/20th house site. Recorded aboriginal sites are very sparse in this part of the state. A reconnaissance survey was carried out in 1995 north of the survey parameters in association with the proposed U.S. 80 Uniontown Bypass. This proposed bypass will pass to the north of the survey area.

## 2.2 NATIONAL REGISTER OF HISTORIC PLACES

The NRHP lists one property within three miles of the survey tract: "Pitts' Folly" is an antebellum house constructed (1852-1853) by Phillip Henry Pitts on Old Cahaba Road in Uniontown which was listed on August 9, 1984 (Figure 4). The property is located northwest of the project area in Section 18, Township 17 N, Range 6 E and comprises 9.6 acres. Mrs. Kitty Gray Long, a descendant of Phillip Henry Pitts, is the current owner of the property.

## 2.3 PRELIMINARY DOCUMENTARY HISTORY

On July 7th, 2001 an interview was conducted with Mrs. Kitty Gray Long at her home, "Pitts' Folly". Mrs. Long was kind enough to share family oral history, locate individuals who were born and lived on the survey tract, and provide a copy of Phillip Henry Pitts' "Diary and Account Book: September 1850-April 1855" and his "Diary: January 1860-January 1865." The originals of these documents were placed by another family member in the Southern Historical Collection at the University of North Carolina in Chapel Hill. It is not known at this time if additional Pitts family documents may be found in this collection.

Mrs. Long recounted that the area associated with the survey tract had been a wedding gift to Phillip Henry Pitts and Margaret Mary Davidson after their marriage in 1840 by her parents, Col. John Howard Davidson and Martha Caldwell Davidson, and was known as "Rural Hill Plantation". Phillip Henry Pitts makes numerous references to Ruril or

Rurill Hill Plantation in his diaries. It appears from family oral history and documentary sources that Phillip Henry and Margaret Mary Pitts lived on their plantation at Rural Hill before building "Pitts' Folly" and that Mr. Pitts continued to maintain a plantation at Rural Hill thereafter.

Deed Book "P" in the Perry County Courthouse, page 613, contains a deed recorded on November 28, 1862 in which Martha C. Davidson deeds to her daughter Margaret M. Pitts 640 acres which lies within the survey parameters of this project. This deed was recorded after the death of Margaret Pitts' father. Mrs. Davidson stated in the deed that the property had been previously given to the Pitts by her husband and that the Pitts had lived on the property. Preliminary documentary research indicates that this acreage was part of Rural Hill Plantation.

Additional research indicates that the property has remained in the Pitts family with current ownership by Mr. Phillip Henry Pitts of Selma and his sisters. Mr. Pitts of Selma indicated that he had no recollection of anyone ever living on the property.

Oral history interviews were also conducted with Mr. Richard Johnson of Uniontown who had lived on the property as a child, and with Mr. Willie Armstrong of Uniontown who was born on the property in 1921 and lived there until 1951.

Mr. Johnson and Mr. Armstrong recalled several structures on the tract that had served as residences of tenant farmers and other individuals. Nine structures appear on the 1930 USDA Soil Survey Map of Perry County, Alabama and four structures appear on the 1968 USGS Uniontown East Quadrangle. Oral history interviews indicate that the property was bulldozed and cleared of all standing structures in the 1970's. Several historic artifact scatters approximate to structure locations recorded on these maps were located during this investigation.

# 3.0 SURVEY TECHNIQUES / FIELD METHODS

In order to identify and determine the significance of any cultural resources within the project location, a visual inspection of the parcel was carried out by means of sixty-five walked transects at thirty-meter intervals on a North-South basis and a reconnaissance of the surrounding environs was conducted. All exposed areas within and in proximity to the tracts were inspected for any evidence of cultural resources. One thousand seventy-four subsurface shovel tests at least 30 cm in diameter were carried out at a minimum of thirty-meter intervals across the tract where appropriate (Figure 2). Soil from shovel tests was screened through ¼ inch mesh.

Assisting Robert H. Campbell in field investigations were Mr. Myles Horne, Mr. Roddy V. Campbell, Mr. Mickey Horne, Mr. Rodney Duncan, and Dr. Joseph Freda. Photographic documentation of the survey area and all discovered sites was made (Figures 6- 43).

Very thin surface soils were encountered across most portions of the study area consisting of Demopolis-Sumter complex clay loams and Okitibbeha clay loam along upper elevations and slopes with Sumter clay loams in bottoms and lower areas. Underlying Demopolis Chalk was exposed across portions of the tract, especially on slopes.

Generally the tract had been extensively disturbed by decades of plowing and bulldozer activity in the 1970's. Most recently the property had been converted to a quail hunting reserve with numerous open lanes cut across the tract covered in various herbaceous species and cedars. Numerous transects and lanes were bush-hogged during June and July, 2001 to enhance surface visibility and augment completion of fieldwork.

Walked transects at 30 meter intervals were carried out on a north south basis across the entire survey area. Due to the extensively disturbed nature of the site, shovel tests were concentrated in high probability upper terrace and level terrace areas of the tract. Local informants had indicated that structures had been located on terrace locations and not on

slopes. Lower elevation bottom soils were poorly drained and offered negligible opportunity for prehistoric or historic site location.

## 4.0 FINDINGS

Intensive surface survey and shovel testing revealed the presence of thirty-three non-aboriginal historic sites and seven prehistoric aboriginal sites within the survey parameters. Artifact recovery from all forty of these sites was limited to the surface or the very shallow surface soils present across the tract. Artifact scatters were often spread over a large area and often downslope from terraces, a result of extensive cultivation since the 1840's and modern bulldozer activity on shallow surface soils. Positive shovel tests were extremely sparse and limited to the shallow plowzone. No subsurface features were detected.

Preliminary documentary evidence indicates that the 19th century historic artifact scatters were most likely associated with "Rural Hill Plantation". Some artifact scatters contained 20th century artifacts as well. All seven of the aboriginal artifact scatters were sparse and limited to the surface. Temporary site numbers have been assigned with an HS designation to denote Historic Site and an AS designation to denote Aboriginal Site. Alabama State Sites File forms are being submitted for each of these sites and permanent site numbers will be forwarded to the Alabama Historical Commission.

The New Hope Cemetery property on Old Cahaba Road borders the survey tract and numerous graves extend beyond the cemetery property and onto the survey tract.

The attestation of Mr. Willie Armstrong concerning an abandoned "Old Cemetery" and subsequent apparent location of this old plantation cemetery by him within the survey tract is discussed within the following summary.

# 4.1 SUMMARY OF HISTORIC SITES AND CEMETERIES

**HS 1** Very sparse non-aboriginal 19th and 20th century artifact scatter approximately 60m x 120m located on upper slope of upper terrace; Site location approximate with structure location on 1968 USGS Uniontown East Quadrangle; Very sparse surface recovery of old brick, stoneware, porcelain, milk glass, clear glass, and light green glass; One positive shovel test yielding brick fragment in plowzone; Soil profile consisted of 7cm-12cm 10YR 5/4 fine clay over 10 YR 5/6 clay subsoil; Not considered potentially eligible for nomination to the National Register.

**HS 2** Very dense non-aboriginal 19th and 20th century artifact scatter approximately 120m x 150m located on crest and slope of upper terrace; Site location approximate with structure location on 1968 USGS Uniontown East Quadrangle and on 1930 USDA Soil Survey Map of Perry County, Alabama; Dense surface recovery of old and modern brick, plain whiteware, blue feather edge whiteware, decorated blue and white whiteware, porcelain, terra cotta, stoneware, milk glass, clear glass, dark green bottle glass, light green glass, aqua glass, aqua glass bottle top, blue glass, purple glass, brown glass, cut nails, and iron fragments; Three positive shovel tests in the plowzone yielding plain whiteware, brick fragment, and glass; Soil profile consisted of 9cm-12cm 10YR 5/4 fine clay over 10 YR 5/6 clay subsoil. Considered potentially eligible for nomination to the National Register.

Informant survey with 89 year old Mr. Theo Brown of Uniontown: Mr. Brown recalled house at this site was the "Big House". Also informant survey with 79 year old Mr. Willie Armstrong of Uniontown who was born on this plantation: Mr. Armstrong stated that this location was where the "Big House" was located and that it faced west toward the old cemetery.

**HS 3** Moderate non-aboriginal 19th and 20th century artifact scatter approximately 90m x 90m located near crest and on slope of upper terrace; Site location approximate with structure location on 1930 USDA Soil Survey Map of Perry County, Alabama;

Surface recovery of old and modern brick, plain whiteware, modern china, stoneware, clear glass screw-top jar fragments, window pane glass, brown glass, and glass jar lid; One positive shovel test in the plowzone yielding plain whiteware, brick fragment, and glass; Soil profile consisted of 7cm-14cm 10YR 5/4 fine clay over 10 YR 4/3 clay subsoil. Considered potentially eligible for nomination to the National Register.

Informant survey with Mr. Richard Johnson of Uniontown: Mr. Johnson stated this location was the residence of his aunt Louella Watts, a local midwife who delivered hundreds of babies, black and white.

**HS 4** Very sparse non-aboriginal 19th and 20th century artifact scatter approximately 15m x 15m located on terrace crest; Very sparse surface recovery of whiteware and glass; No positive shovel tests; Soil profile consisted of 10YR 5/4 clay over 30 cm deep; Not considered potentially eligible for nomination to the National Register.

**HS 5** Dense non-aboriginal 19th and possibly 20th century artifact scatter approximately 60m x 150m located on crest and slope of upper terrace; Site location approximate with structure location on 1930 USDA Soil Survey Map of Perry County, Alabama; Dense surface recovery of old brick, plain whiteware, blue feather edge whiteware, stoneware, clear glass, dark green bottle glass, aqua glass, purple glass, cut nails, and iron fragments; Two positive shovel tests in the plowzone yielding brick fragment, and aqua glass; Soil profile consisted of exposed 10YR 5/3 clay subsoil; Considered potentially eligible for nomination to the National Register.

**HS 6** Dense non-aboriginal 19th and possibly 20th century artifact scatter approximately 90m x 120m located on downslope of upper terrace; Site location approximate with structure location on 1930 USDA Soil Survey Map of Perry County, Alabama; Dense surface recovery of old brick, plain whiteware, stoneware, clear glass, light green glass, aqua glass, blue glass, horseshoe or muleshoe fragment, and iron

fragments; One positive shovel tests in the plowzone yielding stoneware; Soil profile consisted of exposed 10YR 4/6 clay subsoil; Considered potentially eligible for nomination to the National Register.

**HS 7** Very dense non-aboriginal 19th and 20th century artifact scatter approximately 90m x 210m located on crest and slope of upper terrace; Extreme downslope portion of scatter approximate with structure location on 1930 USDA Soil Survey Map of Perry County, Alabama; Very dense surface recovery of old brick, plain whiteware, blue feather edge whiteware, porcelain, ironstone from Vodrey Pottery 1847-1928, tureen handles, whiteware tea cup handle, stoneware, stoneware handles, milk glass, clear glass, dark green bottle glass, aqua glass, blue glass, purple glass decanter tops, clear glass condiment bottle base, clear candy dish fragment, wine glass base and rim fragment, brown glass, unidentified buttons, small and large cut nails, iron spike, iron ring, iron belt buckle, iron hook, iron fragments, and copper fragment; Four positive shovel tests in the plowzone yielding plain whiteware, clear glass bottle fragment, and cut nail fragment; Soil profile consisted of 8cm-12cm 10YR 5/3 fine clay over 7.5 YR 4/6 clay subsoil. Considered potentially eligible for nomination to the National Register.

Assemblage suggests high status residence, potential location of plantation house of Phillip Henry Pitts at Rural Hill Plantation.

**HS 8** Dense non-aboriginal 19th century artifact scatter approximately 60m x 120m located on crest and slope of upper terrace; Dense surface recovery of old brick, plain whiteware, porcelain, stoneware, stoneware handle, clear glass, dark green bottle glass, dark green bottle base with very deep pontil, aqua glass, purple glass bottle top, purple glass, brown glass, unidentified buttons, small and large cut nails, and iron fragments; Two positive shovel tests in the plowzone yielding plain whiteware, brick fragment, and stoneware; Soil profile consisted of 3cm-7cm 10YR 5/3 clay over 10 YR 5/4 clay subsoil. Considered potentially eligible for nomination to the National Register.

**HS 9** Very sparse non-aboriginal 20th century artifact scatter approximately 20m x 60m located on downslope of lower terrace; Site location approximate with structure location on 1968 USGS Uniontown East Quadrangle; Very sparse surface recovery of brick, clear glass, and brown glass; No positive shovel tests; Soil profile consisted of 20cm 10YR 4/4 clay over 10 YR 5/4 clay subsoil; Not considered potentially eligible for nomination to the National Register.

**HS 10** Very sparse non-aboriginal 19th or 20th century glass scatter approximately 30m x 30m located on lower terrace; Very sparse surface recovery of purple glass fragments; No positive shovel tests; Soil profile consisted of exposed 10YR 8/2 chalk; Not considered potentially eligible for nomination to the National Register.

**HS 11** Moderate non-aboriginal 19th and 20th century artifact scatter approximately 50m x 90m located on downslope of upper terrace; Sparse surface recovery of old brick, whiteware, dark green bottle glass, aqua glass, purple glass, large iron pin, and iron chain with ring and swivel; No positive shovel tests; Soil profile consisted of exposed 10YR 8/2 chalk; Considered potentially eligible for nomination to the National Register.

**HS 12** Very sparse non-aboriginal 19th century artifact scatter approximately 15m x 15m located on downslope of lower terrace; Very sparse surface recovery of brick, purple glass, and cut nail; No positive shovel tests; Soil profile consisted of exposed 10YR 7/2 chalk; Not considered potentially eligible for nomination to the National Register.

**HS 13** Very sparse non-aboriginal 19th or 20th century artifact scatter approximately 15m x 15m located within 100 feet of Old Cahaba Road: Surface recovery of brick and stoneware; No positive shovel tests; Soil profile consisted of 10cm 10YR 5/3 clay over 10 YR 6/3 clay subsoil; Not considered potentially eligible for nomination to the National Register.

**HS 14** Dense non-aboriginal 19th and 20th century artifact scatter approximately 70m x 100m located on crest and slope of upper terrace; Dense surface recovery of brick, plain whiteware, porcelain, milk glass, stoneware, clear glass, dark green bottle glass, aqua glass, blue glass, purple glass, brown glass bottle base and glass stopper fragment, clear glass screw-top bottle top, and iron fragments; Three positive shovel tests in the plowzone yielding clear glass, purple glass, and stoneware; Soil profile consisted of 20cm-27cm 10YR 4/4 clay over 10 YR 7/2 chalk subsoil; Considered potentially eligible for nomination to the National Register.

Mr. Willie Armstrong remembers house to be one room wood-frame structure with an attached shed room and to be directly west and across small branch from old cemetery.

**HS 16** Sparse non-aboriginal 19th century artifact scatter approximately 30m x 40m located downslope of upper terrace; Surface recovery of old brick, plain whiteware, stoneware, dark green bottle glass, aqua glass, purple glass bottle top, and cut nail fragments; No positive shovel tests; Soil profile consisted of exposed 10YR 5/2 chalk; Considered potentially eligible for nomination to the National Register.

**HS 17** Very sparse non-aboriginal 19th or 20th century artifact scatter approximately 30m x 30m located on crest of lower slope; Surface recovery of brick and dark green bottle glass; No positive shovel tests; Soil profile consisted of 11 cm 10YR 6/4 fine chalk over 10YR 8/2 chalk; Not considered potentially eligible for nomination to the National Register.

**HS 18** Very sparse non-aboriginal 19th century artifact scatter approximately 30m x 60m located on crest of upper terrace; Surface recovery of old brick, plain whiteware, and dark green bottle glass; No positive shovel tests; Soil profile consisted of 12 cm 10YR 5/3 clay over 10 YR 5/6 clay subsoil ; Not considered potentially eligible for nomination to the National Register.

**HS 19** Very sparse non-aboriginal 19th century artifact scatter approximately 30m x 120m located on crest and downslope of upper terrace; Surface recovery of brick, clear glass, purple glass, and brown glass; No positive shovel tests; Soil profile consisted of 10 cm 10YR 4/3 fine clay over 10 YR 7/2 chalk subsoil; Not considered potentially eligible for nomination to the National Register.

**HS 20** Very sparse non-aboriginal 19th century artifact scatter approximately 20m x 20m located on lower downslope; Surface recovery of old brick, plain whiteware, and stoneware; No positive shovel tests; Soil profile consisted of 11 cm 10YR 4/2 clay over 10 YR 5/3 clay subsoil; Not considered potentially eligible for nomination to the National Register.

**HS 21** Very sparse non-aboriginal 19th or 20th century artifact scatter approximately 30m x 100m located on crest and downslope of upper terrace; Surface recovery of whiteware and clear glass; No positive shovel tests; Soil profile consisted of 10 cm 10YR 5/4 clay over 10 YR 4/6 clay subsoil; Not considered potentially eligible for nomination to the National Register.

**HS 22** Sparse non-aboriginal 19th century artifact scatter approximately 30m x 90m located on crest and downslope of upper terrace; Surface recovery of old brick, plain whiteware, stoneware mug or bottle base fragment, clear glass, aqua glass, purple glass bottle top, and iron fragments; No positive shovel tests; Soil profile consisted of exposed 10YR 6/2 clay subsoil; Considered potentially eligible for nomination to the National Register.

**HS 23** Sparse non-aboriginal 19th and 20th century artifact scatter approximately 30m x 60m located on upper downslope; Surface recovery of old and modern brick, plain whiteware, clear glass, aqua glass, and cut nail fragments; No positive shovel tests; Soil profile consisted of exposed 10YR 4/6 clay subsoil; Considered potentially eligible for nomination to the National Register.

**HS 24** Very sparse non-aboriginal 19th century artifact scatter approximately 20m x 30m located on crest of upper terrace; Surface recovery of old brick, decorated blue and white whiteware, and clear glass; No positive shovel tests; Soil profile consisted of 25 cm 10YR 3/2 chalk over 2.5 Y 6/3 chalk subsoil. Not considered potentially eligible for nomination to the National Register.

**HS 25** Very sparse non-aboriginal 20th century artifact scatter approximately 15m x 15m located on crest of lower terrace; Surface recovery of brick, milk glass, clear glass, and iron wire; No positive shovel tests; Soil profile consisted of 10 cm 10YR 4/3 clay over 10 YR 5/4 clay; Not considered potentially eligible for nomination to the National Register.

**HS 26** Moderate non-aboriginal 19th century artifact scatter approximately 40m x 60m located downslope of upper terrace; Surface recovery of old brick, plain whiteware, stoneware, dark green bottle glass, aqua glass, purple glass, clear glass, light green glass, and brown glass; No positive shovel tests; Soil profile consisted of exposed 10YR 7/2 chalk; Considered potentially eligible for nomination to the National Register.

**HS 27** Moderate non-aboriginal 19th century artifact scatter approximately 20m x 30m located downslope of upper terrace; Surface recovery of brick, plain whiteware, stoneware, dark green bottle glass, aqua glass, purple glass bottle top, clear glass, light green glass, and brown glass and iron fragments; No positive shovel tests; Soil profile consisted of exposed 10YR 7/2 chalk; Considered potentially eligible for nomination to the National Register.

**HS 28** Very sparse non-aboriginal 20th century artifact scatter approximately 20m x 60m located downslope of upper terrace; Site location approximate with structure location on 1968 USGS Uniontown East Quadrangle; Surface recovery of brick and plain whiteware; No positive shovel tests; Soil profile consisted of 8 cm 10YR 5/4 fine clay over 10 YR 5/6 clay subsoil; Not considered potentially eligible for nomination to the National Register.

**HS 29** Moderate non-aboriginal 19th and 20th century artifact scatter approximately 50m x 70m located downslope of upper terrace; Site location approximate with structure location on 1930 USDA soil survey map of Perry County, Alabama; Surface recovery of old brick, dark green bottle glass, clear glass, light green glass, and cut nails; No positive shovel tests; Soil profile consisted of 21 cm 10YR 6/4 chalk over 10 YR 8/2 chalk; Considered potentially eligible for nomination to the National Register.

**HS 30** Very sparse non-aboriginal 20th century artifact scatter approximately 20m x 30m located on downslope of lower terrace; Surface recovery of plain whiteware, clear glass, and light green glass; No positive shovel tests; Soil profile consisted of exposed 10YR 7/2 chalk; Not considered potentially eligible for nomination to the National Register.

**HS 31** Very sparse non-aboriginal 19th or 20th century artifact scatter approximately 10m x 10m located downslope of upper terrace; Surface recovery of brick and stoneware; No positive shovel tests; Soil profile consisted of exposed 10YR 7/2 chalk; Not considered potentially eligible for nomination to the National Register.

**HS 32** Very sparse non-aboriginal 19th and 20th century artifact scatter approximately 10m x 10m located on upper terrace; Surface recovery of brick and light green glass; No positive shovel tests; Soil profile consisted of 14 cm 10YR 5/4 clay over 7.5 YR 4/6 clay subsoil; Not considered potentially eligible for nomination to the National Register.

**HS 33** Moderate non-aboriginal 19th and 20th century artifact scatter approximately 30m x 60m located on lower terrace; Surface recovery of brick, plain whiteware, porcelain, blue glass, aqua glass, purple glass, clear glass, brown glass, and a small iron wheel; No positive shovel tests; Soil profile consisted of exposed 10YR 7/2 chalk; Considered potentially eligible for nomination to the National Register.

**HS 34** Very sparse non-aboriginal 20th century artifact scatter approximately 10m x 10m located on crest of upper terrace; Surface recovery of brick and bed-spring wire; No positive shovel tests; Soil profile consisted of exposed 10YR 7/2 chalk; Not considered potentially eligible for nomination to the National Register.

**New Hope Cemetery** The area to the west of the New Hope Cemetery property contains marked graves and has the potential to contain unmarked graves. Mr. Willie Armstrong, who was born on Rural Hill Plantation, stated that the community stated using this "new cemetery" in 1953 with the latest internment in 1996.

**Old Plantation Cemetery** On July 26th, 2001 an informant survey was conducted on the survey tract with Mr. Willie Armstrong who was born at Rural Hill Plantation in 1921 and lived there until 1951. Mr. Armstrong recalled that the plantation was leased to a Dr. Weissinger in the 1970's and that he cleared the land of all structures. Mr. Richard Johnson stated that Dr. Weissinger ran six bulldozers day and night until the plantation was cleared of all structures and converted to soybean production.

Mr. Armstrong described an "old cemetery" on the plantation and its spatial relationship to surrounding houses and the local topography. His descriptions fit exactly with the terrace located between HS 14 and HS 2. As we drove toward the area and the terrace came into view, Mr. Armstrong stated, "Right on that hill over there is the old cemetery. That's where they buried my grand momma's daddy, my granddaddy, my momma, my uncle, and on and on; and my cousins too." As we approached the area he stated, "...that tall pack of trees, that's where it was...right down from them, right at them trees, that's where that graveyard was right there." Mr. Armstrong recalled the following individuals who lived on the plantation and were buried in this cemetery:

Joe Green, buried in 1937, Mr. Armstrong's great grandfather, said to have been over 100 and a former slave;

Emma Green, Mr. Armstrong's great grandmother;

Irene Armstrong, buried in 1938, Mr. Armstrong's mother;

Ward Armstrong, buried in 1941, Mr. Armstrong's grandfather;

Paul Green, a former slave, Mr. Armstrong's great uncle;

Albert Armstrong, Mr. Armstrong's uncle;

Rachel Davis.

Mr. Armstrong recalled that the only tombstone that remained in the cemetery in the 1970's when Dr. Weissinger cleared the plantation was on the grave of Rachel Davis. He stated that Dr. Weissinger had it removed and dumped by the old bell tower at New Hope Church.

Very sparse surface recovery yielded brick fragments, a single plain whiteware sherd, a flat smooth sandstone or limestone fragment, and small bone fragments. Dr. Bill Grantham of the Archaeological Research Center at Troy State University examined the bone fragments and determined that they were not human skeletal material.

## 4.2 SUMMARY OF ABORIGINAL SITES

**AS 1** Sparse aboriginal artifact scatter approximately 30m x 30m located on downslope of upper terrace; Surface recovery of 5 plain sand and grit tempered sherds, 4 plain sand tempered sherds, 1 fired clay fragment, 1 cobble mano, 1 cobble mano fragment, 1 quartz biface fragment, 7 quartz flakes, and 1 red chert flake; No positive shovel tests; Soil profile consisted of exposed 10 YR 7/2 chalk; Not considered potentially eligible for nomination to the National Register.

**AS 2** Sparse aboriginal lithic scatter approximately 10m x 30m located on lower terrace; Surface recovery of 1 Tallahatta quartzite straight base projectile point stem fragment, 2 Tallahatta quartzite flakes, and 1 quartz flake; No positive shovel tests; Soil

profile consisted of 10 cm 10 YR 5/4 clay over 10 YR 4/6 clay subsoil; Not considered potentially eligible for nomination to the National Register.

**AS 3** Sparse aboriginal artifact scatter approximately 20m x 30m located on crest of lower terrace; Surface recovery of 1 Tallahatta quartzite biface, 1 Tallahatta quartzite rounded base projectile point stem fragment, 3 quartz flakes, and 1 plain sand and grit tempered sherd; No positive shovel tests; Soil profile consisted of 10 cm 10 YR 4/3 clay over 10 YR 5/4 clay subsoil; Not considered potentially eligible for nomination to the National Register.

**AS 10** Very sparse aboriginal artifact scatter approximately 10m x 10m located on downslope of lower terrace; Surface recovery of 1 plain sand and grit tempered sherd and 1 cracked cobble fragment; No positive shovel tests; Soil profile consisted of exposed 10 YR 8/2 chalk; Not considered potentially eligible for nomination to the National Register.

**AS 11** Very sparse aboriginal artifact scatter approximately 10m x 10m located on upper slope of upper terrace; Surface recovery of 2 plain sand and grit tempered sherds, 1 plain sand tempered sherd, and 1 quartz flake; No positive shovel tests; Soil profile consisted of 16 cm 10 YR 5/6 fine clay over 7.5 YR 5/6 clay subsoil; Not considered potentially eligible for nomination to the National Register.

**AS 12** Sparse aboriginal artifact scatter approximately 10m x 20m located on upper terrace; Surface recovery of 4 plain sand and grit tempered sherds, 4 quartz flakes, and 1 red chert flake; No positive shovel tests; Soil profile consisted of 12 cm 10 YR 5/4 clay over 7.5 YR 4/6 clay subsoil; Not considered potentially eligible for nomination to the National Register.

**AS 13** Very sparse aboriginal artifact scatter approximately 10m x 10m located on downslope of upper terrace; Surface recovery of 4 plain sand and grit tempered sherds,

and 1 quartz flake; No positive shovel tests; Soil profile consisted of exposed 10 YR 7/2 chalk; Not considered potentially eligible for nomination to the National Register.

**Isolate Finds** Single aboriginal artifacts were encountered during the surface survey and are not considered significant. Alabama State Site File forms will not be completed for these finds: a single small triangular red chert projectile point found in quadrant G 1; a single greenstone implement fragment found in quadrant G 15; and a single quartz cobble hammerstone found in quadrant G 22.

## 5.0 EVALUATION AND RECOMMENDATIONS

Shallow surface soils on clay and chalk subsoils presented diminished potential for site preservation. Cultural deposition has largely been destroyed by extensive cultivation since the 1840's and extensive bulldozer activity in the 1970's. However the potential does exist on some of the historic sites for undisturbed subsurface features below the plowzone such as cisterns, privies, coolers, and root cellars that could contribute to our knowledge of 19$^{th}$ century plantation life in the Alabama Black Belt region.

Because of this potential, the following sites are considered potentially eligible for nomination to the National Register: HS 2, HS 3, HS 5, HS 6, HS 7, HS 8, HS 11, HS 14, HS 16, HS 22, HS 23, HS 26, HS 27, HS 29, and HS 33. Additional archaeology is recommended for these sites in an effort to locate undisturbed subsurface features.

The potential for undisturbed subsurface features is considered negligible for the following sites which are not considered potentially eligible for nomination to the National Register: HS 1, HS 4, HS 9, HS 10, HS 12, HS 13, HS 17, HS 18, HS 19, HS 20, HS 21, HS 24, HS 25, HS 28, HS 30, HS 31, HS 32, HS 34, AS 1, AS 2, AS 3, AS 10, AS 11, AS 12, and AS 13. Further archaeology is not recommended for these sites.

The relationship of Rural Hill Plantation to Pitts' Folly, a National Register property, raises the issue of a NRHP district and need for additional documentary research in a Phase II investigation. Preparation of a documentary history of Rural Hill Plantation and the survey tract is recommended.

Mechanical stripping of the plowzone on lanes on portions of the level areas associated with HS 2, HS 3, HS 5, HS 6, HS 7, HS 8, HS 11, HS 14, HS 16, HS 22, HS 23, HS 26, HS 27, HS 29 and HS 33 is recommended as the most efficient and timely means to locate potential subsurface features that may be associated with these sites. An archaeologist should be present on site to record any features revealed and further ascertain potential eligibility of NRHP nominations. Further archaeology would not be recommended if subsurface deposits are not located during the Phase II investigation.

Avoidance is recommended for the area associated with graves to the west of New Hope Cemetery. Marked graves extend west beyond church property approximately 600 feet. From the northwest corner of the church property, an area 600 feet due west to the intermittent stream bed and thence due south to Old Cahaba Road should be avoided and set aside. It is further recommended that an additional 100 feet buffer zone be placed around this entire cemetery area.

Avoidance is also recommended for the area associated with the "Old Cemetery". Documentary historical research may contribute evidence for the presence of the cemetery and additional informant surveys may yield other individuals who recall internments there. It is recommended that additional research and informant surveys be carried out before delineation of this cemetery is completed. The utilization of ground penetrating radar may be necessary to locate and/or substantiate the cemetery location. It is recommended that a 100 feet buffer zone be placed around the cemetery.

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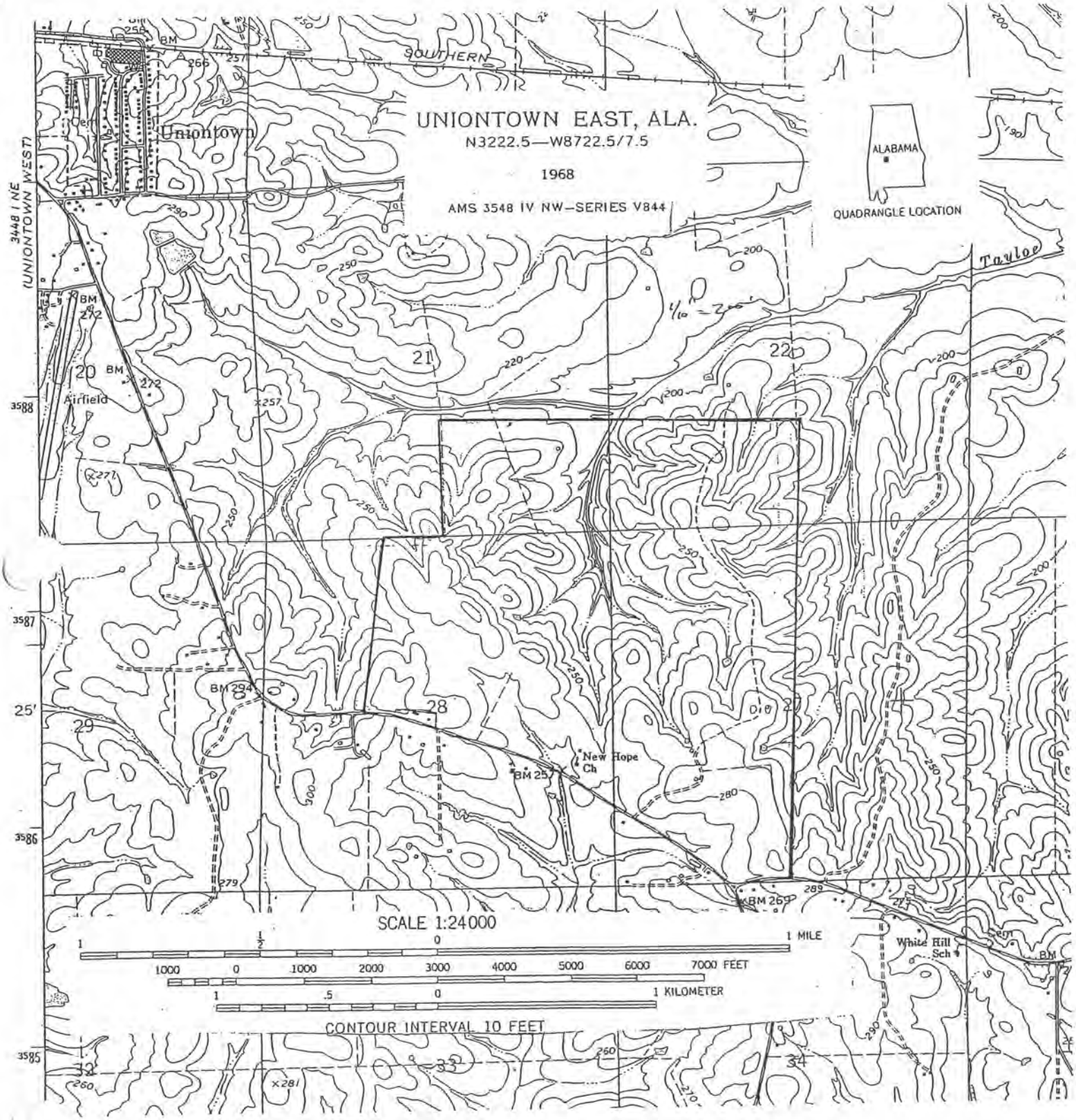
# FIGURE 1
## Survey Location



# FIGURE 2

## Shovel Tests Locations

# FIGURE 3

## Site Locations

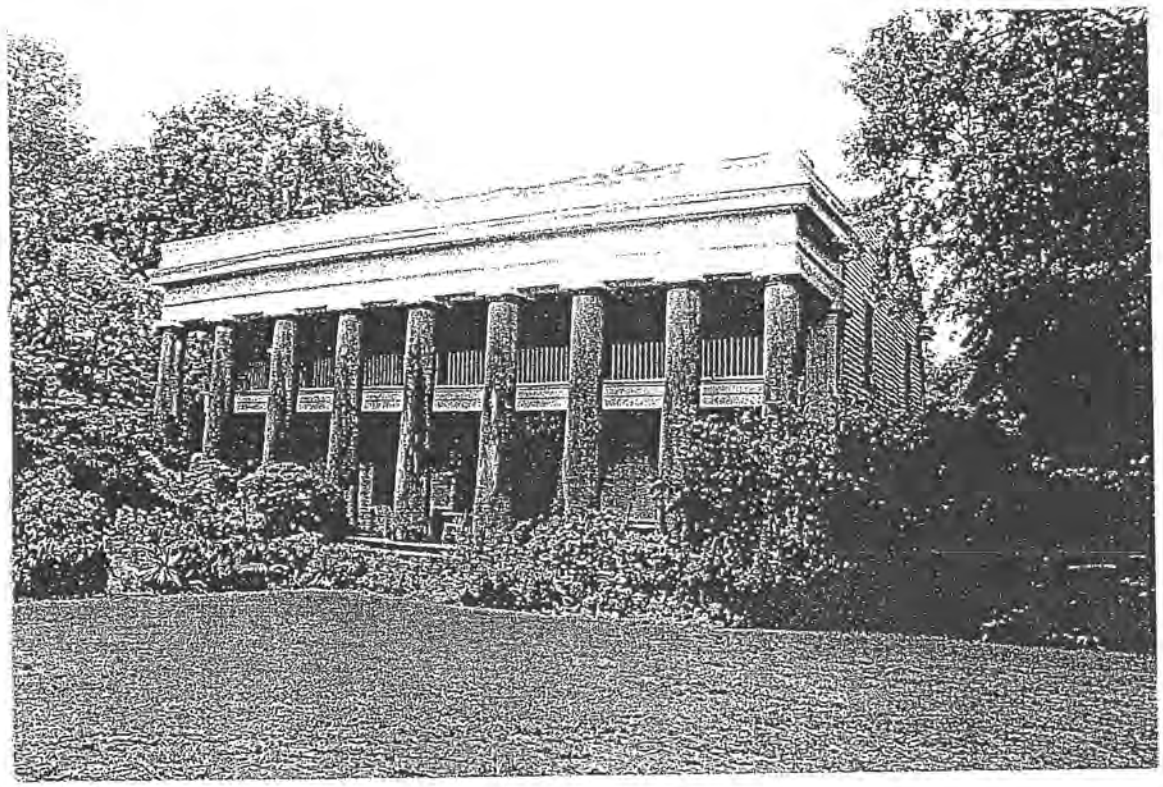


FIGURE 4 Pitts' Folly

FIGURE 5 Example of Small Wood-Frame House with Attached Shed Room

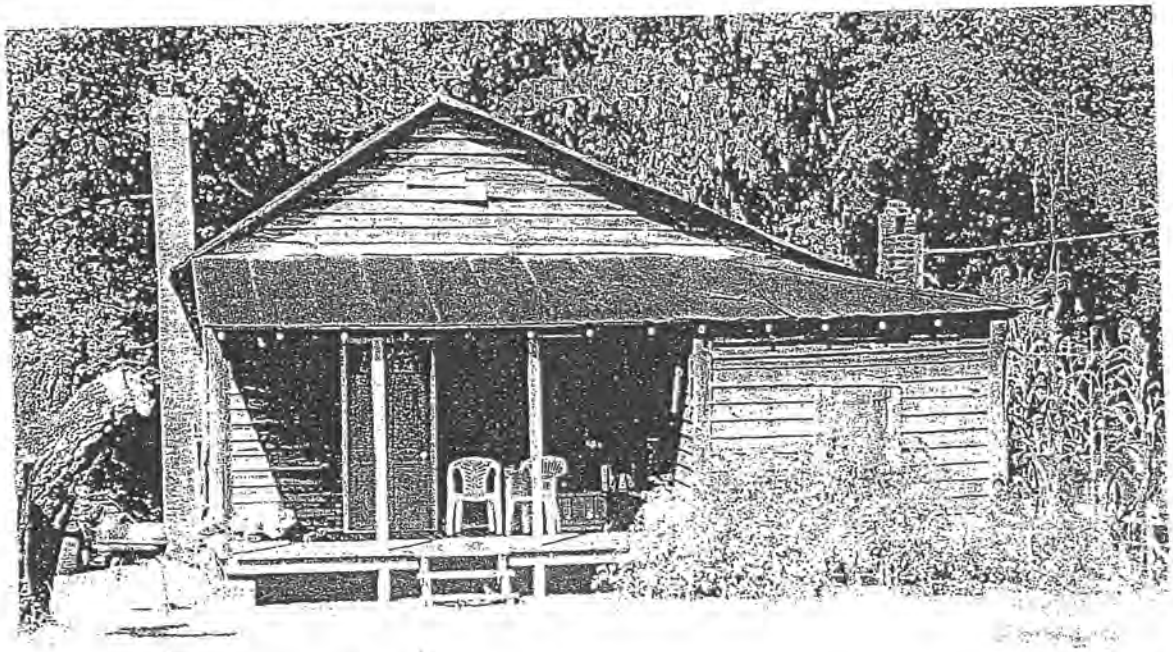


FIGURE 6 HS 1 view to Southwest
FIGURE 7 HS 2 view to West

FIGURE 8 HS 3 view to North
FIGURE 9 HS 4 view to North

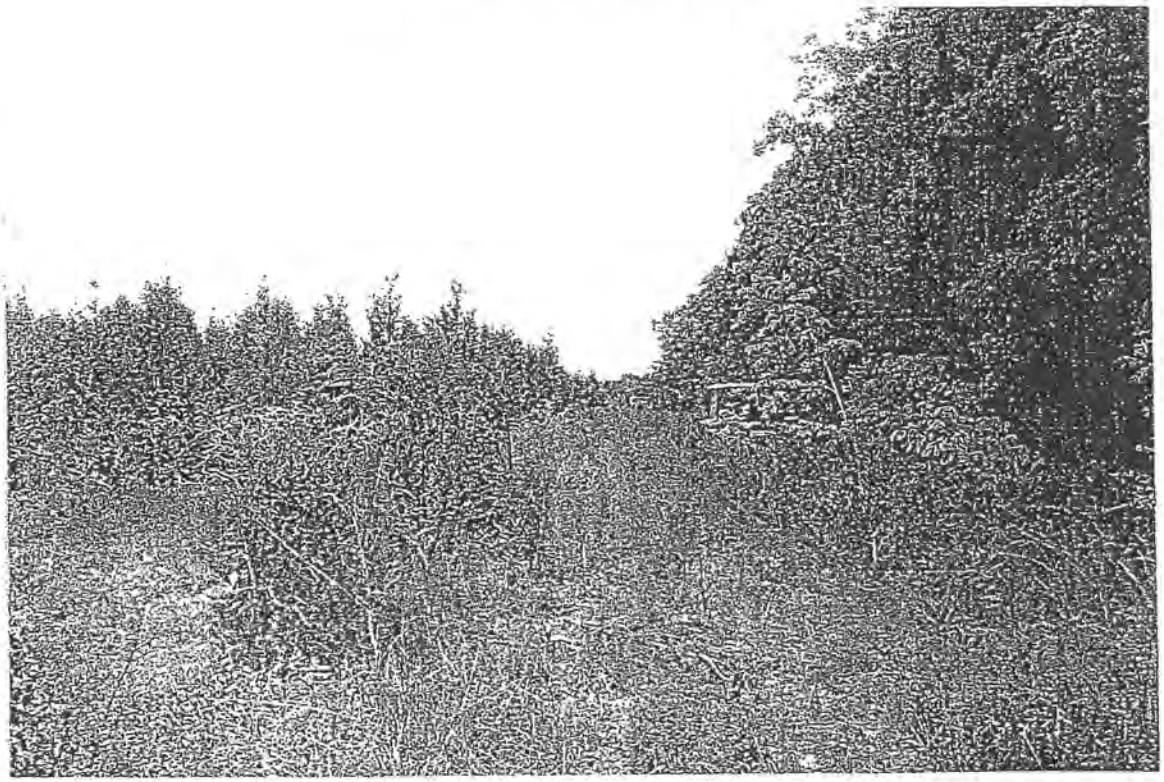
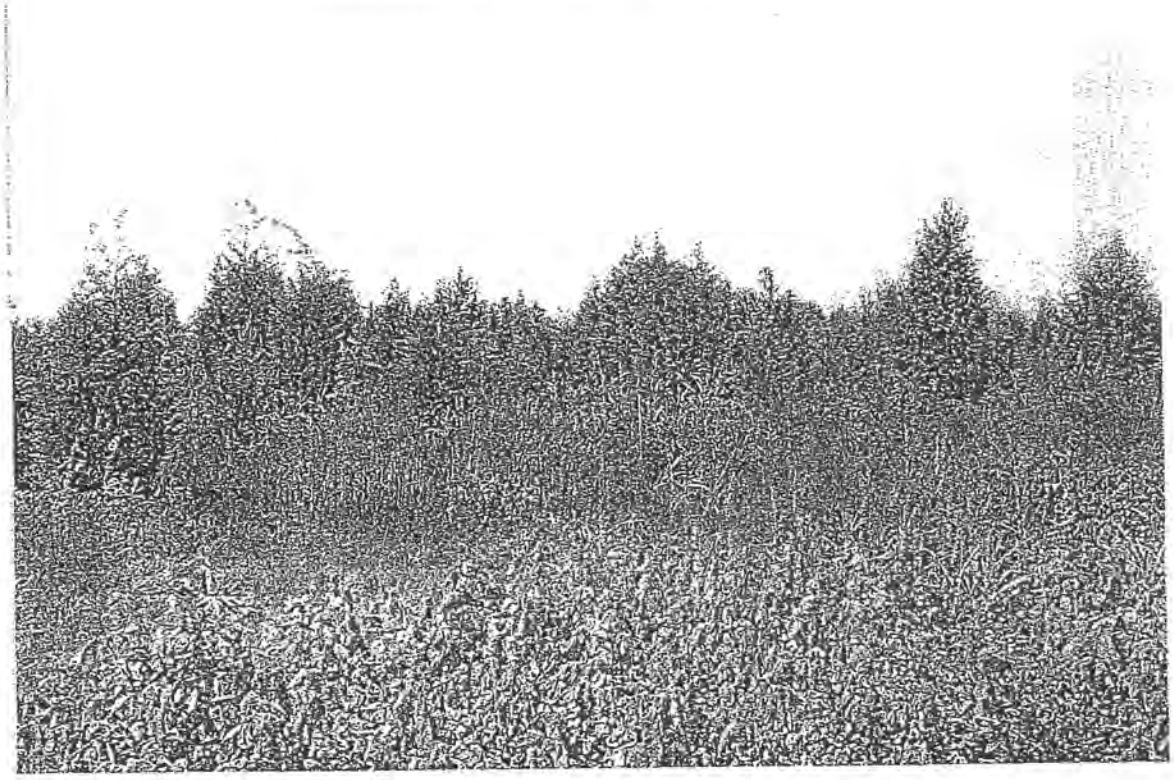


FIGURE 10 HS 5 view to Northwest
FIGURE 11 HS 6 view to Southwest



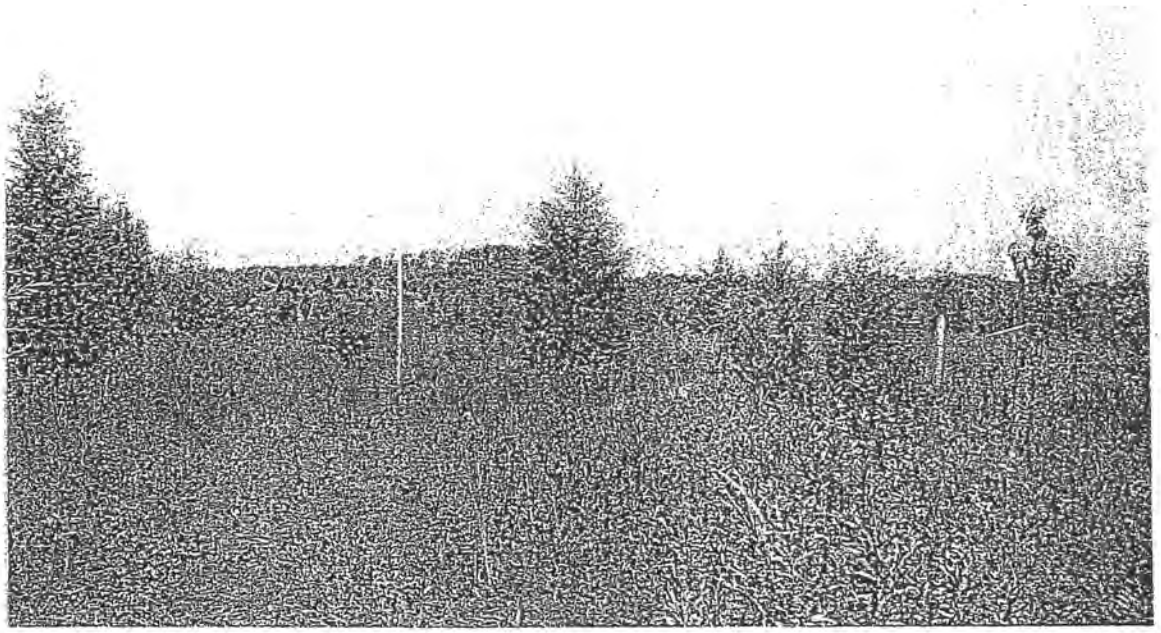
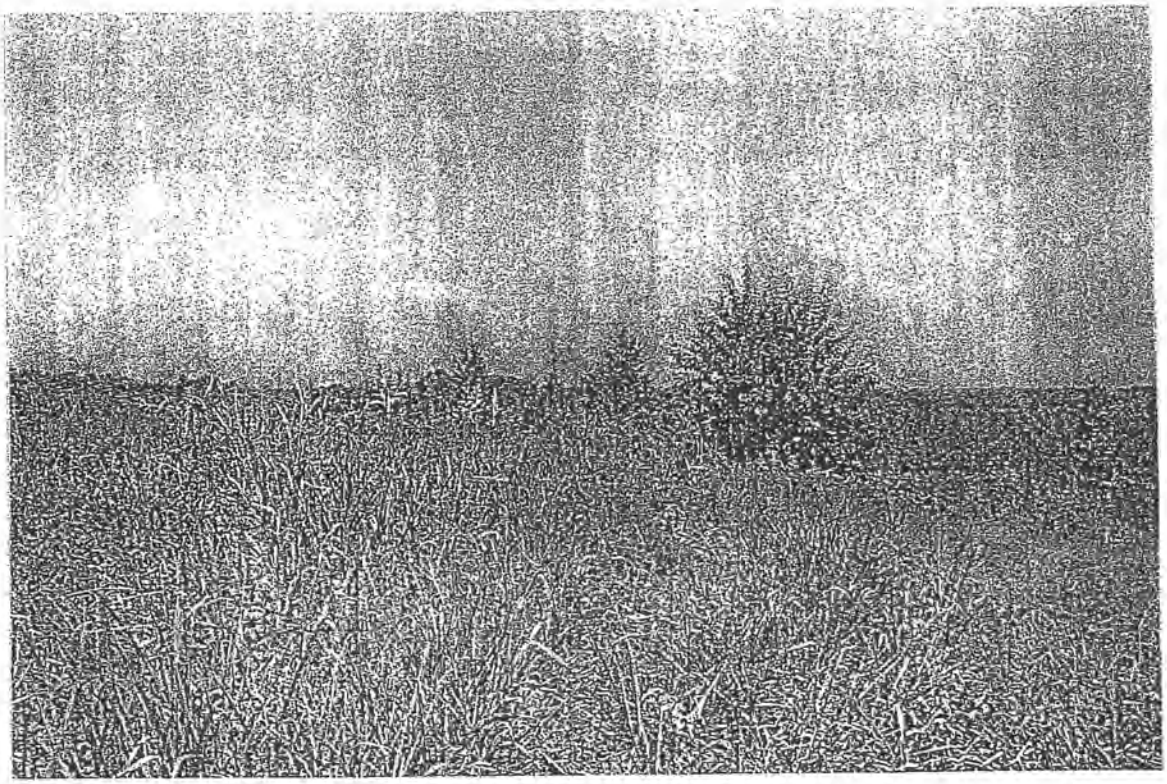


**FIGURE 12 HS 7 view to Northwest**
**FIGURE 13 HS 8 view to Northwest**



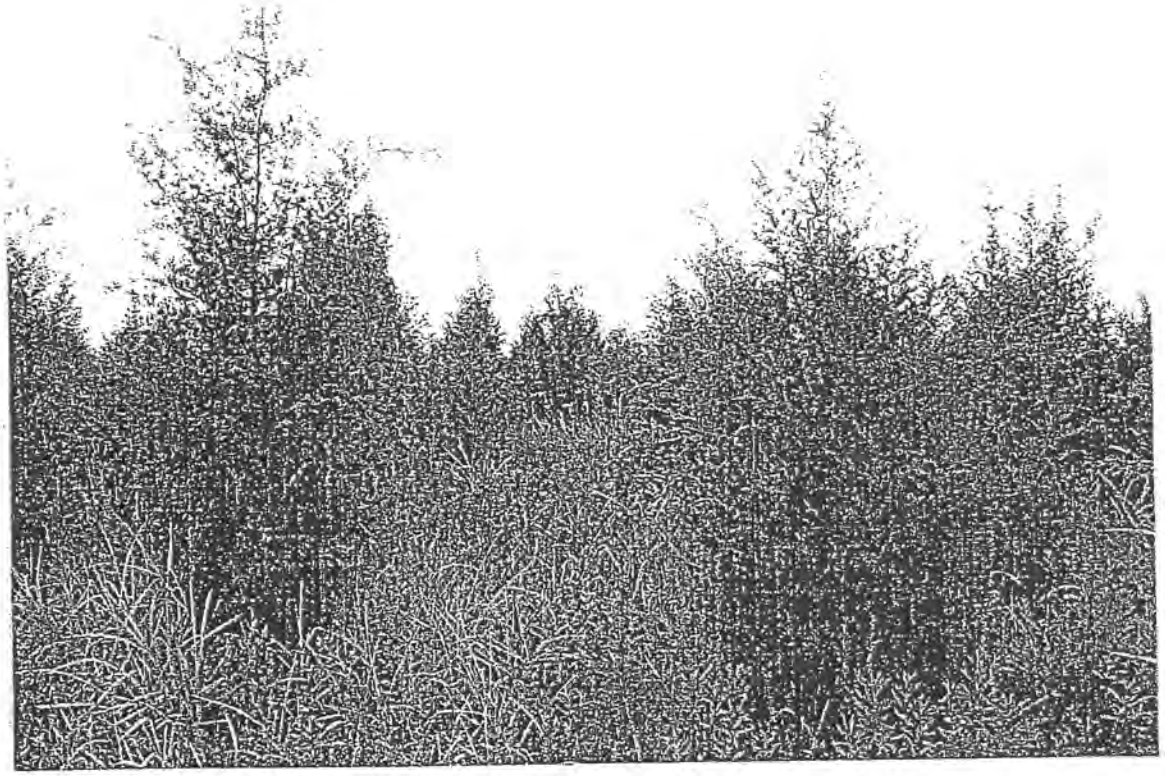
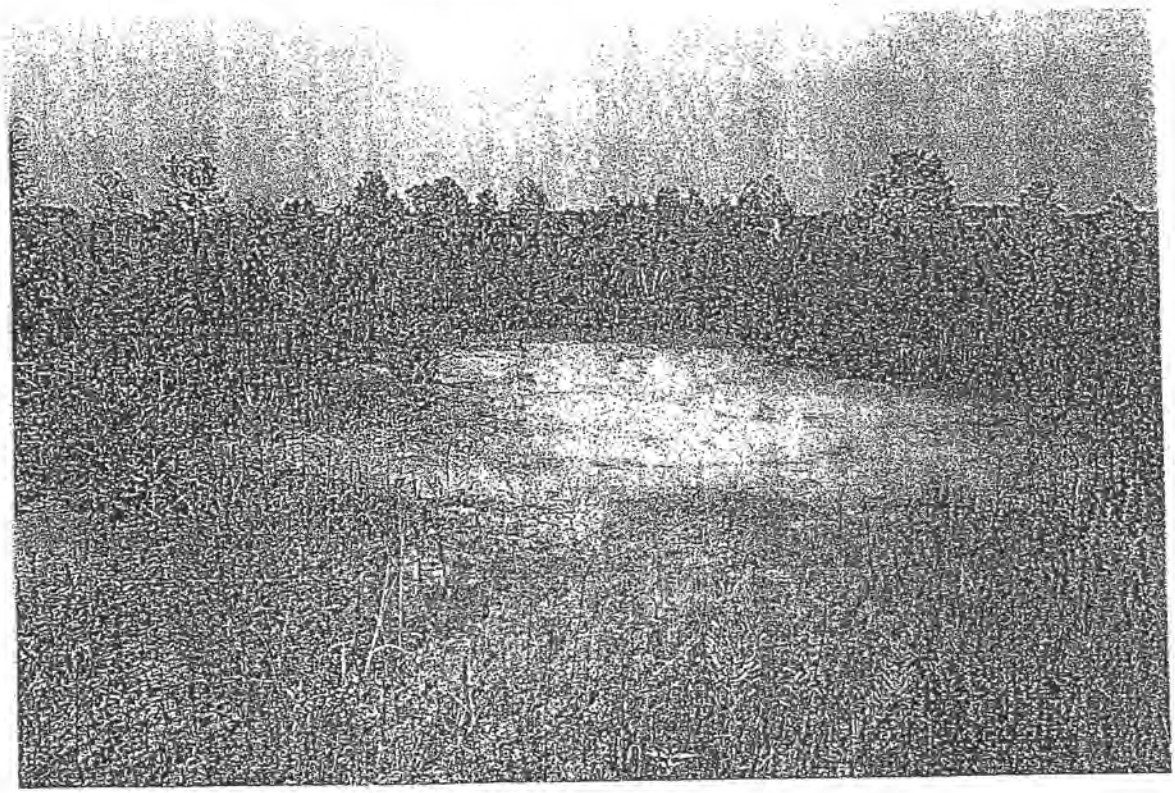


**FIGURE 14 HS 9 view to Northeast**
**FIGURE 15 HS 10 and AS 10 view to Northeast**



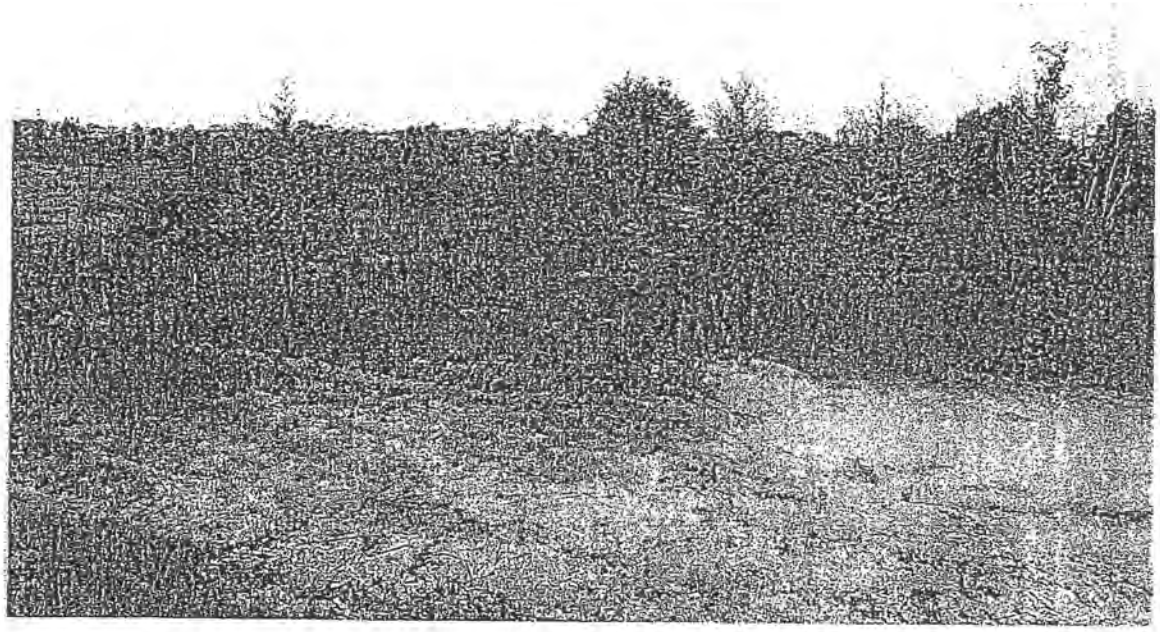


**FIGURE 16 HS 11 view to Northeast**
**FIGURE 17 HS 12 view to East**

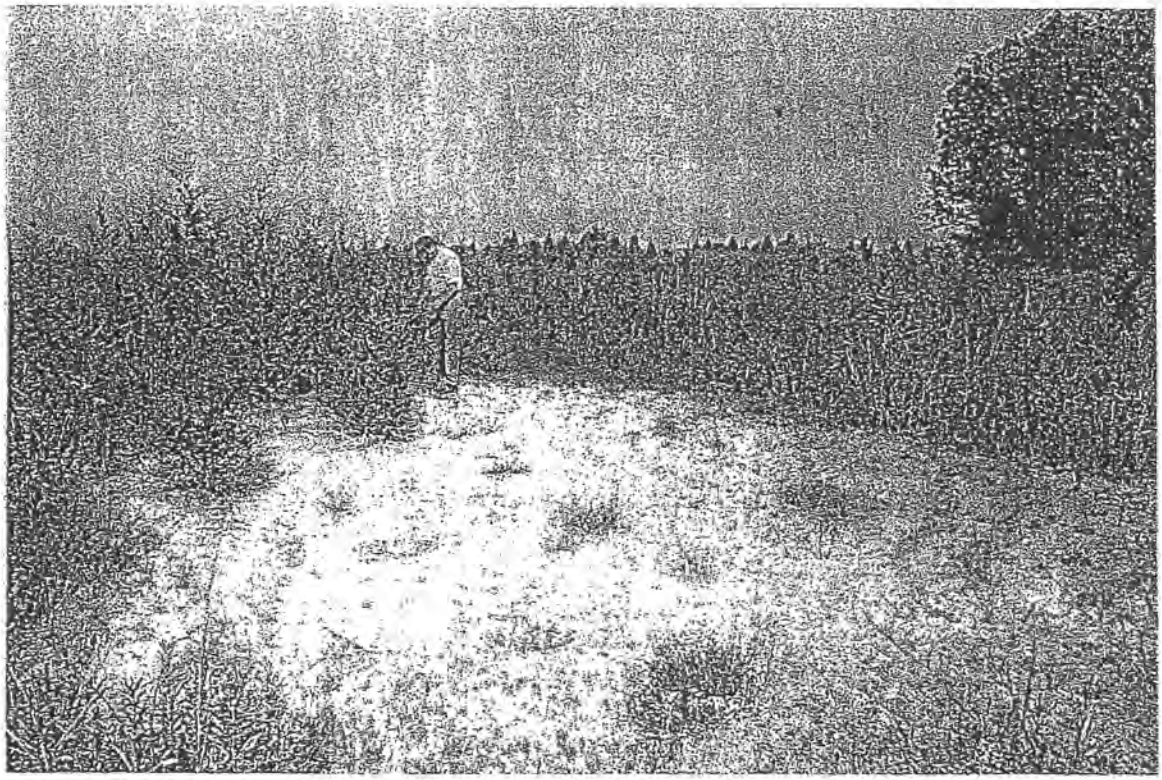
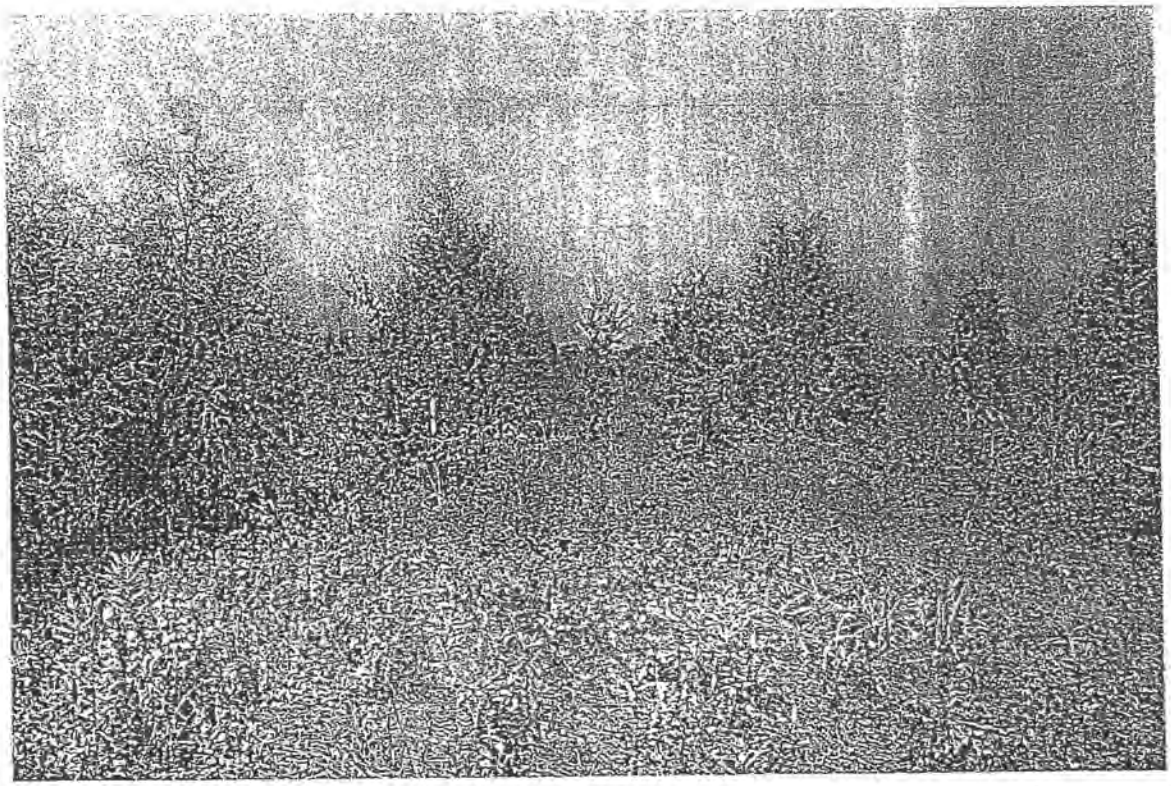


FIGURE 18 HS 13 view to West

FIGURE 19 HS 14 view to Southwest



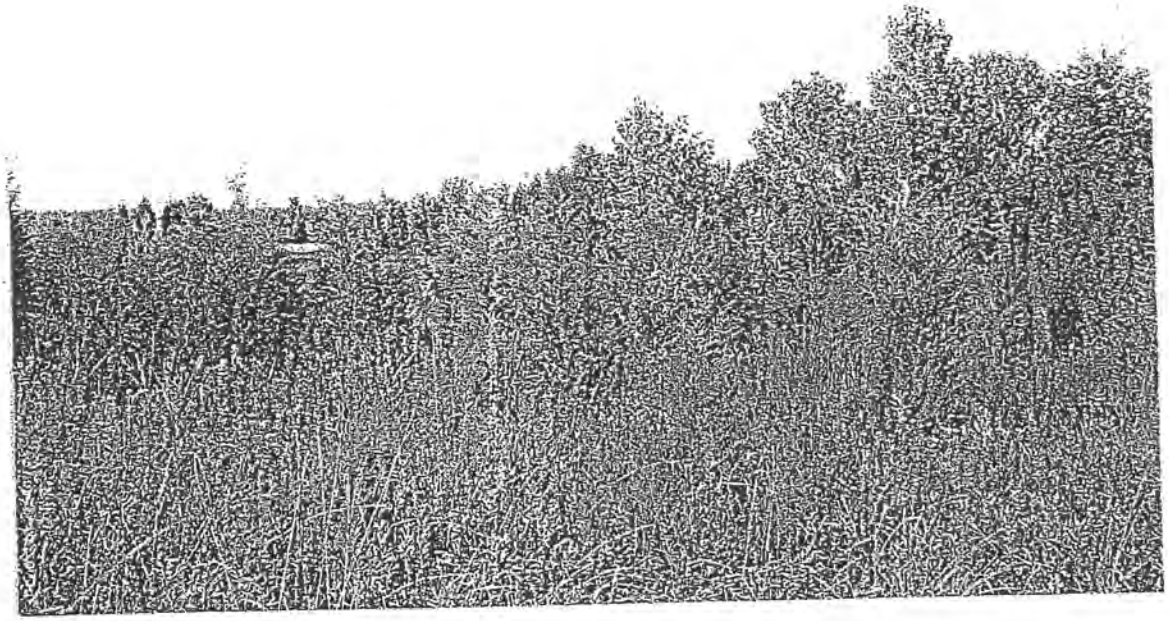
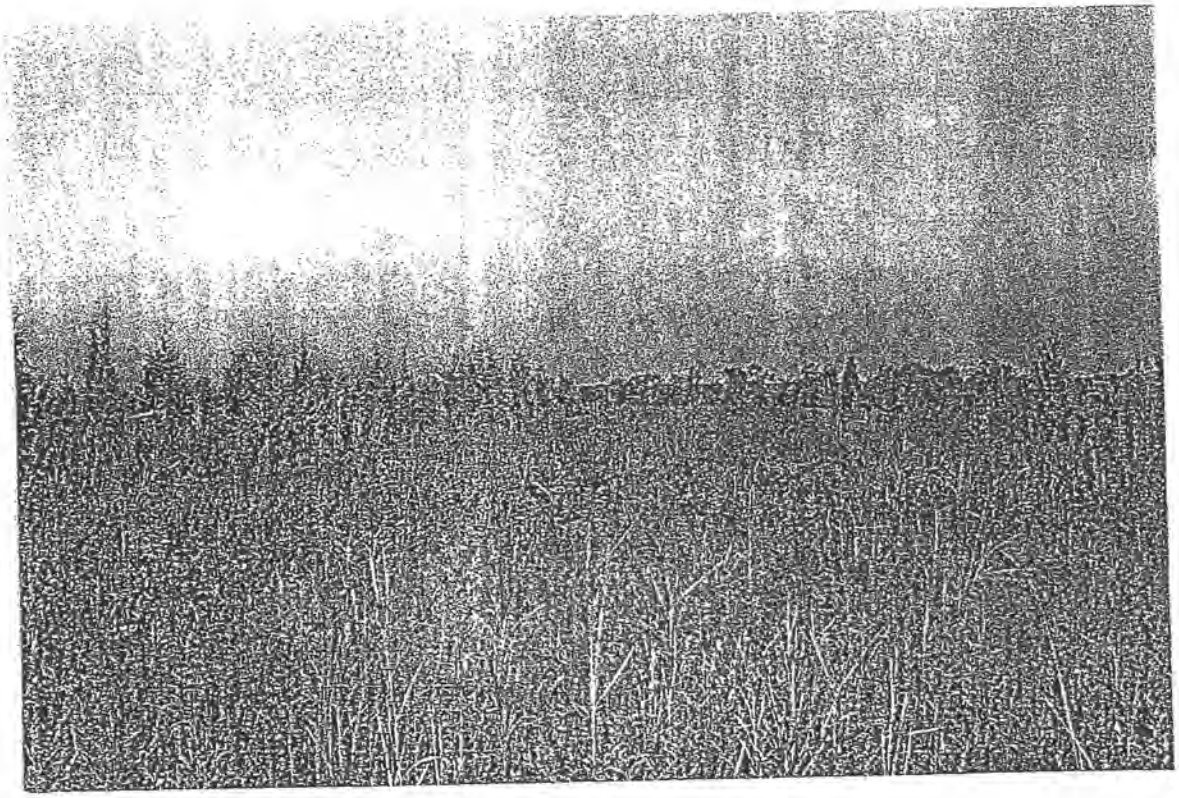


FIGURE 20 HS 16 view to North
FIGURE 21 HS 17 view to East



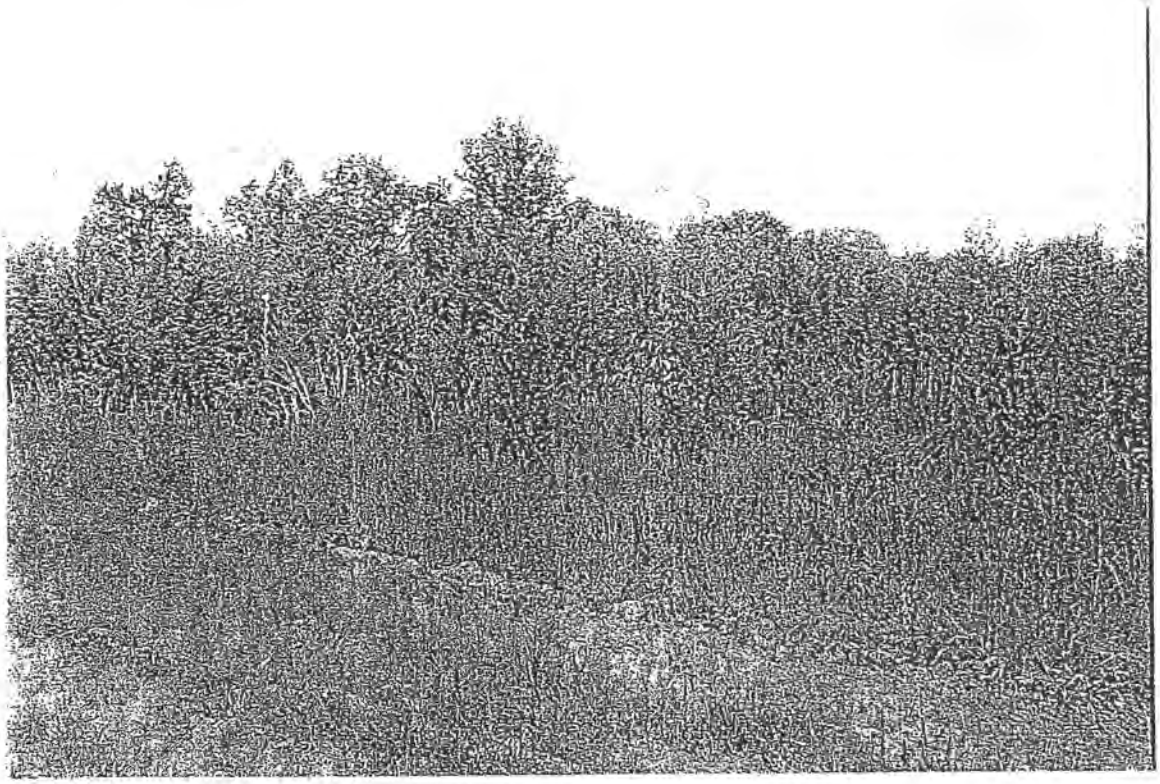


**FIGURE 22 HS 18 view to North**
**FIGURE 23 HS 19 view to Southeast**

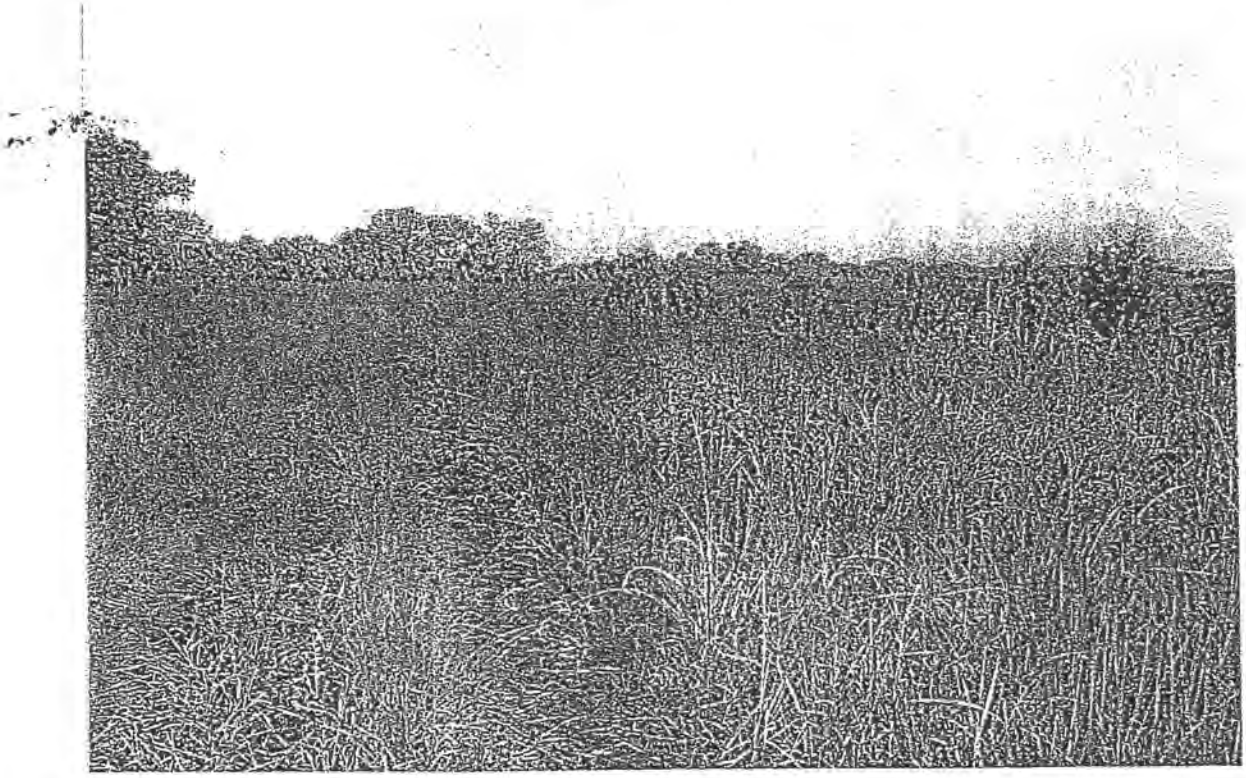


FIGURE 24 HS 20 view to Northwest
FIGURE 25 HS 21 and AS view to North

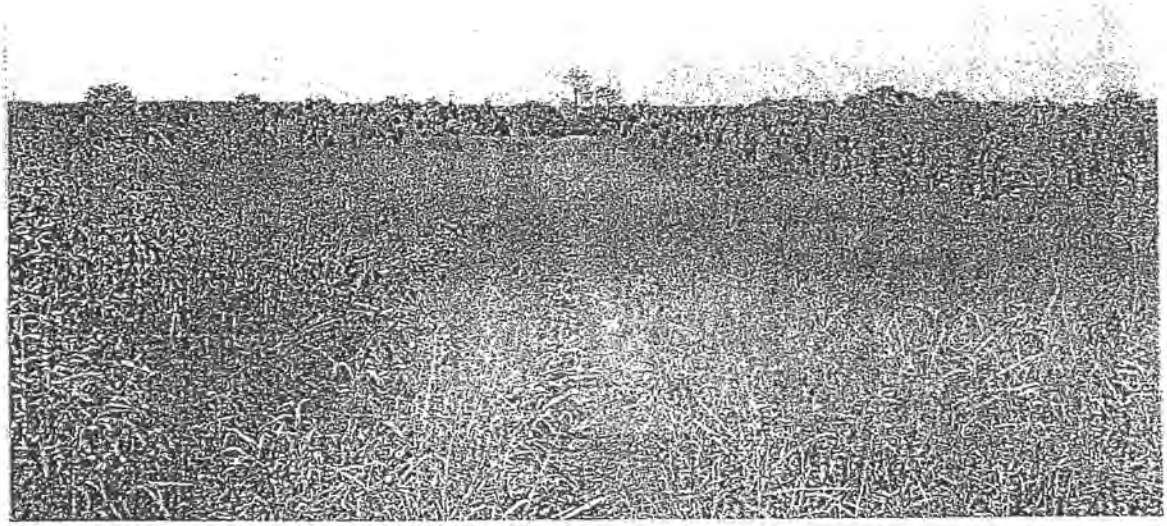
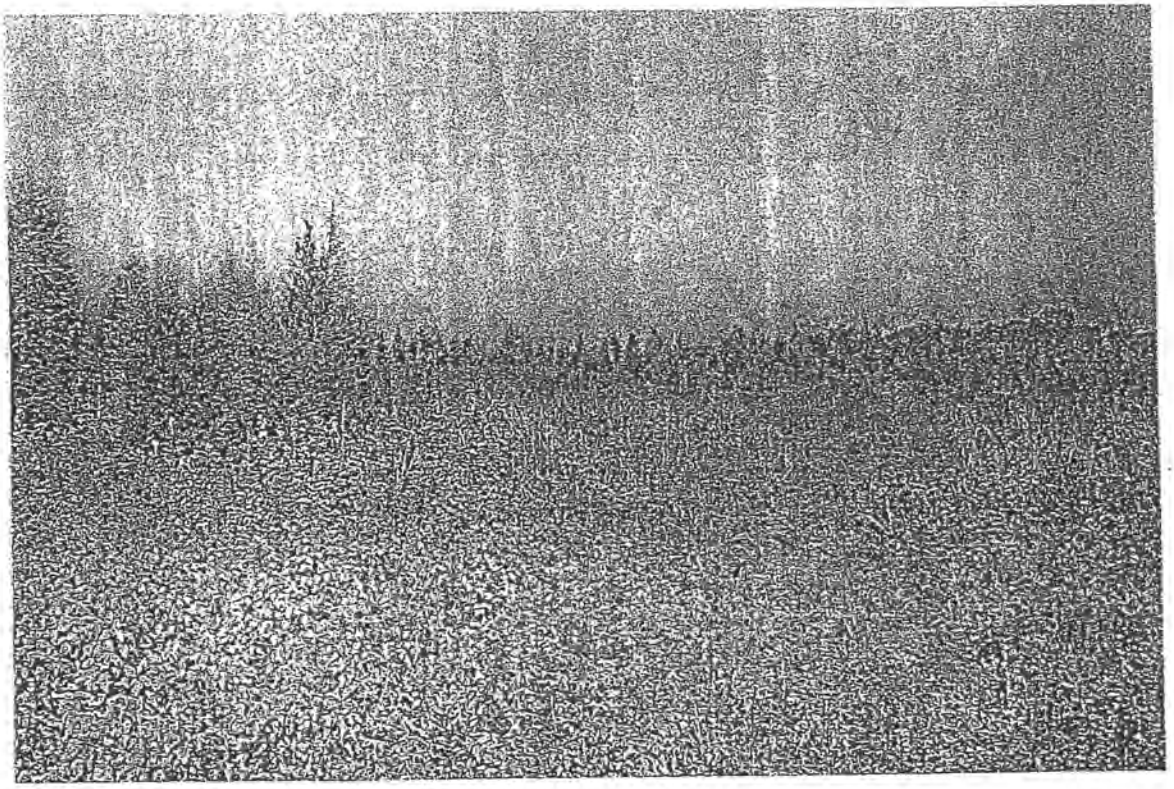


FIGURE 26 HS 22 view to Northwest
FIGURE 27 HS 23 view to Northwest

FIGURE 28 HS 24 view to Northeast
FIGURE 29 HS 25 and AS 3 view to East

**FIGURE 30 HS 26 view to Southeast**
**FIGURE 31 HS 27 view to West**



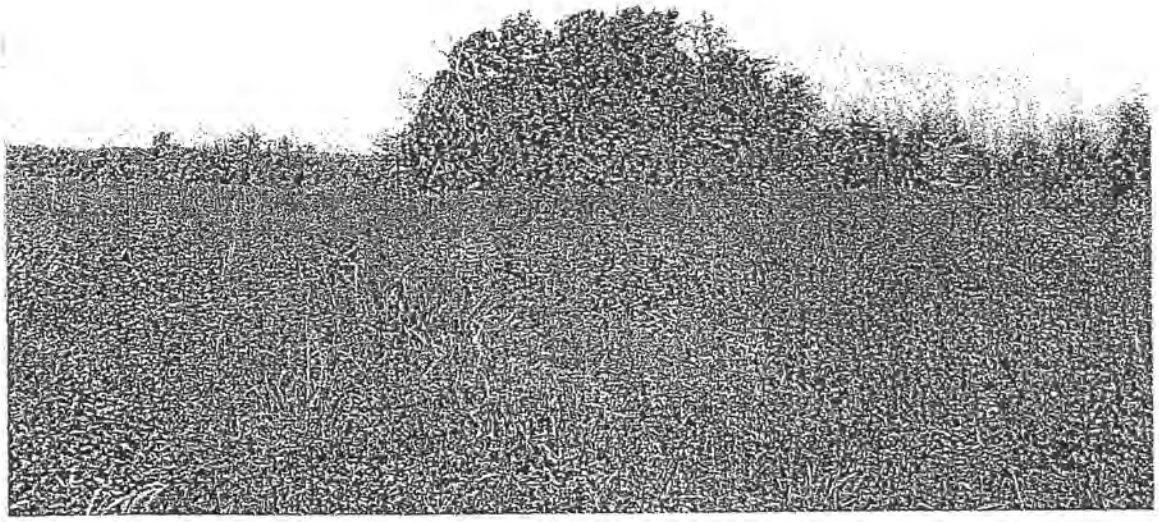


FIGURE 32 HS 28 view to North
FIGURE 33 HS 29 view to Southeast

FIGURE 34 HS 30 view to North
FIGURE 35 HS 31 view to Southwest

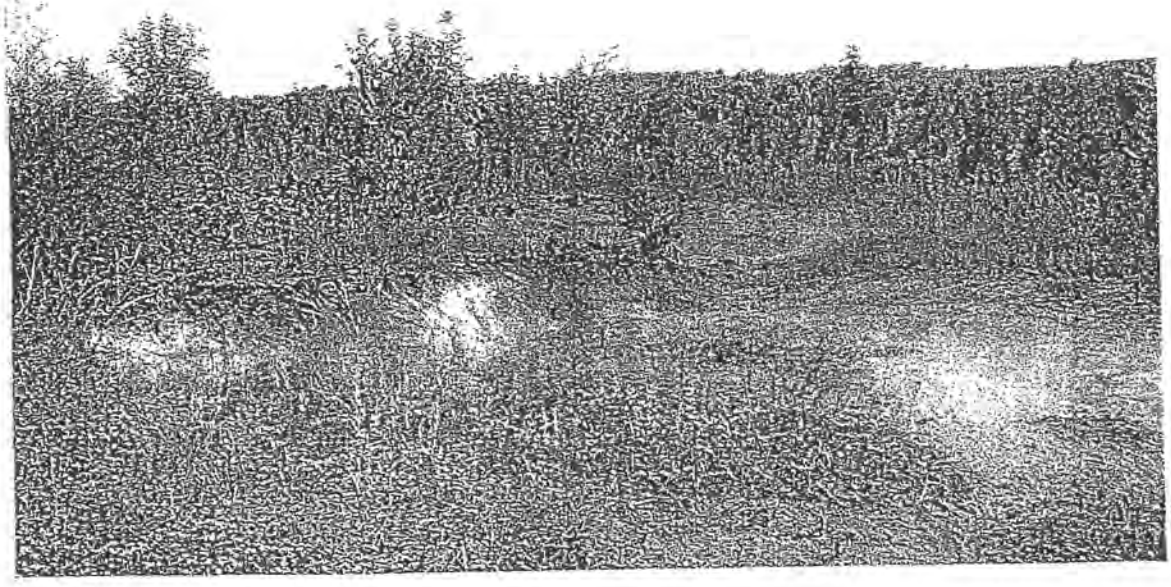
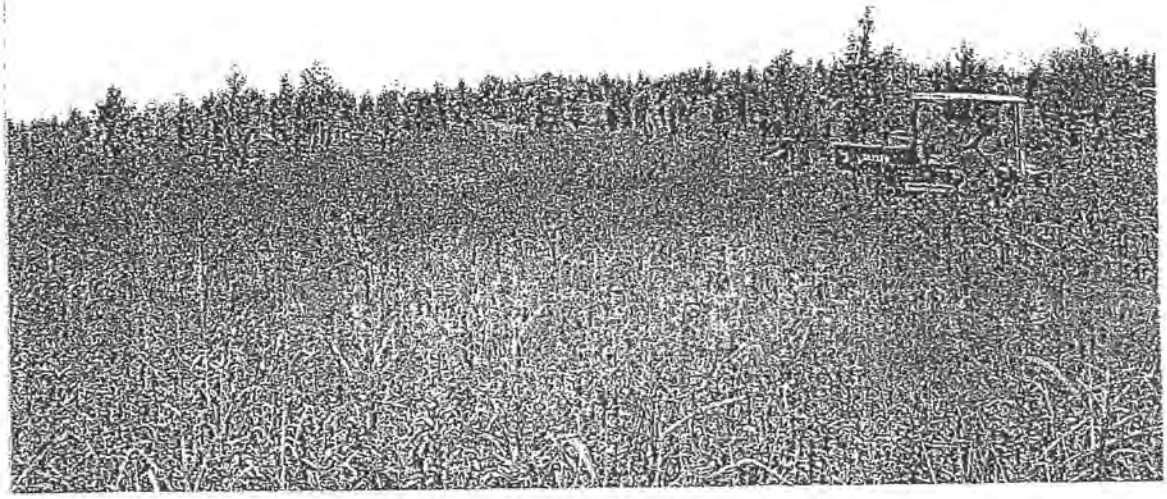


FIGURE 36 HS 32 and AS 12 view to Southeast
FIGURE 37 HS 33 and AS 13 view to East Northeast



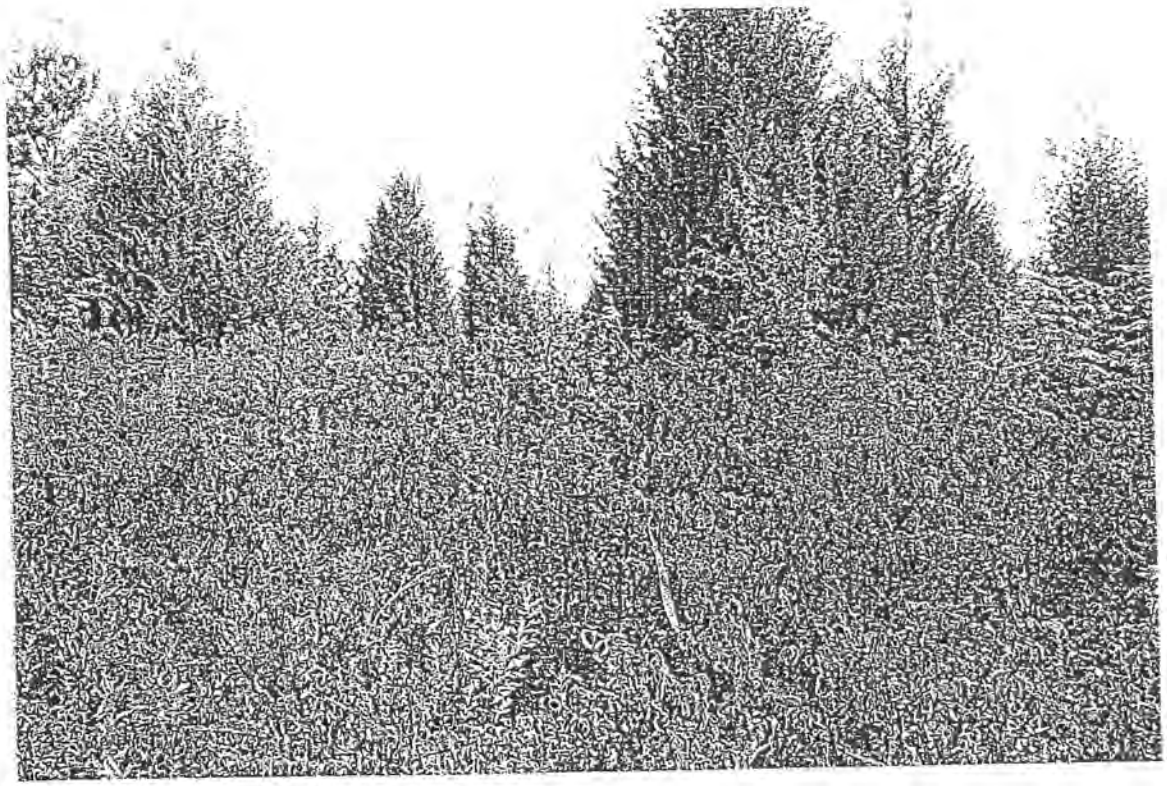


FIGURE 38 HS 34 view to Northeast
FIGURE 39 Old Plantation Cemetery view to South Southeast

FIGURE 40 Old Plantation Cemetery view to Northwest
FIGURE 41 AS 1 view to West

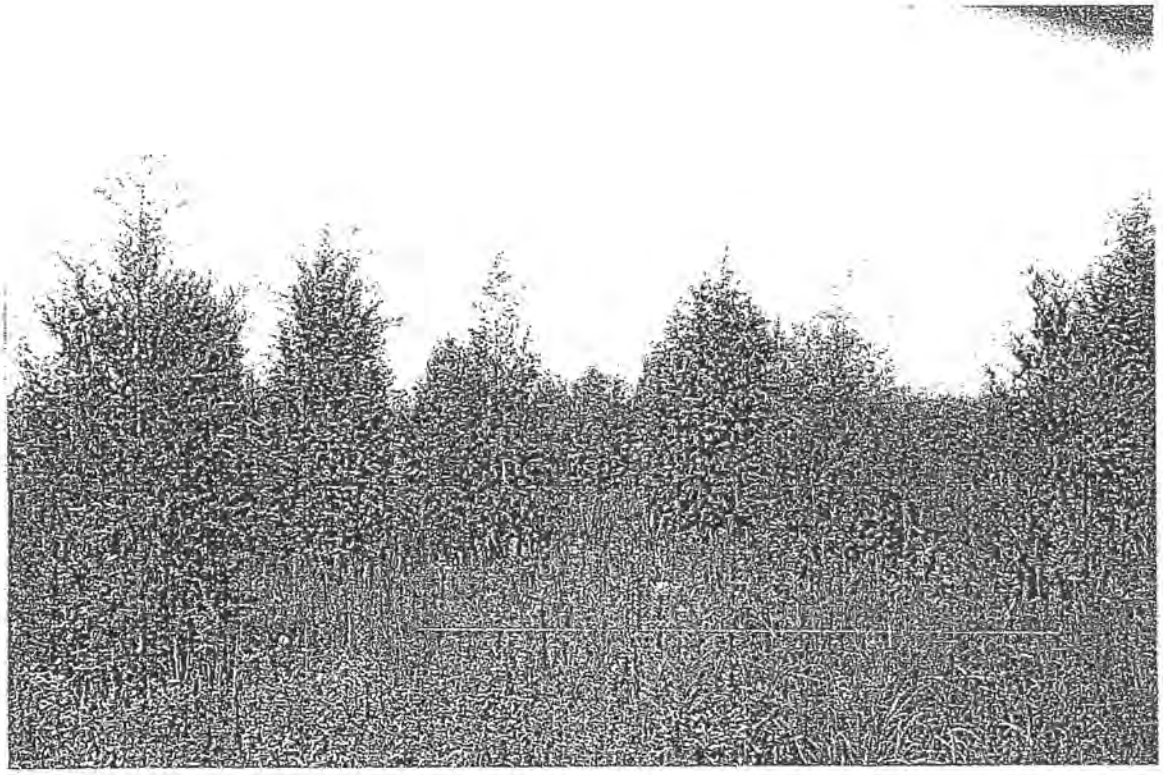
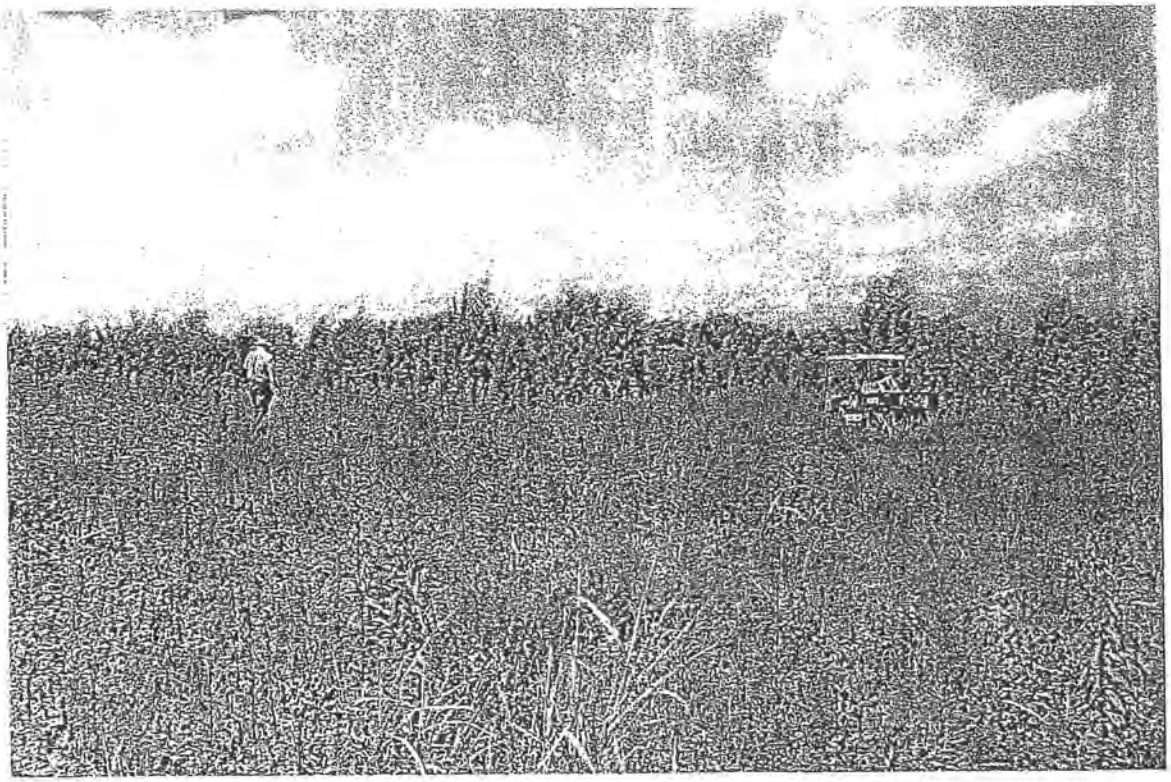


**FIGURE 42 AS 11 view to West**
**FIGURE 43 General Environs**



Jordan Jones & Goulding INCORPORATED

# SECTION G

## Boring Logs for Shallow and Deep Piezometers

## Boring / Monitoring Well Installation Log

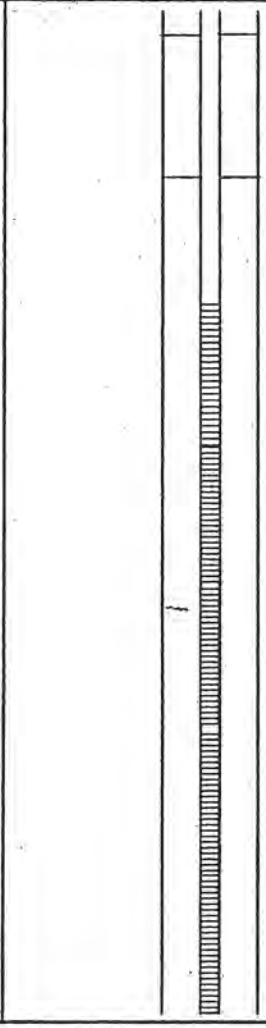
| | | | | | |
|---|---|---|---|---|---|
| **Project Name** | Perry County Landfill | **Inspector** | John Roberts | **Boring No.** | P-1 |
| **Project Number** | 4305.001 | **Weather** | Partly Cloudy | **Sheet** 1 | **of** 2 |
| **Drilling Company** | QORE Property Sciences | **Temperature** | 73 – 85 F | **Surface Elev.** | 280.3 |
| **Drill Rig** | CME 550 ATV | **Depth Hole** | 60 ft | **Datum** | MSL (NAD 1983) |
| **Wt Hammer** N/A | **Drop** N/A | **Hole Diam.** | 8 in | **Started** | 5/1/01 1020 |
| **Driller** | Wade Hawkins | **Drilling Mud** | N/A | **Completed** | 5/2/01 1000 |
| **Sampling Method** | HSA, SS, and Shelby Tube | **No. Dist. S.A.** | 12 | **No. UD. S.A.** | 1 |
| **Initial Depth W.L.** | Dry | **Time W.L.** | 1000 | **Date W.L.** | 5/2/01 |

## Well Materials Inventory

| | | | | | |
|---|---|---|---|---|---|
| **Well I.D.** | P-1 | **Filter Pack Qty** | 1500 lbs. | **Grout Install** | N/A |
| **Well Casing Dia.** | 2 in **L.F.** 10 ft | **Pack Type & Size** | Sand / DSI 1 | **End Cap/Sump** | 4 in |
| **Casing Type** | Sch. 40 PVC | **Install Method** | Poured | **Prot. Casing: Y** | N X |
| **Joint Type** | Flush Treaded | **Seal Type** | Bentonite Chips | **Well Pad Size** | Concrete seal |
| **Well Screen Dia.** | 2 in **L.F.** 50 ft | **Qty/Install Method** | 100 lbs. / Poured | **TOC Elevation** | 283.53 |
| **Screen Type** | Factory Slotted | **Grout Type & Qty** | N/A | **Water Level** | Dry |
| **Slot Size** | 0.010-in. machine slot | **Mix Ratio** | N/A | **Date WL** 5/3 | **Time** 1200 |

## Boring and Well Diagram

| Depth (ft) | Sample No. | Blows / Foot | % Rec | Sample Time (GA) | Lithologic Description | Well Diagram* / Comments (Stickup - 3 ft) |
|---|---|---|---|---|---|---|
| | | | | | Well completed with concrete seal and locking cap. See well construction diagram | |
| | 1 | | | 5/1/01 | | Bentonite seal 0.5 ft. to 5 ft. |
| 5 | 3.5 to 5 | 6/12/22 | 1.5 | 1035 | Silty clay, light gray, dry Selma Chalk. | |
| | | | | | | Top of sand Pack 5 ft. |
| | 2 | | | | | |
| 10 | 8.5 to 10 | 3/17/23 | 1.5 | | Selma Chalk as above. | |
| | 3 | | | | | |
| 15 | 13.5 to 15 | 7/15/23 | 1.5 | 1110 | Selma Chalk as above grading to light greenish gray with pyrite. | |
| | 4 | | | | | |
| 20 | 18.5 to 20 | 13/27/32 | 1.5 | 1122 | Selma Chalk, greenish gray. | |
| | 5 | | | | | |
| 25 | 23.5 to 25 | 17/27/27 | 1.5 | 1142 | Selma Chalk, greenish gray. | |
| | 6 | | | | Selma Chalk, interlayer light greenish gray, and gray. | |
| 30 | 28.5 to 30 | 20/22/29 | 1.5 | 1202 | | |



Notes: All depths measured below ground surface

* Color identification performed with Munsell Chart

**Boring / Monitoring Well Installation Log**
**Boring No. / Well ID**



P-1

| Depth (ft) | Sample No. | Blows / Foot | % Rec | Frac. Log | Lithologic Description | Well Diagram / Comments |
|---|---|---|---|---|---|---|
| | 7 | | | | | |
| 35 | 33.5 to 35 | 22/27/26 | 1.5 | 1219 | Selma Chalk, greenish gray, medium to high elasticity wet. | |
| | 8 | | | | **Collected Shelby Tube** | |
| 40 | 38.5 to 40 | 19/24/40 | 2 | 1245 | Selma Chalk greenish gray. | |
| | 9 | | | | | |
| 45 | 43.5 to 45 | 23/32/32 | 1.5 | 1300 | Selma Chalk, greenish gray, dry. | |
| | 10 | | | | | |
| 50 | 48.5 to 50 | 20/34/32 | 1.5 | 1434 | Selma Chalk, greenish gray, dry. | |
| | 11 | | | | | Well screen 9.0 to 59.0 |
| 55 | 53.5 to 55 | 24/32/31 | 1.5 | 1451 | Selma Chalk, greenish gray, dry. | |
| | 12 | | | | | |
| 60 | 58.5 to 60 | 28/33/35 | 1.5 | 1517 | Selma Chalk, greenish gray, dry. | Filter Sand 6.0 to 60.0ft |
| 65 | | | | | | |
| 70 | | | | | | |
| 75 | | | | | | |
| 80 | | | | | | |

## Boring / Monitoring Well Installation Log

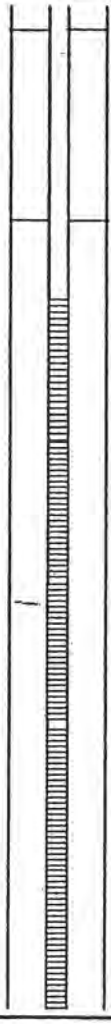
| | | | | | |
|---|---|---|---|---|---|
| **Project Name** | Perry County Landfill | **Inspector** | John Roberts | **Boring No.** | P-2 |
| **Project Number** | 4305.001 | **Weather** | Partly Cloudy | **Sheet** 1 | **of** 2 |
| **Drilling Company** | QORE Property Sciences | **Temperature** | 73 – 85 F | **Surface Elev.** | 281.0 |
| **Drill Rig** | CME 550 ATV | **Depth Hole** | 60 ft | **Datum** | MSL (NAD 1983) |
| **Wt Hammer** N/A | **Drop** N/A | **Hole Diam.** | 8 in | **Started** | 5/1/01 1700 |
| **Driller** | Wade Hawkins | **Drilling Mud** | N/A | **Completed** | 5/2/01 1200 |
| **Sampling Method** | HSA, SS, and Shelby Tube | **No. Dist. S.A.** | 12 | **No. UD. S.A.** | 0 |
| **Initial Depth W.L.** | Dry | **Time W.L.** | 1200 | **Date W.L.** | 5/2/01 |

## Well Materials Inventory

| | | | | | |
|---|---|---|---|---|---|
| **Well I.D.** | P-2 | **Filter Pack Qty** | 1400 lbs. | **Grout Install** | N/A |
| **Well Casing Dia.** | 2 in **L.F.** 10 ft | **Pack Type & Size** | Sand / DSI 1 | **End Cap/Sump** | 4 in |
| **Casing Type** | Sch. 40 PVC | **Install Method** | Poured | **Prot. Casing: Y** | N X |
| **Joint Type** | Flush Treaded | **Seal Type** | Bentonite Chips | **Well Pad Size** | Concrete seal |
| **Well Screen Dia.** | 2 in **L.F.** 50 ft | **Qty/Install Method** | 100 lbs. / Poured | **TOC Elevation** | 283.91 |
| **Screen Type** | Factory Slotted | **Grout Type & Qty** | N/A | **Water Level** | Dry |
| **Slot Size** | 0.010-in. machine slot | **Mix Ratio** | N/A | **Date WL** 5/3 | **Time** 1355 |

## Boring and Well Diagram

| Depth (ft) | Sample No. | Blows / Foot | % Rec | Sample Time (GA) | Lithologic Description | Well Diagram* / Comments (Stickup - 3 ft) |
|---|---|---|---|---|---|---|
| | | | | | Well completed with concrete seal and locking cap. See well construction diagram | |
| | 1 | | | 5/1/01 | | Bentonite seal 0.5 ft. to 6.5 ft. |
| 5 | 3.5 to 5 | 4/11/17 | 1 | | Silty clay, light brownish gray, grading to gray, some organics dry, to moist. | |
| | | | | | | Top of sand Pack 6.5 ft. |
| | 2 | | | | | |
| 10 | 8.5 to 10 | 7/15/23 | 1.5 | 1714 | Selma Chalk as above, greenish gray, dry. | |
| | 3 | | | | Selma Chalk, greenish gray, dry. | |
| 15 | 13.5 to 15 | 1/1/15 | 1.5 | 1730 | When compressed, breaks in layers or lenses. | |
| | 4 | | | | | |
| 20 | 18.5 to 20 | 5/20/21 | 1.5 | 1740 | Selma Chalk, greenish gray. | |
| | 5 | | | | Selma Chalk, interlayer light | |
| 25 | 23.5 to 25 | 10/17/32 | 1.5 | 1751 | greenish gray, and gray, dry. | |
| | 6 | | | | | |
| 30 | 28.5 to 30 | 12/17/27 | 1.5 | 1808 | Selma Chalk, greenish gray, dry. | |



Notes: All depths measured below ground surface

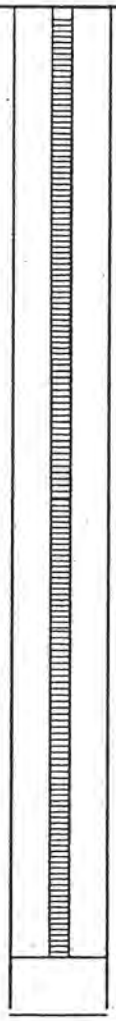
* Color identification performed with Munsell Chart

Boring / Monitoring Well Installation Log
Boring No. / Well ID



P-2

| Depth (ft) | Sample No. | Blows / Foot | % Rec | Frac. Log | Lithologic Description | Well Diagram / Comments |
|---|---|---|---|---|---|---|
| | 7 | | | | | |
| 35 | 33.5 to 35 | 20/28/50 | 1.5 | 1823 | Selma Chalk, greenish gray, dry. | |
| | 8 | | | | Attempted | |
| 40 | 38.5 to 40 | | | | Collected Shelby Tube | |
| | 9 | | | 5/2/01 | Attempted Collected Shelby Tube | |
| 45 | 43.5 to 45 | 24/30/35 | 1.5 | 1043 | Selma Chalk, greenish gray, dry. | |
| | 10 | | | | | |
| 50 | 48.5 to 50 | 15/30/40 | 1.5 | 1056 | Selma Chalk, greenish gray, dry. | |
| | 11 | | | | | Well screen 9.0 to 59.0 |
| 55 | 53.5 to 55 | 27/(50/5) | 1 | 1110 | Selma Chalk, greenish gray, dry. | |
| | 12 | | | | | Filter Sand 6.5 to 60.0ft |
| 60 | 58.5 to 60 | | 1.5 | 1125 | Selma Chalk, greenish gray, dry. | |
| 65 | | | | | | |
| 70 | | | | | | |
| 75 | | | | | | |
| 80 | | | | | | |



## Boring / Monitoring Well Installation Log

| | | | | | |
|---|---|---|---|---|---|
| **Project Name** | Perry County Landfill | **Inspector** | John Roberts | **Boring No.** | P-3 |
| **Project Number** | 4305.001 | **Weather** | Partly Cloudy | **Sheet** 1 | **of** 2 |
| **Drilling Company** | QORE Property Sciences | **Temperature** | 73 – 85 F | **Surface Elev.** | 218.6 |
| **Drill Rig** | CME 550 ATV | **Depth Hole** | 60 ft | **Datum** | MSL (NAD 1983) |
| **Wt Hammer** N/A | **Drop** N/A | **Hole Diam.** | 8 in | **Started** | 5/2/01 1520 |
| **Driller** | Wade Hawkins | **Drilling Mud** | N/A | **Completed** | 5/2/01 1830 |
| **Sampling Method** | HSA, SS, and Shelby Tube | **No. Dist. S.A.** | 10 | **No. UD. S.A.** | 2 |
| **Initial Depth W.L.** | Dry | **Time W.L.** | 1800 | **Date W.L.** | 5/2/01 |

## Well Materials Inventory

| | | | | | |
|---|---|---|---|---|---|
| **Well I.D.** | P-3 | **Filter Pack Qty** | 1400 lbs. | **Grout Install** | N/A |
| **Well Casing Dia.** | 2 in **L.F.** 10 ft | **Pack Type & Size** | Sand / DSI 1 | **End Cap/Sump** | 4 in |
| **Casing Type** | Sch. 40 PVC | **Install Method** | Poured | **Prot. Casing: Y** | N X |
| **Joint Type** | Flush Treaded | **Seal Type** | Bentonite Chips | **Well Pad Size** | Concrete seal |
| **Well Screen Dia.** | 2 in **L.F.** 50 ft | **Qty/Install Method** | 100 lbs. / Poured | **TOC Elevation** | 221.59 |
| **Screen Type** | Factory Slotted | **Grout Type & Qty** | N/A | **Water Level** | Dry |
| **Slot Size** | 0.010-in. machine slot | **Mix Ratio** | N/A | **Date WL** 5/3 | **Time** 1345 |

## Boring and Well Diagram

| Depth (ft) | Sample No. | Blows / Foot | % Rec | Sample Time (GA) | Lithologic Description | Well Diagram* / Comments (Stickup - 3 ft) |
|---|---|---|---|---|---|---|
| | | | | | Well completed with concrete seal and locking cap. See well construction diagram | |
| | 1 | | | 5/2/01 | | Bentonite seal 0.5 ft. to 6.5 ft. |
| 5 | 3.5 to 5 | 3/4/4 | 8" | 1529 | Clay, medium to high elasticity, light olive brown, rootlets, moist. | |
| | 2 | | | | | Top of sand Pack 6.5 ft. |
| 10 | 8.5 to 10 | 4/10/12 | 1 | 1534 | Selma Chalk light brownish gray, dry. | |
| | 3 | | | | As Above interlayer with greenish | |
| 15 | 13.5 to 15 | 6/10/11 | 1.5 | 1540 | gray. Saprolite characteristics | |
| | 4 | | | | Selma Chalk, light brownish gray | |
| 20 | 18.5 to 20 | 9/13/17 | 1.5 | 1546 | with saprolitic joint contacts lined in greenish gray and fine grained sand, dry. | |
| | 5 | | | | | |
| 25 | 23.5 to 25 | 12/16/20 | 1.5 | 1554 | Selma Chalk, dark greenish gray, dry. | |
| 30 | 28.5 to 30 | | | | **Collected a Shelby Tube** Selma Chalk, dark greenish gray. | |

**Notes:** All depths measured below ground surface

* Color identification performed with Munsell Chart

Boring / Monitoring Well Installation Log
Boring No. / Well ID



P-3

| Depth (ft) | Sample No. | Blows / Foot | % Rec | Frac. Log | Lithologic Description | Well Diagram / Comments |
|---|---|---|---|---|---|---|
| | 6 | | | | | |
| | 31 to 31.5 | 15/24/36 | 1.5 | 1654 | Selma Chalk, dark greenish gray, dry. | |
| | | | | | | |
| | 7 | | | | | |
| 35 | 33.5 to 35 | 13/25/28 | 1.5 | 1659 | Selma Chalk, dark greenish gray, dry. | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| 40 | 38.5 to 40 | | | | **Collected a Shelby Tube** | |
| | 8 | | | | | |
| | 40 to 41.5 | 19/25/25 | 1.5 | 1715 | Selma Chalk, dark greenish gray, dry. | |
| | | | | | | |
| | | | | | | |
| 45 | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | 9 | | | | | |
| 50 | 48.5 to 50 | 11/21/26 | 1.5 | 1733 | Selma Chalk, dark greenish gray, dry. | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | Well screen 8.5 to 58.5 |
| 55 | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | 10 | | | | | |
| 60 | 58.5 to 60 | 17/24/30 | 1.5 | 1750 | Selma Chalk, dark greenish gray, dry. | Filter Sand 6.5 to 60.0ft |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| 65 | | | | | | |
| | | | | | | |
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| 70 | | | | | | |
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| 75 | | | | | | |
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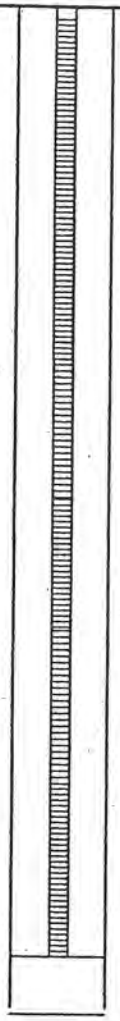
| 80 | | | | | | |



DW-2

# REPORT OF DRILLED WELL

Allen & Willis — #453 — 2-8-01
DRILLING CONTRACTOR — License Number — Address — Zip Code — Date

Larry Matthews — Zip Code
PROPERTY OWNER — Address (mailing)

Perry Co — 27 — T17N — R6E
WELL LOCATION — County — Section — ¼ Section — Township — Range — E/W

Distance and direction from nearest town, community, road junction or other reference point

WELL WILL BE USED FOR: ☐ Private supply ☐ Public supply ☐ Industrial supply ☐ Test well ☐ Irrigation Other:

Estimated starting date

Drilling method: (check) Cable tool ☐ Rotary ☐ Jetted ☐ Bored

5 — Diameter of well
500 — Estimated depth

Other:

Thomas B. Willis
SIGNATURE of Drilling Contractor

Total Depth 560 ft

Completion Date 2-9-01

| Interval | Description of cuttings | Interval | Description of cuttings |
|---|---|---|---|
| 0-2 | Top Clay | | |
| -535 | Limerock | | |
| -540 | Sand & Rock | | |
| -560 | Water Bearing | | |

Completion data: report depths below ground level

**Pump**
Type: ☐ Turb. ☐ Subm. ☐ Jet ☐ Cyl.; Other:
Intake depth ____ H.P. ____ Yield ____ gpm

**Capacity**
Tested by: ☐ pumping ☐ air lift ☐ bailer ☐ none
Measured Static Water Level 132 ft.
Measured pumping level ____ ft. after
____ hrs. pumping ____ gpm
Development time prior to testing ____ hrs.

**Finish**
☐ Open hole ☒ Screened ☐ Slotted pipe ☒ Gravel pk.
Interval(s) screened: 540 to 560 ft.
____ to ____ ; ____ to ____ ft.
Packer(s) set at ____ and ____ ft.
Screen: diam. 2" ; Slot openings .020

**Casing**

| Interval cased | Diam. (inches) | *Type pipe | *Type couplings | Interval grouted |
|---|---|---|---|---|
| 0-20 | 5" | PVC | | 0-20 |
| 0-540 | 2" | PVC | | |
| | | | | |
| | | | | |

*Couplings: Threaded & Coupled [T&C] Welded [W] Threaded & coupled & welded [T&W]
Other:
*Pipe: Black; PVC; Galv.; Other:

**Quality**
Water analysis obtained? (check) ☐ No ☐ Bacteriological ☐ Chemical
Analysis by: ☐ Ala Geol. Surv. ☐ U.S. Geol. Surv. ☐ Ala Health Dept. ☐ Private lab.
Signed:

*For deeper well please attach continuation sheet.

ADEM FORM 60 12/99

DW-3

# REPORT OF DRILLED WELL

Allen & Willis | #453 | | | 2-8-01
DRILLING CONTRACTOR | License Number | Address | Zip Code | Date

Larry Matthews | | Zip Code
PROPERTY OWNER | Address (mailing)

Perry Co | 27 | T17N | R6E | —or:
WELL LOCATION County | Section | ¼ Section | Township | Range

on Co Rd #1 aprx 1½ mi SE of Uniontown
Distance and direction from nearest town, community, road junction or other reference point

WELL WILL BE USED FOR: ☐ Private supply ☐ Public supply ☐ Industrial supply ☐ Test well ☐ Irrigation Other: Monitor water level

5" Diameter of well | 550 Estimated depth

Estimated starting date | Drilling method: (check) Cable tool, (Rotary), Jetted, Bored | Other:

Thomas B. Willis
SIGNATURE of Drilling Contractor

Total Depth 535 | Completion Date 2-10-01

| Interval | Description of cuttings | Interval | Description of cuttings |
|---|---|---|---|
| 0-8 | Top Clay | | |
| 500 | Limerock | | |
| 520 | Soft Clay & Sand | | |
| 535 | Sand | | |

Completion data: report depths below ground level

**Pump**
Type: ☐ Turb. ☐ Subm. ☐ Jet ☐ Cyl.; Other:
Intake depth ____ H.P. ____ Yield ____ gpm

**Capacity**
Tested by: ☐ pumping ☐ air lift ☐ bailer ☐ none
Measured static water level 116 ft.
Measured pumping level ____ ft. after
____ hrs. pumping ____ gpm
Development time prior to testing ____ hrs.

**Finish**
☐ Open hole ☒ Screened ☐ Slotted pipe ☒ Gravel pk.
Interval(s) screened: 515 to 535 ft.
____ to ____; ____ to ____ ft.
Packer(s) set at ____ and ____ ft.
Screen: diam. 2" ; Slot openings .020

**Casing**

| Interval cased | Diam. (inches) | *Type pipe | *Type couplings | Interval grouted |
|---|---|---|---|---|
| 0-20 | 5" | PVC | — | 0-20 |
| 0-515 | 2" | PVC | | |
| | | | | |
| | | | | |

*Couplings: Threaded & Coupled (T&C) Welded (W) Threaded & coupled & welded (T&C&W)
Other:
*Pipe: Black; PVC; Galv.; Other:

**Quality**
Water analysis obtained? (check) ☐ No ☐ Bacteriological ☐ Chemical
Analysis by: ☐ Ala Geol. Surv. ☐ U.S. Geol. Surv. ☐ Ala Health Dept. ☐ Private Lab.
Signed:

*For deeper well please attach continuation sheet.

DW-1

# REPORT OF DRILLED WELL

2-15-01
Date

Allen & Willis — #453 — Address — Zip Code
DRILLING CONTRACTOR — License Number

Larry Matthews — Address (mailing) — Zip Code
PROPERTY OWNER

Perry Co — 27 — T17N — R6E
WELL LOCATION — County — Section — ¼ Section — Township — Range — or:

aprx 2 mi SE of Uniontown on Co Rd #1
Distance and direction from nearest town, community, road junction or other reference point

WELL WILL BE USED FOR: ☐ Private supply ☐ Public supply ☐ Industrial supply ☐ Test well ☐ Irrigation Other: Monitor Water Level

2-16-01 — Estimated starting date
Drilling method: (check) Cable tool ☐ Rotary ☒ Jetted ☐ Bored Other:
5" — Diameter of well
560 — Estimated depth

Thomas B. Willis
SIGNATURE of Drilling Contractor

Total Depth 600
Completion Date 2-27-01

| Interval | Description of cuttings | Interval | Description of cuttings |
|---|---|---|---|
| 0-4 | Top Clay | | |
| 4-570 | Limerock | | |
| 570-580 | Sand, Clay, Rock | | |
| 580-600 | Sand | | |

Completion data: report depths below ground level

**Pump**
Type: ☐ Turb. ☐ Subm. ☐ Jet ☐ Cyl.: Other:
Intake depth ____ H.P. ____ Yield ____ gpm

**Capacity**
Tested by: ☐ pumping ☐ air lift ☐ bailer ☐ none
Measured Static Water Level ____ ft.
Measured pumping level ____ ft. after
____ hrs. pumping ____ gpm
Development time prior to testing ____ hrs.

**Finish**
☐ Open hole ☒ Screened ☐ Slotted pipe ☒ Gravel pk.
Interval(s) screened: 580 to 600 ft.
____ to ____ ; ____ to ____ ft.
Packer(s) set at ____ and ____ ft.
Screen: diam. 2 ; Slot openings .020

**Casing**

| Interval cased | Diam. (inches) | *Type pipe | *Type couplings | Interval grouted |
|---|---|---|---|---|
| 0-20 | 5" | PVC | | 0-20 |
| 0-580 | 2" | PVC | | |
| | | | | |
| | | | | |

*Couplings: Threaded & Coupled (T&C) Welded (W) Threaded & coupled & welded (TC&W)
Other:
*Pipe: Black; PVC; Galv.; Other:

**Quality**
Water analysis obtained? (check) ☐ No ☐ Bacteriological ☐ Chemical
Analysis by: ☐ Ala Geol. Surv. ☐ U.S. Geol. Surv. ☐ Ala Health Dept. ☐ Private lab.
Signed:

*For deeper well please attach continuation sheet.

SW-1

# REPORT OF DRILLED WELL

Allen & Willis — #453 — 2-8-01
DRILLING CONTRACTOR — License Number — Address — Zip Code — Date

Larry Matthews
PROPERTY OWNER — Address (mailing) — Zip Code

Perry — 27 — T17N — R6E
WELL LOCATION — County — Section — ¼ Section — Township — Range — —of:

Distance and direction from nearest town, community, road junction or other reference point

WELL WILL BE USED FOR: ☐ Private supply ☐ Public supply ☐ Industrial supply ☐ Test well ☐ Irrigation Other:

Estimated starting date

Drilling method: (check) Cable tool (Rotary) Dug Bored Other:

2" Diameter of well

60 Estimated depth

Thomas B Willis
SIGNATURE of Drilling Contractor

Total Depth 60 ft

Completion Date

| Interval | Description of cuttings | Interval | Description of cuttings |
|---|---|---|---|
| 0-10 | Red Clay | | |
| 10-60 | Limerock | | |

Completion data: report depths below ground level

**Pump**
Type: ☐ Turb. ☐ Subm. ☐ Jet ☐ Cyl.; Other:
Intake depth ____ H.P. ____ Yield ____ gpm

**Capacity**
Tested by: ☐ pumping ☐ air lift ☐ bailer ☐ none
Measured Static Water Level ____ ft.
Measured pumping level ____ ft. after ____ hrs. pumping ____ gpm
Development time prior to testing ____ hrs.

**Finish**
☐ Open hole ☒ Screened ☐ Slotted pipe ☒ Gravel pk.
Interval(s) screened: 50 to 60 ft.
____ to ____ ; ____ to ____ ft.
Packer(s) set at ____ and ____ ft.
Screen: diam. 2 ; Size openings .020

**Casing**

| Interval cased | Diam. (inches) | *Type pipe | *Type couplings | Interval grouted |
|---|---|---|---|---|
| 0-50 ft | 2" | PVC | | 0-50 |
| | | | | |
| | | | | |
| | | | | |

*Couplings: Threaded & Coupled (T&C) Welded (W) Threaded & coupled & welded (T&CW)
Other:
*Pipe: Black; PVC; Galv.; Other:

**Quality**
Water analysis obtained? (check) ☐ No ☐ Bacteriological ☐ Chemical
Analysis by: ☐ Ala Geol. Surv. ☐ Ala Health Dept. ☐ U.S. Geol. Surv. ☐ Private lab.
Signed:

*For deeper well please attach continuation sheet.

SW-2

# REPORT OF DRILLED WELL

Allen & Willis | #453 | | | 2-8-01
DRILLING CONTRACTOR | License Number | Address | Zip Code | Date

Larry Matthews | | Zip Code
PROPERTY OWNER | Address (mailing)

Perry Co | | 27 | | T17N | R6E
WELL LOCATION | County | Section | ¼ Section | Township | Range | qr.

Distance and direction from nearest town, community, road junction or other reference point

WELL WILL BE USED FOR: ☐ Private supply ☐ Public supply ☐ Industrial supply ☐ Test well ☐ Irrigation Other:

2-10-01 Estimated starting date

Drilling method: (check) Cable tool (Rotary) Jetted Bored Other:

2" Diameter of well

60 Estimated depth

Thomas B. Willis
SIGNATURE of Drilling Contractor

Total Depth | Completion Date

| Interval | Description of cuttings | Interval | Description of cuttings |
|---|---|---|---|
| 0-8 | Top Red Clay | | |
| 8-60 | Fenerock | | |

**Pump**
Completion data: report depths below ground level
Type: ☐ Turb. ☐ Subm. ☐ Jet ☐ Cyl.: Other:
Intake depth ____ H.P. ____ Yield ____ gpm

**Capacity**
Tested by: ☐ pumping ☐ air lift ☐ bailer ☐ none
Measured Static Water Level ____ ft.
Measured pumping level ____ ft. after ____ hrs. pumping ____ gpm
Development time prior to testing ____ hrs.

**Finish**
☐ Open hole ☒ Screened ☐ Slotted pipe ☒ Gravel pk.
Interval(s) screened: 50 to 60 ft.
____ to ____ ; ____ to ____ ft.
Packer(s) set at ____ and ____ ft.
Screen: diam. 2" ; Size openings .020

**Casing**

| Interval cased | Diam. (inches) | *Type pipe | *Type couplings | Interval grouted |
|---|---|---|---|---|
| 0-50 | 2" | PVC | | 0-50 |
| | | | | |
| | | | | |

*Couplings: Threaded & Coupled (T&C) Welded (W) Threaded & coupled & welded (TC&W)
Other:
*Pipe: Black; PVC; Galv.; Other:

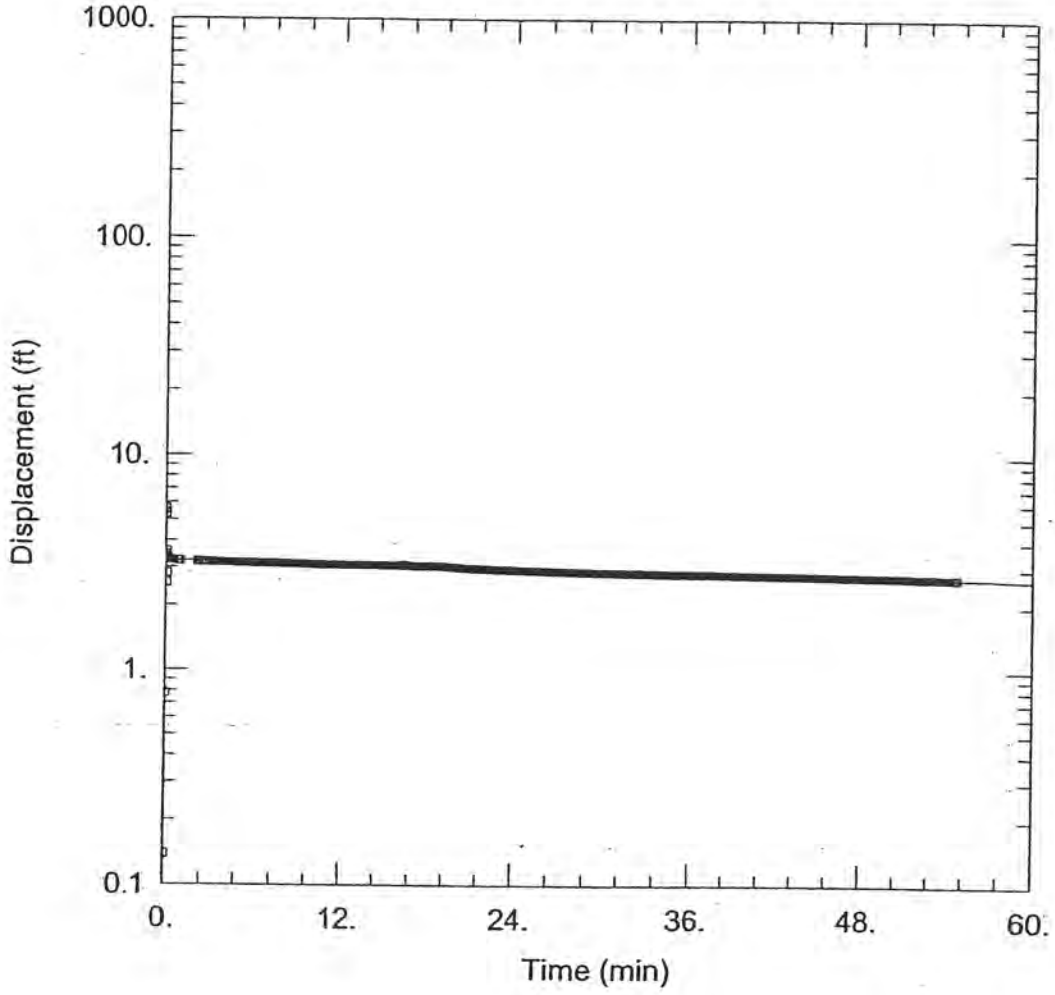
**Quality**
Water analysis obtained? (check) ☐ No ☐ Bacteriological ☐ Chemical
Analysis by: ☐ Ala Geol. Surv. ☐ U.S. Geol. Surv. ☐ Ala Health Dept. ☐ Private lab
Signed:

*For deeper well please attach continuation sheet.

Jordan Jones & Goulding INCORPORATED

# APPENDIX H

## Slug Test Data for DW-1, DW-2, and DW-3




## WELL DW-1

Data Set: P:\4305-001\Hydrogeology\DW-1.aqt
Date: 06/14/01 Time: 09:39:11

## PROJECT INFORMATION

Client: Perry County Associates
Project: 4305.001
Test Location: Uniontown
Test Well: DW-1
Test Date: 5/3/01

## AQUIFER DATA

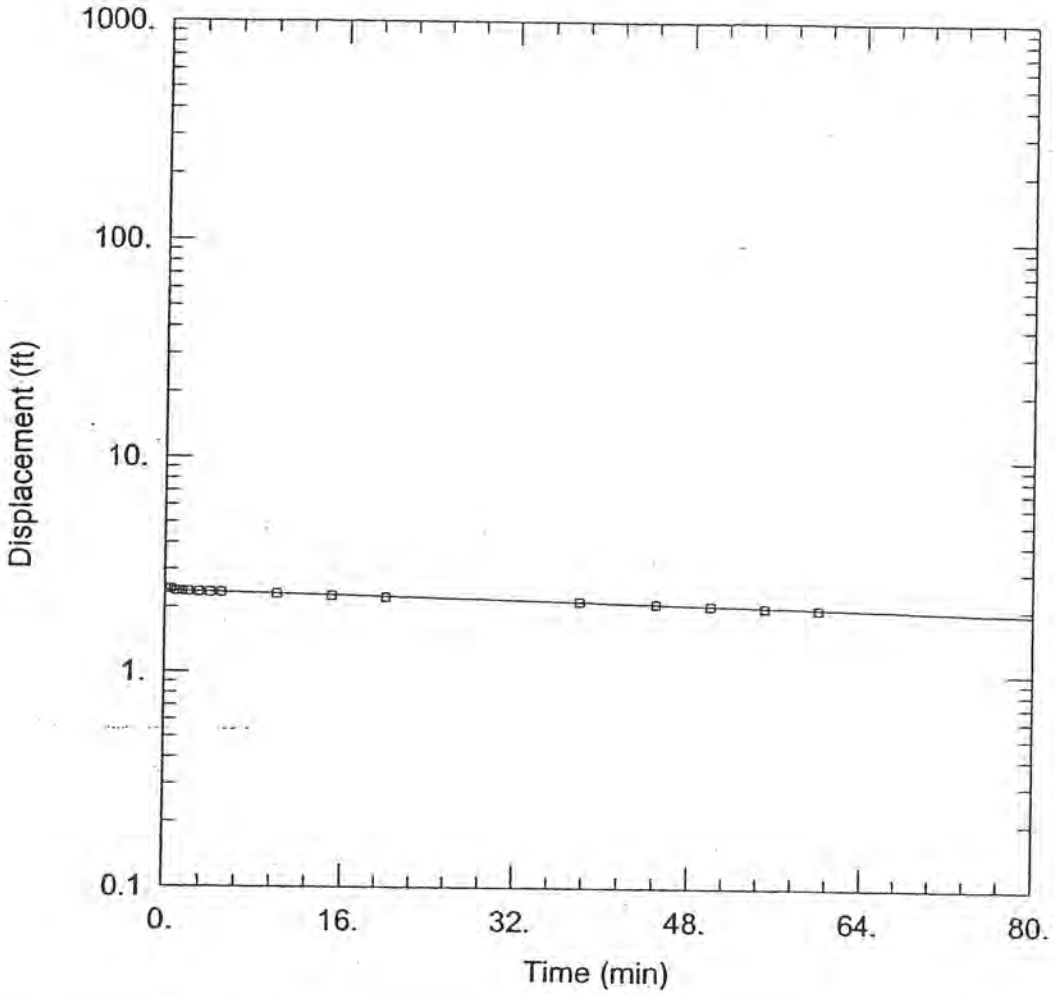
Saturated Thickness: 428. ft Anisotropy Ratio (Kz/Kr): 1.

## WELL DATA (DW-1)

Initial Displacement: 5.6 ft
Casing Radius: 0.0833 ft
n Length: 10. ft
Water Column Height: 428. ft
Wellbore Radius: 0.302 ft
Gravel Pack Porosity: 0.3

## SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice
K = 0.03497 ft/day
y0 = 3.244 ft




## WELL DW-2

Data Set: P:\4305-001\Hydrogeology\DW-2.aqt
Date: 06/14/01 Time: 09:40:12

## PROJECT INFORMATION

Client: Perry County Associates
Project: 4305.001
Test Location: Uniontown
Test Well: DW-2
Test Date: 5/3/01

## AQUIFER DATA

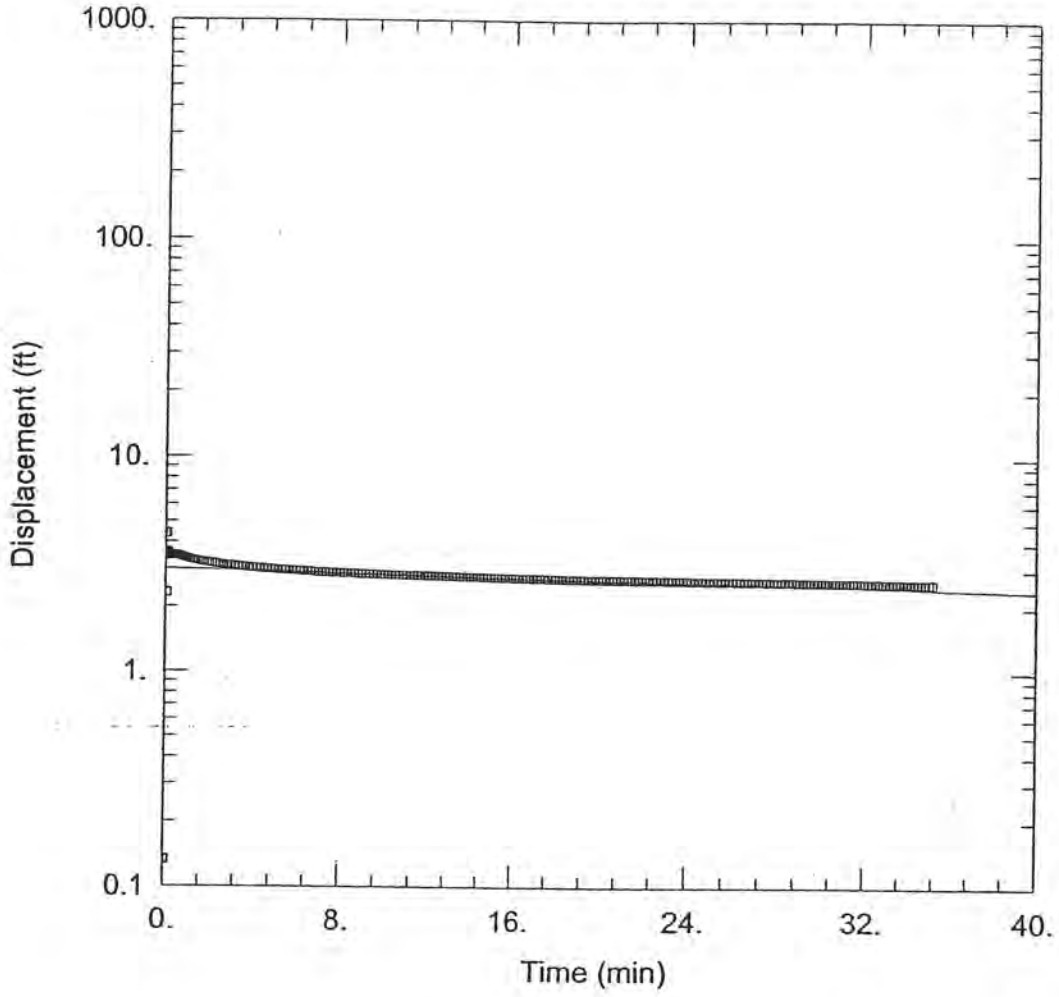
Saturated Thickness: 451. ft Anisotropy Ratio (Kz/Kr): 1.

## WELL DATA (DW-2)

Initial Displacement: 2.43 ft
Casing Radius: 0.0833 ft
n Length: 10. ft
Water Column Height: 451. ft
Wellbore Radius: 0.302 ft
Gravel Pack Porosity: 0.3

## SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice
K = 0.03048 ft/day
y0 = 2.388 ft




## WELL DW-3

Data Set: P:\4305-001\Hydrogeology\DW-3.aqt
Date: 06/14/01 Time: 09:41:16

## PROJECT INFORMATION

Client: Perry County Associates
Project: 4305.001
Test Location: Uniontown
Test Well: DW-3
Test Date: 5/3/01

## AQUIFER DATA

Saturated Thickness: 487. ft
Anisotropy Ratio (Kz/Kr): 1.

## WELL DATA (DW-3)

Initial Displacement: 4.4 ft
Casing Radius: 0.0833 ft
Screen Length: 10. ft
Water Column Height: 487. ft
Wellbore Radius: 0.302 ft
Gravel Pack Porosity: 0.3

## SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice
K = 0.06239 ft/day
y0 = 3.008 ft

Jordan Jones & Goulding
INCORPORATED

# Appendix I
# Geotechnical Analyses Data

QORE
PROPERTY SCIENCES

JUN 1 2001
TO | A | I | C | SEEN | ACTION
LFG
FILE NO.
RETURN TO

May 24, 2001

Jordan Jones & Goulding
6801 Governors Lake Parkway
Norcross, Georgia 30071

Attention: Mr. Leo F. Gentile

Subject: Perry County Project
QORE Job No. 22305, Report No. 193150

Gentlemen:

QORE, Inc. has completed the laboratory testing on the soil samples sent by your office. The following tests were performed:

- Dry Bulk Density
- Vertical Permeability (ASTM D-5084)
- Moisture Content (ASTM D-2216
- Cation Exchange Capacity
- Sieve Analysis (ASTM D-422)
- Atterberg Limits (ASTM D-4318)
- Specific Gravity (ASTM D-854)
- Soil Classification (ASTM D-2487)
- Organic Content (ASTM D-2974)

QORE, Inc. performs soil tests in general accordance with the applicable American Society for Testing and Materials (ASTM) or AASHTO procedures. These procedures are generally recognized as the basis for uniformity and consistency of test results in the geotechnical engineering profession. All the work is supervised by a qualified engineer. Attached are test results for your review.

QORE, Inc. appreciates the opportunity to provide these laboratory services. Please contact us if you have any questions concerning this report or if we may be of further service.

Respectfully submitted,
QORE, INC.

Ashok K Mangla

Ashok K. Mangla, B.E. (Civil)
Geotechnical Laboratory Manager
Member ASTM D-18, D-35

C. Scott Fletcher

C. Scott Fletcher, P.E.
Chief Geotechnical Engineer
Reg. Ga. 16170

AKM/CSF/jk
Attachment

11420 Johns Creek Parkway Duluth, Georgia 30097 (770) 476-3555 fax (770) 476-0213

QORE
PROPERTY SCIENCES

# SUMMARY OF SOIL TESTS

JOB NAME : Perry County , Alabama Project

JOB NO. : 22305 REPORT NO. : 193150 DATE : 05/24/01 REVIEWED BY :

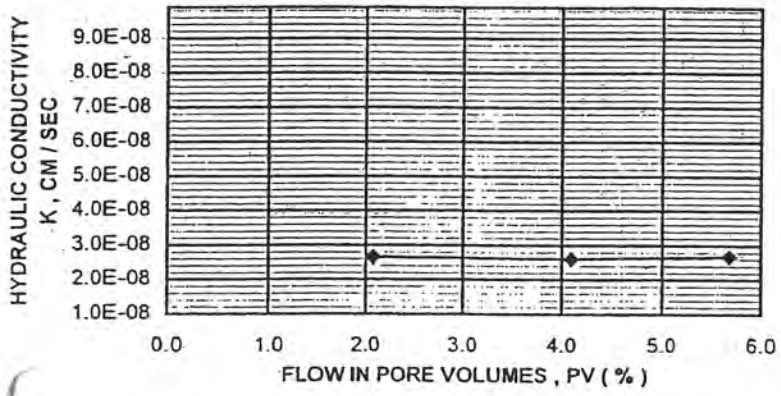
| BORING NO. | DEPTH | SAMPLE TYPE | ATTERBERG LIMITS ASTM D422 | | | NATURAL MOISTURE CONTENT ASTM D 2216 | AMOUNT OF FINES ASTM D422 | UNIFIED SOIL CLASSIFICATION ASTM D2487 | SPECIFIC GRAVITY ASTM D854 | ORGANIC CONTENT ASTM D2974 | CATION EXCHANGE CAPACITY | DRY BULK DENSITY | VERTICAL PERMEABILITY ASTM D5084 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | LL | PL | PI | | | | | | | | |
| | | | % | % | % | % | % | | $G_s$ | % | Meq / 100 ML | PCF | CM / SEC |
| P-1 | 38.5'-40' | UD | 56 | 26 | 30 | 19.8 | 96 | CH | 2.669 | 2.05 | 14.1 | 85.5 | 2.6E-08 |
| P-3 | 28.5'-30' | UD | 59 | 21 | 38 | 13.1 | 94 | CH | 2.673 | 1.44 | 16.4 | 105.9 | 4.6E-08 |
| P-3 | 38.5'-40' | UD | 58 | 21 | 37 | 24.8 | 86 | CH | 2.669 | 2.48 | 18.0 | 94.8 | 7.3E-09 |
| - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| - | - | - | - | - | - | - | - | - | - | - | - | - | - |

# FLEXIBLE WALL PERMEABILITY TEST REPORT
## ( ASTM D 5084 )

CORE LABORATORY SCIENCES

AAP AASHTO R18

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| B NAME : | Perry County , Alabama Project | | | | | | |
| JOB NO. : | 22305 | REPORT NO. : | - | DATE: | 05/07/01 | REVIEWED BY : | |
| BORING / PIT: | P-1 | DEPTH / ELEV. : | 38.5'-40' | SAMPLE NO. : | - | SAMPLE TYPE: | UD |
| SAMPLE LOCATION: - | | | | | | DIAMETER , INCHES : | 2.86 |
| SOIL DESCRIPTION | Greenish gray clay . | | | | | LENGTH , INCHES : | 3.45 |
| LIQUID LIMIT, % : | 56 | PLASTICITY INDEX , % | 30 | FINES , % : | 96 | SPECIFIC GRAVITY, Gs : | 2.67 |




| HYDRAULIC CONDUCTIVITY, k | |
|---|---|
| 2.6E-08 | CM / SEC @ 20 °C |

| SPECIMEN PROPERTIES | | | |
|---|---|---|---|
| **INITIAL** | | | |
| MOISTURE CONTENT | $W_o$ | 19.8 | % |
| DRY UNIT WEIGHT | $\gamma_{dry_o}$ | 85.5 | pcf |
| SATURATION | $S_o$ | 55.8 | % |
| VOID RATIO | $e_o$ | 0.948 | |
| **AFTER CONSOLIDATION** | | | |
| MOISTURE CONTENT | $W_c$ | 34.3 | % |
| DRY UNIT WEIGHT | $\gamma_{dry_c}$ | 86.9 | pcf |
| SATURATION | $S_c$ | 100 | % |
| VOID RATIO | $e_c$ | 0.916 | |
| **PERMEATION** | | | |
| FINAL BACK PRESSURE | $u_o$ | 65.0 | psi |
| EFFECTIVE CONSOLIDATION PRESSURE | $\sigma_3'$ | 20.0 | psi |
| PORE PRESSURE DIFFERENCE TO INDUCE FLOW | $\Delta u_o$ | 3.7 | psi |
| HYDRAULIC GRADIENT | i | 30 | |
| QUANTITY OF FLOW | Q | 9.7 | $cm^3$ |
| TOTAL PORE VOLUME | PV | 5.7 | % |

| PERMEANT PROPERTIES |
|---|
| PERMEANT DESCRIPTION : |
| *Deaired Tap Water* |
| @ 22 °C |

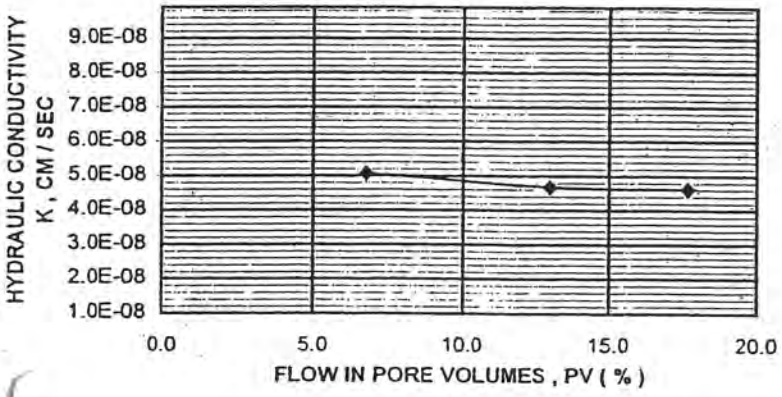
| REMOLDED SOIL PROPERTIES | | |
|---|---|---|
| *N/A* | | |
| MAXIMUM DRY DENSITY : | - | PCF |
| OPTIMUM MOISTURE CONTENT : | - | % |

# FLEXIBLE WALL PERMEABILITY TEST REPORT
## ( ASTM D 5084 )

CORE LTY SCIENCES

AAR AASHTO R18

| | | | | | |
|---|---|---|---|---|---|
| JOB NAME : Perry County , Alabama Project | | | | | |
| JOB NO. : 22305 | REPORT NO. : - | DATE: 05/07/01 | REVIEWED BY : | | |
| BORING / PIT: P-3 | DEPTH / ELEV. : 28.5'-30' | SAMPLE NO. : - | SAMPLE TYPE: | UD | |
| SAMPLE LOCATION: - | | | DIAMETER , INCHES : | 2.89 | |
| SOIL DESCRIPTION Greenish gray clay . | | | LENGTH , INCHES : | 3.03 | |
| LIQUID LIMIT, % : 59 | PLASTICITY INDEX , % 38 | FINES , % : 94 | SPECIFIC GRAVITY, Gs : | 2.67 | |




| HYDRAULIC CONDUCTIVITY, k | |
|---|---|
| 4.6E-08 | CM / SEC @ 20 °C |

| SPECIMEN PROPERTIES | | | |
|---|---|---|---|
| **INITIAL** | | | |
| MOISTURE CONTENT | $W_o$ | 13.1 | % |
| DRY UNIT WEIGHT | $\gamma_{dryo}$ | 105.9 | pcf |
| SATURATION | $S_o$ | 61.1 | % |
| VOID RATIO | $e_o$ | 0.575 | |
| **AFTER CONSOLIDATION** | | | |
| MOISTURE CONTENT | $W_c$ | 19.3 | % |
| DRY UNIT WEIGHT | $\gamma_{dryc}$ | 110.0 | pcf |
| SATURATION | $S_c$ | 100 | % |
| VOID RATIO | $e_c$ | 0.517 | |
| **PERMEATION** | | | |
| FINAL BACK PRESSURE | $u_o$ | 65.0 | psi |
| EFFECTIVE CONSOLIDATION PRESSURE | $\sigma_3'$ | 25.0 | psi |
| PORE PRESSURE DIFFERENCE TO INDUCE FLOW | $\Delta u_o$ | 3.3 | psi |
| HYDRAULIC GRADIENT | i | 30 | |
| QUANTITY OF FLOW | Q | 18.8 | $cm^3$ |
| TOTAL PORE VOLUME | PV | 17.7 | % |

| PERMEANT PROPERTIES |
|---|
| PERMEANT DESCRIPTION : |
| *Deaired Tap Water* |
| @ 22 °C |

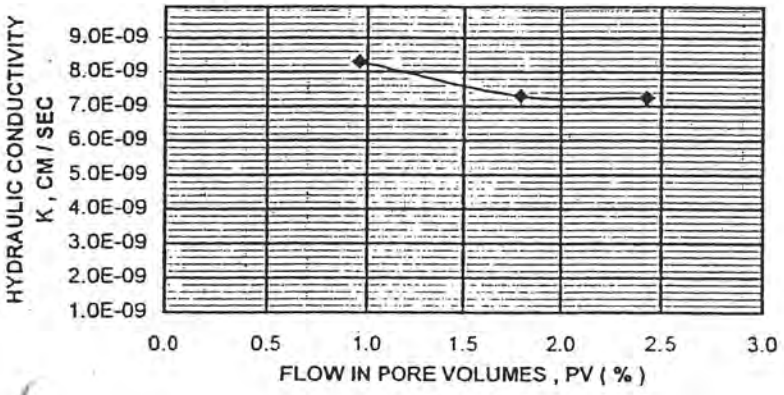
| REMOLDED SOIL PROPERTIES | | |
|---|---|---|
| *N/A* | | |
| MAXIMUM DRY DENSITY : | - | PCF |
| OPTIMUM MOISTURE CONTENT : | - | % |

# FLEXIBLE WALL PERMEABILITY TEST REPORT
## ( ASTM D 5084 )

CORE
TY SCIENCES

AAP AASHTO R18

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| AME : Perry County , Alabama Project | | | | | | | |
| OB NO. : | 22305 | REPORT NO. : | - | DATE: | 05/07/01 | REVIEWED BY : | |
| ORING / PIT: | P-3 | DEPTH / ELEV. : | 38.5'-40' | SAMPLE NO. : | - | SAMPLE TYPE: | UD |
| AMPLE LOCATION: - | | | | | | DIAMETER , INCHES : | 2.87 |
| OIL DESCRIPTION | Greenish gray slightly sandy clay . | | | | | LENGTH , INCHES : | 2.97 |
| IQUID LIMIT, % : | 58 | PLASTICITY INDEX , % | 37 | FINES , % : | 86 | SPECIFIC GRAVITY, Gs : | 2.67 |




| HYDRAULIC CONDUCTIVITY, k | |
|---|---|
| 7.3E-09 | CM / SEC @ 20 °C |

| SPECIMEN PROPERTIES | | | |
|---|---|---|---|
| **INITIAL** | | | |
| MOISTURE CONTENT | $W_o$ | 24.8 | % |
| DRY UNIT WEIGHT | $\gamma_{dry_o}$ | 94.8 | pcf |
| SATURATION | $S_o$ | 87.3 | % |
| VOID RATIO | $e_o$ | 0.757 | |
| **AFTER CONSOLIDATION** | | | |
| MOISTURE CONTENT | $W_c$ | 26.3 | % |
| DRY UNIT WEIGHT | $\gamma_{dry_c}$ | 97.9 | pcf |
| SATURATION | $S_c$ | 100 | % |
| VOID RATIO | $e_c$ | 0.701 | |
| **PERMEATION** | | | |
| FINAL BACK PRESSURE | $u_o$ | 65.0 | psi |
| EFFECTIVE CONSOLIDATION PRESSURE | $\sigma_3'$ | 30.0 | psi |
| PORE PRESSURE DIFFERENCE TO INDUCE FLOW | $\Delta u_o$ | 3.2 | psi |
| HYDRAULIC GRADIENT | i | 30 | |
| QUANTITY OF FLOW | Q | 3.1 | $cm^3$ |
| TOTAL PORE VOLUME | PV | 2.4 | % |

| PERMEANT PROPERTIES |
|---|
| ERMEANT DESCRIPTION : |
| *Deaired Tap Water* |
| @ 22 °C |

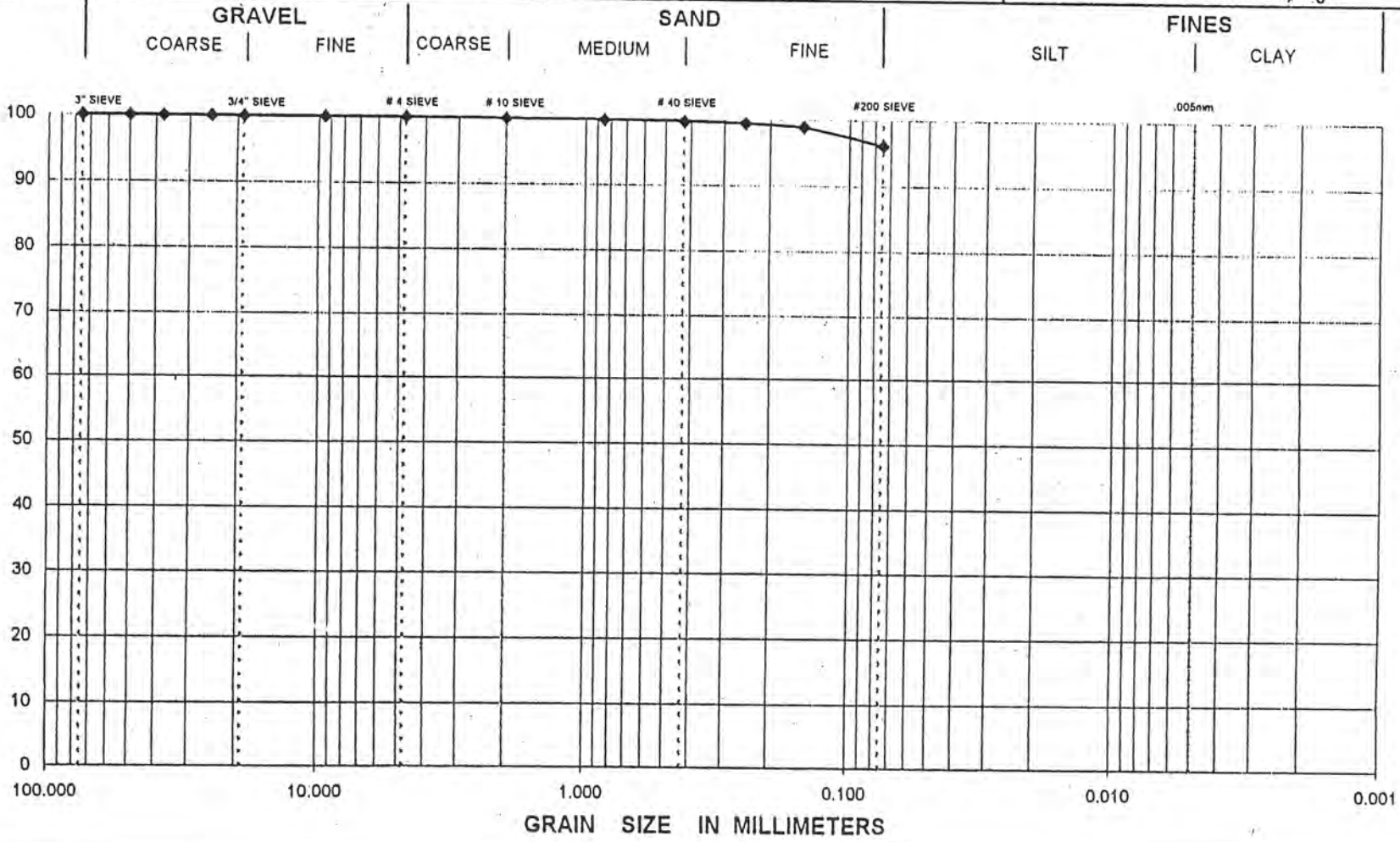
| REMOLDED SOIL PROPERTIES | | |
|---|---|---|
| *N/A* | | |
| MAXIMUM DRY DENSITY : | - | PCF |
| OPTIMUM MOISTURE CONTENT : | - | % |

QORE
PROPERTY SCIENCES

# GRAIN SIZE DISTRIBUTION TEST REPORT
## ( ASTM D422 )

AAP AASHTO R18

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| JOB NAME : | Perry County , Alabama Project | | | | | | |
| JOB NO. : | 22305 | REPORT NO. : | - | DATE : | 5/7/01 | REVIEWED BY : | |
| BORING / PIT NO. : | P-1 | DEPTH / ELEV. : | 38.5'-40' | SAMPLE NO. : | - | SAMPLE TYPE : | UD |
| SAMPLE LOCATION : | - | | | | | | |
| SOIL DESCRIPTION : | Greenish gray clay . | | | | | SP. GRAVITY, Gs : | 2.67 |
| LIQUID LIMIT, % : | 56 | PLASTICITY INDEX , % : | 30 | MOISTURE , % : | - | FINES , % : | 96 |
| D10 , MM : | - | D30 , MM : | - | D60 , MM : | - | COEFF. OF CURVATURE , $C_C$ : | - |
| CLASSIFICATION | | UNIFIED : | CH | AASHTO : | - | COEFF. OF UNIFORMITY , $C_U$ : | - |

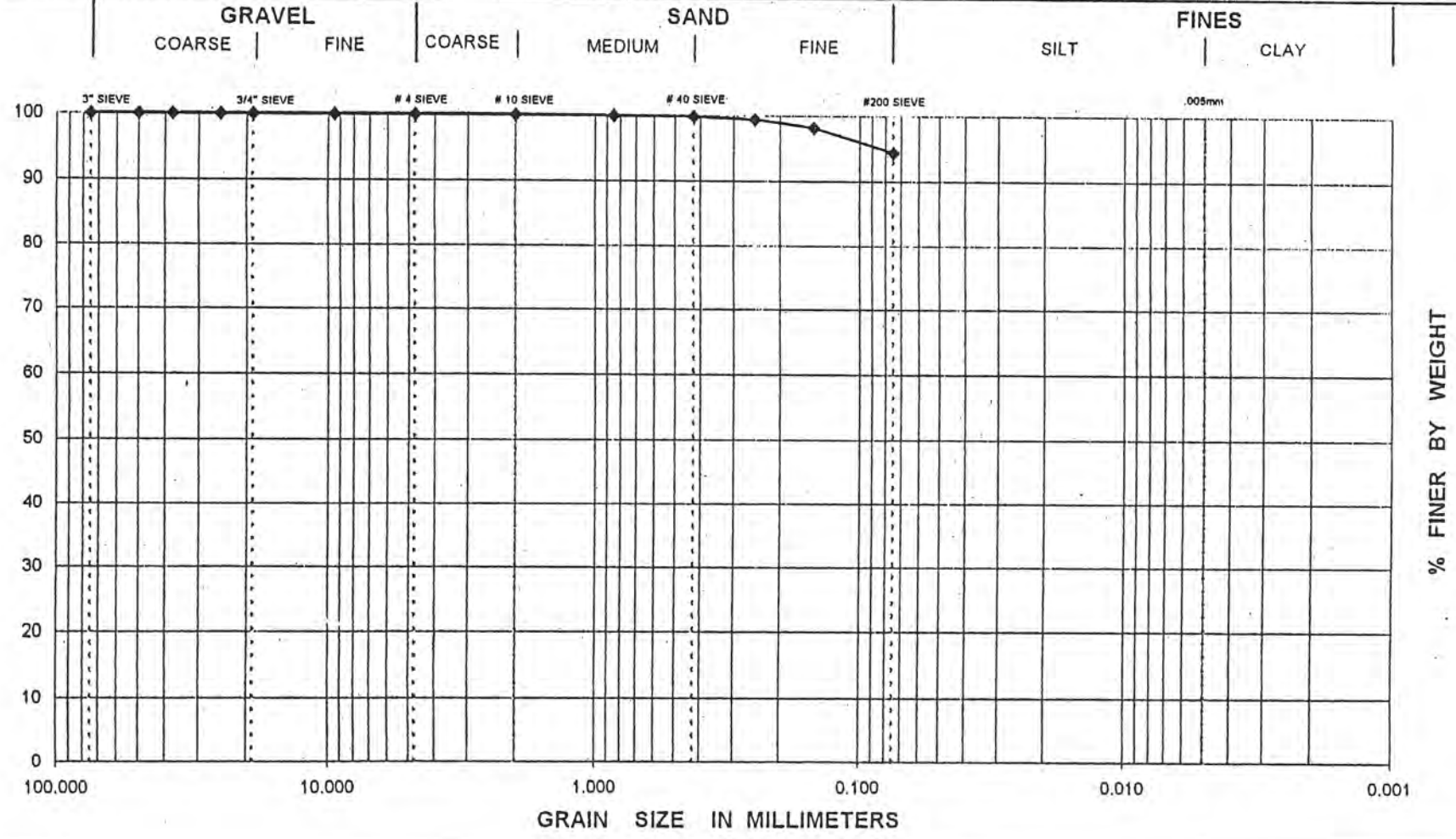


QORE
PROPERTY SCIENCES

# GRAIN SIZE DISTRIBUTION TEST REPORT
( ASTM D422 )

AAP SM
AASHTO R18

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| JOB NAME : | *Perry County , Alabama Project* | | | | | | |
| JOB NO. : | *22305* | REPORT NO. : | - | DATE : | 5/7/01 | REVIEWED BY : | |
| BORING / PIT NO. : | *P-3* | DEPTH / ELEV. : | *28.5'-30'* | SAMPLE NO. : | - | SAMPLE TYPE : | *UD* |
| SAMPLE LOCATION : | - | | | | | | |
| SOIL DESCRIPTION : | *Greenish gray clay .* | | | | | SP. GRAVITY, Gs : | - |
| LIQUID LIMIT, % : | *59* | PLASTICITY INDEX , % : | *38* | MOISTURE , % : | - | FINES , % : | *94* |
| D10 , MM : | - | D30 , MM : | - | D60 , MM : | - | COEFF. OF CURVATURE , $C_C$ : | - |
| CLASSIFICATION | | UNIFIED : | *CH* | AASHTO : | - | COEFF. OF UNIFORMITY , $C_U$ : | - |

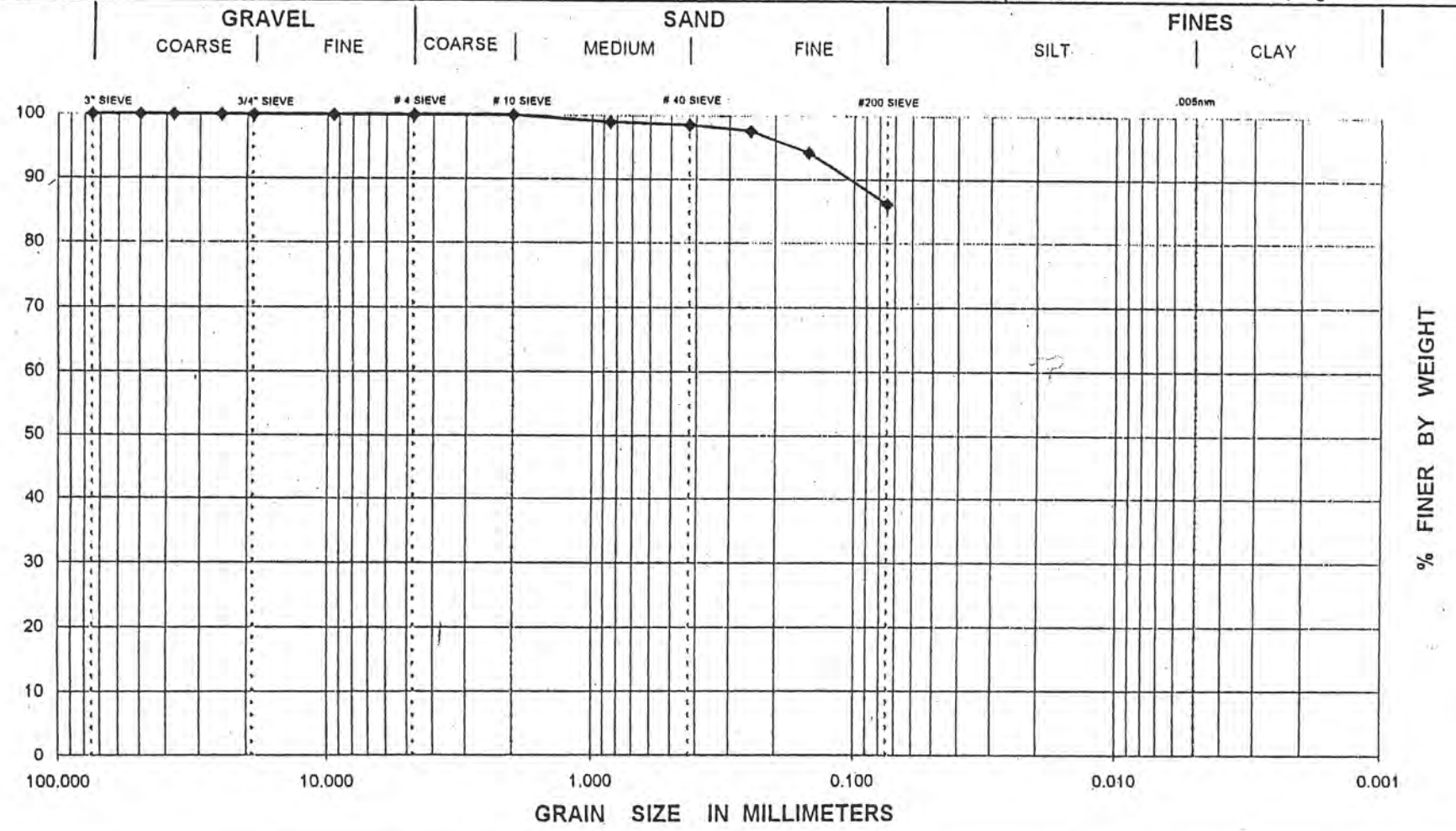


QORE™
PROPERTY SCIENCES

# GRAIN SIZE DISTRIBUTION TEST REPORT
( ASTM D422 )

AAP℠ AASHTO R18

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| JOB NAME : | *Perry County , Alabama Project* | | | | | | |
| JOB NO. : | *22305* | REPORT NO. : | - | DATE : | 5/7/01 | REVIEWED BY : | |
| BORING / PIT NO. : | *P-3* | DEPTH / ELEV. : | *38.5'-40'* | SAMPLE NO. : | - | SAMPLE TYPE : | *UD* |
| SAMPLE LOCATION : | - | | | | | | |
| SOIL DESCRIPTION : | *Greenish gray slightly sandy clay .* | | | | | SP. GRAVITY, Gs : | - |
| LIQUID LIMIT, % : | *58* | PLASTICITY INDEX , % : | *37* | MOISTURE , % : | - | FINES , % : | *86* |
| D10 , MM : | - | D30 , MM : | - | D60 , MM : | - | COEFF. OF CURVATURE , $C_C$ : | - |
| CLASSIFICATION | | UNIFIED : | *CH* | AASHTO : | - | COEFF. OF UNIFORMITY , $C_U$ : | - |



## F. ALABAMA HISTORICAL COMMISSION CLEARANCE LETTER

STATE OF ALABAMA
ALABAMA HISTORICAL COMMISSION
468 SOUTH PERRY STREET
MONTGOMERY, ALABAMA 36130-0900

COLONEL (RET.) JOHN A. NEUBAUER
EXECUTIVE DIRECTOR

TEL: 334-242-3184
FAX: 334-240-3477

September 21, 2007

Greg S. Hendryx
Environmental Services, Inc.
7220 Financial Way
Suite 100
Jacksonville, Florida 32256

Re: AHC 2002-0018
Perry County Landfill
Phase II Report for Eight Archaeological Sites; 1Pe194, 1Pe195, 1Pe196, 1Pe197, 1Pe198, 1Pe199, 1Pe200, & 1Pe201

Dear Mr. Hendryx:

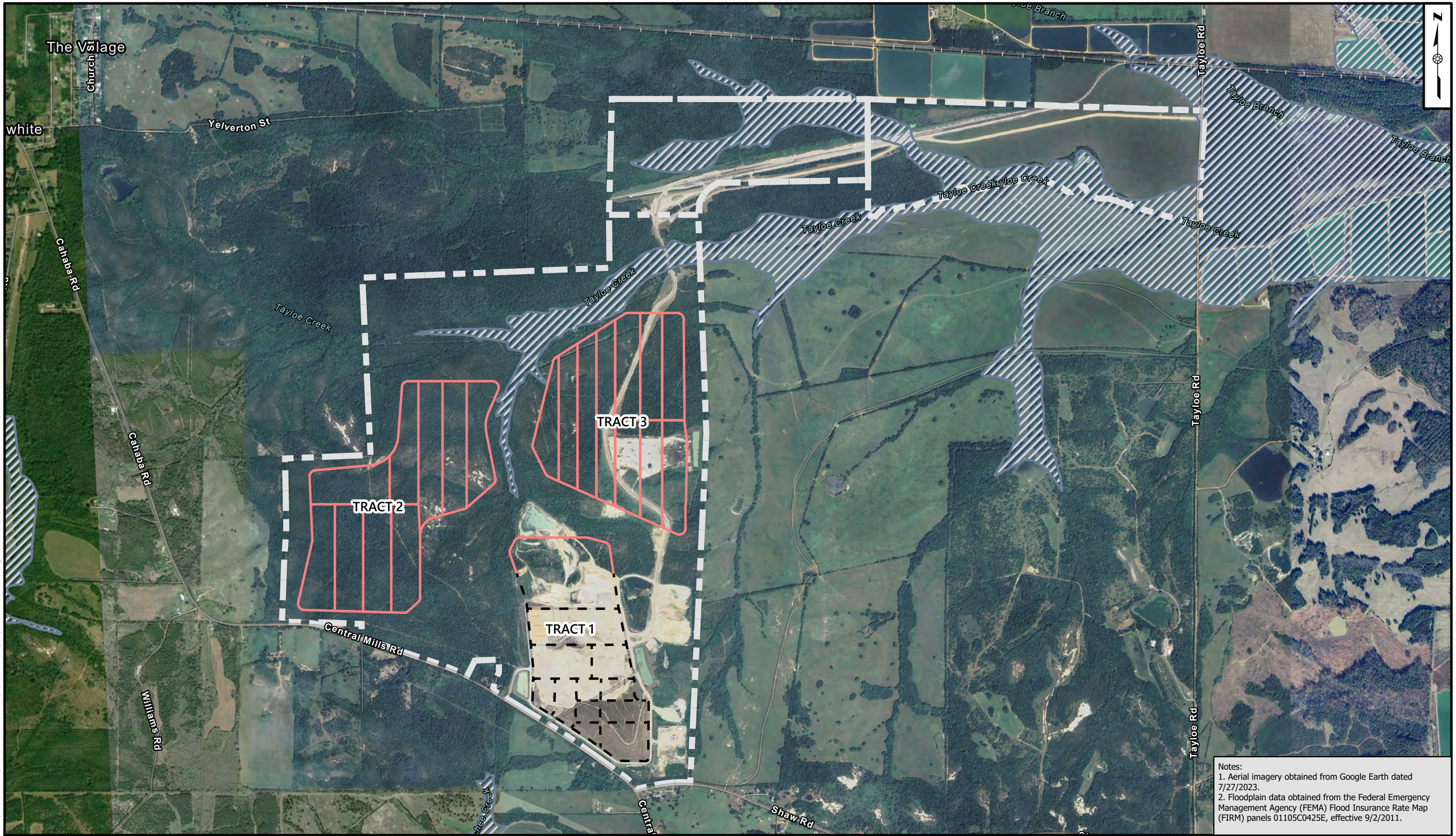
Per your request on September 21, 2007, we provide this letter granting specific clearance for the archaeological sites listed above that were evaluated at the Phase II level at the Perry County Landfill property in Perry County, Alabama. As noted in our letter dated August 10, 2007, we agree with your findings that none of the eight evaluated sites listed above retain the context necessary to yield significant information about life at the Rurill Hill Plantation. Consequently, at your request, we offer this letter with the explicit statement that the historical sites shown on the Solid Waste Permit Plans approved by the Alabama Department of Environmental Management may now have impacts from development provided that all necessary permits are obtained. Also consistent with our August 10, 2007 letter, we recommend that any inadvertent discovery of either burial shafts or human remains associated with the purported cemetery be immediately conveyed to our office and that all ground disturbing activities cease in that area.

We appreciate your commitment to helping us preserve Alabama's non-renewable resources. Should you have any questions, the point of contact for this matter is Stacye Hathorn at 334-230-2649. Please have the AHC tracking number referenced above available and include it with any correspondence.

Truly Yours,

Elizabeth Ann Brown
Deputy State Historic Preservation Officer

## G. UPDATED FEMA FLOOD INSURANCE RATE MAP




Notes:
1. Aerial imagery obtained from Google Earth dated 7/27/2023.
2. Floodplain data obtained from the Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map (FIRM) panels 01105C0425E, effective 9/2/2011.

# Floodplain Map

Vertical Expansion
Arrowhead Landfill
Perry County, Alabama
*1/3/2025*

0 700 1,400
Feet
1 inch equals 1,400 Feet

DISCLAIMER:
This drawing and the information contained herein is for general presentation purposes only and is a compilation of shapefile(s) provided by various source(s). The source and accuracy of the file(s) has not been verified by HHNT and therefore the drawing is not intended for use as a engineering drawing or for design purposes.

Legend

- Property Boundary
- Existing Cells
- Future Cells
- 100 Year Floodplain

HHNT
Hodges, Harbin, Newberry & Tribble, Inc.
*Consulting Engineers*

Path: B:\GIS\Arrowhead\Vertical Expansion FEMA Map\FEMA Map.aprx User: bmcgee

## H. STATEMENT OF CONSISTENCY FROM THE ALABAMA-TOMBIGBEE REGIONAL COMMISSION

# ALABAMA-TOMBIGBEE REGIONAL COMMISSION

107 Broad Street
Camden, Alabama 36726

JOHN CLYDE RIGGS
Executive Director

(334) 682-4234
Fax
(334) 682-4205


## STATEMENT OF CONSISTENCY

The Alabama-Tombigbee Regional Commission (ATRC) is in receipt of a request for a "Statement of Consistency" regarding a Solid Waste Permit Application being updated for a landfill development project in Perry County, Alabama. This request is being made by Perry County Associates (PCA).

The Alabama-Tombigbee Regional Commission (ATRC) is in receipt of Perry County's Solid Waste Management Plan (SWMP) which was approved by the Alabama Department of Environmental Management (ADEM) on April 8, 2005. The SWMP was prepared by Volkert and Associates and the Alabama-Tombigbee Regional Commission has reviewed the plan. ATRC was not involved in the preparation of this plan and does not certify to the accuracy or validity of information contained therein.

Based on the information contained in the Regional Solid Waste Needs Assessment, which does not verify the origin and destination of all solid waste coming in or going out of the ATRC region and based upon the recommendations contained in Perry County's Solid Waste Management Plan, it appears that the proposed amendment is consistent with information contained in the Regional Solid Waste Needs Assessment and the County's Solid Waste Management Plan.

This the 21st day of April, 2011.

John Clyde Riggs, Executive Director
Alabama-Tombigbee Regional Commission

Sworn to and subscribed before me on this the 21st day of April, 2011.

Evelyn J. Morton
Notary Public

My Commission Expires: 5-3-2011

(Official Seal)

# I. HOST GOVERNMENT APPROVAL

**COUNTY OF PERRY )**
**)**
**STATE OF ALABAMA )**

**FIRST AMENDED LANDFILL AGREEMENT**

This Agreement made and entered into on this the 12th day of December, 2008, by and between Perry County, Alabama (hereinafter referred to as the "County"), a body corporate and politic as defined in the Constitution of the State of Alabama, and Perry County Associates, LLC, an Alabama limited liability company, its designees, successors, transferees or assigns (hereinafter referred to collectively as "PCA"):

**WITNESSETH:**

WHEREAS, on May 24, 2005 an application for approval of a solid waste management site to include a proposed Subtitle D regional landfill near Uniontown, Alabama in Perry County was submitted to the County by PCA together with a proposal to provide certain services to the County pursuant to the terms of a Landfill Agreement executed on October 11, 2005; and

WHEREAS, PCA subsequently obtained a permit ("the Permit") for a municipal waste landfill issued by the Alabama Department of Environmental Management ("ADEM") on a one thousand one hundred thirteen (1,113) acre, more or less, tract of land lying and being in Perry County, Alabama (later amended so that the permitted site area decreased in size to 976.5 acres) owned by Perry Uniontown Ventures I, LLC (hereinafter referred to as "PUV"), the sole owner of PCA (hereinafter referred to collectively as "Permitted Facility"); and

WHEREAS, PCA and its principals, designees, transferees and/or assignees had prior experience in the construction, management and operation of municipal waste disposal facilities and have constructed, managed and operated the Permitted Facility; and

WHEREAS, on September 30, 2008, an application for approval of an amended solid waste management permit for the aforesaid Subtitle D regional landfill near Uniontown, Alabama, in Perry County was submitted to the County by PCA together with a proposal to provide certain services to the County pursuant to the terms of this First Amended Landfill Agreement; and

WHEREAS, pursuant to the Constitution and laws of this State, the County is authorized to enter into valid, binding contracts with private persons, corporations and other entities to provide for garbage and waste collection and disposal services and facilities; and

WHEREAS, the parties hereto, intending to be legally bound thereby, have heretofore entered into such a contract and desire to amend same by this First Amended Landfill Agreement and do wish to freely and voluntarily enter into the following covenants, agreements and promises regarding the matters set forth herein; and

WHEREAS, by resolution dated October 14, 2008, the County scheduled a public hearing on the application for approval of an amended solid waste management permit and this First Amended Landfill Agreement for November 25, 2008, at 3:00 p.m. and caused to be published the requisite public notice for the hearing; and

WHEREAS, by that same resolution, the County scheduled a second informational public hearing on the application for approval of an amended solid waste management permit and this First Amended Landfill Agreement for November 20, 2008, at 6:00 p.m. in Uniontown, Alabama, and caused to be published a public notice for that hearing.

NOW, THEREFORE, for and in consideration of the covenants, agreements and promises herein set forth and having considered the comment received at the above referenced public hearings, the parties hereto, do covenant and agree as follows:

1. TERM OF AGREEMENT. This Agreement shall be calculated from October 15, 2007 (hereinafter referred to as the "Effective Date). The obligations of PCA hereunder for the disposal of solid waste shall be in effect for a period of not less than twenty (20) years but not greater than the life of the Permit, or any renewals, expansions or extensions of same.

2. MANAGEMENT AND OPERATION.

(a) The County hereby acknowledges and agrees that the management and operation of the Permitted Facility shall be solely within the province of PCA or its successors, transferees, designees or assigns. PCA agrees to comply with the laws applicable to such landfills and to operate the Permitted Facility in accordance with the requirements of law.

(b) The County covenants and agrees that the construction, regulation and operation of the Permitted Facility shall be governed by the applicable State of Alabama and/or federal laws and regulations.

(c) PCA agrees to construct all cells permitted under ADEM Permit No. 53-03, as amended, and to manage and operate the Permitted Facility, in accordance with the plans and specifications and environmental laws and other applicable laws.

(d) PCA shall pay all costs associated with the acquisition, construction, equipping and obtaining of permits and approvals with respect to the Permitted Facility.

(e) PCA agrees that the maximum daily deposit into the Permitted Facility shall not exceed 15,000 tons and that the service area will include Alabama, Arkansas, Connecticut, Delaware, Florida, Georgia, Illinois, Indiana, Iowa, Kentucky, Louisiana, Maine, Maryland, Massachusetts, Michigan, Minnesota, Mississippi, Missouri, New Hampshire, New Jersey, New York, North Carolina, Ohio, Oklahoma, Pennsylvania, Rhode Island, South Carolina, Tennessee, Texas, Vermont, Virginia, West Virginia, Wisconsin.

3. WASTE DISPOSAL AND FEES.

(a) PCA shall have the absolute right to accept or reject any items or amounts of waste to be disposed of in the Permitted Facility, subject only to the requirement, restrictions and limitations set forth in the Permit, except PCA shall not accept any excluded waste such as whole automobiles, infectious waste, biomedical and hospital waste or other waste which does not pass federal and state regulations for treatment of infectious waste prior to disposal, volatile, highly flammable, explosive waste material or any other waste excluded by any applicable state law or regulations, including any solid waste which contains hazardous waste as defined by ADEM regulations.

(b) PCA will not charge the County, the City of Uniontown or the City of Marion for household municipal solid waste (MSW) or household construction and demolition waste (C&D) generated by its residents within and collected from their respective jurisdictions and brought to the Permitted Facility by them, or their respective employees or contractual privies operating for them; provided, however, that the amount of waste for which no charge shall be made shall not exceed 20 tons per day for each of the County, the City of Uniontown or the City of Marion. The fee for household municipal solid waste (MSW) or household construction and demolition waste (C&D) generated by the residents of the County, the City of Uniontown or the City of Marion brought to the Permitted Facility by them that is in excess of the allowed 20 tons per day (representing approximately five times the average current volume generated by them on the date of this Agreement) shall be equal to one half (1/2) of the then current "gate rate" for municipal solid waste (MSW) or household construction and demolition waste (C&D) charged by PCA. The foregoing notwithstanding, the County and Cities will collect from their customers and remit to PCA the tax or fee imposed by the enactment of HB 395, which became effective October 1, 2008, and any successor or similar laws.

(c) Except as expressly herein provided to the contrary, or as otherwise limited by law, PCA shall have the express and unlimited authority to determine, in its sole discretion, the fees,

charges or expenses applicable to all other garbage, refuse and waste deposited in the Permitted Facility from any source whatsoever.

(d) As additional consideration for this Agreement, the parties mutually, freely and voluntarily acknowledge and agree that PCA will pay to the County a fee, inclusive of all local, state and federally required payments, fees or charges for deposits placed in the Permitted Facility as follows: the sum of One Dollar ($1.00) per ton on all deposits of waste (other than County or City waste for the duration of the exemption provided in subparagraph "(b)", above) per day. Payment of this fee shall be made quarterly, in arrears, to the Perry County Commission and shall be based upon PCA's collected revenues from the deposit of such waste. Payment of this fee shall be in lieu of all license, privilege and excise taxes that may be imposed on the Permitted Facility, and no other license, privilege or excise tax may be imposed on the Permitted Facility by the state or any county, municipality or other political subdivision thereof. Nothing contained herein, however, shall be construed to confer any exemption with respect to any uniform taxes levied generally on property, income or business activity, including, without limitation, (1) income taxes levied by the state, (2) ad valorem taxes levied on the Permitted Facility at the same rates as are applicable to other commercial property having comparable market value, and (3) state and local sales taxes on merchandise sold to or by PCA.

(e) As additional consideration for this Agreement, the parties hereto mutually acknowledge and agree that PCA shall have the right, during the term of this Agreement, (i) to transport waste to the Permitted Facility from sources inside or outside the boundaries of the County (including, without limitation, from sources outside the boundaries of the State of Alabama), (ii) to operate the Permitted Facility in the County in accordance with the terms and provisions of this Agreement and (iii) to receive waste for deposit from sources outside the

boundaries of the County (including, without limitation, from sources outside the boundaries of the State of Alabama).

4. HOURS OF OPERATION. The Permitted Facility's operating hours shall be restricted as follows:

(a) Deposits may be received by truck on Monday through Saturday and by train on Monday through Sunday. PCA shall be permitted to utilize the facility for making disposal of waste received in accordance with this schedule at any time on any day;

(b) Emergency repairs and/or maintenance shall be permitted at any time on any day; and

(c) No general public access to the Permitted Facility shall be allowed at any time.

5. REGULATORY PROVISIONS.

(a) In addition to the above referenced fee, PCA further voluntarily and freely agrees to establish a dedicated escrow account (hereinafter referred to as the "Escrow Account") into which PCA will pay five cents ($0.05) per ton on all deposits of waste (other than County waste for the duration of the exemption provided in subparagraph "3(b)", above). Payment of this fee shall be made quarterly, in arrears, and shall be based upon PCA's collected revenues from the deposit of such waste. Payment of this fee shall be based on deposits made beginning on the Effective Date and are payable thereafter as long as the Permitted Facility is: (i) in possession of and actively operating under a valid, unsuspended state permit; and (ii) receiving deposits of permitted waste on which the fees and charges set out in paragraph 3 are imposed. The funds deposited into the Escrow Account shall be used to pay for the resurfacing, construction and maintenance of the County's roads accessing the Permitted Facility and, provided that so long as such roads are properly and safely maintained, constructed and surfaced, then surplus deposits may be used for maintenance, construction and surfacing or resurfacing of other public roads in

the County. The County agrees that no assessment, tax, levy or other charges shall be asserted against either PCA, its property or the Permitted Facility for construction, resurfacing, maintenance or otherwise in connection with roads accessing the Permitted Facility so long as funds are being paid into the Escrow Account pursuant to this Agreement and provided escrow funds are sufficient to cover the costs associated with maintenance and construction of roads accessing the Permitted Facility.

(b) The County agrees that PCA's Permitted Facility and property will be uniformly assessed in accordance with other area property for purposes of state, county and local ad valorem taxation and that all unimproved property will be assessed at its "current use" value.

(c) The County or its designated auditors shall have the right on a yearly basis and upon reasonable written notice to PCA to audit the volume or tonnage reports prepared by PCA in connection with the use and operation of the Permitted Facility.

(d) At the request of PCA, the County agrees to certify from time to time that PCA's tract of land on which and in which the Permitted Facility is located, is suitable for that use in accordance with the County's Solid Waste Plan, land use and zoning regulations, plans and rules, if any.

(e) The County agrees that any future amendments to its Solid Waste Management Plan will not have any detrimental effect on the Permitted Facility and to the extent that such amendments negatively impact the Permitted Facility, as determined by PCA in its sole and absolute discretion, those changes shall not apply to the Permitted Facility.

(f) The County will not oppose, obstruct, appeal, legislate against, litigate or otherwise take any action to interfere with or preclude PCA's operation and utilization of the Permitted

Facility in accordance with the agreements, representations and covenants contained in this Agreement and specifically will not seek to have imposed additional fees or taxes through local legislation.

6. COUNTY COVENANTS AND REPRESENTATIONS.

(a) The execution, delivery and performance of this Agreement by the County has been duly authorized, and no further action is necessary on the County's part to make this Agreement valid, binding and enforceable against the County in accordance with its terms or to carry out the matters contemplated herein.

(b) There are no County ordinances, rules, regulations or restrictions which govern, restrict or prohibit the matters herein agreed to or the County's right to enter into this Agreement.

(c) There are currently no County development or disturbance permits required for continued construction and development of the Permitted Facility. Should the County become authorized to issue such permits, it will expedite the review of, and will issue to PCA all necessary development or disturbance permits for construction and development of the Permitted Facility upon PCA's substantial compliance with the usual, customary and reasonable requirements for the issuance of such permits..

7. ENFORCEMENT. The parties hereto shall have all rights, at law or in equity, provided under the laws of the State of Alabama or the United States to insure the enforcement of the terms, provisions and conditions contained in this Agreement and/or for compensation or damages resulting from a breach of this Agreement. The parties hereto further agree that damages at law may be an inadequate remedy for a breach of any provision of this Agreement and that, in the event of any such breach, the respective rights and obligations hereunder shall include the right of any aggrieved party to seek appropriate injunctive relief.

8. NO EXPENDITURE OF FUNDS BY COUNTY. PCA covenants and agrees that no term, provision or condition of this Agreement, and no other written or oral agreement or understanding of any nature whatsoever, shall operate or be construed to obligate the expenditure of any funds or the incurrence of any pecuniary liability, with respect to the Permitted Facility and the disposal of Solid Waste in accordance with the terms hereof, or the lending or obligation of any credit, of whatsoever nature, by the County, directly or indirectly, in connection with the Permitted Facility or otherwise pursuant to any agreement or understanding.

9. NO EXCLUSIVE RIGHTS OR PRIVILEGES. PCA covenants and agrees that this Agreement and each term, condition and provision hereof will not operate or be construed to grant or authorize the granting to PCA or any person of any exclusive franchise, privilege or right to acquire, engineer, permit, construct, operate and provide closure and post-closure services for a sanitary landfill or solid waste disposal facilities or solid waste management site in, or to provide solid waste disposal facilities or solid waste disposal services in or about, the County, and (1) will not in any way (i) prohibit the County or any person from developing or approving a solid waste management site or landfill or the provision of solid waste disposal services in the County or (ii) prohibit the County from entering into agreements with any other persons regarding the development, use or operation of a landfill or other solid waste management site or the provision of solid waste disposal services and (2) will not (i) obligate the County to assist any person to obtain any required approvals, licenses or permits to operate a landfill or other solid waste management site or to provide solid waste disposal services or (ii) obligate or require the County or any person to use the Permitted Facility or receive solid waste disposal services.

10. INDEMNITY OF COUNTY BY PCA (a) Special Environmental Indemnity. PCA shall defend, indemnify, agree to pay, and save harmless the County (including, without limitation, all officers, agents, and representatives of the County and members of the governing body of the County) against any and all liabilities, claims, damages, causes of action, judgments, fines, penalties, response costs, and other losses, costs and expenses of any nature whatsoever (including all reasonable attorney's fees and expenses and, litigation costs and expenses of investigation) asserted against or suffered or incurred by the County that are a direct result of (1) any material violation of, or material noncompliance with applicable state and federal environmental laws, or (2) result from the presence of hazardous substances now or hereafter on or under or included in the Permitted Facility resulting from solely from PCA's negligence in its operations at the Permitted Facility (and not related to activities by any prior owner or adjacent owner of adjacent or nearby activities, including without limitation the County's closed landfill), and any investigation, clean up or removal of, or other remedial action or response costs with respect to, any hazardous substances now or hereafter located on or under or included in the Permitted Facility, or any part thereof, that may be required by any environmental law or by regulatory authorities with respect to any environmental law (specifically including, without limitation, any and all liabilities, damages, fines, penalties, response costs, investigatory or other costs pursuant to the Comprehensive Environmental Response, Compensation and Liability Act of 1980 as amended, 42 U.S.C. Sections 9601 et seq.), and including without limitation claims (including claims alleging negligence by the County) alleging noncompliance with environmental laws which seek relief under or are based on state or common law theories such as trespass or nuisance. (The foregoing indemnity is subject to PCA's right of contribution, if any,

under environmental laws against other parties, and is also conditioned (as to the County) on the County's compliance with the terms hereof).

(b) General Indemnity. With respect to all matters not within the Special Environmental Indemnity, PCA shall defend, indemnify, agree to pay, and save harmless the County (including, without limitation, all officers, agents, and representatives of the County and members of the governing body of the County) against, any and all liabilities, claims, damages, causes of action, judgments, fines penalties, and other losses, costs and expenses of any nature whatsoever (including all reasonable attorneys' fees and expenses and litigation costs) suffered or incurred by the County, and caused by or resulting solely from any the gross negligence or willful act or omission of PCA (and/or its agents and employees), unless a court of competent jurisdiction makes the ultimate determination that such liability is due in part to the wanton, willful, or intentional misconduct of the County, related to or arising from or in connection with, or occur from any cause whatsoever with respect to the permitting, acquisition, construction, maintenance operation, use, non-use, closure and post-closure of the Permitted Facility.

(c) Claims made or brought against the County under subparagraphs (a) and (b), above, are referred to herein as "Indemnified Claims". The County shall provide PCA with timely written notice of Indemnified Claims and PCA shall thereafter defend the County in any action or proceeding brought on an Indemnified Claim. PCA may provide such defense under a reservation of rights. PCA shall retain the exclusive right to select counsel, to direct the defense, and to settle any Indemnified Claim without the consent of or advance notice to the County. However, the County shall be entitled to receive copies of pleadings, settlement documents, and other matters timely requested, subject to such confidentiality obligations as may be ordered by the court or agreed to or requested by PCA. Notwithstanding anything in this Agreement to the

contrary, PCA shall not be obligated to indemnify, hold harmless, or release the County from claims, demands, liabilities, or costs for any non-indemnified claim or with respect to a non-indemnified act committed by the County; nor shall PCA be responsible for any costs, expenses, attorneys fees or damages incurred or paid outside the terms of this Paragraph 10.

11. COMPLIANCE WITH ENVIRONMENTAL LAWS.

(a) PCA shall fully comply with all environmental laws and all other applicable laws, rules and regulations applicable to the Permitted Facility of any governmental authority presently having recognized and established jurisdiction with respect thereto and shall maintain in full force and effect all required approvals, authorizations, franchises, licenses and permits necessary for the Permitted Facility and pay all costs and expenses in connection with the foregoing.

(b) PCA shall not knowingly or willfully, and shall not knowingly or willfully permit any other person to, bring any hazardous wastes onto the Permitted Facility and shall (l) if any release of hazardous substances or disposal of hazardous waste occurs on the Permitted Facility, take the following actions to the extent deemed necessary or advisable in PCA's reasonable discretion or so ordered by a court of competent jurisdiction: (i) immediately remove or dispose of the same in accordance with applicable environmental laws; (ii) cause the Permitted Facility and the operations conducted thereon (including all operations conducted thereon by other persons) to comply with all environmental laws; (iii) undertake any and all preventive, investigatory and remedial action (including emergency response, removal, clean up, containment and other remedial action) that is (A) required by an applicable environmental law or (B) necessary to prevent or minimize any property damage (including damage to any of the Permitted Facility), personal injury, or harm to the environment, or the threat of any such damage or injury, by releases of or exposure to hazardous substances in connection with the

Permitted Facility or the operations on the Permitted Facility; and (2) promptly give notice to the County in writing if PCA should become aware of (A) any material spill, release or disposal of any hazardous substances or imminent threat thereof, at the Permitted Facility, in connection with the operations on the Permitted Facility, or at any adjacent property that could migrate to, through or under the Permitted Facility, (B) any violation of environmental laws regarding the Permitted Facility or operations on the Permitted Facility, (C) any disposal of hazardous waste at the Permitted Facility, and (D) any investigation, claim or threatened claim under any environmental law, or any notice of violation under any environmental law, involving PCA or the Permitted Facility.

12. CLOSURE AND POST-CLOSURE OF THE PERMITTED FACILITY. PCA shall be obligated to provide for, at PCA's sole cost and expense, the closure and the post-closure maintenance of the Permitted Facility in compliance with applicable state and federal laws and regulations as then in effect for the maximum period then required by applicable state and federal laws and regulations after PCA shall have ceased accepting Solid Waste at the Permitted Facility. Upon cessation of operation of the Permitted Facility and commencement of post-closure, PCA shall give written notice of intent to commence post-closure of the Permitted Facility and, if and when requested by the County, submit any plans required by law for the closure and post-closure, maintenance program to the County, and shall include therewith the provision of all costs of closure, post-closure maintenance, and any remedial action required with respect thereto. PCA shall provide copies of all certifications of closure or post-closure as received. In the event of cessation by PCA of operation of the Permitted Facility for any reason, PCA shall be responsible for closure of any cells constructed to that point by PCA but not for

closure of cells thereafter constructed by any other person. An assignment shall operate to transfer all closure and post-closure responsibilities to the assignee(s).

13. AGREEMENT TO PAY ATTORNEYS' FEES AND EXPENSES.

(a) If the County institutes or defends an action in a court of competent jurisdiction to enforce performance or observance by PCA of any obligation or agreement by PCA under this Agreement, upon adjudication by the court in favor of the County on all claims or defenses, the court shall award the reasonable attorneys fees or other expenses incurred by County with respect to such action.

(b) If PCA institutes or defends an action in a court of competent jurisdiction to enforce performance or observance by the County of any obligation or agreement by the County under this Agreement, upon adjudication by the court in favor of PCA on all claims or defenses, the court shall award the reasonable attorneys fees or other expenses incurred by PCA with respect to such action.

14. SUCCESSORS AND ASSIGNS. This Agreement and the obligations, benefits, payments, covenants and conditions set forth herein shall be binding upon, and inure to the benefit of the respective parties, their successors, transferees and assigns. Nothing contained herein shall prevent PCA from transferring or assigning any or all of its rights, duties or obligations hereunder in any manner whatsoever or shall restrict its right to contract with, joint venture with, or otherwise arrange for the provision of the services and payment of the sums herein provided. In the event of any such contract, assignment, transfer or otherwise by PCA, then the terms, provisions and conditions of this Agreement applicable thereto shall be deemed to have been legally transferred and assigned in accordance with the terms and provisions of any such action taken by or on behalf of PCA, and the County thereafter shall look to the transferee,

designee or assignee for the full and complete performance of the provisions contained herein or hereunder.

15. ADDITIONAL ACTIONS. From time to time at either party's request, the other party hereby agrees to execute and deliver such additional or further instruments, documents, certifications or otherwise, and to take such actions as may be reasonably necessary in order to carry out the terms, conditions and provisions contemplated by this Agreement.

16. ENTIRE AGREEMENT. This Agreement constitutes the entire Agreement and understanding between the parties hereto and supersedes any prior representations, statements, agreements or understandings, written or oral, between the parties pertaining to the subject matter hereof. This Agreement may be modified or amended only by a written instrument executed by each of the parties hereto or their respective successors, transferees, designees or assigns.

17. GOVERNING LAW. This Agreement and the determination of all matters rising hereunder shall be construed under and in accordance with the laws of the State of Alabama.

18. NOTICES. All notices, requests, demands or other communications expressly provided for hereunder or contemplated hereunder shall be in writing and shall be given by depositing the same in the United States mail, addressed to the party to be notified, postage prepaid and by registered or certified mail with return receipt requested.

(a) If to the County, addressed to it at:

Perry County Commission
Post Office Box 478
Marion, Alabama 36756-0478

With a copy that does not constitute notice to:

Collins Pettaway, Jr., Esq.

CHESTNUT, SANDERS, SANDERS & PETTAWAY, LLC
P. O. Box 1290
Selma, AL 36702-1290

(b) If to PCA, addressed to it at:

Perry County Associates, LLC
Post Office Box 126
2870 Peachtree Road, NW
Atlanta, Georgia 30305

With a copy that does not constitute notice to:

Michael D. Smith, Esq.
MICHAEL D. SMITH, LLC
701 22nd Avenue, Suite 1
Tuscaloosa, AL 35401

The parties may change the address to which the notices are to be sent hereunder by giving written notice of such change of address to the other party hereto as provided in this section.

19. TIME. Time is of the essence of this Agreement.

20. VALIDITY AND ENFORCEABLITY. In the event that any section, paragraph or provision of this Agreement shall be declared invalid, illegal or unenforceable, then the remaining terms and provisions of this Agreement, to the extent possible, shall be modified in such manner as to be valid, legal and enforceable so as to most nearly retain the intent of the parties. If such modification is not possible, then the provision, term or paragraph declared invalid, illegal or enforceable shall be severed from this Agreement, and in either case, the validity, legality and enforceability of the remaining provisions of this Agreement shall not in any way be affected or impaired thereby.

21. MULTIPLE COUNTERPARTS. This Agreement may be executed simultaneously in two or more counterparts, each of which shall be deemed an original and all of which together shall constitute but one and the same instrument.

IN WITNESS WHEREOF the County and PCA have each caused this Agreement to be executed in its name and on its behalf by officers thereof duly authorized thereunto on the day and year first above written.

**PERRY COUNTY, ALABAMA**

Fairest Cureton, Chairman
Perry County Commission

STATE OF ALABAMA )
)
COUNTY OF PERRY )

I, the undersigned authority, a Notary Public in and for said County, in said State, hereby certify that Fairest Cureton, whose name as Chairman of the Perry County Commission is signed to the foregoing instrument, and who is known to me, acknowledged before me on this day that, being informed of the contents of the instrument, he executed the same voluntarily and with full authority on behalf of the said Commission on the day the same bears date.

Given under my hand and official seal, this 9th day of December, 2008.

**(Seal)**

NOTARY PUBLIC

My Commission Expires: 1/20/2009

IN WITNESS WHEREOF the County and PCA have each caused this Agreement to be executed in its name and on its behalf by officers thereof duly authorized thereunto on the day and year first above written.

**PERRY COUNTY ASSOCIATES, LLC**

John Porter, Managing Partner

STATE OF GEORGIA )
)
COUNTY OF Cobb )

I, the undersigned authority, a Notary Public in and for said County, in said State, hereby certify that John Porter, whose name as Managing Partner of Perry County Associates, LLC, is signed to the foregoing instrument, and who is known to me, acknowledged before me on this day that, being informed of the contents of the instrument, he executed the same voluntarily and with full authority on behalf of the said company on the day the same bears date.

Given under my hand and official seal, this 12th day of December, 2008.

**(Seal)**

NOTARY PUBLIC

My Commission Expires: 11/13/2012

# J. CCR ACCEPTANCE PLAN

# CCR ACCEPTANCE PLAN

## 2025 SOLID WASTE MAJOR MODIFICIATION APPLICATION
## ARROWHEAD LANDFILL

## PERRY COUNTY ASSOCIATES, LLC
## PERRY COUNTY, ALABAMA

## JANUARY 2025

HHNT
HODGES, HARBIN, NEWBERRY & TRIBBLE, INC.
*Consulting Engineers*

3920 Arkwright Road, Suite 101 | Macon, Georgia | Phone: (478) 743-7175 | Fax: (478) 743-1703

# TABLE OF CONTENTS

**1. INTRODUCTION ..... 1**

**2. WASTE ACCEPTANCE CRITERIA ..... 3**
2.1 PROHIBITED WASTES ..... 3

**3. ARROWHEAD FACILITY OPERATIONS ..... 5**
3.1 PERSONNEL ..... 5
3.2 WORKING AREA OPERATIONS ..... 6
3.3 INSPECTION OF WASTES ..... 6
3.4 TRAFFIC CONTROL ..... 7
3.5 HOUSEKEEPING AND LITTER CONTROL ..... 7
3.6 NOISE CONTROL ..... 7
3.7 ODOR CONTROL ..... 7
3.8 DUST CONTROL ..... 8
3.9 STRUCTURAL INTEGRITY ..... 8
3.10 LANDSCAPE MAINTENANCE ..... 8
3.11 RECORD-KEEPING ..... 8

**4. PROCEDURES TO PROTECT HUMAN HEALTH AND THE ENVIRONMENT ..... 9**
4.1 DISEASE AND VECTOR CONTROL ..... 9
4.2 ENVIRONMENTAL MONITORING ..... 9
4.3 STORM WATER POLLUTION PREVENTION ..... 9
4.4 EMPLOYEE TRAINING ..... 10

**5. SIGN AND SAFETY REQUIREMENTS ..... 11**
5.1 SIGN REQUIREMENTS ..... 11
5.2 OPEN BURNING OF WASTE ..... 11
5.3 FIRE PROTECTION EQUIPMENT ..... 11
5.4 NOTIFICATION OF FIRE ..... 12

**6. ACCESS AND SECURITY REQUIREMENTS ..... 13**
6.1 ACCESS AND SECURITY ..... 13
6.2 ATTENDANT ..... 13
6.3 ACCESS ROAD ..... 13

**7. FACILITY INSPECTIONS ..... 14**

APPENDIX ..... 15

A. Location Map

B. Site Plan

C. Load Inspection Form

D. ADPH Solid Waste Transfer Station Permit No. TS-01

E. ADEM Solid Waste Disposal Facility Permit No. 53-03

F. Final Coal Ash Rule – 40 CFR Part 257, Subpart D - Standards for the Disposal of CCR in Landfills and Surface Impoundments

# 1. INTRODUCTION

Arrowhead Landfill and Arrowhead Trans-Load Station make up the Arrowhead facility in Perry County, Alabama. The Arrowhead Landfill (ADEM Solid Waste Permit #53-03) consists of existing and future waste disposal cells that are separated into three tracts. The Arrowhead Trans-Load Station (ADPH Permit No. TS-01) is a permanent railroad transfer station. The permittee for both operations is Perry County Associates, LLC (PCA). The facility is bounded by an existing Norfolk Southern Rail Line and catfish farm ponds to the north. Cahaba Road borders the facility to the south and southwest with residential properties beyond it. Tayloe Road borders the trans-load station to the east, undeveloped land borders the landfill property to the east, and undeveloped land borders both properties to the west.

The Arrowhead Trans-Load Station working area occupies approximately 15 acres of the 368 acre parcel of property. Access to the facility is gained from a gravel entrance road off Tayloe Road. The access roads have all-weather construction (crushed gravel), and are constructed to handle the anticipated loads. The scale house is equipped with a truck scale to weigh trucks or loads as they either enter or leave the site.

The Arrowhead Trans-Load Station consists of five (5) industrial railroad service tracks which connect to an existing Norfolk Southern main line. Adjacent to the tracks are gravel working areas which are used for unloading waste from rail cars to transfer trucks. Trucks will be used to transport waste across a scale and then directly to the Arrowhead Landfill which is located on property adjacent to and south of the Arrowhead Trans-Load Station. Waste will not be unloaded from rail cars and transported along public roads. Once the trucks arrive at the active landfill area, the trucks will be unloaded using appropriate methods.

Arrowhead Landfill is a permitted Subtitle D landfill that can accept coal combustion residual (CCR) material via both truck and dedicated rail once approved by Alabama Department of Environmental Management (ADEM) via Form 300 approval and Alabama Department of Public Health (ADPH). The Arrowhead facility has a proven track record of handling CCR material in a safe and protective manner as it received over 4,000,000 tons of remedial CCR material from the TVA Kingston Ash Spill in 2009 and 2010. The Arrowhead facility was selected as the best facility to receive the ash because of its ideal infrastructure, abundant capacity, and the unique low permeability geologic formation underlying the facility.

In accordance with EPA recommendations in the preamble of the 2015 Final Coal Ash Rule (40 CFR Part 257, Subpart D), this CCR Acceptance Plan has been prepared to describe the measures in place to ensure protection of human health and the environment. The excerpt from the preamble to the 2015 Final Coal Ash Rule is copied below:

> *The Agency has concluded that CCR can readily be handled in permitted MSWLFs provided that they are evaluated for waste compatibility and placement as required under the part 258 requirements. Furthermore, consistent with the recordkeeping requirements in § 258.29, the Agency further*

*expects State Directors to encourage MSWLF units receiving CCR after the effective date of this rule to do so pursuant to a ''CCR acceptance plan'' that is maintained in the facility operating* record. *This plan would assure that the MSWLF facility is aware of the physical and chemical characteristics of the waste received (i.e., CCR) and handles it with the additional precautions necessary to avoid dust, maintain structural integrity, and avoid compromising the gas and leachate collection systems of the landfill so that human health and the environment are protected. While the Agency sees no need to impose duplicative requirements for MSWLFs that receive CCR for disposal or daily cover; development of these acceptance plans as well as a revised list of groundwater detection monitoring constituents will help ensure that CCR is being managed in the most protective manner consistent with the Part 258 requirements.*

# 2. WASTE ACCEPTANCE CRITERIA

In accordance with the ADEM Solid Waste Rules and ADPH Administrative Code 420-3-5-.11(4), the Arrowhead Landfill and Trans-Load Station will only accept those wastes which they are permitted to receive. The landfill and transfer station can accept municipal solid waste (MSW) (i.e., residential, commercial, and industrial waste) and C&D materials. Incoming waste is solely transported to the Arrowhead Trans-Load Station by the Norfolk Southern Railway. The current service area for this facility includes the states of Alabama, Arkansas, Connecticut, Delaware, Florida, Georgia, Illinois, Indiana, Iowa, Kentucky, Louisiana, Maine, Maryland, Massachusetts, Michigan, Minnesota, Mississippi, Missouri, New Hampshire, New York, New Jersey, North Carolina, Ohio, Oklahoma, Pennsylvania, Rhode Island, South Carolina, Tennessee, Texas, Vermont, Virginia, West Virginia and Wisconsin. The landfill is currently approved to receive up to 15,000 tons per day of waste. The daily tonnage rate is subject to change due to fluctuations in the amount of waste delivered to the facility on any given day, and also due to seasonal fluctuations in the waste stream.

CCR is a byproduct of the combustion of coal at power plants resulting in fly ash, bottom ash, boiler slag, and flue gas desulfurization (FGD) material. The Arrowhead facility can receive CCR for disposal upon approval of an ADEM Form 300 and approval from ADPH. Fly ash is a very fine, powdery material and bottom ash is a more coarse material. Bottom ash is fused ash particles that accumulate on boiler side walls and fall to the bottom of the boiler. The bottom ash is run through a grinder to crush larger chunks prior to disposal. Boiler slag collects at the bottom of a wet bottom boilers and is maintained in a molten state. When the slag comes in contact with quenching water it forms glassy pellets. FGD material is generated from $SO_2$ gas scrubber systems. The sludge is dewatered and stabilized for disposal at a landfill.

## 2.1 PROHIBITED WASTES

The Arrowhead Landfill and Trans-Load Station will not accept barrels and drums unless they are empty and perforated sufficiently to ensure that no liquid or hazardous waste is contained in them. No hazardous or liquid waste will be accepted. In addition, the Arrowhead Landfill and Trans-Load Station will not accept PCB's, asbestos material, infectious waste, medical waste, animal waste, animal carcasses, radioactive waste, lead acid batteries, whole tires, or white goods. A report will be prepared for any attempted delivery of waste of which the Arrowhead Landfill or Trans-Load Station is not permitted to receive, including waste from outside the permitted service area, and waste from persons other than permitted solid waste collectors or transporters. The report will be forwarded to the local health department and other appropriate regulatory authorities:

| | |
|---|---|
| Perry County Health Department<br>Environmental Office<br>P.O. Box 119<br>Marion, AL 36756-0119 | ADEM<br>Solid Waste Division, Land Branch<br>P.O. Box 301463<br>Montgomery, Alabama 36130-1463 |
| Phone Number: (334) 683-6153 | Phone Number: (334) 271-7730 |

The Operator shall record the following information concerning the incident and attach to the Load Inspection Form found in the Appendix of this document:

1. Date and time prohibited waste was discovered
2. Date and time the local health officer and other authorities were notified
3. Quantity of waste
4. Where the waste was generated
5. Name, address, phone number, and permit number of person who deposited such waste, if known
6. Type of waste discovered
7. Other information concerning the incident that is known by the Operator

# 3. ARROWHEAD FACILITY OPERATIONS

According to the Landfill Host Agreement, waste may be received by truck on Monday through Saturday and by train on Monday through Sunday. Currently, the landfill operates Monday through Friday, 7:00 AM – 4:00 PM and the Arrowhead Trans-Load Station currently operates Monday through Friday 5:00 AM – 8:00 PM, and Saturdays 5:00 AM – 12:00 PM. The current operating hours can change as needed within the limitations set forth in the Landfill Host Agreement. Both the landfill and trans-load station are typically closed on Sundays and designated holidays. However, maintenance or improvements may be accomplished on these days. A sign is posted at the entrance to the facility identifying the hours of operation.

The only equipment required for safe and effective operation of the facility is heavy equipment such as bulldozers, compactors, excavators, transfer trucks, and the truck scales. However, additional equipment may be utilized to facilitate loading operations. The Owner will provide properly trained personnel for daily operations of the transfer station and primary equipment, backup equipment, and equipment maintenance. Backup equipment and trucks for transferring and hauling waste will be available on-site and from equipment rental companies.

Solid waste received at the trans-load station will be transferred via various types of transfer trucks to the Arrowhead Landfill, which is located on property adjacent to the Arrowhead Trans-Load Station. Other MSW Landfills with acceptable service areas may be utilized as alternate disposal sites, if necessary. This alternate disposal is not anticipated.

## 3.1 PERSONNEL

Operations will be supervised by the general manager. All employees at the landfill and trans-load station will be properly trained according to ADEM and ADPH Regulations and internal training programs in safety procedures and the inspection of incoming wastes (see Section 3.3 - Inspection of Wastes).

In addition, employees will receive training in the maintenance of equipment, spill control practices, types of materials handled, traffic control, basic housekeeping, prevention of human pathogens, emergency response, and compliance with applicable laws and regulations.

Safety meetings will be held once a month at a minimum to provide and review updated information on safety procedures for all employees. In addition, a refresher course on emergency responses will be given twice a year to all personnel.

Protective gear will be supplied to ensure the health and safety of all personnel working at the facility. The protective gear will include at a minimum: hard hats, protective eye wear, ear plugs,

and safety vests. Facility personnel will be required to wear steel-toe boots, shirts with sleeves, and long pants.

## 3.2 WORKING AREA OPERATIONS

CCR will primarily be delivered to the facility via rail, but it may also be delivered via truck to the landfill. Rail cars delivering CCR to the Arrowhead Trans-Load Station will enter the facility via the railroad main line to the railroad industrial service tracks where the rail cars will be unloaded directly into transfer trucks. The rail cars will be unloaded in an orderly progression. Once the transfer trucks are loaded, they will pass over the truck scales and continue along the access road until reaching the Arrowhead Landfill. The Arrowhead Trans-Load Station attendant will direct vehicles, waiting to weigh in an orderly progression. Trucks that do not have their tare weight on record must be weighed prior to loading or after unloading to determine the weight of waste brought to the Arrowhead facility. Once at the active area of the landfill, the containers will be unloaded using appropriate methods.

A modified variance is requested to operate 3 working faces: two (2) working faces may be utilized for disposal operations in two separate Tracts simultaneously, and a third for a fluff layer over the liner of newly constructed cells. The use of multiple working faces will eliminate the need for ash waste to be commingled with MSW/C&D waste.

## 3.3 INSPECTION OF WASTES

Access to the Arrowhead Trans-Load Station is controlled by a perimeter fence along Tayloe Road and wooded buffers. All waste leaving the trans-load station must pass the scale prior to entering the active landfill area. As CCR is deposited onto the active landfill area, an employee who has received proper training will conduct a visual inspection of the waste materials. Should unacceptable waste be found, the driver of the vehicle will be instructed to terminate unloading, and the unacceptable waste material will be re-loaded into the container for removal from the site. A list of items in that load should be listed on the Load Inspection Form found in the Appendix of this document. This form shall be retained by the facility. Waste collection agreements will be kept on file for each of the waste delivery accounts, allowing the trans-load station operator to maintain accountability for the different haulers utilizing the facility. In addition, all actions specified in Section 2.0 (WASTE ACCEPTANCE CRITERIA) will be strictly adhered to by the facility operator and its employees.

## 3.4 TRAFFIC CONTROL

Arrowhead Trans-Load Station employees will direct and coordinate the movement of vehicles into and out of the working areas. All vehicles leaving the working areas of the trans-load station are directed to the Arrowhead Landfill by the scale house operator after their weight is recorded. The landfill site attendant will direct the vehicles to the active landfill unloading area, as outlined in Section 3.2 (WORKING AREA OPERATIONS). The flow of traffic will be aided by directional signs.

## 3.5 HOUSEKEEPING AND LITTER CONTROL

All incoming rail cars are required to be covered. Throughout the day and at the end of each day, facility personnel will police the facility and surrounding areas for any wind-blown litter. Since the rail cars will be covered, wind-blown litter should not be a major operational concern. Any wind-blown litter discovered at the end of an operating day will be collected for disposal at the landfill.

## 3.6 NOISE CONTROL

Noise will be created at the facility resulting from vehicular traffic and operation of the trans-load station equipment. Noise from the transfer trucks, as well as the heavy equipment servicing the working areas are all reduced by mufflers and the surrounding wooded buffers. Other noise generated within the facility will be minimized as much as possible.

## 3.7 ODOR CONTROL

Odors are controlled by prompt unloading and transfer of all delivered wastes at the trans-load station. Adequate fresh air exchange is ensured since there are no confining structures. The only time waste is stored temporarily at the trans-load station is when a rail load cannot be completely off-loaded by the end of the day and must wait until the landfill disposal site opens the following day, or at the end of a weekend or holiday. Efforts will be made to ensure timely deliveries by rail, so as to allow complete unloading of all rail cars prior to the landfill closing for the day. In such cases, the waste will be stored in the rail cars.

The facility may utilize a mechanical odor control system if the above items fail to adequately control odors. However, under normal operating conditions, an odor control system is not required at the facility.

## 3.8 DUST CONTROL

Numerous practices are in place to avoid dust generation. CCR is primarily delivered to the facility in covered rail cars, but CCR can also be delivered via truck. Haul roads from the rail unloading facility to the disposal cell are sprayed with water as needed and low speed limits on haul roads are enforced. The haul trucks may be covered if needed to prevent ash from blowing out of the trucks. Once spread in the disposal cell, if ash becomes dry enough to be wind-blown, operations will halt and a small amount of cover material will be applied or the CCR will be wetted. If wind is persistent or too strong, operations will stop until weather permits.

## 3.9 STRUCTURAL INTEGRITY

CCR material will be disposed of in Subtitle D landfill cells. Moisture levels will have the greatest impact on structural integrity. Moisture content of CCR deliveries will be closely monitored and paint filter tests will be run to ensure the ash does not have too much moisture. Loads not passing the paint filter test will not be disposed of in the landfill.

CCR placed in the cells will be spread and graded. Daily and intermediate cover material will be placed in between lifts. Disposal operations will follow best engineering practices and will be closely monitored to ensure structural integrity.

The leachate collection system of the landfill disposal cells is designed to prevent clogging by the fine ash particles. Leachate piping and sumps are encased with stone filter media comprised of clean washed gravel of appropriate size. Geotextile fabric is placed under leachate collection pipes and on top of the stone filter media for separation. The landfill is installing a voluntary landfill gas collection system in 2025, and will be designed to prevent clogging by the fine ash particles.

## 3.10 LANDSCAPE MAINTENANCE

All landfill sideslopes that have reached final design grade will be seeded and maintained. All vegetated areas will be trimmed and maintained on a regular basis.

## 3.11 RECORD-KEEPING

All waste accepted at this facility will be weighed on a certified truck scale. A daily log will be maintained indicating date, weather, site conditions, quantity of waste received, quantity of waste transported, and origin of waste. Regulatory authorities shall have the right to review the records in the files and conduct inspections of the site at any time during normal business hours. Reports will be retained at the facility for a minimum of two (2) years.

# 4. PROCEDURES TO PROTECT HUMAN HEALTH AND THE ENVIRONMENT

## 4.1 DISEASE AND VECTOR CONTROL

The Arrowhead Landfill and Trans-Load Station will provide effective vector control measures for the protection of human health and the environment. Disease vectors are defined as any rodents, birds, flies, mosquitoes, or other animals, including insects, capable of transmitting disease to humans.

Control of disease vectors will be maintained by keeping the site clean and picked up. The facility operator may also use insecticides or pest control professionals to control disease vectors, if necessary. Stagnant ponded water will be prevented from occurring to control mosquito breeding. If problems controlling disease vectors occur, a pest control professional certified by the Alabama Department of Agriculture and Industries to perform pest control services will be employed.

## 4.2 ENVIRONMENTAL MONITORING

Arrowhead Landfill conducts routine environmental monitoring at the site including groundwater, storm water, and methane. Groundwater and storm water reports are submitted to ADEM on a semi-annual basis. Methane reports are submitted to ADEM on a quarterly basis. Additional CCR groundwater parameters have been added to the sampling protocol in accordance with EPA recommendations in the preamble of the 2015 Final Coal Ash rules (40 CFR Part 257, Subpart D). Monitoring is conducted semi-annually and results are reviewed and placed in the facility's operating record.

## 4.3 STORM WATER POLLUTION PREVENTION

Storm Water Pollution Prevention Plans (SWPPPs) have been prepared for the landfill and trans-load station. The SWPPPs outline best management practices for the facilities to implement in order to prevent industrial activities onsite from impacting storm water runoff that leaves the site. These are reviewed annually and updated as necessary. Semi-annual sampling is conducted at the outfalls of the landfill sediment ponds and the rail outfall in accordance with the facilities' NPDES permits.

## 4.4 EMPLOYEE TRAINING

Employee training in CCR management practices will be conducted routinely at the facility and whenever new personnel are hired. A Safe Work Plan is in place at the facility and should be reviewed with each employee and readily available on site for review. Employees are closely supervised during operations. Personal protection equipment includes a safety vest, hard hat, ear plugs, and safety glasses that should be worn at all times when an employee is on duty.

# 5. SIGN AND SAFETY REQUIREMENTS

## 5.1 SIGN REQUIREMENTS

The Arrowhead Trans-Load Station will maintain signs at the entrance indicating operational procedures, hours of operation, tipping fee, and the permit number. Signs will be clearly posted stating that no hazardous or liquid waste can be received. Traffic signs and markers will be provided as necessary to promote an orderly traffic pattern to and from the loading area, and to maintain efficient operating conditions.

## 5.2 OPEN BURNING OF WASTE

Open burning of waste is prohibited at the Arrowhead Trans-Load Station and the Arrowhead Landfill.

## 5.3 FIRE PROTECTION EQUIPMENT

Fire suppression equipment will be provided to control accidental fires, and arrangements have been made with the local fire department to immediately provide fire-fighting services when needed. The Arrowhead Trans-Load Station will be equipped with an appropriate number of fire extinguishers to effectively control accidental fires. The fire department will be invited to visit the facility periodically to inspect for deficiencies or suggested improvements. In addition, the following Fire Protection Plan shall be established on site:

5.3.1 All emergency telephone numbers shall be posted in the scale house. These numbers will include the local fire department, police department, and Emergency Medical Service. These numbers shall be verified and updated semi-annually.

5.3.2 Smoke detectors and fire extinguishers shall be installed in all buildings, as required by law.

5.3.3 All employees will be trained in the steps to take in the event that a fire breaks out. Employee training shall include use of fire protection equipment, first aid, identification of building exits, and methods for employee reconnaissance during the fire.

## 5.4 NOTIFICATION OF FIRE

Fires that occur at the Arrowhead Landfill or Trans-Load Station require verbal notice to the Alabama Department of Public Health within 24 hours, and written notification shall be submitted within 15 days. Verbal and written notification will be submitted to:

Perry County Health Department
Environmental Office
P.O. Box 119
Marion, AL 36756-0119

Phone Number: (334) 683-6153

When calling, reference ADPH Solid Waste Transfer Station Permit No. TS-01.

# 6. ACCESS AND SECURITY REQUIREMENTS

## 6.1 ACCESS AND SECURITY

The Arrowhead Landfill and Trans-Load Station is secured by means of gates, berms, fences, wooded buffers and other security measures to prevent unauthorized entry. All vehicles transporting waste from the Arrowhead Trans-Load Station to the landfill will pass the scale house operator. Fencing, wooded areas, and drainage ditches surrounding the Arrowhead Trans-Load Station property prevent unauthorized vehicle access to the facility.

## 6.2 ATTENDANT

The Arrowhead Landfill and Arrowhead Trans-Load Station have full-time scale house operators located in the scale house during operating hours. In addition, a trans-load station attendant will be at the facility at all times during operating hours. The scale house operators and Arrowhead Trans-Load Station attendant will be responsible for verifying that all vehicles comply with the permitted operational requirements.

## 6.3 ACCESS ROAD

The access roads for the facility have been constructed of an all-weather surface (graded aggregate) and will be maintained in good condition. Potholes, ruts, and debris on the gravel surfaces will receive immediate attention in order to avoid damage to the vehicles. Access road shoulders will be re-graded as necessary to maintain positive slope for adequate drainage. Since collection and transfer vehicles travel at low speeds on gravel roads, dust generation is not anticipated to be a problem. Should dust control become necessary, a water truck will be utilized.

# 7. FACILITY INSPECTIONS

There will be regular inspections conducted at the Arrowhead Landfill and Trans-Load Station. Inspections will be conducted by site personnel who are familiar with the operations of the facility. Items that will be inspected monthly will include, but not be limited to, the following:

1. Transfer trucks;
2. Fire extinguishers;
3. Electrical controls;

Records of all facility inspections will be maintained in the scale house.

If unsatisfactory conditions are noted during the inspection or by the Arrowhead facility personnel at any other time, the concerns shall be reported to the general manager. If a threat to safety or to the environment is identified, immediate action shall be taken to correct the situation. If necessary, operations will be suspended temporarily until the proper corrective actions have been taken.

In addition to these records, random inspection forms discussed in Section 3.3 shall be retained by the facility.

# APPENDIX

A. Location Map

B. Site Plan

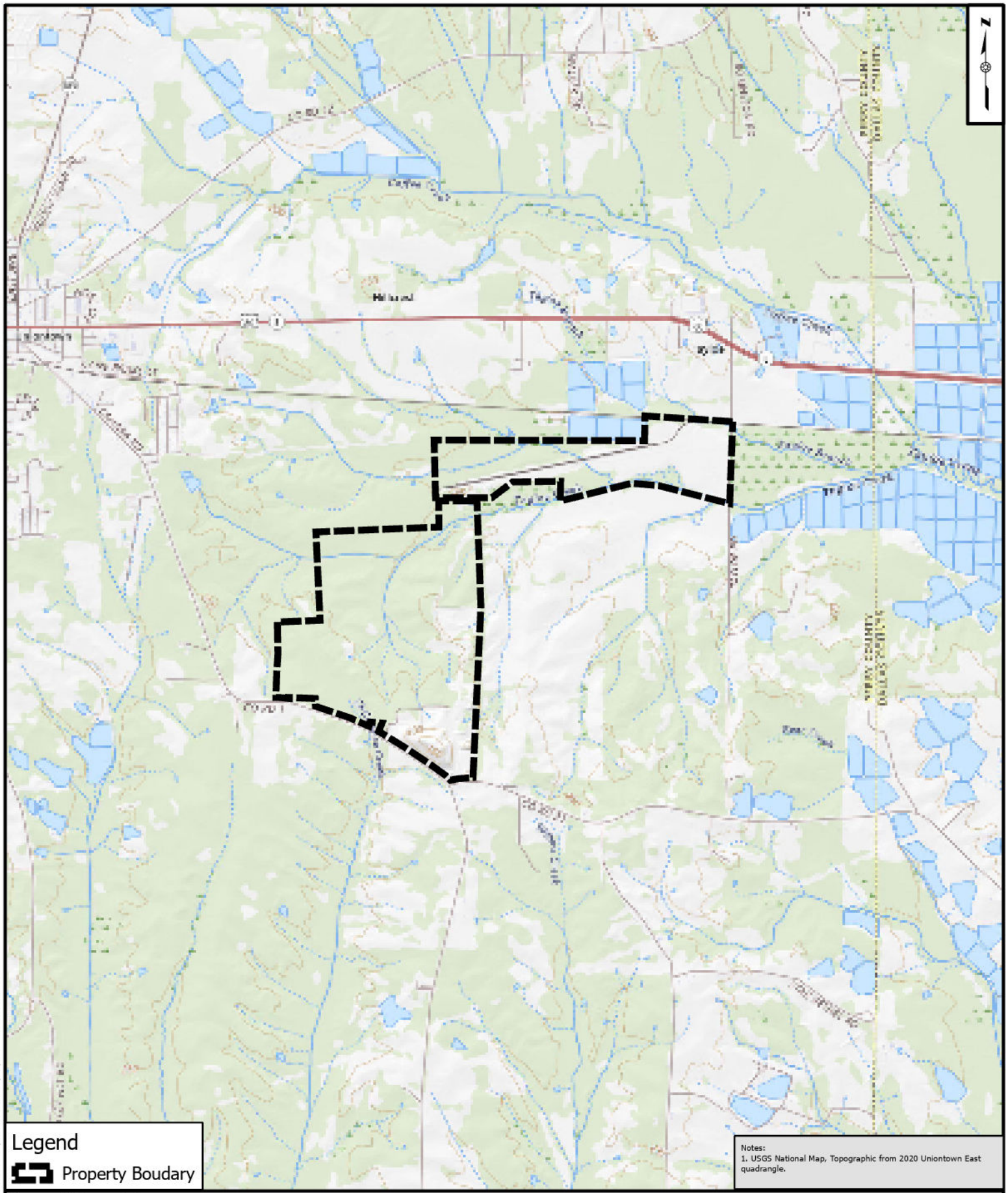
C. Load Inspection Form

D. ADPH Solid Waste Transfer Station Permit No. TS-01

E. ADEM Solid Waste Disposal Facility Permit No. 53-03

F. Final Coal Ash Rule – 40 CFR Part 257, Subpart D - Standards for the Disposal of CCR in Landfills and Surface Impoundments

# A. LOCATION MAP




# Location Map

Arrowhead Landfill
Arrowhead Environmental Partners, LLC
Perry County, Alabama

*8/10/2023*

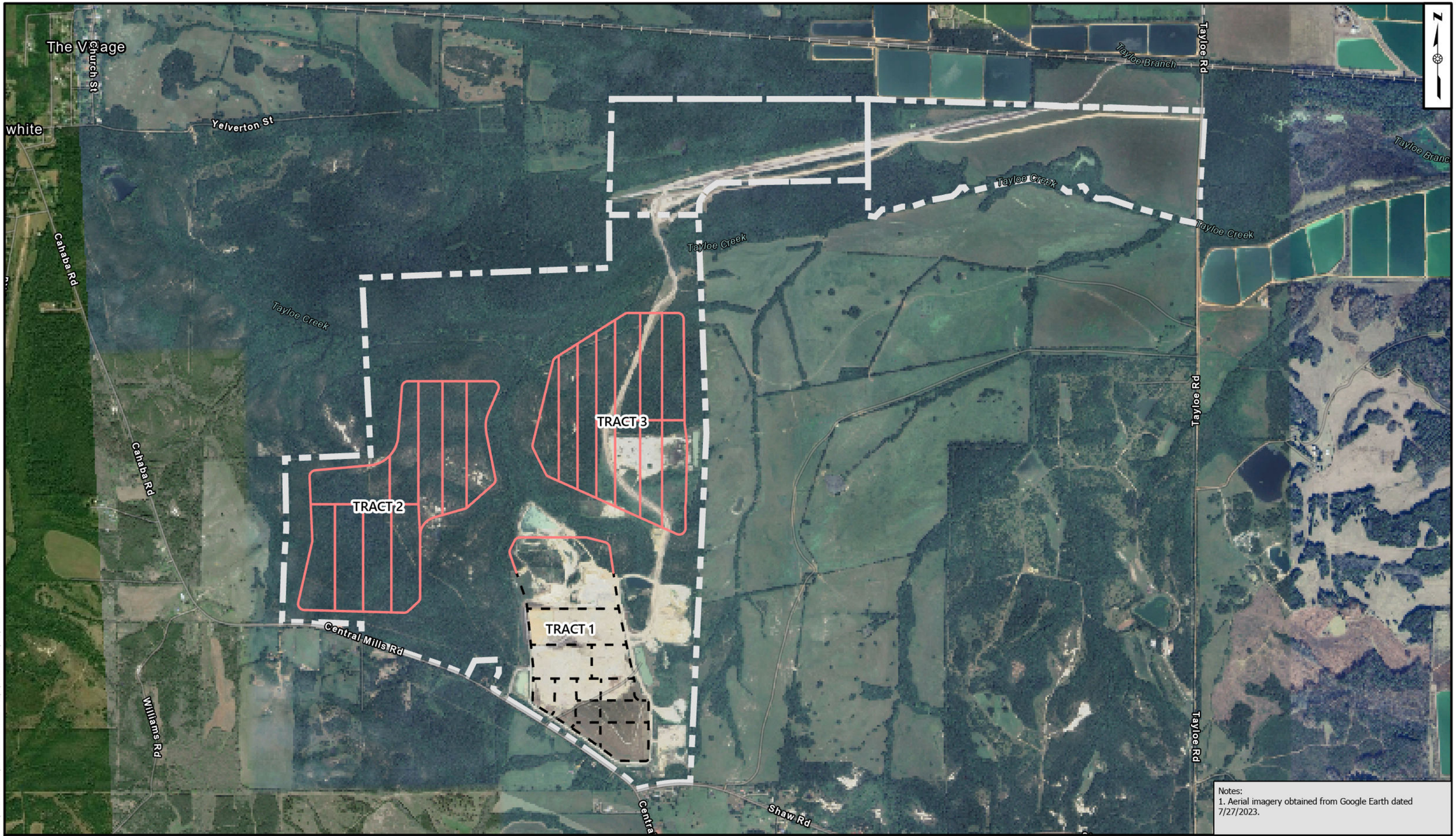
0 2,000 4,000 Feet
1 inch equals 4,000 Feet

DISCLAIMER:
This drawing and the information contained herein is for general presentation purposes only and is a compilation of shapefile(s) provided by various source(s). The source and accuracy of the file(s) has not been verified by HHNT and therefore the drawing is not intended for use as a engineering drawing or for design purposes.

HHNT
HODGES, HARBIN, NEWBERRY & TRIBBLE, INC.
*Consulting Engineers*

Path: B:\GIS\Arrowhead\Location Map\Location Map.aprx User: elambert

## B. SITE PLAN




Notes:
1. Aerial imagery obtained from Google Earth dated 7/27/2023.

# Site Map

Vertical Expansion
Arrowhead Landfill
Perry County, Alabama
*1/3/2025*

0 700 1,400 Feet
1 inch equals 1,400 Feet

DISCLAIMER:
This drawing and the information contained herein is for general presentation purposes only and is a compilation of shapefile(s) provided by various source(s). The source and accuracy of the file(s) has not been verified by HHNT and therefore the drawing is not intended for use as a engineering drawing or for design purposes.

Legend
- Property Boundary
- Existing Cells
- Future Cells

HHNT
HODGES, HARBIN, NEWBERRY & TRIBBLE, INC.
*Consulting Engineers*

Path: B:\GIS\Arrowhead\Vertical Expansion FEMA Map\FEMA Map.aprx User: elambert

## C. LOAD INSPECTION FORM

# LOAD INSPECTION FORM

Date: _____ Time: _____am/pm

Inspection Type: 1) Random Inspection _____
2) Suspicious Load _____

Reason for Suspicion: _____

## SOURCE INFORMATION

1) Waste Hauler Name _____
2) Driver Name _____
3) Vehicle ID No. _____
4) Waste Generator Name _____

## INSPECTION RESULTS

1) Describe Waste Inspected _____

_____

2) Prohibited Wastes Present? _____ Yes _____ No
3) Containers (drums, cans) Present? _____ Yes _____ No
4) Approved MSW Waste _____ Yes _____ No
5) Other Observations _____

_____

_____

6) Disposition _____ Load Accepted
_____ Load Rejected
_____ Operator / ADEM Notified

_____ (Waste Inspector)

(Signature)

*(This form may be revised or updated as necessary by the Landfill Operator to meet the needs at this facility.)*

## D. ADPH SOLID WASTE TRANSFER STATION PERMIT NO. TS-01

# Alabama Department of Public Health

# Solid Waste Transfer Station Permit

**Perry**
County

**TS-01**
Permit Number

**Perry County Associates LLC**
Business Owner or Authorized Agent
**IS HEREBY PERMITTED TO MAINTAIN AND OPERATE**

**Arrowhead Trans-Load Station**
Establishment
**LOCATED AT**

| **622 Tayloe Road** | **Uniontown** | **36786** |
|---|---|---|
| Street | City or Town | Zip |

**This Permit Signifies Compliance on the Date of Issue with the State Board of Health Rules for Solid Waste Collection and Transportation, Chapter 420-3-5. Pursuant to Alabama Law (Section 22-2-2(6), 22-10-1 et seq. and 22-27-1 et seq. Code of Ala., 1975) and is Valid Until Permit Expires, is Suspended or Revoked.**

**10/1/2024**
Date Issued

**9/30/2025**
Expiration Date

**Scott Harris, M.D.**
Local, District, or State Health Official

Not Transferable with Respect to Persons or Establishments

ADPH-CEP-300/4-95

## E. ADEM SOLID WASTE DISPOSAL FACILITY PERMIT NO. 53-03

**LANCE R. LEFLEUR**
DIRECTOR

**KAY IVEY**
GOVERNOR

Alabama Department of Environmental Management
adem.alabama.gov
1400 Coliseum Blvd. 36110-2400 ▪ Post Office Box 301463
Montgomery, Alabama 36130-1463
(334) 271-7700 ▪ FAX (334) 271-7950

March 3, 2023

Mr. William Gay, Chief Executive Officer
Arrowhead Environmental Partners, LLC
Perry County Associates, LLC
65 Challenger Road, Suite 312
Ridgefield Park, NJ 07660

RE: Permit Renewal
Arrowhead Landfill
Permit No. 53-03

Dear Mr. Gay:

Enclosed is the Solid Waste Facility Disposal Permit for the Arrowhead Landfill (Permit No. 53-03). The permit date is effective March 3, 2023, and will expire on March 2, 2033.

If you should have any questions, please contact Mrs. Mary Catherine Muscha of the Solid Waste Engineering Section at (334) 270-5651.

Sincerely,

Jason Wilson, Chief
Solid Waste Branch
Land Division

JW/mcm

Enclosure

**Birmingham Branch**
110 Vulcan Road
Birmingham, AL 35209-4702
(205) 942-6168
(205) 941-1603 (FAX)

**Decatur Branch**
2715 Sandlin Road, S.W.
Decatur, AL 35603-1333
(256) 353-1713
(256) 340-9359 (FAX)

**Mobile Branch**
2204 Perimeter Road
Mobile, AL 36615-1131
(251) 450-3400
(251) 479-2593 (FAX)

**Mobile-Coastal**
3664 Dauphin Street, Suite B
Mobile, AL 36608
(251) 304-1176
(251) 304-1189 (FAX)

**FINAL DETERMINATION**

PERMIT RENEWAL

Perry County Associates, LLC
65 Challenger Road, Suite 312
Ridgefield Park, NJ 07660

Arrowhead Landfill
Permit No. 53-03

March 3, 2023

Perry County Associates, LLC submitted to the Alabama Department of Environmental Management (ADEM) an application to renew the solid waste disposal permit for the municipal solid waste landfill known as the Arrowhead Landfill (Permit 53-03).

The landfill is located in Sections 21, 22, 27, and 28, Township 17 North, Range 6 East in Perry County, Alabama. The permitted facility consists of 973.85 acres with 425.33 acres permitted for disposal operations. The waste stream for the Arrowhead Landfill would remain nonhazardous solid wastes, noninfectious putrescible and nonputrescible wastes including but not limited to household garbage, commercial waste, industrial waste, construction and demolition debris, other similar type materials, and special waste approved by ADEM. The service area for the Arrowhead Landfill would remain the States of Alabama, Arkansas, Connecticut, Delaware, Florida, Georgia, Illinois, Indiana, Iowa, Kentucky, Louisiana, Maine, Maryland, Massachusetts, Michigan, Minnesota, Mississippi, Missouri, New Hampshire, New Jersey, New York, North Carolina, Ohio, Oklahoma, Pennsylvania, Rhode Island, South Carolina, Tennessee, Texas, Vermont, Virginia, West Virginia, and Wisconsin. The maximum average daily volume of waste disposed at the Arrowhead Landfill would remain 15,000 tons per day. The application requested that all conditions of the current permit for the Arrowhead Landfill, including previously approved variances and special conditions, be granted in the renewed permit.

A public comment period was announced by ADEM on December 22, 2021, and ended on July 20, 2022. A public hearing was held at the Uniontown Municipal Building on April 14, 2022. Two public meetings were held at the Uniontown Municipal Building on January 27, 2022 and April 14, 2022. The permit application and draft permit were available to the public at the Alabama Department of Environmental Management and at the Uniontown City Hall Council Chambers. All timely submitted comments were considered and the appropriate responses have been prepared.

The Solid Waste Engineering Section has determined that the permit application complies with the applicable requirements of ADEM's Administrative Code Division 13 regulations for a municipal solid waste landfill.

Technical Contact:

Mrs. Mary Catherine Muscha
Solid Waste Engineering Section
Land Division

ADEM
Alabama Department of Environmental Management

# *SOLID WASTE DISPOSAL FACILITY PERMIT*

| | |
|---|---|
| **PERMITTEE:** | **Perry County Associates, LLC** |
| **FACILITY NAME:** | **Arrowhead Landfill** |
| **FACILITY LOCATION:** | **Sections 21, 22, 27 and 28, Township 17 North, Range 6 East in Perry County. The facility consists of 973.85 acres with a disposal area of 425.33 acres.** |
| **PERMIT NUMBER:** | **53-03** |
| **PERMIT TYPE:** | **Municipal Solid Waste Landfill** |
| **WASTE APPROVED FOR DISPOSAL:** | **Nonhazardous solid wastes, noninfectious putrescible and nonputrescible wastes including but not limited to household garbage, commercial waste, industrial waste, construction and demolition debris, tires, and other similar type materials. Special waste approved by ADEM may also be accepted.** |
| **APPROVED WASTE VOLUME:** | **15,000 tons per day** |
| **APPROVED SERVICE AREA:** | **States of Alabama, Arkansas, Connecticut, Delaware, Florida, Georgia, Illinois, Indiana, Iowa, Kentucky, Louisiana, Maine, Maryland, Massachusetts, Michigan, Minnesota, Mississippi, Missouri, New Hampshire, New Jersey, New York, North Carolina, Ohio, Oklahoma, Pennsylvania, Rhode Island, South Carolina, Tennessee, Texas, Vermont, Virginia, West Virginia and Wisconsin** |

*In accordance with and subject to the provisions of the Alabama Solid Wastes and Recyclable Materials Management Act, as amended, Code of Alabama 1975, SS 22-27-1 to 22-27-27 ("SWRMMA"), the Alabama Environmental Management Act, as amended, Code of Alabama 1975, SS 22-22A-1 to 22-22A-15, and rules and regulations adopted thereunder, and subject further to the conditions set forth in this permit, the Permittee is hereby authorized to dispose of the above-described solid wastes at the above-described facility location.*

| | |
|---|---|
| **ISSUANCE DATE:** | **March 3, 2023** |
| **EFFECTIVE DATE:** | **March 3, 2023** |
| **EXPIRATION DATE:** | **March 2, 2033** |

**Alabama Department of Environmental Management**

# ALABAMA DEPARTMENT OF ENVIRONMENTAL MANAGEMENT
# SOLID WASTE PERMIT

| | |
|---|---|
| Permittee: | Perry County Associates, LLC<br>65 Challenger Road, Suite 312<br>Ridgefield Park, NJ 07660 |
| Landfill Name: | Arrowhead Landfill |
| Landfill Location: | Sections 21, 22, 27 and 28, Township 17 North, Range 6 East in Perry County, Alabama |
| Permit Number: | 53-03 |
| Landfill Type: | Municipal Solid Waste |

Pursuant to the Alabama Solid Wastes and Recyclable Materials Management Act, Code of Alabama 1975, §§ 22-27-1, *et seq.*, as amended, and attendant regulations promulgated thereunder by the Alabama Department of Environmental Management (ADEM), this permit is issued to Perry County Associates, LLC (hereinafter called the Permittee), to operate a solid waste disposal facility, known as the Arrowhead Landfill.

The Permittee must comply with all terms and conditions of this permit. This permit consists of the conditions set forth herein (including those in any attachments), and the applicable regulations contained in Chapters 335-13-1 through 335-13-16 of the ADEM Administrative Code (hereinafter referred to as the "ADEM Admin. Code"). Rules cited are set forth in this document for the purpose of Permittee reference. Any Rule that is cited incorrectly in this document does not constitute grounds for noncompliance on the part of the Permittee. Applicable ADEM Administrative Codes are those that are in effect on the date of issuance of this permit or any revisions approved after permit issuance.

This permit is based on the information submitted to the Department on August 5, 2021, for permit renewal, and as amended, and is known as the Permit Application (hereby incorporated by reference and hereinafter referred to as the Application). Any inaccuracies found in this information could lead to the termination or modification of this permit and potential enforcement action. The Permittee must inform ADEM of any deviation from or changes in the information in the Application that would affect the Permittee's ability to comply with the applicable ADEM Admin. Code or permit conditions.

This permit is effective as of **March 3, 2023**, and shall remain in effect until **March 2, 2033,** unless suspended or revoked.

Alabama Department of Environmental Management

3/3/2023
Date Signed

## SECTION I. STANDARD CONDITIONS

A. Effect of Permit. The Permittee is allowed to dispose of nonhazardous solid waste in accordance with the conditions of this permit and ADEM Admin. Code Div. 13. Issuance of this permit does not convey property rights of any sort or any exclusive privilege, nor does it authorize any injury to persons or property, any invasion of other private rights, or any infringement of state or local laws or regulations. Except for actions brought under Code of Alabama 1975, §§ 22-27-1, *et seq.*, as amended, compliance with the conditions of this permit shall be deemed to be compliance with applicable requirements in effect as of the date of issuance of this permit and any future revisions.

B. Permit Actions. This permit may be suspended, revoked or modified for cause. The filing of a request for a permit modification or the notification of planned changes or anticipated noncompliance on the part of the Permittee, and the suspension or revocation does not stay the applicability or enforceability of any permit condition.

C. Severability. The provisions of this permit are severable, and if any provision of this permit, or the application of any provision of this permit to any circumstance, is held invalid, the application of such provision to other circumstances, and the remainder of this permit, shall not be affected thereby.

D. Definitions. For the purpose of this permit, terms used herein shall have the same meaning as those in ADEM Admin. Code Division 13, unless this permit specifically provides otherwise; where terms are not otherwise defined, the meaning associated with such terms shall be as defined by a standard dictionary reference or the generally accepted scientific or industrial meaning of the term.

1. "EPA" for purposes of this permit means the United States Environmental Protection Agency.

2. "Permit Application" for the purposes of this permit, means all permit application forms, design plans, operational plans, closure plans, technical data, reports, specifications, plats, geological and hydrological reports, and other materials which are submitted to the Department in pursuit of a solid waste disposal permit.

E. Duties and Requirements.

1. Duty to Comply. The Permittee must comply with all conditions of this permit except to the extent and for the duration such noncompliance is authorized by a variance granted by the Department. Any permit noncompliance, other than noncompliance authorized by a variance, constitutes a violation of Code of Alabama 1975, §§ 22-27-1 *et seq.*, as amended, and is grounds for enforcement action, permit suspension, revocation, modification, and/or denial of a permit renewal application.

2. Duty to Reapply. If the Permittee wishes to continue an activity regulated by this permit after the expiration date of this permit, the Permittee must apply for and obtain a new permit. The renewal application must be submitted to the Department at least 180 days before this permit expires.

3. Permit Expiration. This permit and all conditions therein will remain in effect beyond the permit's expiration date if the Permittee has submitted a timely, complete application as required by Section I.E.2., and, through no fault of the Permittee, the Department has not made a final decision regarding the renewal application.

4. Need to Halt or Reduce Activity Not A Defense. It shall not be a defense for the Permittee in an enforcement action that it would have been necessary to halt or reduce the permitted activity to maintain compliance with the conditions of this permit.

5. Duty to Mitigate. In the event of noncompliance with this permit, the Permittee shall take all reasonable steps to minimize releases to the environment, and shall carry out such measures as are reasonable to prevent significant adverse impacts on human health or the environment.

6. Proper Operation and Maintenance. The Permittee shall at all times properly operate and maintain all facilities and systems of control (and related appurtenances) that are installed or used by the Permittee to achieve compliance with the conditions of this permit.

7. Duty to Provide Information. If requested, the Permittee shall furnish to ADEM, within a reasonable time, any information that ADEM may reasonably need to determine whether cause exists for denying, suspending, revoking, or modifying this permit, or to determine compliance with this permit. If requested, the Permittee shall also furnish the Department with copies of records kept as a requirement of this permit.

8. Inspection and Entry. Upon presentation of credentials and other documents as may be required by law, the Permittee shall allow the employees of the Department or their authorized representative to:

   a. Enter at reasonable times the Permittee's premises where the regulated facility or activity is located or conducted, or where records must be kept under the conditions of this permit.

   b. Have access to and copy, at reasonable times, any records that must be kept under the conditions of this permit.

   c. Inspect, at reasonable times, any facilities, equipment (including monitoring and control equipment), practices, or operations regulated or required under this permit.

   d. Sample or monitor, at reasonable times, any substances or parameters at any location for the purposes of assuring permit compliance or as otherwise authorized by Code of Alabama 1975, §§ 22-27-1 *et seq*.

9. Monitoring, Corrective Actions, and Records.

   a. Samples and measurements taken for the purpose of monitoring or corrective action shall be representative of the monitored activity. The methods used to obtain representative samples to be analyzed must be the appropriate method from Chapter 335-13-4 or the methods as specified in the Application attached hereto and incorporated by reference. Laboratory methods must be those specified in Standard Methods for the Examination of Water and Wastewater (American Public Health Association, latest edition), Methods for Chemical Analysis of Water and Wastes (EPA-600/4-79-020), Test Methods for Evaluating Solid Waste, Physical/Chemical Methods (EPA Publication SW-846, latest edition), other appropriate EPA methods, or as specified in the Application. All field tests must be conducted using approved EPA test kits and procedures.

   b. The Permittee shall retain records, at the location specified in Section I.I., of all monitoring, or corrective action information, including all calibration and maintenance records, copies of all reports and records required by this permit, and records of all data used to complete the application for this permit for a period of at least three years from the date of the sample, measurement, report or record or for periods elsewhere specified in this permit. These periods may be extended by the request of the Department at any time and are automatically extended during the course of any unresolved enforcement action regarding this facility.

   c. Records of monitoring and corrective action information shall include.

      i. The exact place, date, and time of sampling or measurement.

      ii. The individual(s) and company who performed the sampling or measurements.

      iii. The date(s) analyses were performed.

      iv. The individual(s) and company who performed the analyses.

v. The analytical techniques or methods used.

vi. The results of such analyses.

d. The Permittee shall submit all monitoring and corrective action results at the interval specified elsewhere in this permit.

10. Reporting Planned Changes. The Permittee shall notify the Department, in the form of a request for permit modification, at least 120 days prior to any change in the permitted service area, increase in the waste received, or change in the design or operating procedure as described in this permit, including any planned changes in the permitted facility or activity which may result in noncompliance with permit requirements.

11. Transfer of Permit. This permit may be transferred to a new owner or operator. All requests for transfer of permits shall be in writing and shall be submitted on forms provided by the Department. Before transferring ownership or operation of the facility during its operating life, the Permittee shall notify the new owner or operator in writing of the requirements of this permit.

12. Certification of Construction. The Permittee may not commence disposal of waste in any new cell or phase until the Permittee has submitted to the Department, by certified mail or hand delivery, a letter signed by both the Permittee and a professional engineer stating that the facility has been constructed in compliance with the permit. The Department must inspect the constructed cells or phases before the owner or operator can commence waste disposal unless the Permittee is notified that the Department will waive the inspection.

13. Compliance Schedules. Reports of compliance or noncompliance with or any progress reports on interim and final requirements contained in any compliance schedule required and approved by the Department shall be submitted no later than 14 days following each schedule date.

14. Other Noncompliance. The Permittee shall report all instances of noncompliance with the permit at the time monitoring reports are submitted.

15. Other Information. If the Permittee becomes aware that information required by the Application was not submitted or was incorrect in the Application or in any report to the Department, the Permittee shall promptly submit such facts or information. In addition, upon request, the Permittee shall furnish to the Department, within a reasonable time, information related to compliance with the permit.

F. Design and Operation of Facility. The Permittee shall maintain and operate the facility to minimize the possibility of a fire, explosion, or any unplanned sudden or nonsudden release of contaminants (including leachate and explosive gases) to air, soil, groundwater, or surface water, which could threaten human health or the environment.

G. Inspection Requirements.

1. The Permittee shall comply with all requirements set forth under ADEM Admin. Code Division 13.

2. The Permittee shall conduct random inspections of incoming loads.

3. Records of all inspections shall be included in the operating record.

H. Recordkeeping and Reporting.

1. The Permittee shall maintain a written operating record at the location specified in Section I.I. The operating record shall include:

a. Documentation of inspection and maintenance activities.

b. Daily Volume reports.

c. Personnel training documents and records.

d. Solid/Hazardous Waste Determination Forms for Industrial Wastes, and associated ADEM disposal approval correspondence for special wastes, industrial wastes, etc.

e. Groundwater monitoring records.

f. Explosive gas monitoring records.

g. Surface water and leachate monitoring records. Monitoring is subject to applicable conditions of Section VII. of the permit.

h. Copies of this Permit and the Application.

i. Copies of all variances granted by the Department, including copies of all approvals of special operating conditions (such as approvals for open burning,).

2. Quarterly Volume Report. Beginning with the effective date of this permit, the Permittee shall submit, within thirty (30) days after the end of each calendar quarter, a report summarizing the daily waste receipts for the previous (just ended) quarter. Copies of the quarterly reports shall be maintained in the operating record.

3. Monitoring and Corrective Action Reports. The Permittee shall submit reports on all monitoring and corrective activities conducted pursuant to the requirements of this permit, including, but not limited to, groundwater, surface water, explosive gas and leachate monitoring. The groundwater monitoring shall be conducted in March and September of each year and the reports shall be submitted at least semi-annually. The reports should contain all monitoring results and conclusions from samples and measurements conducted during the sampling period. Explosive gas monitoring must be submitted on a quarterly basis, and the reports should be submitted to the department and placed in the operating record within 30 days of the monitoring event. Copies of the semi-annual groundwater and quarterly explosive gas monitoring reports shall be maintained in the operating record.

4. Availability, Retention, and Disposition of Records.

a. All records, including plans, required under this permit or Division 13 must be furnished upon request, and made available at reasonable times for inspection by any officer, employee, or representative of the Department.

b. All records, including plans, required under this permit or Division 13 shall be retained by the Permittee for a period of at least three years. The retention period for all records is extended automatically during the course of any unresolved enforcement action regarding the facility, or as requested by the Department.

c. A copy of records of waste disposal locations and quantities must be submitted to the Department and local land authority upon closure of the facility.

I. Documents to be Maintained by the Permittee. The Permittee shall maintain, at the Arrowhead Landfill office, the following documents and amendments, revisions and modifications to these documents until an engineer certifies closure of the permitted landfill.

1. Operating record

2. Closure Plan.

J. Mailing Location. All reports, notifications, or other submissions which are required by this permit should be sent via signed mail (i.e. certified mail, express mail delivery service, etc.) or hand delivered to:

Mailing Address.
Chief, Solid Waste Branch, Land Division
Alabama Department of Environmental Management
P.O. Box 301463
Montgomery, AL 36130-1463

Physical Address.
Chief, Solid Waste Branch, Land Division
Alabama Department of Environmental Management
1400 Coliseum Blvd.
Montgomery, Alabama 36110-2400

K. Signatory Requirement. All applications, reports or information required by this permit, or otherwise submitted to the Department, shall be signed and certified by the owner as follows:

1. If an individual, by the applicant.

2. If a city, county, or other municipality or governmental entity, by the ranking elected official, or by a duly authorized representative of that person.

3. If a corporation, organization, or other legal entity, by a principal executive officer, of at least the level of Vice President, or by a duly authorized representative of that person.

L. Confidential Information. The Permittee may claim information submitted as confidential if the information is protected under Code of Alabama 1975 §§ 22-39-18, as amended.

M. State Laws and Regulations. Nothing in this permit shall be construed to preclude the initiation of any legal action or to relieve the Permittee from any responsibilities, liabilities, or penalties established pursuant to any applicable state law or regulation.

## SECTION II. GENERAL OPERATING CONDITIONS

A. Operation of Facility. The Permittee shall operate and maintain the disposal facility consistent with the Application, this permit, and ADEM Admin. Code, Division 13.

B. Open Burning. The Permittee shall not allow open burning without prior written approval from the Department and other appropriate agencies. A burn request should be submitted in writing to the Department outlining why that burn request should be granted. This request should include, but not be limited to, specifically what areas will be utilized, types of waste to be burned, the projected starting and completion dates for the project, and the projected days and hours of operation. The approval, if granted, shall be included in the operating record.

C. Prevention of Unauthorized Disposal. The Permittee shall follow the approved procedures for the detecting and preventing the disposal of free liquids, regulated hazardous waste, PCB's, and medical waste at the facility.

D. Unauthorized Discharge. The Permittee shall operate the disposal facility in such a manner that there will be no water pollution or unauthorized discharge. Any discharge from the disposal facility or practice thereof may require a National Pollutant Discharge Elimination System permit under the Alabama Water Pollution Control Act.

E. Industrial and Medical Waste Disposal. The Permittee shall dispose of industrial process waste as required by ADEM Admin. Code Division 13, and as specified in the Application. The Permittee, prior to disposal of industrial waste and/or medical waste, shall obtain from each generator a written certification that the material to be disposed does not contain free liquids, regulated hazardous wastes, regulated medical waste, or regulated PCB wastes.

F. Boundary Markers. The Permittee shall ensure that the facility is identified with a sufficient number of permanent boundary markers that are at least visible from one marker to the next.

G. Certified Operator. The Permittee shall be required to have an operator certified by the Department on-site during hours of operation, in accordance with the requirements of ADEM Admin. Code 335-13-12.

## SECTION III. SPECIFIC MSW LANDFILL REQUIREMENTS

A. Waste Identification and Management.

1. Subject to the terms of this permit, the Permittee may dispose of the nonhazardous solid wastes listed in Section III.B. Disposal of other waste streams is prohibited, except waste that is granted a temporary or one-time waiver by the Director.

2. The total permitted area for the Arrowhead Landfill is 973.85 acres with 425.33 acres (Tract 1 is 117.63 acres, Tract 2 is 159.28 acres, and Tract 3 is 148.42 acres) permitted for disposal operations.

3. The maximum average daily volume of waste disposed at the facility and approved by the Perry County Commission, and as contained in the permit application shall not exceed 15,000 tons/day, except as provided under Rule 335-13-5-.06(2)(b)2. The average daily volume shall be computed as specified by Rule 335-13-4-.22(2)(g).

B. Waste Streams. The Permittee may accept for disposal nonhazardous solid wastes, noninfectious putrescible and nonputrescible wastes including but not limited to household garbage, commercial waste, industrial waste, construction and demolition debris, tires, and other similar type materials. Special waste approved by ADEM may also be accepted.

C. Service Area. The Service area for the Arrowhead Landfill as contained in the permit application and approved by the Perry County Commission is the States of Alabama, Arkansas, Connecticut, Delaware, Florida, Georgia, Illinois, Indiana, Iowa, Kentucky, Louisiana, Maine, Maryland, Massachusetts, Michigan, Minnesota, Mississippi, Missouri, New Hampshire, New Jersey, New York, North Carolina, Ohio, Oklahoma, Pennsylvania, Rhode Island, South Carolina, Tennessee, Texas, Vermont, Virginia, West Virginia and Wisconsin.

D. Special Waste. Disposal of special wastes is subject to a Hazardous/Solid Waste determination by ADEM.

1. Asbestos Waste. The Permittee shall dispose of asbestos waste in accordance with Rule 335-13-4-.26.

2. Foundry Sand. The Permittee shall dispose of foundry waste in accordance with Rule 335-13-4-.26.

3. Petroleum Contaminated Waste. The Permittee shall dispose of petroleum contaminated waste in accordance with Rule 335-13-4-.26.

4. Municipal Solid Waste Ash. The Permittee shall dispose of municipal solid waste ash in accordance with Rule 335-13-4-.26.

E. Liner Requirements. The Permittee shall install a composite liner system as described in the Application consisting of two feet of clay with a hydraulic conductivity of $1 \times 10^{-7}$ cm/sec or less, overlain by a 60 mil High Density Polyethylene (HDPE) geomembrane, overlain by an 8 ounce per square yard non-woven

geotextile fabric, and overlain by 12" of protective cover with a hydraulic conductivity greater than or equal to 1 x $10^{-2}$ cm/sec. The base of the composite liner system shall be a minimum of five (5) feet above the highest measured groundwater level as determined by 335-13-4-.11(2)(a).

F Septic Tank Pumpings and Sewage Sludge. The Permittee shall not dispose of septic tank pumpings and/or sewage sludge unless specifically approved in writing by the department.

G. Large Dead Animals and Highly Putrescible Wastes. The Permittee shall handle the disposal of large dead animals and/or highly putrescible waste as required by Rule 335-13-4-.22(1)(j).

H. Cover Requirements. The Permittee shall cover all wastes as required by ADEM Admin. Code Division 13.

List of Alternate Daily Covers approved for use at the Arrowhead Landfill:

1. Synthetic Tarps. The Synthetic Tarps used should be at least 50' x 75' and shall be LandPac Tarps by Pactec or an equivalent. At the conclusion of each week's operation, the Permittee shall be required to cover all exposed waste with a minimum of six inches of compacted earth.

2. Petroleum Contaminated Soil (PCS). The maximum petroleum contaminant level of the soil that will be used as alternative daily cover material should be 100 parts per million (ppm) of Total Petroleum Hydrocarbons (TPH). The PCS should be used in the same manner as soil daily cover; covering the waste with a uniform compacted 6" thick layer. PCS should be stockpiled within the cell away from daily traffic and operations in such a manner that rainwater runoff will not leave the limits of the lined cell area.

3. Posi-shell. The Posi-shell will be spray-applied using a standard hydro seeding unit. The typical application thickness should be approximately 1/8" and should not be applied during extremely wet weather. During these extremely wet times, daily soil should be used to cover the waste. At the conclusion of each week's operation, the Permittee shall be required to cover all exposed waste with a minimum of six inches of compacted earth.

4. Automotive Shredder Residue (ASR). Automotive shredder residue (ASR) as it is commonly known is the non-metal waste generated after junked vehicles go through auto shredders. It is a mixture of crushed glass, ceramics, cloth, rubber, plastic, foam, wood, and air bags. About 25 percent of a shredded vehicle is ASR. Metal components, which are sold for reuse in new products, make up the remainder. ASR should be used in a 6" thick blanket in a manner similar to soil and consistent with the rules. ASR should not be used during rainfall events or on exterior slopes where runoff from the ASR could leave the cell. All run-off from ASR shall be contained within the lined cell. At the conclusion of each week's operation, the Permittee shall be required to cover all exposed waste with a minimum of six inches of compacted earth.

I. Waste Compaction. All waste shall be thoroughly compacted with adequate landfill equipment before the daily cover is applied. A completed daily cell shall not exceed eight feet in vertical thickness measured perpendicular to the slope of the preceding cell.

J. Daily Cells. All waste shall be confined to an area as small as possible within a single working face and spread to a depth not exceeding two feet prior to compaction, and such compaction shall be accomplished on a face slope not to exceed 4 to 1 or as otherwise approved by the Department. Arrowhead Landfill is granted a variance to operate three working faces. Two working faces have been approved as follows: the first for the placement of MSW/Construction and Demolition waste and the second for the placement of ash waste. Additionally, a temporary working face has been approved for newly constructed cells. This working face will consist of a fluff layer or selected waste that will protect the integrity of the liner and will only be applicable for newly constructed cells until a sufficiently thick initial fluff lift has been achieved. (See Section X., A.). Each of the working faces should be confined to as small an area as possible.

K. Security. The Permittee shall provide artificial and/or natural barriers, which prevent entry of unauthorized vehicular traffic to the facility.

L. All Weather Access Roads. The Permittee shall provide an all-weather access road to the dumping face that is wide enough to allow passage of collection vehicles.

M. Adverse Weather Disposal. The Permittee shall provide for disposal activities in adverse weather conditions.

N. Personnel. The Permittee shall maintain adequate personnel to ensure continued and smooth operation of the facility.

O. Equipment. The Permittee shall provide the landfill equipment as required by Rule 335-13-4-.22(1)(f).

P. Environmental Monitoring and Treatment Structures. The Permittee shall provide protection and proper maintenance of environmental monitoring and treatment structures.

Q. Vector Control. The Permittee shall provide for vector control as required by ADEM Admin. Code Division 13.

R. Bulk or Noncontainerized Liquid Waste. The Permittee shall not dispose of bulk or noncontainerized liquid waste, or containers capable of holding liquids, unless the conditions of Rule 335-13-4-.22(1)(k) are met.

S. Empty Containers. The Permittee shall render empty containers larger than normally found in household waste unsuitable for holding liquids prior to delivery to the landfill unit unless otherwise approved by the Department.

T. Other Requirements. The Department may enhance or reduce any requirements for operating and maintaining the landfill as deemed necessary by the Land Division.

U. Other Permits. The Permittee shall operate the landfill according to this and any other applicable permits. Additionally, the Department will verify that the Permittee has obtained a valid permit from the U. S. Army Corps of Engineers regarding an unnamed tributary located within Tract 3 before the construction of Tract 3 may commence.

V. Scavenging and Salvaging Operations. The Permittee shall prevent scavenging and salvaging operations, except as part of a controlled recycling effort. Any recycling operation must be in accordance with plans submitted and approved by the Department.

W. Signs. The Permittee shall provide a sign outlining instructions for use of the site. The sign shall be posted and have the information required by Rule 335-13-4-.22(1)(i).

X. Litter Control. The Permittee shall control litter.

Y. Fire Control. The Permittee shall provide fire control measures.

## SECTION IV. GROUNDWATER MONITORING REQUIREMENTS

A. The Permittee shall install and/or maintain a groundwater monitoring system, as specified below.

1. The permittee shall construct and maintain the groundwater monitoring wells identified in Tables IV.1. and IV.4. at the locations and schedules specified in the Application, and any other groundwater monitoring wells which are added (Section IV.A.3.) during the active life and the post closure care period.

2. The Permittee shall maintain groundwater monitoring wells GWM-1 and GWM-5 as the background groundwater monitoring wells for the entire facility.

3. The Permittee shall install and maintain additional groundwater monitoring wells as necessary to assess changes in the rate and extent of any plume of contamination or as otherwise deemed necessary to maintain compliance with the ADEM Admin. Code.

4. Prior to installing any additional groundwater monitoring wells, the Permittee shall submit a report to the Department with a permit modification request specifying the design, location and installation of any additional monitoring wells. This report shall be submitted within 120 days prior to the installation which, at a minimum, shall include.

   a. Well construction techniques including proposed casing depths, proposed total depth, and proposed screened interval of well(s);

   b. Well development method(s);

   c. A complete analysis of well construction materials;

   d. A schedule of implementation for construction; and

   e. Provisions for determining the lithologic characteristics, hydraulic conductivity and grain-size distribution for the applicable aquifer unit(s) at the location of the new well(s).

B. Groundwater Monitoring Requirements.

1. The Permittee shall determine the groundwater surface elevation at each monitoring well and piezometer identified in Table IV.1. each time the well or piezometer is sampled and at least semi-annually throughout the active life and post-closure care period.

2. The Permittee shall determine the groundwater flow rate and direction in the first zone of saturation at least annually or each time groundwater is sampled and submit as required by ADEM Admin. Code Division 13.

3. Prior to the initial receipt of waste at the facility, the Permittee shall sample, and analyze for the parameters listed in Appendix I of Rule 335-13-4-.27, and/or any other parameters specified by the Department in Table IV. 2., all monitoring wells identified in Section IV.A.2. to establish background water quality and/or as directed by Rule 335-13-4-.27(2)(j) and 335-13-4-.27(2)(a)(1).

4. The Permittee shall sample and analyze all monitoring wells identified in Table IV.1 for the parameters listed in Table IV.3, on a semi-annual basis throughout the active life of the facility and the post-closure care period in accordance with Rule 335-13-4-.27(3). Sampling shall be conducted during March and September of each year, beginning with the effective date of this permit. The records and results of this sampling and analysis activity shall be submitted to ADEM, within ninety (90) days of the date of sampling.

5. In addition to the requirements of Sections IV., B.1., B.2., B.3. and B.4., the Permittee shall record water levels, mean sea level elevation measuring point, depth to water, and the results of field tests for pH and specific conductance at the time of sampling for each well.

C. Sampling and Analysis Procedures. The Permittee shall use the following techniques and procedures when obtaining and analyzing samples from the groundwater monitoring wells described in Section IV.A. to provide a reliable indication of the quality of the groundwater.

1. Samples shall be collected, preserved, and shipped (when shipped off-site for analysis) in accordance with the procedures specified in the Application.

2. Samples shall be analyzed according to the procedures specified of the Application, Standard Methods for the Examination of Water and Wastewater (American Public Health Association, latest edition),

Methods for Chemical Analysis of Water and Wastes (EPA-600/4-79-020), Test Methods for Evaluating Solid Waste, Physical/Chemical Methods (EPA Publication SW-846, latest edition), or other appropriate methods approved by this Department. All field tests must be conducted using approved EPA test kits and procedures. The Permittee is approved for intrawell statistical analysis.

3. Samples shall be tracked and controlled using the chain-of-custody and QA/QC procedures specified of the Application.

D. Recordkeeping and Reporting Requirements.

1. Recording of Results. For each sample and/or measurement taken pursuant to the requirements of this permit, the Permittee shall record the information required by Section I.E.9.c.

2. Recordkeeping. Records and results of all groundwater monitoring, sampling, and analysis activities conducted pursuant to the requirements of this permit shall be included in the operating record required by Section I.I.1.

E. Permit Modification. If at any time the Permittee or the Department determines that the groundwater monitoring system no longer satisfies the requirements of 335-13-4-.14 or Section IV.A. of this permit, the Permittee must, within 120 days, submit an application for a permit modification to make any necessary and/or appropriate changes to the system.

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TABLE IV.1.
INSTALLED GROUNDWATER MONITORING WELLS

| Well | Northing | Easting | Top Casing Elev | Surface Elev | Well Type |
|---|---|---|---|---|---|
| GWM-1 | 884667.24 | 1979482.39 | 203.37 | 200.1 | Up Grad |
| GWM-2 | 876720.18 | 1978344.96 | 274.67 | 271.2 | Dn. Grad |
| GWM-3 | 877237.63 | 1977604.4 | 272.67 | 269.5 | Dn. Grad |
| GWM-4 | 877927.07 | 1976503.62 | 272.66 | 269.0 | Dn. Grad |
| GWM-5 | 883499.74 | 1976238.62 | 215.84 | 212.7 | Up Grad |
| GWM-6 | 878866.18 | 1979676.92 | 262.71 | 259.1 | Dn. Grad |
| GWM-12 | 878746.96 | 1978684.14 | 276.43 | 272.9 | Dn. Grad |
| GWM-13 | 879504.50 | 1978499.15 | 262.77 | 259.1 | Dn. Grad |
| GWM-14 | 880438.28 | 1978283.93 | 238.42 | 235.1 | Dn. Grad |
| GWM-15 | 876717.19 | 1978352.88 | 274.69 | 271.2 | Dn. Grad |
| GWM-16 | 877234.71 | 1977611.58 | 272.72 | 269.5 | Dn. Grad |
| GWM-17 | 877934.67 | 1976495.99 | 273.33 | 269.4 | Dn. Grad |
| GWM-18 | 877891.57 | 1979006.68 | 286.05 | 282.6 | Dn. Grad |

*ft-bls = Depth in feet below land surface

TABLE IV.2.
BACKGROUND GROUNDWATER MONITORING

NOTE: The parameters in this Table are those listed in Appendix I of Chapter 335-13-4.

NOTE: The Permittee shall conduct a minimum of four independent sampling events as the initial sampling event, and analyze for the parameters listed above, in order to establish background water quality. Following the four independent events, the Permittee can submit a request, with justification, for the deletion of or change in these parameters

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TABLE IV.3.
SEMI-ANNUAL GROUNDWATER MONITORING PARAMETERS

Boron, Calcium, Chloride, Fluoride, Sulfate, Total Dissolved Solids (TDS), and the parameters listed in Appendix I of 335-13-4-.27(3)

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TABLE IV.4.
GROUNDWATER MONITORING WELLS TO BE INSTALLED

| Monitoring Well Number | Top of Casing (feet msl) | Part Monitoring |
|---|---|---|
| GWM-7 | To be installed | Tract 2 |
| GWM-8 | To be installed | Tract 2 |
| GWM-9 | To be installed | Tract 2 |
| GWM-10 | To be installed | Tract 2 |
| GWM-11 | To be installed | Tract 2 |
| GWM-19 | To be installed | Tract 2 |
| GWM-20 | To be installed | Tract 2 |
| GWM-21 | To be installed | Tract 2 |
| GWM-22 | To be installed | Tract 2 |
| GWM-23 | To be installed | Tract 2 |
| GWM-24 | To be installed | Tract 2 |
| GWM-25 | To be installed | Tract 2 |
| GWM-26 | To be installed | Tract 2 |
| GWM-27 | To be installed | Tract 3 |
| GWM-28 | To be installed | Tract 3 |
| GWM-29 | To be installed | Tract 3 |
| GWM-30 | To be installed | Tract 3 |
| GWM-31 | To be installed | Tract 3 |
| GWM-32 | To be installed | Tract 3 |
| GWM-33 | To be installed | Tract 3 |
| GWM-34 | To be installed | Tract 3 |
| GWM-35 | To be installed | Tract 3 |
| GWM-36 | To be installed | Tract 3 |
| GWM-37 | To be installed | Tract 3 |
| GWM-38 | To be installed | Tract 3 |
| GWM-39 | To be installed | Tract 3 |
| GWM-40 | To be installed | Tract 3 |

## SECTION V. GAS MONITORING REQUIREMENTS

The Permittee must install and maintain an explosive gas monitoring system in accordance with ADEM Admin. Code Division 13.

## SECTION VI – MUNICIPAL SOLID WASTE LANDFILL AIR EMISSIONS

This landfill may be subject to ADEM Admin. Code Division 3 Admin. Code and the Federal Clean Air Act. Contact the ADEM Air Division for applicable requirements and permits.

## SECTION VII. LEACHATE AND SURFACE WATER MANAGEMENT REQUIREMENTS

The Permittee must collect and dispose of the leachate that is generated at the facility. The Permittee shall install a leachate collection system designed to maintain less than 12 inches (30 cm) depth of leachate over the liner. Prior to disposal, the permittee shall provide the Department with a letter from the receiving publicly or privately owned treatment works, approving the acceptance of the leachate. Discharges to publicly or privately owned treatment works may be subject to the requirements of the ADEM Water Division's State Indirect Discharge (SID) Program. The permittee shall construct and maintain run-on and run-off control structures. Surface water discharges from drainage control structures shall be permitted through the ADEM Water Division's National Pollutant Discharge Elimination System (NPDES) Program.

Arrowhead Landfill is granted permission for leachate recirculation. Leachate recirculation should be accomplished through two (2) methods. The first method should involve loading leachate at the leachate storage tank and hauling it by tanker to the working face where it will be distributed via a spray nozzle. The second method should involve injecting leachate into the leachate recirculation lines that will be constructed 4' to 6' below the waste surface. Both methods should distribute leachate at a rate and manner that does not cause runoff, odor, or operation difficulties. Leachate should not be recirculated during or immediately after rainfall events. Also, care should be taken to assure that no more leachate is applied than the facility can manage. Records of leachate recirculation should be made part of the facility operating record. The maximum daily leachate recirculation should be 20,000 gpd and should only be applied where there is a minimum of 20 feet of waste in place (See Section X.D.).

The Permittee is also granted permission to construct an Intermediate Drainage System (Capillary Break) to provide stability to the waste mass in the coal ash disposal area in the Tract 1 Area of the landfill and as depicted on the engineering plans dated July 30, 2010. This Intermediate Drainage System should be constructed with Double Bonded Geocomposite Drainage Media as its primary drainage path. The Geocomposite Drainage Media should be 250 mil thick HDPE geonet material with 6 ounce per square yard non-woven geotextile bonded to the geonet. The proposed system should require the Geocomposite Drainage Media to be placed over a large portion of the Tract 1 area at grades greater than 5% and less than 10% and should be installed approximately 90 vertical feet above the landfill base liner system to promote drainage within the waste mass at that elevation.

## SECTION VIII. CLOSURE AND POST- CLOSURE REQUIREMENTS

The Permittee shall close the landfill and perform post-closure care of the landfill in accordance with Division 13.

A. Final Cover. The Permittee shall grade final soil cover such that surface water does not pond over the permitted area as specified in the Application. The final cover system as specified in the application shall consist of 12 inches of compacted soil with a permeability of $1x10^{-5}$ cm/sec, 40 mil flexible membrane liner, geocomposite drainage system, 18 inches of protective soil, 6 inches of topsoil capable of supporting vegetative cover.

B. Vegetative Cover. The Permittee shall establish a vegetative or other appropriate cover within 90 days after completion of final grading requirements in the Application. Preparation of a vegetative cover shall include, but not be limited to, the placement of seed, fertilizer, mulch, and water.

C. Notice of Intent. The Permittee shall place in the operating record and notify the Department of their intent to close the landfill prior to beginning closure.

D. Completion of Closure Activities. The Permittee must complete closure activities of each landfill unit in accordance with the Closure Plan within 180 days of the last known receipt of waste.

E. Certification of Closure. Following closure of each unit, the Permittee must submit to the Department a certification, signed by an engineer, verifying the closure has been completed according to the Closure Plan.

F. Post-Closure Care Period. Post-closure care activities shall be conducted after closure of each unit throughout the life of this permit and continuing for a period of thirty (30) years following closure of the facility. The Department may shorten or extend the post-closure care period applicable to the solid waste disposal facility. The Permittee shall reapply in order to fulfill the post-closure care requirements of this permit.

G. Post-Closure Maintenance. The Permittee shall provide post closure maintenance of the facility to include regularly scheduled inspections. This shall include maintenance of the cover, vegetation, monitoring devices and pollution control equipment and correction of other deficiencies that may be observed by ADEM. Monitoring requirements shall continue throughout the post closure period as determined by the Department unless all waste is removed and no unpermitted discharge to waters of the State have occurred.

H. Post-Closure Use of Property. The Permittee shall ensure that post closure use of the property never be allowed to disturb the integrity of the final cover, liner, or any other component of the containment system. This shall preclude the growing of deep-rooted vegetation on the closed area.

I. Certification of Post-Closure. Following post-closure of each unit, the Permittee must submit to the Department a certification, signed by an engineer, verifying the post-closure has been completed according to the Post-Closure Plan.

J. Notice in Deed to Property. The Permittee must provide documentation of compliance with the requirements of the Uniform Environmental Covenants Program in ADEM Admin. Code Division 335-5 and shall record a notation onto the land deed containing the property utilized for disposal within 90 days after permit expiration, revocation or when closure requirements are achieved as determined by the Department as stated in the Application. This notation shall state that the land has been used as a solid waste disposal facility, the name of the Permittee, type of disposal activity, location of the disposal facility and beginning and closure dates of the disposal activity.

K. Recording Instrument. The Permittee shall submit a certified copy of the recording instrument to the Department within 120 days after permit expiration, revocation, or as directed by the Department as described in the Application.

L. Removal of Waste. If the Permittee, or any other person(s), wishes to remove waste, waste residues, the liner, or any contaminated soils, the owner must request and receive prior approval from the Department.

## SECTION IX. FINANCIAL ASSURANCE

A. The Permittee shall maintain detailed written cost estimates, in current dollars, at the landfill office and on file with ADEM in accordance with ADEM Admin. Code 335-13-4-.28.

B. All cost estimates must be updated annually as required by ADEM Admin Code 335-13-4-28.

C. The Permittee must place a copy of the financial assurance mechanism along with other items required by ADEM Admin. Code 335-13-4-28. into the landfill operating record and submitted to ADEM before the initial receipt of waste in the case of closure, post-closure care, or no later than 120 days after corrective action remedy has been selected.

D. The financial assurance mechanisms must ensure that funds will be available in a timely fashion when needed.

E. The financial assurance mechanisms must be legally valid, binding, and enforceable under state and federal law.

F. The Permittee shall demonstrate continuous compliance with ADEM Admin. Code 335-13-4-28. by providing documentation of financial assurance in at least the amount that equals or exceeds the cost estimate. Changes in the financial assurance mechanism must be approved by the Department.

G. The Permittee shall increase the closure, post-closure or corrective action cost estimates and the amount of financial assurance if changes in the closure, post-closure or correction action plans or landfill conditions increase the maximum cost.

H. The Permittee may reduce the amount of financial assurance by submitting justification and a revised estimate to ADEM for approval.

## SECTION X. VARIANCES AND SPECIAL CONDITIONS

A. A variance is granted for the Arrowhead Landfill from Rule 335-13-4-.22.(1)(b) which states that all waste shall be confined to as small an area as possible. Under this variance, the Arrowhead Landfill is allowed to operate three working faces. Two working faces have been approved as follows: the first for the placement of MSW/Construction and Demolition waste and the second for the placement of ash waste. Additionally, a temporary working face has been approved for newly constructed cells. This working face will consist of a fluff layer or selected waste that will protect the integrity of the liner and will only be applicable for newly constructed cells until a sufficiently thick initial fluff lift has been achieved. Each of the working faces should be confined to as small an area as possible. (See Section III.J.)

B. A variance is granted from Rule 335-13-4-.20(2)(c)3. requiring terraces every 20 feet rise in elevation. This variance requires terraces every 40 feet rise in elevation.

C. The Permittee is allowed to solidify waste within the waste solidification mixing pit constructed as shown in the Application. Solidification shall follow the procedures specified in the Application. The solidification mixing pit shall be located within a lined cell area at all times.

D. Arrowhead Landfill is granted permission for leachate recirculation. Leachate recirculation should be accomplished through two (2) methods. The first method should involve loading leachate at the leachate storage tank and hauling it by tanker to the working face where it will be distributed via a spray nozzle. The second method should involve injecting leachate into the leachate recirculation lines that will be constructed 4' to 6' below the waste surface. Both methods should distribute leachate at a rate and manner that does not cause runoff, odor, or operation difficulties. Leachate should not be recirculated during or immediately after rainfall events. Also, care should be taken to assure that no more leachate is applied than the facility can manage. Records of leachate recirculation should be made part of the facility operating record. The maximum daily leachate recirculation should be 20,000 gpd and should only be applied where there is a minimum of 20 feet of waste in place (See Section VII).

Any variance granted by the Department may be terminated by the Department whenever the Department finds, after notice and opportunity for hearing, that the petitioner is in violation of any requirement, condition, schedule, limitation or any other provision of the variance, or that operation under the variance does not meet the minimum requirements established by state and federal laws.

# F. FINAL COAL ASH RULE – 40 CFR PART 257, SUBPART D - STANDARDS FOR THE DISPOSAL OF CCR IN LANDFILLS AND SURFACE IMPOUNDMENTS

This content is from the eCFR and is authoritative but unofficial.

# Title 40 —Protection of Environment
## Chapter I —Environmental Protection Agency
## Subchapter I —Solid Wastes
## Part 257 —Criteria for Classification of Solid Waste Disposal Facilities and Practices

**Authority:** 42 U.S.C. 6907(a)(3), 6912(a)(1), 6927, 6944, 6945(a) and (d); 33 U.S.C. 1345(d) and (e).
**Source:** 44 FR 53460, Sept. 13, 1979, unless otherwise noted.

**Subpart D** Standards for the Disposal of Coal Combustion Residuals in Landfills and Surface Impoundments

**§ 257.50** Scope and purpose.
*§ 257.51 [Reserved]*
**§ 257.52** Applicability of other regulations.
**§ 257.53** Definitions.
Location Restrictions
**§ 257.60** Placement above the uppermost aquifer.
**§ 257.61** Wetlands.
**§ 257.62** Fault areas.
**§ 257.63** Seismic impact zones.
**§ 257.64** Unstable areas.
Design Criteria
**§ 257.70** Design criteria for new CCR landfills and any lateral expansion of a CCR landfill.
**§ 257.71** Liner design criteria for existing CCR surface impoundments.
**§ 257.72** Liner design criteria for new CCR surface impoundments and any lateral expansion of a CCR surface impoundment.
**§ 257.73** Structural integrity criteria for existing CCR surface impoundments.
**§ 257.74** Structural integrity criteria for new CCR surface impoundments and any lateral expansion of a CCR surface impoundment.
**§ 257.75** Requirements for identifying CCR management units.
Operating Criteria
**§ 257.80** Air criteria.
**§ 257.81** Run-on and run-off controls for CCR landfills.
**§ 257.82** Hydrologic and hydraulic capacity requirements for CCR surface impoundments.
**§ 257.83** Inspection requirements for CCR surface impoundments.
**§ 257.84** Inspection requirements for CCR landfills.
Groundwater Monitoring and Corrective Action
**§ 257.90** Applicability.
**§ 257.91** Groundwater monitoring systems.
*§ 257.92 [Reserved]*

**§ 257.93** Groundwater sampling and analysis requirements.
**§ 257.94** Detection monitoring program.
**§ 257.95** Assessment monitoring program.
**§ 257.96** Assessment of corrective measures.
**§ 257.97** Selection of remedy.
**§ 257.98** Implementation of the corrective action program.
Closure and Post-Closure Care
**§ 257.100** Inactive CCR surface impoundments and Legacy CCR surface impoundments.
**§ 257.101** Closure or retrofit of CCR units.
**§ 257.102** Criteria for conducting the closure or retrofit of CCR units and closure of CCR management units.
**§ 257.103** Alternative closure requirements.
**§ 257.104** Post-closure care requirements.
Recordkeeping, Notification, and Posting of Information to the Internet
**§ 257.105** Recordkeeping requirements.
**§ 257.106** Notification requirements.
**§ 257.107** Publicly accessible internet site requirements.

## Subpart D—Standards for the Disposal of Coal Combustion Residuals in Landfills and Surface Impoundments

**Source:** 80 FR 21468, Apr. 17, 2015, unless otherwise noted.

### § 257.50 Scope and purpose.

Link to an amendment published at 90 FR 4642, Jan. 16, 2025.

(a) This subpart establishes minimum national criteria for purposes of determining which solid waste disposal facilities and solid waste management practices do not pose a reasonable probability of adverse effects on health or the environment under sections 1008(a)(3) and 4004(a) of the Resource Conservation and Recovery Act.

(b) This subpart applies to owners and operators of new and existing landfills and surface impoundments, including any lateral expansions of such units that dispose or otherwise engage in solid waste management of CCR generated from the combustion of coal at electric utilities and independent power producers. Unless otherwise provided in this subpart, these requirements also apply to disposal units located off-site of the electric utility or independent power producer. This subpart also applies to any practice that does not meet the definition of a beneficial use of CCR.

(c) This subpart also applies to inactive CCR surface impoundments at active electric utilities or independent power producers, regardless of how electricity is currently being produced at the facility.

(d)

(1) This subpart applies to CCR management units containing 1,000 tons or greater of CCR, located at active facilities or facilities with a legacy CCR surface impoundment.

(2) CCR management units containing greater than or equal to 1 ton and less than 1,000 tons of CCR, located at active facilities or facilities with a legacy CCR surface impoundment, are subject only to the requirements of the facility evaluation report in § 257.75 until a permitting authority determines that regulation of these units, either individually or in the aggregate, is warranted and determines the applicable requirements.

(e) This subpart applies to electric utilities or independent power producers that ceased producing electricity prior to October 19, 2015 and have a legacy CCR surface impoundment onsite.

(f) This subpart does not apply to wastes, including fly ash, bottom ash, boiler slag, and flue gas desulfurization materials generated at facilities that are not part of an electric utility or independent power producer, such as manufacturing facilities, universities, and hospitals. This subpart also does not apply to fly ash, bottom ash, boiler slag, and flue gas desulfurization materials, generated primarily from the combustion of fuels (including other fossil fuels) other than coal, for the purpose of generating electricity unless the fuel burned consists of more than fifty percent (50%) coal on a total heat input or mass input basis, whichever results in the greater mass feed rate of coal.

(g) This subpart does not apply to practices that meet the definition of a beneficial use of CCR.

(h) This subpart does not apply to CCR placement at active or abandoned underground or surface coal mines.

(i) This subpart does not apply to municipal solid waste landfills that receive CCR.

*[80 FR 21468, Apr. 17, 2015, as amended at 89 FR 39099, May 8, 2024]*

## § 257.51 [Reserved]

## § 257.52 Applicability of other regulations.

(a) Compliance with the requirements of this subpart does not affect the need for the owner or operator of a CCR unit to comply with all other applicable federal, state, tribal, or local laws or other requirements.

(b) Any CCR unit continues to be subject to the requirements in §§ 257.3-1, 257.3-2, and 257.3-3.

*[89 FR 39099, May 8, 2024]*

## § 257.53 Definitions.

Link to an amendment published at 89 FR 39099, May 8, 2024.

Link to an amendment published at 90 FR 4642, Jan. 16, 2025.

The following definitions apply to this subpart. Terms not defined in this section have the meaning given by RCRA.

*Acre foot* means the volume of one acre of surface area to a depth of one foot.

*Active facility* or *active electric utilities or independent power producers* means any facility subject to the requirements of this subpart that is in operation on or after October 19, 2015. An electric utility or independent power producer is in operation if it is generating electricity that is provided to electric power transmission systems or to electric power distribution systems on or after October 19, 2015. An off-site disposal facility is in operation if it is accepting or managing CCR on or after October 19, 2015.

*Active life* or *in operation* means the period of operation beginning with the initial placement of CCR in the CCR unit and ending at completion of closure activities in accordance with § 257.102.

*Active portion* means that part of the CCR unit that has received or is receiving CCR or non-CCR waste and that has not completed closure in accordance with § 257.102.

*Aquifer* means a geologic formation, group of formations, or portion of a formation capable of yielding usable quantities of groundwater to wells or springs.

*Area-capacity curves* means graphic curves which readily show the reservoir water surface area, in acres, at different elevations from the bottom of the reservoir to the maximum water surface, and the capacity or volume, in acre-feet, of the water contained in the reservoir at various elevations.

*Areas susceptible to mass movement* means those areas of influence (*i.e.,* areas characterized as having an active or substantial possibility of mass movement) where, because of natural or human-induced events, the movement of earthen material at, beneath, or adjacent to the CCR unit results in the downslope transport of soil and rock material by means of gravitational influence. Areas of mass movement include, but are not limited to, landslides, avalanches, debris slides and flows, soil fluctuation, block sliding, and rock fall.

*Beneficial use of CCR* means the CCR meet all of the following conditions:

(1) The CCR must provide a functional benefit;

(2) The CCR must substitute for the use of a virgin material, conserving natural resources that would otherwise need to be obtained through practices, such as extraction;

(3) The use of the CCR must meet relevant product specifications, regulatory standards or design standards when available, and when such standards are not available, the CCR is not used in excess quantities; and

(4) When unencapsulated use of CCR involving placement on the land of 12,400 tons or more in non-roadway applications, the user must demonstrate and keep records, and provide such documentation upon request, that environmental releases to groundwater, surface water, soil and air are comparable to or lower than those from analogous products made without CCR, or that environmental releases to groundwater, surface water, soil and air will be at or below relevant regulatory and health-based benchmarks for human and ecological receptors during use.

*Closed* means placement of CCR in a CCR unit has ceased, and the owner or operator has completed closure of the CCR unit in accordance with § 257.102 and has initiated post-closure care in accordance with § 257.104.

*Closed prior to October 19, 2015* means the CCR landfill or surface impoundment completed closure of the unit in accordance with state law prior to October 19, 2015.

*Coal combustion residuals (CCR)* means fly ash, bottom ash, boiler slag, and flue gas desulfurization materials generated from burning coal for the purpose of generating electricity by electric utilities and independent power producers.

*CCR fugitive dust* means solid airborne particulate matter that contains or is derived from CCR, emitted from any source other than a stack or chimney.

*CCR landfill or landfill* means an area of land or an excavation that contains CCR and which is not a surface impoundment, an underground injection well, a salt dome formation, a salt bed formation, an underground or surface coal mine, or a cave. For purposes of this subpart, a CCR landfill also includes sand and gravel pits and quarries that receive CCR, CCR piles, and any practice that does not meet the definition of a beneficial use of CCR.

*CCR management unit* means any area of land on which any noncontainerized accumulation of CCR is received, is placed, or is otherwise managed, that is not a regulated CCR unit. This includes inactive CCR landfills and CCR units that closed prior to October 19, 2015, but does not include roadbed and associated embankments in which CCR is used unless the facility or a permitting authority determines that the roadbed is causing or contributing to a statistically significant level above the groundwater protection standard established under § 257.95(h).

*CCR pile or pile* means any non-containerized accumulation of solid, non-flowing CCR that is placed on the land. CCR that is beneficially used off-site is not a CCR pile.

*CCR surface impoundment* or *impoundment* means a natural topographic depression, man-made excavation, or diked area, designed to hold an accumulation of CCR and liquids, and the unit treats, stores, or disposes of CCR.

*CCR unit* means any CCR landfill, CCR surface impoundment, or lateral expansion of a CCR landfill or CCR surface impoundment, or a combination of more than one of these units, based on the context of the paragraph(s) in which it is used. This term includes both new and existing units, unless otherwise specified. This term includes CCR management units and legacy CCR surface impoundments.

*Contains both CCR and liquids* means that both CCR and liquids are present in a CCR surface impoundment, except where the owner or operator demonstrates that the standard in § 257.102(d)(2)(i) has been met.

*Critical infrastructure* means physical structures, such as buildings, railways, bridges, or tunnels, that are not readily replaced or relocated and are either:

(1) Necessary for the continued generation of power, or

(2) Vital to the success or continuation of other on-going site activity for the public welfare. Examples of critical infrastructure include high power electric transmission towers, air pollution control or wastewater treatment systems, active CCR units, buildings, or an electrical substation. Buildings or other structures that exclusively provide commercial or financial benefit to private entities are not critical infrastructure.

*Dike* means an embankment, berm, or ridge of either natural or man-made materials used to prevent the movement of liquids, sludges, solids, or other materials.

*Displacement* means the relative movement of any two sides of a fault measured in any direction.

*Disposal* means the discharge, deposit, injection, dumping, spilling, leaking, or placing of any solid waste as defined in section 1004(27) of the Resource Conservation and Recovery Act into or on any land or water so that such solid waste, or constituent thereof, may enter the environment or be emitted into the air or discharged into any waters, including groundwaters. For purposes of this subpart, disposal does not include the storage or the beneficial use of CCR.

*Downstream toe* means the junction of the downstream slope or face of the CCR surface impoundment with the ground surface.

*Eligible unlined CCR surface impoundment* means an existing CCR surface impoundment that meets all of the following conditions:

(1) The owner or operator has documented that the CCR unit is in compliance with the location restrictions specified under §§ 257.60 through 257.64;

(2) The owner or operator has documented that the CCR unit is in compliance with the periodic safety factor assessment requirements under § 257.73(e) and (f); and

(3) No constituent listed in Appendix IV to this part has been detected at a statistically significant level exceeding a groundwater protection standard defined under § 257.95(h).

*Encapsulated beneficial use* means a beneficial use of CCR that binds the CCR into a solid matrix that minimizes its mobilization into the surrounding environment.

*Existing CCR landfill* means a CCR landfill that receives CCR both before and after October 19, 2015, or for which construction commenced prior to October 19, 2015 and receives CCR on or after October 19, 2015. A CCR landfill has commenced construction if the owner or operator has obtained the federal, state, and local approvals or permits necessary to begin physical construction and a continuous on-site, physical construction program had begun prior to October 19, 2015.

*Existing CCR surface impoundment* means a CCR surface impoundment that receives CCR both before and after October 19, 2015, or for which construction commenced prior to October 19, 2015 and receives CCR on or after October 19, 2015. A CCR surface impoundment has commenced construction if the owner or operator has obtained the federal, state, and local approvals or permits necessary to begin physical construction and a continuous on-site, physical construction program had begun prior to October 19, 2015.

*Facility* means all contiguous land, and structures, other appurtenances, and improvements on the land, used for treating, storing, disposing, or otherwise conducting solid waste management of CCR. A facility may consist of several treatment, storage, or disposal operational units (e.g., one or more landfills, surface impoundments, or combinations of them).

*Factor of safety (Safety factor)* means the ratio of the forces tending to resist the failure of a structure to the forces tending to cause such failure as determined by accepted engineering practice.

*Fault* means a fracture or a zone of fractures in any material along which strata on one side have been displaced with respect to that on the other side.

*Flood hydrograph* means a graph showing, for a given point on a stream, the discharge, height, or other characteristic of a flood as a function of time.

*Freeboard* means the vertical distance between the lowest point on the crest of the impoundment dike and the surface of the waste contained therein.

*Free liquids* means liquids that readily separate from the solid portion of a waste under ambient temperature and pressure.

*Groundwater* means water below the land surface in a zone of saturation.

*Hazard potential classification* means the possible adverse incremental consequences that result from the release of water or stored contents due to failure of the diked CCR surface impoundment or mis-operation of the diked CCR surface impoundment or its appurtenances. The hazardous potential classifications include high hazard potential CCR surface impoundment, significant hazard potential CCR surface impoundment, and low hazard potential CCR surface impoundment, which terms mean:

(1) ***High hazard potential CCR surface impoundment*** means a diked surface impoundment where failure or mis-operation will probably cause loss of human life.

(2) ***Low hazard potential CCR surface impoundment*** means a diked surface impoundment where failure or mis-operation results in no probable loss of human life and low economic and/or environmental losses. Losses are principally limited to the surface impoundment owner's property.

(3) ***Significant hazard potential CCR surface impoundment*** means a diked surface impoundment where failure or mis-operation results in no probable loss of human life, but can cause economic loss, environmental damage, disruption of lifeline facilities, or impact other concerns.

*Height* means the vertical measurement from the downstream toe of the CCR surface impoundment at its lowest point to the lowest elevation of the crest of the CCR surface impoundment.

*Holocene* means the most recent epoch of the Quaternary period, extending from the end of the Pleistocene Epoch, at 11,700 years before present, to present.

*Hydraulic conductivity* means the rate at which water can move through a permeable medium (*i.e.,* the coefficient of permeability).

*Inactive CCR landfill* means an area of land or an excavation that contains CCR but that no longer receives CCR on or after October 19, 2015 and that is not a surface impoundment, an underground injection well, a salt dome formation, a salt bed formation, an underground or surface coal mine, or a cave. This term also includes sand and gravel pits that contain CCR and CCR piles, which have not received CCR on or after October 19, 2015, and abandoned or inactive CCR piles.

*Inactive CCR surface impoundment* means a CCR surface impoundment located at an active facility that no longer receives CCR on or after October 19, 2015, and still contains both CCR and liquids on or after October 19, 2015.

*Inactive facility* or *inactive electric utility or independent power producer* means any electric utility or independent power producer that ceased providing power to electric power transmission systems or to electric power distribution systems before October 19, 2015. An off-site disposal facility is inactive if it ceased accepting or managing CCR prior to October 19, 2015.

*Incised CCR surface impoundment* means a CCR surface impoundment which is constructed by excavating entirely below the natural ground surface, holds an accumulation of CCR entirely below the adjacent natural ground surface, and does not consist of any constructed diked portion.

*Indian country* or *Indian lands* means:

(1) All land within the limits of any Indian reservation under the jurisdiction of the United States Government, notwithstanding the issuance of any patent, and including rights-of-way running throughout the reservation;

(2) All dependent Indian communities within the borders of the United States whether within the original or subsequently acquired territory thereof, and whether within or without the limits of the State; and

(3) All Indian allotments, the Indian titles to which have not been extinguished, including rights of way running through the same.

*Indian Tribe* or *Tribe* means any Indian tribe, band, nation, or community recognized by the Secretary of the Interior and exercising substantial governmental duties and powers on Indian lands.

*Infiltration* means the migration or movement of liquid, such as surface water or ground water, into or through a CCR unit from any direction, including from the surface, laterally, and through the bottom of the unit.

*Inflow design flood* means the flood hydrograph that is used in the design or modification of the CCR surface impoundments and its appurtenant works.

*In operation* means the same as *active life*.

*Karst terrain* means an area where karst topography, with its characteristic erosional surface and subterranean features, is developed as the result of dissolution of limestone, dolomite, or other soluble rock. Characteristic physiographic features present in karst terranes include, but are not limited to, dolines, collapse shafts (sinkholes), sinking streams, caves, seeps, large springs, and blind valleys.

*Lateral expansion* means a horizontal expansion of the waste boundaries of an existing CCR landfill or existing CCR surface impoundment made after October 19, 2015.

*Legacy CCR surface impoundment* means a CCR surface impoundment that no longer receives CCR but contained both CCR and liquids on or after October 19, 2015, and that is located at an inactive electric utility or independent power producer.

*Liquefaction factor of safety* means the factor of safety (safety factor) determined using analysis under liquefaction conditions.

*Liquids* means any fluid (such as water) that has no independent shape but has a definite volume and does not expand indefinitely and that is only slightly compressible. This encompasses all of the various types of liquids that may be present in a CCR unit, including water that was sluiced into an impoundment along with CCR, precipitation, surface water, groundwater, and any other form of water that has migrated into the impoundment, which may be found as free water or standing water ponded above CCR or porewater intermingled with CCR.

*Lithified earth material* means all rock, including all naturally occurring and naturally formed aggregates or masses of minerals or small particles of older rock that formed by crystallization of magma or by induration of loose sediments. This term does not include man-made materials, such as fill, concrete, and asphalt, or unconsolidated earth materials, soil, or regolith lying at or near the earth surface.

*Maximum horizontal acceleration in lithified earth material* means the maximum expected horizontal acceleration at the ground surface as depicted on a seismic hazard map, with a 98% or greater probability that the acceleration will not be exceeded in 50 years, or the maximum expected horizontal acceleration based on a site-specific seismic risk assessment.

*New CCR landfill* means a CCR landfill or lateral expansion of a CCR landfill that first receives CCR or commences construction after October 19, 2015. A new CCR landfill has commenced construction if the owner or operator has obtained the federal, state, and local approvals or permits necessary to begin physical construction and a continuous on-site, physical construction program had begun after October 19, 2015. Overfills are also considered new CCR landfills.

*New CCR surface impoundment* means a CCR surface impoundment or lateral expansion of an existing or new CCR surface impoundment that first receives CCR or commences construction after October 19, 2015. A new CCR surface impoundment has commenced construction if the owner or operator has obtained the federal, state, and local approvals or permits necessary to begin physical construction and a continuous on-site, physical construction program had begun after October 19, 2015.

*Nonparticipating State* means a State—

(1) For which the Administrator has not approved a State permit program or other system of prior approval and conditions under RCRA section 4005(d)(1)(B);

(2) The Governor of which has not submitted to the Administrator for approval evidence to operate a State permit program or other system of prior approval and conditions under RCRA section 4005(d)(1)(A);

(3) The Governor of which provides notice to the Administrator that, not fewer than 90 days after the date on which the Governor provides the notice to the Administrator, the State will relinquish an approval under RCRA section 4005(d)(1)(B) to operate a permit program or other system of prior approval and conditions; or

(4) For which the Administrator has withdrawn approval for a permit program or other system of prior approval and conditions under RCRA section 4005(d)(1)(E).

*Operator* means the person(s) responsible for the overall operation of a CCR unit. This term includes those person(s) or parties responsible for disposal or otherwise actively engaged in the solid waste management of CCR. It also includes those responsible for directing or overseeing groundwater monitoring, closure or post-closure activities at a CCR unit.

*Overfill* means a new CCR landfill constructed over a closed CCR surface impoundment.

*Owner* means the person(s) who owns a CCR unit or part of a CCR unit, or a facility, whether in full or in part.

*Participating State* means a state with a state program for control of CCR that has been approved pursuant to RCRA section 4005(d).

*Participating State Director* means the chief administrative officer of any state agency operating the CCR permit program in a participating state or the delegated representative of the Participating State Director. If responsibility is divided among two or more state agencies, Participating State Director means the chief administrative officer of the state agency authorized to perform the particular function or procedure to which reference is made.

*Poor foundation conditions* mean those areas where features exist which indicate that a natural or human-induced event may result in inadequate foundation support for the structural components of an existing or new CCR unit. For example, failure to maintain static and seismic factors of safety as required in §§ 257.73(e) and 257.74(e) would cause a poor foundation condition.

*Probable maximum flood* means the flood that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the drainage basin.

*Qualified person* means a person or persons trained to recognize specific appearances of structural weakness and other conditions which are disrupting or have the potential to disrupt the operation or safety of the CCR unit by visual observation and, if applicable, to monitor instrumentation.

*Qualified professional engineer* means an individual who is licensed by a state as a Professional Engineer to practice one or more disciplines of engineering and who is qualified by education, technical knowledge and experience to make the specific technical certifications required under this subpart. Professional engineers making these certifications must be currently licensed in the state where the CCR unit(s) is located.

*Recognized and generally accepted good engineering practices* means engineering maintenance or operation activities based on established codes, widely accepted standards, published technical reports, or a practice widely recommended throughout the industry. Such practices generally detail approved ways to perform specific engineering, inspection, or mechanical integrity activities.

*Regulated CCR unit* means any new CCR landfill, existing CCR landfill, new CCR surface impoundment, existing CCR surface impoundment, inactive CCR surface impoundment, or legacy CCR surface impoundment. This term does not include CCR management units.

*Retrofit* means to remove all CCR and contaminated soils and sediments from the CCR surface impoundment, and to ensure the unit complies with the requirements in § 257.72

*Representative sample* means a sample of a universe or whole (e.g., waste pile, lagoon, and groundwater) which can be expected to exhibit the average properties of the universe or whole. See EPA publication SW-846, Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, Chapter 9 (available at *http://www.epa.gov/epawaste/hazard/testmethods/sw846/online/index.htm*) for a discussion and examples of representative samples.

*Run-off* means any rainwater, leachate, or other liquid that drains over land from any part of a CCR landfill or lateral expansion of a CCR landfill.

*Run-on* means any rainwater, leachate, or other liquid that drains over land onto any part of a CCR landfill or lateral expansion of a CCR landfill.

*Sand and gravel pit or quarry* means an excavation for the extraction of aggregate, minerals or metals. The term sand and gravel pit and/or quarry does not include subsurface or surface coal mines.

*Seismic factor of safety* means the factor of safety (safety factor) determined using analysis under earthquake conditions using the peak ground acceleration for a seismic event with a 2% probability of exceedance in 50 years, equivalent to a return period of approximately 2,500 years, based on the U.S. Geological Survey (USGS) seismic hazard maps for seismic events with this return period for the region where the CCR surface impoundment is located.

*Seismic impact zone* means an area having a 2% or greater probability that the maximum expected horizontal acceleration, expressed as a percentage of the earth's gravitational pull (g), will exceed 0.10 g in 50 years.

*Slope protection* means engineered or non-engineered measures installed on the upstream or downstream slope of the CCR surface impoundment to protect the slope against wave action or erosion, including but not limited to rock riprap, wooden pile, or concrete revetments, vegetated wave berms, concrete facing, gabions, geotextiles, or fascines.

*Solid waste management or management* means the systematic administration of the activities which provide for the collection, source separation, storage, transportation, processing, treatment, or disposal of solid waste.

*State* means any of the fifty States in addition to the District of Columbia, the Commonwealth of Puerto Rico, the Virgin Islands, Guam, American Samoa, and the Commonwealth of the Northern Mariana Islands.

*State Director* means the chief administrative officer of the lead state agency responsible for implementing the state program regulating disposal in CCR units.

*Static factor of safety* means the factor of safety (safety factor) determined using analysis under the long-term, maximum storage pool loading condition, the maximum surcharge pool loading condition, and under the end-of-construction loading condition.

*Structural components* mean liners, leachate collection and removal systems, final covers, run-on and run-off systems, inflow design flood control systems, and any other component used in the construction and operation of the CCR unit that is necessary to ensure the integrity of the unit and that the contents of the unit are not released into the environment.

*Technically feasible* or *feasible* means possible to do in a way that would likely be successful.

*Technically infeasible* or *infeasible* means not possible to do in a way that would likely be successful.

*Unstable area* means a location that is susceptible to natural or human-induced events or forces capable of impairing the integrity, including structural components of some or all of the CCR unit that are responsible for preventing releases from such unit. Unstable areas can include poor foundation conditions, areas susceptible to mass movements, and karst terrains.

*Uppermost aquifer* means the geologic formation nearest the natural ground surface that is an aquifer, as well as lower aquifers that are hydraulically interconnected with this aquifer within the facility's property boundary. Upper limit is measured at a point nearest to the natural ground surface to which the aquifer rises during the wet season.

*Waste boundary* means a vertical surface located at the hydraulically downgradient limit of the CCR unit. The vertical surface extends down into the uppermost aquifer.

*[80 FR 21468, Apr. 17, 2015, as amended at 80 FR 37991, July 2, 2015; 83 FR 36451, July 30, 2018; 85 FR 53561, Aug. 28, 2020; 89 FR 39099, May 8, 2024]*

LOCATION RESTRICTIONS

## § 257.60 Placement above the uppermost aquifer.

(a) New CCR landfills, existing and new CCR surface impoundments, and all lateral expansions of CCR units must be constructed with a base that is located no less than 1.52 meters (five feet) above the upper limit of the uppermost aquifer, or must demonstrate that there will not be an intermittent, recurring, or sustained hydraulic connection between any portion of the base of the CCR unit and the uppermost aquifer due to normal fluctuations in groundwater elevations (including the seasonal high water table). The owner or operator must demonstrate by the dates specified in paragraph (c) of this section that the CCR unit meets the minimum requirements for placement above the uppermost aquifer.

(b) The owner or operator of the CCR unit must obtain a certification from a qualified professional engineer or approval from the Participating State Director or approval from EPA where EPA is the permitting authority stating that the demonstration meets the requirements of paragraph (a) of this section.

(c) The owner or operator of the CCR unit must complete the demonstration required by paragraph (a) of this section by the date specified in either paragraph (c)(1) or (2) of this section.

(1) For an existing CCR surface impoundment, the owner or operator must complete the demonstration no later than October 17, 2018.

(2) For a new CCR landfill, new CCR surface impoundment, or any lateral expansion of a CCR unit, the owner or operator must complete the demonstration no later than the date of initial receipt of CCR in the CCR unit.

(3) The owner or operator has completed the demonstration required by paragraph (a) of this section when the demonstration is placed in the facility's operating record as required by § 257.105(e).

(4) An owner or operator of an existing CCR surface impoundment who fails to demonstrate compliance with the requirements of paragraph (a) of this section by the date specified in paragraph (c)(1) of this section is subject to the requirements of § 257.101(b)(1).

(5) An owner or operator of a new CCR landfill, new CCR surface impoundment, or any lateral expansion of a CCR unit who fails to make the demonstration showing compliance with the requirements of paragraph (a) of this section is prohibited from placing CCR in the CCR unit.

(d) The owner or operator of the CCR unit must comply with the recordkeeping requirements specified in § 257.105(e), the notification requirements specified in § 257.106(e), and the internet requirements specified in § 257.107(e).

*[80 FR 21468, Apr. 17, 2015, as amended at 83 FR 36451, July 30, 2018]*

## § 257.61 Wetlands.

(a) New CCR landfills, existing and new CCR surface impoundments, and all lateral expansions of CCR units must not be located in wetlands, as defined in § 230.41(a) of this chapter, unless the owner or operator demonstrates by the dates specified in paragraph (c) of this section that the CCR unit meets the requirements of paragraphs (a)(1) through (5) of this section.

(1) Where applicable under section 404 of the Clean Water Act or applicable state wetlands laws, a clear and objective rebuttal of the presumption that an alternative to the CCR unit is reasonably available that does not involve wetlands.

(2) The construction and operation of the CCR unit will not cause or contribute to any of the following:

(i) A violation of any applicable state or federal water quality standard;

(ii) A violation of any applicable toxic effluent standard or prohibition under section 307 of the Clean Water Act;

(iii) Jeopardize the continued existence of endangered or threatened species or result in the destruction or adverse modification of a critical habitat, protected under the Endangered Species Act of 1973; and

(iv) A violation of any requirement under the Marine Protection, Research, and Sanctuaries Act of 1972 for the protection of a marine sanctuary.

(3) The CCR unit will not cause or contribute to significant degradation of wetlands by addressing all of the following factors:

(i) Erosion, stability, and migration potential of native wetland soils, muds and deposits used to support the CCR unit;

(ii) Erosion, stability, and migration potential of dredged and fill materials used to support the CCR unit;

(iii) The volume and chemical nature of the CCR;

(iv) Impacts on fish, wildlife, and other aquatic resources and their habitat from release of CCR;

(v) The potential effects of catastrophic release of CCR to the wetland and the resulting impacts on the environment; and

(vi) Any additional factors, as necessary, to demonstrate that ecological resources in the wetland are sufficiently protected.

(4) To the extent required under section 404 of the Clean Water Act or applicable state wetlands laws, steps have been taken to attempt to achieve no net loss of wetlands (as defined by acreage and function) by first avoiding impacts to wetlands to the maximum extent reasonable as required by paragraphs (a)(1) through (3) of this section, then minimizing unavoidable impacts to the maximum extent reasonable, and finally offsetting remaining unavoidable wetland impacts through all appropriate and reasonable compensatory mitigation actions (e.g., restoration of existing degraded wetlands or creation of man-made wetlands); and

(5) Sufficient information is available to make a reasoned determination with respect to the demonstrations in paragraphs (a)(1) through (4) of this section.

(b) The owner or operator of the CCR unit must obtain a certification from a qualified professional engineer or approval from the Participating State Director or approval from EPA where EPA is the permitting authority stating that the demonstration meets the requirements of paragraph (a) of this section.

(c) The owner or operator of the CCR unit must complete the demonstrations required by paragraph (a) of this section by the date specified in either paragraph (c)(1) or (2) of this section.

(1) For an existing CCR surface impoundment, the owner or operator must complete the demonstration no later than October 17, 2018.

(2) For a new CCR landfill, new CCR surface impoundment, or any lateral expansion of a CCR unit, the owner or operator must complete the demonstration no later than the date of initial receipt of CCR in the CCR unit.

(3) The owner or operator has completed the demonstration required by paragraph (a) of this section when the demonstration is placed in the facility's operating record as required by § 257.105(e).

(4) An owner or operator of an existing CCR surface impoundment who fails to demonstrate compliance with the requirements of paragraph (a) of this section by the date specified in paragraph (c)(1) of this section is subject to the requirements of § 257.101(b)(1).

(5) An owner or operator of a new CCR landfill, new CCR surface impoundment, or any lateral expansion of a CCR unit who fails to make the demonstrations showing compliance with the requirements of paragraph (a) of this section is prohibited from placing CCR in the CCR unit.

(d) The owner or operator must comply with the recordkeeping requirements specified in § 257.105(e), the notification requirements specified in § 257.106(e), and the Internet requirements specified in § 257.107(e).

*[80 FR 21468, Apr. 17, 2015, as amended at 83 FR 36451, July 30, 2018; 89 FR 39101, May 8, 2024]*

## § 257.62 Fault areas.

(a) New CCR landfills, existing and new CCR surface impoundments, and all lateral expansions of CCR units must not be located within 60 meters (200 feet) of the outermost damage zone of a fault that has had displacement in Holocene time unless the owner or operator demonstrates by the dates specified in paragraph (c) of this section that an alternative setback distance of less than 60 meters (200 feet) will prevent damage to the structural integrity of the CCR unit.

(b) The owner or operator of the CCR unit must obtain a certification from a qualified professional engineer or approval from the Participating State Director or approval from EPA where EPA is the permitting authority stating that the demonstration meets the requirements of paragraph (a) of this section.

(c) The owner or operator of the CCR unit must complete the demonstration required by paragraph (a) of this section by the date specified in either paragraph (c)(1) or (2) of this section.

(1) For an existing CCR surface impoundment, the owner or operator must complete the demonstration no later than October 17, 2018.

(2) For a new CCR landfill, new CCR surface impoundment, or any lateral expansion of a CCR unit, the owner or operator must complete the demonstration no later than the date of initial receipt of CCR in the CCR unit.

(3) The owner or operator has completed the demonstration required by paragraph (a) of this section when the demonstration is placed in the facility's operating record as required by § 257.105(e).

(4) An owner or operator of an existing CCR surface impoundment who fails to demonstrate compliance with the requirements of paragraph (a) of this section by the date specified in paragraph (c)(1) of this section is subject to the requirements of § 257.101(b)(1).

(5) An owner or operator of a new CCR landfill, new CCR surface impoundment, or any lateral expansion of a CCR unit who fails to make the demonstration showing compliance with the requirements of paragraph (a) of this section is prohibited from placing CCR in the CCR unit.

(d) The owner or operator of the CCR unit must comply with the recordkeeping requirements specified in § 257.105(e), the notification requirements specified in § 257.106(e), and the Internet requirements specified in § 257.107(e).

*[80 FR 21468, Apr. 17, 2015, as amended at 83 FR 36451, July 30, 2018]*

## § 257.63 Seismic impact zones.

(a) New CCR landfills, existing and new CCR surface impoundments, and all lateral expansions of CCR units must not be located in seismic impact zones unless the owner or operator demonstrates by the dates specified in paragraph (c) of this section that all structural components including liners, leachate collection and removal systems, and surface water control systems, are designed to resist the maximum horizontal acceleration in lithified earth material for the site.

(b) The owner or operator of the CCR unit must obtain a certification from a qualified professional engineer or approval from the Participating State Director or approval from EPA where EPA is the permitting authority stating that the demonstration meets the requirements of paragraph (a) of this section.

(c) The owner or operator of the CCR unit must complete the demonstration required by paragraph (a) of this section by the date specified in either paragraph (c)(1) or (2) of this section.

(1) For an existing CCR surface impoundment, the owner or operator must complete the demonstration no later than October 17, 2018.

(2) For a new CCR landfill, new CCR surface impoundment, or any lateral expansion of a CCR unit, the owner or operator must complete the demonstration no later than the date of initial receipt of CCR in the CCR unit.

(3) The owner or operator has completed the demonstration required by paragraph (a) of this section when the demonstration is placed in the facility's operating record as required by § 257.105(e).

(4) An owner or operator of an existing CCR surface impoundment who fails to demonstrate compliance with the requirements of paragraph (a) of this section by the date specified in paragraph (c)(1) of this section is subject to the requirements of § 257.101(b)(1).

(5) An owner or operator of a new CCR landfill, new CCR surface impoundment, or any lateral expansion of a CCR unit who fails to make the demonstration showing compliance with the requirements of paragraph (a) of this section is prohibited from placing CCR in the CCR unit.

(d) The owner or operator of the CCR unit must comply with the recordkeeping requirements specified in § 257.105(e), the notification requirements specified in § 257.106(e), and the Internet requirements specified in § 257.107(e).

*[80 FR 21468, Apr. 17, 2015, as amended at 83 FR 36451, July 30, 2018]*

## § 257.64 Unstable areas.

(a) An existing or new CCR landfill, existing or new CCR surface impoundment, or any lateral expansion of a CCR unit must not be located in an unstable area unless the owner or operator demonstrates by the dates specified in paragraph (d) of this section that recognized and generally accepted good engineering practices have been incorporated into the design of the CCR unit to ensure that the integrity of the structural components of the CCR unit will not be disrupted.

(b) The owner or operator must consider all of the following factors, at a minimum, when determining whether an area is unstable:

(1) On-site or local soil conditions that may result in significant differential settling;

(2) On-site or local geologic or geomorphologic features; and

(3) On-site or local human-made features or events (both surface and subsurface).

(c) The owner or operator of the CCR unit must obtain a certification from a qualified professional engineer or approval from the Participating State Director or approval from EPA where EPA is the permitting authority stating that the demonstration meets the requirements of paragraph (a) of this section.

(d) The owner or operator of the CCR unit must complete the demonstration required by paragraph (a) of this section by the date specified in either paragraph (d)(1) or (2) of this section.

(1) For an existing CCR landfill or existing CCR surface impoundment, the owner or operator must complete the demonstration no later than October 17, 2018.

(2) For a new CCR landfill, new CCR surface impoundment, or any lateral expansion of a CCR unit, the owner or operator must complete the demonstration no later than the date of initial receipt of CCR in the CCR unit.

(3) The owner or operator has completed the demonstration required by paragraph (a) of this section when the demonstration is placed in the facility's operating record as required by § 257.105(e).

(4) An owner or operator of an existing CCR surface impoundment or existing CCR landfill who fails to demonstrate compliance with the requirements of paragraph (a) of this section by the date specified in paragraph (d)(1) of this section is subject to the requirements of § 257.101(b)(1) or (d)(1), respectively.

(5) An owner or operator of a new CCR landfill, new CCR surface impoundment, or any lateral expansion of a CCR unit who fails to make the demonstration showing compliance with the requirements of paragraph (a) of this section is prohibited from placing CCR in the CCR unit.

(e) The owner or operator of the CCR unit must comply with the recordkeeping requirements specified in § 257.105(e), the notification requirements specified in § 257.106(e), and the Internet requirements specified in § 257.107(e).

*[80 FR 21468, Apr. 17, 2015, as amended at 83 FR 36451, July 30, 2018]*

## Design Criteria

## § 257.70 Design criteria for new CCR landfills and any lateral expansion of a CCR landfill.

(a)

(1) New CCR landfills and any lateral expansion of a CCR landfill must be designed, constructed, operated, and maintained with either a composite liner that meets the requirements of paragraph (b) of this section or an alternative composite liner that meets the requirements in paragraph (c) of this section, and a leachate collection and removal system that meets the requirements of paragraph (d) of this section.

(2) Prior to construction of an overfill the underlying surface impoundment must meet the requirements of § 257.102(d).

(b) A *composite liner* must consist of two components; the upper component consisting of, at a minimum, a 30-mil geomembrane liner (GM), and the lower component consisting of at least a two-foot layer of compacted soil with a hydraulic conductivity of no more than $1 \times 10^{-7}$ centimeters per second (cm/sec). GM components consisting of high density polyethylene (HDPE) must be at least 60-mil thick. The GM or upper liner component must be installed in direct and uniform contact with the compacted soil or lower liner component. The composite liner must be:

(1) Constructed of materials that have appropriate chemical properties and sufficient strength and thickness to prevent failure due to pressure gradients (including static head and external hydrogeologic forces), physical contact with the CCR or leachate to which they are exposed, climatic conditions, the stress of installation, and the stress of daily operation;

(2) Constructed of materials that provide appropriate shear resistance of the upper and lower component interface to prevent sliding of the upper component including on slopes;

(3) Placed upon a foundation or base capable of providing support to the liner and resistance to pressure gradients above and below the liner to prevent failure of the liner due to settlement, compression, or uplift; and

(4) Installed to cover all surrounding earth likely to be in contact with the CCR or leachate.

(c) If the owner or operator elects to install an alternative composite liner, all of the following requirements must be met:

(1) An *alternative composite liner* must consist of two components; the upper component consisting of, at a minimum, a 30-mil GM, and a lower component, that is not a geomembrane, with a liquid flow rate no greater than the liquid flow rate of two feet of compacted soil with a hydraulic conductivity of no more than $1 \times 10^{-7}$ cm/sec. GM components consisting of high density polyethylene (HDPE) must be at least 60-mil thick. If the lower component of the alternative liner is compacted soil, the GM must be installed in direct and uniform contact with the compacted soil.

(2) The owner or operator must obtain certification from a qualified professional engineer or approval from the Participating State Director or approval from EPA where EPA is the permitting authority that the liquid flow rate through the lower component of the alternative composite liner is no greater than the liquid flow rate through two feet of compacted soil with a hydraulic conductivity of $1x10^{-7}$ cm/sec. The hydraulic conductivity for the two feet of compacted soil used in the comparison shall be no greater than $1x10^{-7}$ cm/sec. The hydraulic conductivity of any alternative to the two feet of compacted soil must be determined using recognized and generally accepted methods. The liquid flow rate comparison must be made using Equation 1 of this section, which is derived from Darcy's Law for gravity flow through porous media.

(Eq. 1):

$$\frac{Q}{A} = q = k\left(\frac{h}{t} + 1\right)$$

Where:

Q = flow rate (cubic centimeters/second);

A = surface area of the liner (squared centimeters);

q = flow rate per unit area (cubic centimeters/second/squared centimeter);

k = hydraulic conductivity of the liner (centimeters/second);

h = hydraulic head above the liner (centimeters); and

t = thickness of the liner (centimeters).

(3) The alternative composite liner must meet the requirements specified in paragraphs (b)(1) through (4) of this section.

(d) The *leachate collection and removal system* must be designed, constructed, operated, and maintained to collect and remove leachate from the landfill during the active life and post-closure care period. The leachate collection and removal system must be:

(1) Designed and operated to maintain less than a 30-centimeter depth of leachate over the composite liner or alternative composite liner;

(2) Constructed of materials that are chemically resistant to the CCR and any non-CCR waste managed in the CCR unit and the leachate expected to be generated, and of sufficient strength and thickness to prevent collapse under the pressures exerted by overlying waste, waste cover materials, and equipment used at the CCR unit; and

(3) Designed and operated to minimize clogging during the active life and post-closure care period.

(e) Prior to construction of the CCR landfill or any lateral expansion of a CCR landfill, the owner or operator must obtain a certification from a qualified professional engineer or approval from the Participating State Director or approval from EPA where EPA is the permitting authority that the design of the composite liner (or, if applicable, alternative composite liner) and the leachate collection and removal system meets the requirements of this section.

(f) Upon completion of construction of the CCR landfill or any lateral expansion of a CCR landfill, the owner or operator must obtain a certification from a qualified professional engineer or approval from the Participating State Director or approval from EPA where EPA is the permitting authority that the design of the composite liner (or, if applicable, alternative composite liner) and the leachate collection and removal system have been constructed in accordance with the requirements of this section.

(g) The owner or operator of the CCR unit must comply with the recordkeeping requirements specified in § 257.105(f), the notification requirements specified in § 257.106(f), and the Internet requirements specified in § 257.107(f).

*[80 FR 21468, Apr. 17, 2015, as amended at 83 FR 36451, July 30, 2018]*

## § 257.71 Liner design criteria for existing CCR surface impoundments.

(a)

(1) No later than October 17, 2016, the owner or operator of an existing CCR surface impoundment must document whether or not such unit was constructed with any one of the following:

(i) [Reserved]

(ii) A composite liner that meets the requirements of § 257.70(b); or

(iii) An alternative composite liner that meets the requirements of § 257.70(c).

(2) The hydraulic conductivity of the compacted soil must be determined using recognized and generally accepted methods.

(3) An existing CCR surface impoundment is considered to be an existing unlined CCR surface impoundment if either:

(i) The owner or operator of the CCR unit determines that the CCR unit is not constructed with a liner that meets the requirements of paragraph (a)(1)(ii) or (iii) of this section; or

(ii) The owner or operator of the CCR unit fails to document whether the CCR unit was constructed with a liner that meets the requirements of paragraph (a)(1)(ii) or (iii) of this section.

(4) All existing unlined CCR surface impoundments are subject to the requirements of § 257.101(a).

(b) The owner or operator of the CCR unit must obtain a certification from a qualified professional engineer or approval from the Participating State Director or approval from EPA where EPA is the permitting authority attesting that the documentation as to whether a CCR unit meets the requirements of paragraph (a) of this section is accurate.

(c) The owner or operator of the CCR unit must comply with the recordkeeping requirements specified in § 257.105(f), the notification requirements specified in § 257.106(f), and the Internet requirements specified in § 257.107(f).

(d) ***Alternate Liner Demonstration.*** An owner or operator of a CCR surface impoundment constructed without a composite liner or alternate composite liner, as defined in § 257.70(b) or (c), may submit an Alternate Liner Demonstration to the Administrator or the Participating State Director to demonstrate that based on the construction of the unit and surrounding site conditions, that there is no reasonable probability that continued operation of the surface impoundment will result in adverse effects to human health or the environment. The application and demonstration must be submitted to the Administrator or the Participating State Director no later than the relevant deadline in paragraph (d)(2) of this section. The Administrator or the Participating State Director will act on the submissions in accordance with the procedures in paragraph (d)(2) of this section.

(1) ***Application and alternative liner demonstration submission requirements.*** To obtain approval under this paragraph (d), the owner or operator of the CCR surface impoundment must submit all of the following:

(i) ***Application.*** The owner or operator of the CCR surface impoundment must submit a letter to the Administrator or the Participating State Director, announcing their intention to submit a demonstration under paragraph (d)(1)(ii) of this section. The application must include the location of the facility and identify the specific CCR surface impoundment for which the demonstration will be made. The letter must include all of the following:

(A) A certification signed by the owner or operator that the CCR unit is in full compliance with this subpart except for § 257.71(a)(1);

(B) Documentation supporting the certification required under paragraph (d)(1)(i)(A) of this section that includes all the following:

(*1*) Documentation that the groundwater monitoring network meets all the requirements of § 257.91. This must include documentation that the existing network of groundwater monitoring wells is sufficient to ensure detection of any groundwater contamination resulting from the impoundment, based on direction of flow, well location, screening depth and other relevant factors. At a minimum, the documentation must include all of the following:

(*i*) Map(s) of groundwater monitoring well locations in relation to the CCR unit(s) that depict the elevation of the potentiometric surface and the direction(s) of groundwater flow across the site;

(*ii*) Well construction diagrams and drilling logs for all groundwater monitoring wells;

(*iii*) Maps that characterize the direction of groundwater flow accounting for temporal variations; and

(*iv*) Any other data and analyses the owner or operator of the CCR surface impoundment relied upon when determining the design and location of the groundwater monitoring network.

(*2*) Documentation that the CCR surface impoundment remains in detection monitoring pursuant to § 257.94 as a precondition for submitting an application. This includes documentation that the groundwater monitoring program meets the requirements of §§ 257.93 and 257.94. Such documentation includes data of constituent concentrations, summarized in table format, at each groundwater monitoring well monitored during each sampling event, and documentation of the most recent statistical tests conducted, analyses of the tests, and the rationale for the methods used in these comparisons. As part of this rationale, the owner or operator of the CCR surface impoundment must provide all data and analyses relied upon to comply with each of the requirements of this part;

(*3*) Documentation that the unit meets all the location restrictions under §§ 257.60 through 257.64;

(*4*) The most recent structural stability assessment required at § 257.73(d); and

(*5*) The most recent safety factor assessment required at § 257.73(e).

(C) Documentation of the design specifications for any engineered liner components, as well as all data and analyses the owner or operator of the CCR surface impoundment relied on when determining that the materials are suitable for use and that the construction of the liner is of good quality and in-line with proven and accepted engineering practices.

(D) Facilities with CCR surface impoundments located on properties adjacent to a water body must demonstrate that there is no reasonable probability that a complete and direct transport pathway (*i.e.,* not mediated by groundwater) can exist between the impoundment and any nearby water body. If the potential for such a pathway is identified, then the unit would not be eligible to submit a demonstration. If ongoing releases are identified, the owner or operator of the CCR unit must address these releases in accordance with § 257.96(a); and

(E) Upon submission of the application and any supplemental materials submitted in support of the application to the Administrator or the Participating State Director, the owner or operator must place the complete application in the facility's operating record as required by § 257.105(f)(14).

(ii) ***Alternate Liner Demonstration Package.*** The completed alternate liner demonstration package must be certified by a qualified professional engineer. The package must present evidence to demonstrate that, based on the construction of the unit and surrounding site conditions, there is no reasonable probability that operation of the surface impoundment will result in concentrations of constituents listed in appendix IV to this part in the uppermost aquifer at levels above a groundwater protection standard. For each line of evidence, as well as any other data and assumptions incorporated into the demonstration, the owner or operator of the CCR surface impoundment must include documentation on how the data were collected and why these data and assumptions adequately reflect potential contaminant transport from that specific impoundment. The alternate liner demonstration at a minimum must contain all of the following lines of evidence:

(A) ***Characterization of site hydrogeology.*** A characterization of the variability of site-specific soil and hydrogeology surrounding the surface impoundment that will control the rate and direction of contaminant transport from the impoundment. The owner or operator must provide all of the following as part of this line of evidence:

(*1*) Measurements of the hydraulic conductivity in the uppermost aquifer from all monitoring wells associated with the impoundment(s) and discussion of the methods used to obtain these measurements;

(*2*) Measurements of the variability in subsurface soil characteristics collected from around the perimeter of the CCR surface impoundment to identify regions of substantially higher conductivity;

(*3*) Documentation that all sampling methods used are in line with recognized and generally accepted practices that can provide data at a spatial resolution necessary to adequately characterize the variability of subsurface conditions that will control contaminant transport;

(*4*) Explanation of how the specific number and location of samples collected are sufficient to capture subsurface variability if:

(*i*) Samples are advanced to a depth less than the top of the groundwater table or 20 feet beneath the bottom of the nearest water body, whichever is greater, and/or

(*ii*) Samples are spaced further apart than 200 feet around the impoundment perimeter;

(*5*) A narrative description of site geological history; and

(*6*) Conceptual site models with cross-sectional depictions of the site environmental sequence stratigraphy that include, at a minimum:

(*i*) The relative location of the impoundment with depth of ponded water noted;

(*ii*) Monitoring wells with screening depth noted;

(*iii*) Depiction of the location of other samples used in the development of the model;

(*iv*) The upper and lower limits of the uppermost aquifer across the site;

(*v*) The upper and lower limits of the depth to groundwater measured from monitoring wells if the uppermost aquifer is confined; and

(*vi*) Both the location and geometry of any nearby points of groundwater discharge or recharge (*e.g.,* surface water bodies) with potential to influence groundwater depth and flow measured around the unit.

(B) ***Potential for infiltration.*** A characterization of the potential for infiltration through any soil-based liner components and/or naturally occurring soil that control release and transport of leachate. All samples collected in the field for measurement of saturated hydraulic conductivity must be sent to a certified laboratory for analysis under controlled conditions

and analyzed using recognized and generally accepted methodology. Facilities must document how the selected method is designed to simulate on-site conditions. The owner or operator must also provide documentation of the following as part of this line of evidence:

(*1*) The location, number, depth, and spacing of samples relied upon is supported by the data collected in paragraph (d)(1)(ii)(A) of this section and is sufficient to capture the variability of saturated hydraulic conductivity for the soil-based liner components and/or naturally occurring soil;

(*2*) The liquid used to pre-hydrate the samples and measure long-term hydraulic conductivity reflects the pH and major ion composition of the CCR surface impoundment porewater;

(*3*) That samples intended to represent the hydraulic conductivity of naturally occurring soils (*i.e.,* not mechanically compacted) are handled in a manner that will ensure the macrostructure of the soil is not disturbed during collection, transport, or analysis; and

(*4*) Any test for hydraulic conductivity relied upon includes, in addition to other relevant termination criteria specified by the method, criteria that equilibrium has been achieved between the inflow and outflow, within acceptable tolerance limits, for both electrical conductivity and pH.

(C) ***Mathematical model to estimate the potential for releases.*** Owners or operators must incorporate the data collected for paragraphs (d)(1)(ii)(A) and (d)(1)(ii)(B) of this section into a mathematical model to calculate the potential groundwater concentrations that may result in downgradient wells as a result of the impoundment. Facilities must also, where available, incorporate the national-scale data on constituent concentrations and behavior provided by the existing risk record. Application of the model must account for the full range of site current and potential future conditions at and around the site to ensure that high-end groundwater concentrations have been effectively characterized. All of the data and assumptions incorporated into the model must be documented and justified.

(*1*) The models relied upon in this paragraph (d)(1)(ii)(C) must be well-established and validated, with documentation that can be made available for public review.

(*2*) The owner or operator must use the models to demonstrate that, for each constituent in appendix IV of this part, there is no reasonable probability that the peak groundwater concentration that may result from releases to groundwater from the CCR surface impoundment throughout its active life will exceed the groundwater protection standard at the waste boundary.

(*3*) The demonstration must include the peak groundwater concentrations modeled for all constituents in appendix IV of this part attributed both to the impoundment in isolation and in addition to background.

(D) Upon submission of the alternative liner demonstration to the Administrator or the Participating State Director, the owner or operator must place the complete demonstration in the facility's operating record as required by § 257.105(f)(15).

(2) ***Procedures for adjudicating requests*** —

(i) ***Deadline for application submission.*** The owner or operator must submit the application under paragraph (d)(1)(i) of this section to EPA or the Participating State Director for approval no later than November 30, 2020.

(ii) ***Deadline for demonstration submission.*** If the application is approved the owner or operator must submit the demonstration required under paragraph (d)(1)(ii) of this section to EPA or the Participating State Director for approval no later than November 30, 2021.

(A) ***Extension due to analytical limitations.*** If the owner or operator cannot meet the demonstration deadline due to analytical limitations related to the measurement of hydraulic conductivity, the owner or operator must submit a request for an extension no later than September 1, 2021 that includes a summary of the data that have been analyzed to date for the samples responsible for the delay and an alternate timeline for completion that has been certified by the laboratory. The extension request must include all of the following:

(*1*) A timeline of fieldwork to confirm that samples were collected expeditiously;

(*2*) A chain of custody documenting when samples were sent to the laboratory;

(*3*) Written certification from the lab identifying how long it is projected for the tests to reach the relevant termination criteria related to solution chemistry, and

(*4*) Documentation of the progression towards all test termination metrics to date.

(B) ***Length of extension.*** If the extension is granted, the owner or operator will have 45 days beyond the timeframe certified by the laboratory to submit the completed demonstration.

(C) ***Extension due to analytical limitations for chemical equilibrium.*** If the measured hydraulic conductivity has not stabilized to within acceptable tolerance limits by the time the termination criteria for solution chemistry are met, the owner or operator must submit a preliminary demonstration no later than September 1, 2021 (with or without the one-time extension for analytical limitations).

(*1*) In this preliminary demonstration, the owner or operator must submit a justification of how the bounds of uncertainty applied to the available measurements of hydraulic conductivity ensure that the final value is not underestimated.

(*2*) EPA will review the preliminary demonstration to determine if it is complete and, if so, will propose to deny or to tentatively approve the demonstration. The proposed determination will be posted in the docket on *www.regulations.gov* and will be available for public comment for 30 days. After consideration of the comments, EPA will issue its decision on the application within four months of receiving a complete preliminary demonstration.

(*3*) Once the final laboratory results are available, the owner or operator must submit a final demonstration that updates only the finalized hydraulic conductivity data to confirm that the model results in the preliminary demonstration are accurate.

(*4*) Until the time that EPA approves this final demonstration, the surface impoundment must remain in detection monitoring or the demonstration will be denied.

(*5*) If EPA tentatively approved the preliminary demonstration, EPA will then take action on the newly submitted final demonstration using the procedures in paragraphs (d)(2)(iv) through (vi) of this section.

(*6*) The public will have 30 days to comment but may comment only on the new information presented in the complete final demonstration or in EPA's tentative decision on the newly submitted demonstration.

(D) Upon submission of a request for an extension to the deadline for the demonstration due to analytical limitations pursuant to paragraph (d)(2)(ii)(A) of this section, the owner or operator must place the alternative liner demonstration extension request in the facility's operating record as required by § 257.105(f)(16).

(E) Upon submission of a preliminary demonstration pursuant to paragraph (d)(2)(ii)(C) of this section, the owner or operator must place the preliminary demonstration in the facility's operating record as required by § 257.105(f)(17).

(iii) ***Application review*** —

(A) EPA will evaluate the application and may request additional information not required as part of the application as necessary to complete its review. Submission of a complete application will toll the facility's deadline to cease receipt of waste until issuance of a final decision under paragraph (d)(2)(iii)(C) of this section. Incomplete submissions will not toll the facility's deadline and will be rejected without further process.

(B) If the application is determined to be incomplete, EPA will notify the facility. The owner or operator must place the notification of an incomplete application in the facility's operating record as required by § 257.105(f)(18).

(C) EPA will publish a proposed decision on complete applications in a docket on *www.regulations.gov* for a 20-day comment period. After consideration of the comments, EPA will issue its decision on the application within sixty days of receiving a complete application.

(D) If the application is approved, the deadline to cease receipt of waste will be tolled until an alternate liner demonstration is determined to be incomplete or a final decision under paragraph (d)(2)(vi) of this section is issued.

(E) If the surface impoundment is determined by EPA to be ineligible to apply for an alternate liner demonstration, and the facility lacks alternative capacity to manage its CCR and/or non-CCR wastestreams, the owner or operator may apply for an alternative closure deadline in accordance with the procedures in § 257.103(f). The owner or operator will be given four months from the date of the ineligibility determination to apply for the alternative closure provisions in either § 257.103(f)(1) or (f)(2), during which time the facility's deadline to cease receipt of waste will be tolled.

(F) Upon receipt of a decision on the application pursuant to paragraph (d)(2)(iii)(C) of this section, the owner or operator must place the decision on the application in the facility's operating record as required by § 257.105(f)(19).

(iv) ***Demonstration review.*** EPA will evaluate the demonstration package and may request additional information not required as part of the demonstration as necessary to complete its review. Submission of a complete demonstration package will continue to toll the facility's deadline to

cease receipt of waste into that CCR surface impoundment until issuance of a final decision under paragraph (d)(2)(vi) of this section. Upon a determination that a demonstration is incomplete the tolling of the facility's deadline will cease and the submission will be rejected without further process.

(v) ***Proposed decision on demonstration.*** EPA will publish a proposed decision on a complete demonstration package in a docket on *www.regulations.gov* for a 30-day comment period.

(vi) ***Final decision on demonstration.*** After consideration of the comments, EPA will issue its decision on the alternate liner demonstration package within four months of receiving a complete demonstration package. Upon approval the facility may continue to operate the impoundment as long as the impoundment remains in detection monitoring. Upon detection of a statistically significant increase over background of a constituent listed on appendix III to this part, the facility must proceed in accordance with the requirements of paragraph (ix) of this section.

(vii) ***Facility operating record requirements.*** Upon receipt of the final decision on the alternate liner demonstration pursuant to paragraph (vi) of this section, the owner or operator must place the final decision in the facility's operating record as required by § 257.105(f)(20).

(viii) ***Effect of Demonstration Denial.*** If EPA determines that the CCR surface impoundment's alternate liner does not meet the standard for approval in this paragraph (d), the owner or operator must cease receipt of waste and initiate closure as determined in EPA's decision. If the owner or operator needs to obtain alternate capacity, they may do so in accordance with the procedures in § 257.103. The owner or operator will have four months from the date of EPA's decision to apply for an alternative closure deadline under either § 257.103(f)(1) or (f)(2), during which time the facility's deadline to cease receipt of waste will be tolled.

(ix) ***Loss of authorization*** -(A) The owner or operator of the CCR unit must comply with all of the following upon determining that there is a statistically significant increase over background levels for one or more constituents listed in appendix III to this part pursuant to § 257.94(e):

(*1*) In addition to the requirements specified in this paragraph (d), comply with the groundwater monitoring and corrective action procedures specified in §§ 257.90 through 257.98;

(*2*) Submit the notification required by § 257.94(e)(3) to EPA within 14 days of placing the notification in the facility's operating record as required by § 257.105(h)(5);

(*3*) Conduct intra-well analysis on each downgradient well to identify any trends of increasing concentrations as required by paragraph (d)(2)(ix)(B) of this section. The owner and operator must conduct the initial groundwater sampling and analysis for all constituents listed in appendix IV to this part according to the timeframes specified in § 257.95(b);

(*4*) The owner or operator may elect to pursue an alternative source demonstration pursuant to § 257.94(e)(2) that a source other than the CCR unit caused the contamination, or that the statistically significant increase resulted from error in sampling, analysis, statistical evaluation, or natural variation in groundwater quality, provided that such alternative source demonstration must be conducted simultaneously with the sampling and analysis required by paragraph (d)(2)(ix)(A)(*3*) of this section. If the owner or operator believes that a successful demonstration has been made, the demonstration must be submitted to EPA for review and

approval. The owner or operator must place the demonstration in the facility's operating record within the deadlines specified in § 257.94(e)(2) and submit the demonstration to EPA within 14 days of placing the demonstration in the facility's operating record.

(*5*) The alternative source demonstration must be posted to the facility's publicly accessible CCR internet site and submitted to EPA within 14 days of completion. EPA will publish a proposed decision on the alternative source determination on *www.regulations.gov* for a 20-day comment period. After consideration of the comments, EPA will issue its decision. If the alternative source demonstration is approved, the owner or operator may cease conducting the trend analysis and return to detection monitoring. If the alternative source demonstration is denied, the owner or operator must either complete the trend analysis or cease receipt of waste. Upon receipt of the final decision on the alternative source demonstration, the owner or operator must place the final decision in the facility's operating record as required by § 257.105(f)(22).

(B) ***Trend analysis.***

(*1*) Except as provided for in § 257.95(c), the owner or operator must collect a minimum of four independent samples from each well (background and downgradient) on a quarterly basis within the first year of triggering assessment monitoring and analyze each sample for all constituents listed in appendix IV to this part. Consistent with 257.95(b), the first samples must be collected within 90 days of triggering assessment monitoring. After the initial year of sampling, the owner or operator must then conduct sampling as prescribed in § 257.95(d)(1). After each sampling event, the owner or operator must update the trend analysis with the new sampling information.

(*2*) The owner or operator of the CCR surface impoundment must apply an appropriate statistical test to identify any trends of increasing concentrations within the monitoring data. For normally distributed datasets, linear regression will be used to identify trends and determine the associated magnitude. For non-normally distributed datasets, the Mann-Kendall test will be used to identify trends and the Theil-Sen trend line will be used to determine the associated magnitude. If a trend is identified, the owner or operator of the CCR surface impoundment will use the upper 95th percentile confidence limit on the trend line to estimate future concentrations. The owner or operator will project this trendline into the future for a duration set to the maximum number of years established in § 257.102 for closure of the surface impoundment.

(*3*) A report of the results of each sampling event, as well as the final trend analysis, must be posted to the facility's publicly accessible CCR internet site and submitted to EPA within 14 days of completion. The trend analysis submitted to EPA must include all data relied upon by the facility to support the analysis. EPA will publish a proposed decision on the trend analysis on *www.regulations.gov* for a 30-day comment period. After consideration of the comments, EPA will issue its decision. If the trend analysis shows the potential for a future exceedance of a groundwater protection standard, before the closure deadlines established in § 257.102, the CCR surface impoundment must cease receipt of waste by the date provided in the notice.

(C) If the trend analysis demonstrates the presence of a statistically significant trend of increasing concentration for one or more constituents listed in appendix IV of this part with potential to result in an exceedance of any groundwater protection standard before closure is complete, or if at any time one or more constituents listed in appendix IV of this part are detected at a statistically significant level above a groundwater protection standard, the authorization will be withdrawn. The provisions at § 257.96(g)(3) do not apply to CCR surface impoundments operating under an alternate liner demonstration. Upon receipt of a decision that the alternate liner demonstration has been withdrawn, the owner or operator must place the decision in the facility's operating record as required by § 257.105(f)(24).

(D) The onus remains on the owner or operator of the CCR surface impoundment at all times to demonstrate that the CCR surface impoundment meets the conditions for authorization under this section. If at any point, any condition for qualification under this section has not been met, EPA or the Participating State Director can without further notice or process deny or revoke the owner or operator's authorization under paragraph (d)(2)(ix) of this section.

*[80 FR 21468, Apr. 17, 2015, as amended at 83 FR 36452, July 30, 2018; 85 FR 53561, Aug. 28, 2020; 85 FR 72539, Nov. 12, 2020]*

## § 257.72 Liner design criteria for new CCR surface impoundments and any lateral expansion of a CCR surface impoundment.

(a) New CCR surface impoundments and lateral expansions of existing and new CCR surface impoundments must be designed, constructed, operated, and maintained with either a composite liner or an alternative composite liner that meets the requirements of § 257.70(b) or (c).

(b) Any liner specified in this section must be installed to cover all surrounding earth likely to be in contact with CCR. Dikes shall not be constructed on top of the composite liner.

(c) Prior to construction of the CCR surface impoundment or any lateral expansion of a CCR surface impoundment, the owner or operator must obtain certification from a qualified professional engineer or approval from the Participating State Director or approval from EPA where EPA is the permitting authority that the design of the composite liner or, if applicable, the design of an alternative composite liner complies with the requirements of this section.

(d) Upon completion, the owner or operator must obtain certification from a qualified professional engineer or approval from the Participating State Director or approval from EPA where EPA is the permitting authority that the composite liner or if applicable, the alternative composite liner has been constructed in accordance with the requirements of this section.

(e) The owner or operator of the CCR unit must comply with the recordkeeping requirements specified in § 257.105(f), the notification requirements specified in § 257.106(f), and the Internet requirements specified in § 257.107(f).

*[80 FR 21468, Apr. 17, 2015, as amended at 83 FR 36452, July 30, 2018]*

## § 257.73 Structural integrity criteria for existing CCR surface impoundments.

Link to an amendment published at 89 FR 88653, Nov. 8, 2024.

(a) The requirements of paragraphs (a)(1) through (4) of this section apply to all existing CCR surface impoundments and legacy CCR surface impoundments, except for those that are incised CCR surface impoundments.

(1) No later than, December 17, 2015, the owner or operator of the CCR unit must place on or immediately adjacent to the CCR unit a permanent identification marker, at least six feet high showing the identification number of the CCR unit, if one has been assigned by the state, the name associated with the CCR unit and the name of the owner or operator of the CCR unit.

(2) ***Periodic hazard potential classification assessments.***

(i) The owner or operator of the CCR unit must conduct initial and periodic hazard potential classification assessments of the CCR unit according to the timeframes specified in paragraph (f) of this section. The owner or operator must document the hazard potential classification of each CCR unit as either a high hazard potential CCR surface impoundment, a significant hazard potential CCR surface impoundment, or a low hazard potential CCR surface impoundment. The owner or operator must also document the basis for each hazard potential classification.

(ii) The owner or operator of the CCR unit must obtain a certification from a qualified professional engineer stating that the initial hazard potential classification and each subsequent periodic classification specified in paragraph (a)(2)(i) of this section was conducted in accordance with the requirements of this section.

(3) ***Emergency Action Plan (EAP)*** —

(i) ***Development of the plan.*** No later than April 17, 2017, the owner or operator of a CCR unit determined to be either a high hazard potential CCR surface impoundment or a significant hazard potential CCR surface impoundment under paragraph (a)(2) of this section must prepare and maintain a written EAP. At a minimum, the EAP must:

(A) Define the events or circumstances involving the CCR unit that represent a safety emergency, along with a description of the procedures that will be followed to detect a safety emergency in a timely manner;

(B) Define responsible persons, their respective responsibilities, and notification procedures in the event of a safety emergency involving the CCR unit;

(C) Provide contact information of emergency responders;

(D) Include a map which delineates the downstream area which would be affected in the event of a CCR unit failure and a physical description of the CCR unit; and

(E) Include provisions for an annual face-to-face meeting or exercise between representatives of the owner or operator of the CCR unit and the local emergency responders.

(ii) ***Amendment of the plan.***

(A) The owner or operator of a CCR unit subject to the requirements of paragraph (a)(3)(i) of this section may amend the written EAP at any time provided the revised plan is placed in the facility's operating record as required by § 257.105(f)(6). The owner or operator must amend the written EAP whenever there is a change in conditions that would substantially affect the EAP in effect.

(B) The written EAP must be evaluated, at a minimum, every five years to ensure the information required in paragraph (a)(3)(i) of this section is accurate. As necessary, the EAP must be updated and a revised EAP placed in the facility's operating record as required by § 257.105(f)(6).

(iii) ***Changes in hazard potential classification.***

(A) If the owner or operator of a CCR unit determines during a periodic hazard potential assessment that the CCR unit is no longer classified as either a high hazard potential CCR surface impoundment or a significant hazard potential CCR surface impoundment, then the owner or operator of the CCR unit is no longer subject to the requirement to prepare and maintain a written EAP beginning on the date the periodic hazard potential assessment documentation is placed in the facility's operating record as required by § 257.105(f)(5).

(B) If the owner or operator of a CCR unit classified as a low hazard potential CCR surface impoundment subsequently determines that the CCR unit is properly re-classified as either a high hazard potential CCR surface impoundment or a significant hazard potential CCR surface impoundment, then the owner or operator of the CCR unit must prepare a written EAP for the CCR unit as required by paragraph (a)(3)(i) of this section within six months of completing such periodic hazard potential assessment.

(iv) The owner or operator of the CCR unit must obtain a certification from a qualified professional engineer stating that the written EAP, and any subsequent amendment of the EAP, meets the requirements of paragraph (a)(3) of this section.

(v) ***Activation of the EAP.*** The EAP must be implemented once events or circumstances involving the CCR unit that represent a safety emergency are detected, including conditions identified during periodic structural stability assessments, annual inspections, and inspections by a qualified person.

(4) The CCR unit and surrounding areas must be designed, constructed, operated, and maintained with vegetated slopes of dikes not to exceed a height of 6 inches above the slope of the dike, except for slopes which are protected with an alternate form(s) of slope protection.

(b) The requirements of paragraphs (c) through (e) of this section apply to an owner or operator of an existing CCR surface impoundment that either:

(1) Has a height of five feet or more and a storage volume of 20 acre-feet or more; or

(2) Has a height of 20 feet or more.

(c)

(1) No later than October 17, 2016, the owner or operator of the CCR unit must compile a history of construction, which shall contain, to the extent feasible, the information specified in paragraphs (c)(1)(i) through (xi) of this section.

(i) The name and address of the person(s) owning or operating the CCR unit; the name associated with the CCR unit; and the identification number of the CCR unit if one has been assigned by the state.

(ii) The location of the CCR unit identified on the most recent U.S. Geological Survey (USGS) $7^{1}/_{2}$ minute or 15 minute topographic quadrangle map, or a topographic map of equivalent scale if a USGS map is not available.

(iii) A statement of the purpose for which the CCR unit is being used.

(iv) The name and size in acres of the watershed within which the CCR unit is located.

(v) A description of the physical and engineering properties of the foundation and abutment materials on which the CCR unit is constructed.

(vi) A statement of the type, size, range, and physical and engineering properties of the materials used in constructing each zone or stage of the CCR unit; the method of site preparation and construction of each zone of the CCR unit; and the approximate dates of construction of each successive stage of construction of the CCR unit.

(vii) At a scale that details engineering structures and appurtenances relevant to the design, construction, operation, and maintenance of the CCR unit, detailed dimensional drawings of the CCR unit, including a plan view and cross sections of the length and width of the CCR unit, showing all zones, foundation improvements, drainage provisions, spillways, diversion ditches, outlets, instrument locations, and slope protection, in addition to the normal operating pool surface elevation and the maximum pool surface elevation following peak discharge from the inflow design flood, the expected maximum depth of CCR within the CCR surface impoundment, and any identifiable natural or manmade features that could adversely affect operation of the CCR unit due to malfunction or mis-operation.

(viii) A description of the type, purpose, and location of existing instrumentation.

(ix) Area-capacity curves for the CCR unit.

(x) A description of each spillway and diversion design features and capacities and calculations used in their determination.

(xi) The construction specifications and provisions for surveillance, maintenance, and repair of the CCR unit.

(xii) Any record or knowledge of structural instability of the CCR unit.

(2) ***Changes to the history of construction.*** If there is a significant change to any information compiled under paragraph (c)(1) of this section, the owner or operator of the CCR unit must update the relevant information and place it in the facility's operating record as required by § 257.105(f)(9).

(d) ***Periodic structural stability assessments.***

(1) The owner or operator of the CCR unit must conduct initial and periodic structural stability assessments and document whether the design, construction, operation, and maintenance of the CCR unit is consistent with recognized and generally accepted good engineering practices for the maximum volume of CCR and CCR wastewater which can be impounded therein. The assessment must, at a minimum, document whether the CCR unit has been designed, constructed, operated, and maintained with:

(i) Stable foundations and abutments;

(ii) Adequate slope protection to protect against surface erosion, wave action, and adverse effects of sudden drawdown;

(iii) Dikes mechanically compacted to a density sufficient to withstand the range of loading conditions in the CCR unit;

(iv) Vegetated slopes of dikes and surrounding areas not to exceed a height of six inches above the slope of the dike, except for slopes which have an alternate form or forms of slope protection;

(v) A single spillway or a combination of spillways configured as specified in paragraph (d)(1)(v)(A) of this section. The combined capacity of all spillways must be designed, constructed, operated, and maintained to adequately manage flow during and following the peak discharge from the event specified in paragraph (d)(1)(v)(B) of this section.

(A) All spillways must be either:

(*1*) Of non-erodible construction and designed to carry sustained flows; or

(*2*) Earth- or grass-lined and designed to carry short-term, infrequent flows at non-erosive velocities where sustained flows are not expected.

(B) The combined capacity of all spillways must adequately manage flow during and following the peak discharge from a:

(*1*) Probable maximum flood (PMF) for a high hazard potential CCR surface impoundment; or

(*2*) 1000-year flood for a significant hazard potential CCR surface impoundment; or

(*3*) 100-year flood for a low hazard potential CCR surface impoundment.

(vi) Hydraulic structures underlying the base of the CCR unit or passing through the dike of the CCR unit that maintain structural integrity and are free of significant deterioration, deformation, distortion, bedding deficiencies, sedimentation, and debris which may negatively affect the operation of the hydraulic structure; and

(vii) For CCR units with downstream slopes which can be inundated by the pool of an adjacent water body, such as a river, stream or lake, downstream slopes that maintain structural stability during low pool of the adjacent water body or sudden drawdown of the adjacent water body.

(2) The periodic assessment described in paragraph (d)(1) of this section must identify any structural stability deficiencies associated with the CCR unit in addition to recommending corrective measures. If a deficiency or a release is identified during the periodic assessment, the owner or operator unit must remedy the deficiency or release as soon as feasible and prepare documentation detailing the corrective measures taken.

(3) The owner or operator of the CCR unit must obtain a certification from a qualified professional engineer stating that the initial assessment and each subsequent periodic assessment was conducted in accordance with the requirements of this section.

(e) ***Periodic safety factor assessments.***

(1) The owner or operator must conduct an initial and periodic safety factor assessments for each CCR unit and document whether the calculated factors of safety for each CCR unit achieve the minimum safety factors specified in paragraphs (e)(1)(i) through (iv) of this section for the critical cross section of the embankment. The critical cross section is the cross section anticipated to be the

most susceptible of all cross sections to structural failure based on appropriate engineering considerations, including loading conditions. The safety factor assessments must be supported by appropriate engineering calculations.

(i) The calculated static factor of safety under the long-term, maximum storage pool loading condition must equal or exceed 1.50.

(ii) The calculated static factor of safety under the maximum surcharge pool loading condition must equal or exceed 1.40.

(iii) The calculated seismic factor of safety must equal or exceed 1.00.

(iv) For dikes constructed of soils that have susceptibility to liquefaction, the calculated liquefaction factor of safety must equal or exceed 1.20.

(2) The owner or operator of the CCR unit must obtain a certification from a qualified professional engineer stating that the initial assessment and each subsequent periodic assessment specified in paragraph (e)(1) of this section meets the requirements of this section.

(f) ***Timeframes for periodic assessments*** —

(1) ***Initial assessments.*** Except as provided by paragraph (f)(2) of this section, the owner or operator of the CCR unit must complete the initial assessments required by paragraphs (a)(2), (d), and (e) of this section no later than October 17, 2016. The owner or operator has completed an initial assessment when the owner or operator has placed the assessment required by paragraphs (a)(2), (d), and (e) of this section in the facility's operating record as required by § 257.105(f)(5), (10), and (12).

(2) ***Use of a previously completed assessment(s) in lieu of the initial assessment(s).*** The owner or operator of the CCR unit may elect to use a previously completed assessment to serve as the initial assessment required by paragraphs (a)(2), (d), and (e) of this section provided that the previously completed assessment(s):

(i) Was completed no earlier than 42 months prior to October 17, 2016; and

(ii) Meets the applicable requirements of paragraphs (a)(2), (d), and (e) of this section.

(3) ***Frequency for conducting periodic assessments.*** The owner or operator of the CCR unit must conduct and complete the assessments required by paragraphs (a)(2), (d), and (e) of this section every five years. The date of completing the initial assessment is the basis for establishing the deadline to complete the first subsequent assessment. If the owner or operator elects to use a previously completed assessment(s) in lieu of the initial assessment as provided by paragraph (f)(2) of this section, the date of the report for the previously completed assessment is the basis for establishing the deadline to complete the first subsequent assessment. The owner or operator may complete any required assessment prior to the required deadline provided the owner or operator places the completed assessment(s) into the facility's operating record within a reasonable amount of time. In all cases, the deadline for completing subsequent assessments is based on the date of completing the previous assessment. For purposes of this paragraph (f)(3), the owner or operator has completed an assessment when the relevant assessment(s) required by paragraphs (a)(2), (d), and (e) of this section has been placed in the facility's operating record as required by § 257.105(f)(5), (10), and (12).

(4) ***Closure of the CCR unit.*** An owner or operator of a CCR unit who either fails to complete a timely safety factor assessment or fails to demonstrate minimum safety factors as required by paragraph (e) of this section is subject to the requirements of § 257.101(b)(2).

(g) The owner or operator of the CCR unit must comply with the recordkeeping requirements specified in § 257.105(f), the notification requirements specified in § 257.106(f), and the internet requirements specified in § 257.107(f).

*[80 FR 21468, Apr. 17, 2015, as amended at 89 FR 39101, May 8, 2024]*

## § 257.74 Structural integrity criteria for new CCR surface impoundments and any lateral expansion of a CCR surface impoundment.

(a) The requirements of paragraphs (a)(1) through (4) of this section apply to all new CCR surface impoundments and any lateral expansion of a CCR surface impoundment, except for those new CCR surface impoundments that are incised CCR units. If an incised CCR surface impoundment is subsequently modified (e.g., a dike is constructed) such that the CCR unit no longer meets the definition of an incised CCR unit, the CCR unit is subject to the requirements of paragraphs (a)(1) through (4) of this section.

(1) No later than the initial receipt of CCR, the owner or operator of the CCR unit must place on or immediately adjacent to the CCR unit a permanent identification marker, at least six feet high showing the identification number of the CCR unit, if one has been assigned by the state, the name associated with the CCR unit and the name of the owner or operator of the CCR unit.

(2) ***Periodic hazard potential classification assessments.***

(i) The owner or operator of the CCR unit must conduct initial and periodic hazard potential classification assessments of the CCR unit according to the timeframes specified in paragraph (f) of this section. The owner or operator must document the hazard potential classification of each CCR unit as either a high hazard potential CCR surface impoundment, a significant hazard potential CCR surface impoundment, or a low hazard potential CCR surface impoundment. The owner or operator must also document the basis for each hazard potential classification.

(ii) The owner or operator of the CCR unit must obtain a certification from a qualified professional engineer stating that the initial hazard potential classification and each subsequent periodic classification specified in paragraph (a)(2)(i) of this section was conducted in accordance with the requirements of this section.

(3) ***Emergency Action Plan (EAP)*** —

(i) ***Development of the plan.*** Prior to the initial receipt of CCR in the CCR unit, the owner or operator of a CCR unit determined to be either a high hazard potential CCR surface impoundment or a significant hazard potential CCR surface impoundment under paragraph (a)(2) of this section must prepare and maintain a written EAP. At a minimum, the EAP must:

(A) Define the events or circumstances involving the CCR unit that represent a safety emergency, along with a description of the procedures that will be followed to detect a safety emergency in a timely manner;

(B) Define responsible persons, their respective responsibilities, and notification procedures in the event of a safety emergency involving the CCR unit;

(C) Provide contact information of emergency responders;

(D) Include a map which delineates the downstream area which would be affected in the event of a CCR unit failure and a physical description of the CCR unit; and

(E) Include provisions for an annual face-to-face meeting or exercise between representatives of the owner or operator of the CCR unit and the local emergency responders.

(ii) ***Amendment of the plan.***

(A) The owner or operator of a CCR unit subject to the requirements of paragraph (a)(3)(i) of this section may amend the written EAP at any time provided the revised plan is placed in the facility's operating record as required by § 257.105(f)(6). The owner or operator must amend the written EAP whenever there is a change in conditions that would substantially affect the EAP in effect.

(B) The written EAP must be evaluated, at a minimum, every five years to ensure the information required in paragraph (a)(3)(i) of this section is accurate. As necessary, the EAP must be updated and a revised EAP placed in the facility's operating record as required by § 257.105(f)(6).

(iii) ***Changes in hazard potential classification.***

(A) If the owner or operator of a CCR unit determines during a periodic hazard potential assessment that the CCR unit is no longer classified as either a high hazard potential CCR surface impoundment or a significant hazard potential CCR surface impoundment, then the owner or operator of the CCR unit is no longer subject to the requirement to prepare and maintain a written EAP beginning on the date the periodic hazard potential assessment documentation is placed in the facility's operating record as required by § 257.105(f)(5).

(B) If the owner or operator of a CCR unit classified as a low hazard potential CCR surface impoundment subsequently determines that the CCR unit is properly re-classified as either a high hazard potential CCR surface impoundment or a significant hazard potential CCR surface impoundment, then the owner or operator of the CCR unit must prepare a written EAP for the CCR unit as required by paragraph (a)(3)(i) of this section within six months of completing such periodic hazard potential assessment.

(iv) The owner or operator of the CCR unit must obtain a certification from a qualified professional engineer stating that the written EAP, and any subsequent amendment of the EAP, meets the requirements of paragraph (a)(3) of this section.

(v) ***Activation of the EAP.*** The EAP must be implemented once events or circumstances involving the CCR unit that represent a safety emergency are detected, including conditions identified during periodic structural stability assessments, annual inspections, and inspections by a qualified person.

(4) The CCR unit and surrounding areas must be designed, constructed, operated, and maintained with vegetated slopes of dikes not to exceed a height of six inches above the slope of the dike, except for slopes which are protected with an alternate form(s) of slope protection.

(b) The requirements of paragraphs (c) through (e) of this section apply to an owner or operator of a new CCR surface impoundment and any lateral expansion of a CCR surface impoundment that either:

(1) Has a height of five feet or more and a storage volume of 20 acre-feet or more; or

(2) Has a height of 20 feet or more.

(c)

(1) No later than the initial receipt of CCR in the CCR unit, the owner or operator unit must compile the design and construction plans for the CCR unit, which must include, to the extent feasible, the information specified in paragraphs (c)(1)(i) through (xi) of this section.

(i) The name and address of the person(s) owning or operating the CCR unit; the name associated with the CCR unit; and the identification number of the CCR unit if one has been assigned by the state.

(ii) The location of the CCR unit identified on the most recent U.S. Geological Survey (USGS) $7^{1}/_{2}$ minute or 15 minute topographic quadrangle map, or a topographic map of equivalent scale if a USGS map is not available.

(iii) A statement of the purpose for which the CCR unit is being used.

(iv) The name and size in acres of the watershed within which the CCR unit is located.

(v) A description of the physical and engineering properties of the foundation and abutment materials on which the CCR unit is constructed.

(vi) A statement of the type, size, range, and physical and engineering properties of the materials used in constructing each zone or stage of the CCR unit; the method of site preparation and construction of each zone of the CCR unit; and the dates of construction of each successive stage of construction of the CCR unit.

(vii) At a scale that details engineering structures and appurtenances relevant to the design, construction, operation, and maintenance of the CCR unit, detailed dimensional drawings of the CCR unit, including a plan view and cross sections of the length and width of the CCR unit, showing all zones, foundation improvements, drainage provisions, spillways, diversion ditches, outlets, instrument locations, and slope protection, in addition to the normal operating pool surface elevation and the maximum pool surface elevation following peak discharge from the inflow design flood, the expected maximum depth of CCR within the CCR surface impoundment, and any identifiable natural or manmade features that could adversely affect operation of the CCR unit due to malfunction or mis-operation.

(viii) A description of the type, purpose, and location of existing instrumentation.

(ix) Area-capacity curves for the CCR unit.

(x) A description of each spillway and diversion design features and capacities and calculations used in their determination.

(xi) The construction specifications and provisions for surveillance, maintenance, and repair of the CCR unit.

(xii) Any record or knowledge of structural instability of the CCR unit.

(2) ***Changes in the design and construction.*** If there is a significant change to any information compiled under paragraph (c)(1) of this section, the owner or operator of the CCR unit must update the relevant information and place it in the facility's operating record as required by § 257.105(f)(13).

(d) *Periodic structural stability assessments.*

(1) The owner or operator of the CCR unit must conduct initial and periodic structural stability assessments and document whether the design, construction, operation, and maintenance of the CCR unit is consistent with recognized and generally accepted good engineering practices for the maximum volume of CCR and CCR wastewater which can be impounded therein. The assessment must, at a minimum, document whether the CCR unit has been designed, constructed, operated, and maintained with:

(i) Stable foundations and abutments;

(ii) Adequate slope protection to protect against surface erosion, wave action, and adverse effects of sudden drawdown;

(iii) Dikes mechanically compacted to a density sufficient to withstand the range of loading conditions in the CCR unit;

(iv) Vegetated slopes of dikes and surrounding areas not to exceed a height of six inches above the slope of the dike, except for slopes which have an alternate form or forms of slope protection;

(v) A single spillway or a combination of spillways configured as specified in paragraph (d)(1)(v)(A) of this section. The combined capacity of all spillways must be designed, constructed, operated, and maintained to adequately manage flow during and following the peak discharge from the event specified in paragraph (d)(1)(v)(B) of this section.

(A) All spillways must be either:

(*1*) Of non-erodible construction and designed to carry sustained flows; or

(*2*) Earth- or grass-lined and designed to carry short-term, infrequent flows at non-erosive velocities where sustained flows are not expected.

(B) The combined capacity of all spillways must adequately manage flow during and following the peak discharge from a:

(*1*) Probable maximum flood (PMF) for a high hazard potential CCR surface impoundment; or

(*2*) 1000-year flood for a significant hazard potential CCR surface impoundment; or

(*3*) 100-year flood for a low hazard potential CCR surface impoundment.

(vi) Hydraulic structures underlying the base of the CCR unit or passing through the dike of the CCR unit that maintain structural integrity and are free of significant deterioration, deformation, distortion, bedding deficiencies, sedimentation, and debris which may negatively affect the operation of the hydraulic structure; and

(vii) For CCR units with downstream slopes which can be inundated by the pool of an adjacent water body, such as a river, stream or lake, downstream slopes that maintain structural stability during low pool of the adjacent water body or sudden drawdown of the adjacent water body.

(2) The periodic assessment described in paragraph (d)(1) of this section must identify any structural stability deficiencies associated with the CCR unit in addition to recommending corrective measures. If a deficiency or a release is identified during the periodic assessment, the owner or operator unit must remedy the deficiency or release as soon as feasible and prepare documentation detailing the corrective measures taken.

(3) The owner or operator of the CCR unit must obtain a certification from a qualified professional engineer stating that the initial assessment and each subsequent periodic assessment was conducted in accordance with the requirements of this section.

(e) ***Periodic safety factor assessments.***

(1) The owner or operator must conduct an initial and periodic safety factor assessments for each CCR unit and document whether the calculated factors of safety for each CCR unit achieve the minimum safety factors specified in paragraphs (e)(1)(i) through (v) of this section for the critical cross section of the embankment. The critical cross section is the cross section anticipated to be the most susceptible of all cross sections to structural failure based on appropriate engineering considerations, including loading conditions. The safety factor assessments must be supported by appropriate engineering calculations.

(i) The calculated static factor of safety under the end-of-construction loading condition must equal or exceed 1.30. The assessment of this loading condition is only required for the initial safety factor assessment and is not required for subsequent assessments.

(ii) The calculated static factor of safety under the long-term, maximum storage pool loading condition must equal or exceed 1.50.

(iii) The calculated static factor of safety under the maximum surcharge pool loading condition must equal or exceed 1.40.

(iv) The calculated seismic factor of safety must equal or exceed 1.00.

(v) For dikes constructed of soils that have susceptibility to liquefaction, the calculated liquefaction factor of safety must equal or exceed 1.20.

(2) The owner or operator of the CCR unit must obtain a certification from a qualified professional engineer stating that the initial assessment and each subsequent periodic assessment specified in paragraph (e)(1) of this section meets the requirements of this section.

(f) ***Timeframes for periodic assessments*** —

(1) ***Initial assessments.*** Except as provided by paragraph (f)(2) of this section, the owner or operator of the CCR unit must complete the initial assessments required by paragraphs (a)(2), (d), and (e) of this section prior to the initial receipt of CCR in the unit. The owner or operator has completed an initial assessment when the owner or operator has placed the assessment required by paragraphs (a)(2), (d), and (e) of this section in the facility's operating record as required by § 257.105(f)(5), (10), and (12).

(2) ***Frequency for conducting periodic assessments.*** The owner or operator of the CCR unit must conduct and complete the assessments required by paragraphs (a)(2), (d), and (e) of this section every five years. The date of completing the initial assessment is the basis for establishing the deadline to complete the first subsequent assessment. The owner or operator may complete any required assessment prior to the required deadline provided the owner or operator places the completed

assessment(s) into the facility's operating record within a reasonable amount of time. In all cases, the deadline for completing subsequent assessments is based on the date of completing the previous assessment. For purposes of this paragraph (f)(2), the owner or operator has completed an assessment when the relevant assessment(s) required by paragraphs (a)(2), (d), and (e) of this section has been placed in the facility's operating record as required by § 257.105(f)(5), (10), and (12).

(3) ***Failure to document minimum safety factors during the initial assessment.*** Until the date an owner or operator of a CCR unit documents that the calculated factors of safety achieve the minimum safety factors specified in paragraphs (e)(1)(i) through (v) of this section, the owner or operator is prohibited from placing CCR in such unit.

(4) ***Closure of the CCR unit.*** An owner or operator of a CCR unit who either fails to complete a timely periodic safety factor assessment or fails to demonstrate minimum safety factors as required by paragraph (e) of this section is subject to the requirements of § 257.101(c).

(g) The owner or operator of the CCR unit must comply with the recordkeeping requirements specified in § 257.105(f), the notification requirements specified in § 257.106(f), and the internet requirements specified in § 257.107(f).

## § 257.75 Requirements for identifying CCR management units.

Link to an amendment published at 90 FR 4643, Jan. 16, 2025.

(a) ***Applicability.*** The requirements of this section apply to owners and operators of active facilities or facilities with a legacy CCR surface impoundment.

(b) ***Facility evaluation.*** The owner or operator of an active facility or a facility with a legacy CCR surface impoundment must conduct a facility evaluation to identify all CCR management units at the facility in accordance with paragraphs (c) through (e) of this section. At a minimum, the presence or absence of CCR management units at the facility must be confirmed and documented through a thorough evaluation of reasonably and readily available records that contain the information needed to prepare the Facility Evaluation Reports Part 1 and Part 2 required by paragraphs (c) and (d) of this section. The facility evaluation must also include a physical inspection of the facility. Where necessary, the physical inspection must include field investigation activities to fill data gaps, such as conducting exploratory soil borings, geophysical assessments, or any other similar physical investigation activities to establish the location and boundaries of potential or likely CCR management units, and to affirmatively rule out other areas of potential CCR placement at the facility that were identified during the information review or physical inspection. The facility evaluation must identify all CCR management units at the facility regardless of when the CCR management unit came into existence.

(c) ***Facility Evaluation Report Part 1.***

(1) No later than Monday, February 9, 2026, the owner or operator of an active facility or a facility with a legacy CCR surface impoundment must prepare a Facility Evaluation Report Part 1, which shall contain, to the extent reasonably and readily available, the information specified in paragraphs (c)(1)(i) through (xiv) of this section. The owner or operator has prepared the Facility Evaluation Report Part 1 when the report has been placed in the facility's operating record as required by § 257.105(f)(25).

(i) The name and address of the person(s) owning and operating the facility; the unit name associated with each regulated CCR unit and CCR management unit at the facility; and the identification number of each regulated CCR unit and CCR management unit if any have been assigned by the state or by the owner.

(ii) The location of any CCR management unit identified on the most recent U.S. Geological Survey (USGS) $7^{1}/_{2}$ minute or 15-minute topographic quadrangle map, or a topographic map of equivalent scale if a USGS map is not available. The location of each regulated CCR unit at the facility must also be identified in the same manner.

(iii) A statement of the purpose(s) for which each CCR management unit at the facility is or was used.

(iv) A description of the physical and engineering properties of the foundation and abutment materials on which each CCR management unit is constructed.

(v) A discussion of any known spills or releases of CCR, including any associated remediation activities, from each CCR management unit and whether the spills or releases were reported to state or federal agencies.

(vi) Any record or knowledge of structural instability of each CCR management unit.

(vii) Any record or knowledge of groundwater contamination associated or potentially associated with each CCR management unit.

(viii) The size of each CCR management unit, including the general lateral and vertical dimensions and an estimate of the volume of waste contained within the unit.

(ix) Dates when each CCR management unit first received CCR and when each CCR management unit ceased receiving CCR.

(x) Identification of all types of CCR in each CCR management unit at the facility.

(xi) A narrative description of any closure activities that have occurred, including any applicable engineering drawings or reports.

(xii) A narrative that documents the data reviewed as part of the facility evaluation process, and that lists all data and information indicating the presence or absence of CCR management units at the facility.

(xiii) Any supporting information used to identify and evaluate CCR management units at the facility, including but not limited to any construction diagrams, engineering drawings, permit documents, wastestream flow diagrams, aerial photographs, satellite images, historical facility maps, any field or analytical data, groundwater monitoring data or reports, inspection reports, documentation of interviews with current or former facility workers, and other documents used to identify and evaluate CCR management units at the facility.

(xiv) A narrative description of any data gaps for information in paragraphs (c)(i) through (xiii) of this section, not available in existing information collection records and a plan for remedying identified data gaps through a physical examination of the facility, including any field or laboratory work needed to remedy data gaps in the Facility Evaluation Report Part 1 record. The plan must include the major milestones needed to fill the identified data gaps (*e.g.,* a physical examination of the facility, sampling of media, measurements of CCR concentrations in and

around the unit or physical presence, delineation of CCR management unit(s)) and dates to complete such needed tasks. Also, as necessary and timely, any updates to data gap remedy plans must be added to the public record during the Facility Evaluation Report Part 1.

(2) The owner or operator of any facility regulated under this subpart must obtain a certification from a qualified professional engineer stating that the Facility Evaluation Report Part 1 meets the requirements of paragraph (c)(1) of this section.

(3) The owner or operator of any facility regulated under this subpart must certify the Facility Evaluation Report Part 1 required by paragraph (c)(1) of this section with the following statement signed by the owner or operator or an authorized representative:

> I certify under penalty of law that I have personally examined and am familiar with the information submitted in this demonstration and all attached documents, and that, based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the submitted information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment.

(4) No later than Monday, February 9, 2026, the owner or operator must notify the Agency of the establishment of a CCR website using the procedures in § 257.107(a) via the “contact us” form on EPA's CCR website.

(5) The owner or operator of any facility regulated under this subpart that does not contain any CCR management unit must submit Facility Evaluation Report Part 1 documenting the steps taken during the facility evaluation to determine the absence of any CCR management unit. The Facility Evaluation Report Part 1 must include the certifications required under paragraph (c)(3) of this section.

(d) ***Facility evaluation report part 2.***

(1) No later than Monday, February 8, 2027, the owner or operator of an active facility or a facility with a legacy CCR surface impoundment must prepare a facility evaluation report part 2, which shall contain, to the extent not provided in the Facility Evaluation Report Part 1 under paragraph (c) of this section, the information specified in paragraphs (d)(1)(i) through (xiii) of this section obtained from a physical evaluation of the facility, including where necessary field sampling. The owner or operator has prepared the facility evaluation report part 2 when the report has been placed in the facility's operating record as required by § 257.105(f)(26).

(i) The name and address of the person(s) owning and operating the facility; the unit name associated with each regulated CCR unit and CCR management unit at the facility; and the identification number of each regulated CCR unit and CCR management unit if any have been assigned by the state or by the owner.

(ii) The location of any CCR management unit identified on the most recent U.S. Geological Survey (USGS) $7^{1}/_{2}$ minute or 15-minute topographic quadrangle map, or a topographic map of equivalent scale if a USGS map is not available. The location of each regulated CCR unit at the facility must also be identified in the same manner.

(iii) A statement of the purpose(s) for which each CCR management unit at the facility is or was used.

(iv) A description of the physical and engineering properties of the foundation and abutment materials on which each CCR management unit was constructed.

(v) Any further evidence of known spills or releases, including any associated remediation activities, of CCR from each CCR management unit and whether the spills or releases were reported to state or federal agencies.

(vi) Any further evidence of structural instability of each CCR management unit.

(vii) Any further evidence of groundwater contamination associated or potentially associated with each CCR management unit.

(viii) The size of each CCR management unit, including the general lateral and vertical dimensions and an estimate of the volume of CCR contained within the unit.

(ix) Identification of the types of CCR in each CCR management unit.

(x) A narrative description of any closure activities that have occurred, including any applicable engineering drawings or reports.

(xi) A narrative that documents the nature and extent of field oversight activities and data reviewed as part of the facility evaluation process, and that lists all data and information that was reviewed indicating the presence or absence of CCR management units at the facility.

(xii) Any additional supporting information used to identify and evaluate CCR management units at the facility, including but not limited to any construction diagrams, engineering drawings, permit documents, wastestream flow diagrams, aerial photographs, satellite images, historical facility maps, any field or analytical data, groundwater monitoring data or reports, inspection reports, and other documents used to identify and assess CCR management units at the facility. Additionally, as necessary and timely, any updates to the part 1 data gap remedy plan must be added to the record during the facility evaluation report part 2 timeframe.

(xiii) The Facility Evaluation Report Part 2 must explain how each data gap identified in Facility Evaluation Report Part 1 was addressed.

(xiv) A description of each CCR management unit for which regulation under this subpart is deferred for allowable reasons as specified in § 257.101(g) or (h). The owner or operator must provide documentation in the Facility Evaluation Report Part 2 to substantiate that the requirements § 257.101(g) or (h) have been met.

(2) The owner or operator of any facility regulated under this subpart must obtain a certification from a qualified professional engineer stating that the Facility Evaluation Report Part 2 meets the requirements of paragraph (d)(1) of this section.

(3) The owner or operator of any facility regulated under this subpart must certify the Facility Evaluation Report Part 2 required by paragraph (d)(1) of this section with the following statement signed by the owner or operator or an authorized representative:

> I certify under penalty of law that I have personally examined and am familiar with the information submitted in this demonstration and all attached documents, and that, based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the submitted information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment.

(4) The owner or operator of any facility regulated under this subpart that does not contain any CCR management unit must submit Facility Evaluation Report Part 2 documenting the steps taken during the facility evaluation to determine the absence of any CCR management unit. The Facility Evaluation Report Part 2 must include the certifications required under paragraph (d)(3) of this section.

(e) The owner or operator of the facility must comply with the recordkeeping requirements specified in § 257.105(f), the notification requirements specified in § 257.106(f), and the internet requirements specified in § 257.107(f).

*[89 FR 39101, May 8, 2024]*

OPERATING CRITERIA

## § 257.80 Air criteria.

Link to an amendment published at 90 FR 4645, Jan. 16, 2025.

(a) The owner or operator of a CCR unit must adopt measures that will effectively minimize CCR from becoming airborne at the facility, including CCR fugitive dust originating from CCR units, roads, and other CCR management and material handling activities.

(b) ***CCR fugitive dust control plan.*** The owner or operator of the CCR unit must prepare and operate in accordance with a CCR fugitive dust control plan as specified in paragraphs (b)(1) through (7) of this section. This requirement applies in addition to, not in place of, any applicable standards under the Occupational Safety and Health Act.

(1) The CCR fugitive dust control plan must identify and describe the CCR fugitive dust control measures the owner or operator will use to minimize CCR from becoming airborne at the facility. The owner or operator must select, and include in the CCR fugitive dust control plan, the CCR fugitive dust control measures that are most appropriate for site conditions, along with an explanation of how the measures selected are applicable and appropriate for site conditions. Examples of control measures that may be appropriate include: Locating CCR inside an enclosure or partial enclosure; operating a water spray or fogging system; reducing fall distances at material drop points; using wind barriers, compaction, or vegetative covers; establishing and enforcing reduced vehicle speed limits; paving and sweeping roads; covering trucks transporting CCR; reducing or halting operations during high wind events; or applying a daily cover.

(2) If the owner or operator operates a CCR landfill or any lateral expansion of a CCR landfill, the CCR fugitive dust control plan must include procedures to emplace CCR as conditioned CCR. Conditioned CCR means wetting CCR with water to a moisture content that will prevent wind dispersal, but will not result in free liquids. In lieu of water, CCR conditioning may be accomplished with an appropriate chemical dust suppression agent.

(3) The CCR fugitive dust control plan must include procedures to log citizen complaints received by the owner or operator involving CCR fugitive dust events at the facility.

(4) The CCR fugitive dust control plan must include a description of the procedures the owner or operator will follow to periodically assess the effectiveness of the control plan.

(5) The owner or operator of a CCR unit must prepare an initial CCR fugitive dust control plan for the facility no later than October 19, 2015, or by initial receipt of CCR in any CCR unit at the facility if the owner or operator becomes subject to this subpart after October 19, 2015. The owner or operator has completed the initial CCR fugitive dust control plan when the plan has been placed in the facility's operating record as required by § 257.105(g)(1).

(6) ***Amendment of the plan.*** The owner or operator subject to the requirements of this section may amend the written CCR fugitive dust control plan at any time provided the revised plan is placed in the facility's operating record as required by § 257.105(g)(1). The owner or operator must amend the written plan no later than 30 days whenever there is a change in conditions that would substantially affect the written plan in effect, such as the construction and operation of a new CCR unit.

(7) The owner or operator must obtain a certification from a qualified professional engineer or approval from the Participating State Director or approval from EPA where EPA is the permitting authority that the initial CCR fugitive dust control plan, or any subsequent amendment of it, meets the requirements of this section.

(c) ***Annual CCR fugitive dust control report.*** The owner or operator of a CCR unit must prepare an annual CCR fugitive dust control report that includes a description of the actions taken by the owner or operator to control CCR fugitive dust, a record of all citizen complaints, and a summary of any corrective measures taken. The initial annual report must be completed no later than 14 months after placing the initial CCR fugitive dust control plan in the facility's operating record. The deadline for completing a subsequent report is one year after the date of completing the previous report. For purposes of this paragraph (c), the owner or operator has completed the annual CCR fugitive dust control report when the plan has been placed in the facility's operating record as required by § 257.105(g)(2).

(d) The owner or operator of the CCR unit must comply with the recordkeeping requirements specified in § 257.105(g), the notification requirements specified in § 257.106(g), and the internet requirements specified in § 257.107(g).

*[80 FR 21468, Apr. 17, 2015, as amended at 83 FR 36452, July 30, 2018; 89 FR 39103, May 8, 2024]*

## § 257.81 Run-on and run-off controls for CCR landfills.

(a) The owner or operator of an existing or new CCR landfill or any lateral expansion of a CCR landfill must design, construct, operate, and maintain:

(1) A run-on control system to prevent flow onto the active portion of the CCR unit during the peak discharge from a 24-hour, 25-year storm; and

(2) A run-off control system from the active portion of the CCR unit to collect and control at least the water volume resulting from a 24-hour, 25-year storm.

(b) Run-off from the active portion of the CCR unit must be handled in accordance with the surface water requirements under § 257.3-3.

(c) ***Run-on and run-off control system plan*** —

(1) ***Content of the plan.*** The owner or operator must prepare initial and periodic run-on and run-off control system plans for the CCR unit according to the timeframes specified in paragraphs (c)(3) and (4) of this section. These plans must document how the run-on and run-off control systems have been designed and constructed to meet the applicable requirements of this section. Each plan must

be supported by appropriate engineering calculations. The owner or operator has completed the initial run-on and run-off control system plan when the plan has been placed in the facility's operating record as required by § 257.105(g)(3).

(2) ***Amendment of the plan.*** The owner or operator may amend the written run-on and run-off control system plan at any time provided the revised plan is placed in the facility's operating record as required by § 257.105(g)(3). The owner or operator must amend the written run-on and run-off control system plan whenever there is a change in conditions that would substantially affect the written plan in effect.

(3) ***Timeframes for preparing the initial plan*** —

(i) ***Existing CCR landfills.*** The owner or operator of the CCR unit must prepare the initial run-on and run-off control system plan no later than October 17, 2016.

(ii) ***New CCR landfills and any lateral expansion of a CCR landfill.*** The owner or operator must prepare the initial run-on and run-off control system plan no later than the date of initial receipt of CCR in the CCR unit.

(4) ***Frequency for revising the plan.*** The owner or operator of the CCR unit must prepare periodic run-on and run-off control system plans required by paragraph (c)(1) of this section every five years. The date of completing the initial plan is the basis for establishing the deadline to complete the first subsequent plan. The owner or operator may complete any required plan prior to the required deadline provided the owner or operator places the completed plan into the facility's operating record within a reasonable amount of time. In all cases, the deadline for completing a subsequent plan is based on the date of completing the previous plan. For purposes of this paragraph (c)(4), the owner or operator has completed a periodic run-on and run-off control system plan when the plan has been placed in the facility's operating record as required by § 257.105(g)(3).

(5) The owner or operator must obtain a certification from a qualified professional engineer or approval from the Participating State Director or approval from EPA where EPA is the permitting authority stating that the initial and periodic run-on and run-off control system plans meet the requirements of this section.

(d) The owner or operator of the CCR unit must comply with the recordkeeping requirements specified in § 257.105(g), the notification requirements specified in § 257.106(g), and the internet requirements specified in § 257.107(g).

*[80 FR 21468, Apr. 17, 2015, as amended at 83 FR 36452, July 30, 2018]*

## § 257.82 Hydrologic and hydraulic capacity requirements for CCR surface impoundments.

(a) The owner or operator of an existing or new CCR surface impoundment, legacy CCR surface impoundment, or any lateral expansion of a CCR surface impoundment must design, construct, operate, and maintain an inflow design flood control system as specified in paragraphs (a)(1) and (2) of this section.

(1) The inflow design flood control system must adequately manage flow into the CCR unit during and following the peak discharge of the inflow design flood specified in paragraph (a)(3) of this section.

(2) The inflow design flood control system must adequately manage flow from the CCR unit to collect and control the peak discharge resulting from the inflow design flood specified in paragraph (a)(3) of this section.

(3) The inflow design flood is:

(i) For a high hazard potential CCR surface impoundment, as determined under § 257.73(a)(2) or § 257.74(a)(2), the probable maximum flood;

(ii) For a significant hazard potential CCR surface impoundment, as determined under § 257.73(a)(2) or § 257.74(a)(2), the 1,000-year flood;

(iii) For a low hazard potential CCR surface impoundment, as determined under § 257.73(a)(2) or § 257.74(a)(2), the 100-year flood; or

(iv) For an incised CCR surface impoundment, the 25-year flood.

(b) Discharge from the CCR unit must be handled in accordance with the surface water requirements under § 257.3-3.

(c) ***Inflow design flood control system plan*** —

(1) ***Content of the plan.*** The owner or operator must prepare initial and periodic inflow design flood control system plans for the CCR unit according to the timeframes specified in paragraphs (c)(3) and (4) of this section. These plans must document how the inflow design flood control system has been designed and constructed to meet the requirements of this section. Each plan must be supported by appropriate engineering calculations. The owner or operator of the CCR unit has completed the inflow design flood control system plan when the plan has been placed in the facility's operating record as required by § 257.105(g)(4).

(2) ***Amendment of the plan.*** The owner or operator of the CCR unit may amend the written inflow design flood control system plan at any time provided the revised plan is placed in the facility's operating record as required by § 257.105(g)(4). The owner or operator must amend the written inflow design flood control system plan whenever there is a change in conditions that would substantially affect the written plan in effect.

(3) ***Timeframes for preparing the initial plan*** —

(i) ***Existing CCR surface impoundments.*** The owner or operator of the CCR unit must prepare the initial inflow design flood control system plan no later than October 17, 2016.

(ii) ***New CCR surface impoundments and any lateral expansion of a CCR surface impoundment.*** The owner or operator must prepare the initial inflow design flood control system plan no later than the date of initial receipt of CCR in the CCR unit.

(4) ***Frequency for revising the plan.*** The owner or operator must prepare periodic inflow design flood control system plans required by paragraph (c)(1) of this section every five years. The date of completing the initial plan is the basis for establishing the deadline to complete the first periodic plan. The owner or operator may complete any required plan prior to the required deadline provided the owner or operator places the completed plan into the facility's operating record within a reasonable amount of time. In all cases, the deadline for completing a subsequent plan is based on the date of completing the previous plan. For purposes of this paragraph (c)(4), the owner or operator has completed an inflow design flood control system plan when the plan has been placed in the facility's operating record as required by § 257.105(g)(4).

(5) The owner or operator must obtain a certification from a qualified professional engineer or approval from the Participating State Director or approval from EPA where EPA is the permitting authority stating that the initial and periodic inflow design flood control system plans meet the requirements of this section.

(d) The owner or operator of the CCR unit must comply with the recordkeeping requirements specified in § 257.105(g), the notification requirements specified in § 257.106(g), and the internet requirements specified in § 257.107(g).

*[80 FR 21468, Apr. 17, 2015, as amended at 83 FR 36451, July 30, 2018; 89 FR 39103, May 8, 2024]*

## § 257.83 Inspection requirements for CCR surface impoundments.

(a) ***Inspections by a qualified person.***

(1) All CCR surface impoundments, including legacy CCR surface impoundments, and any lateral expansion of a CCR surface impoundment must be examined by a qualified person as follows:

(i) At intervals not exceeding seven days, inspect for any appearances of actual or potential structural weakness and other conditions which are disrupting or have the potential to disrupt the operation or safety of the CCR unit;

(ii) At intervals not exceeding seven days, inspect the discharge of all outlets of hydraulic structures which pass underneath the base of the surface impoundment or through the dike of the CCR unit for abnormal discoloration, flow or discharge of debris or sediment; and

(iii) At intervals not exceeding 30 days, monitor all CCR unit instrumentation.

(iv) The results of the inspection by a qualified person must be recorded in the facility's operating record as required by § 257.105(g)(5).

(2) ***Timeframes for inspections by a qualified person*** —

(i) ***Existing CCR surface impoundments.*** The owner or operator of the CCR unit must initiate the inspections required under paragraph (a) of this section no later than October 19, 2015.

(ii) ***New CCR surface impoundments and any lateral expansion of a CCR surface impoundment.*** The owner or operator of the CCR unit must initiate the inspections required under paragraph (a) of this section upon initial receipt of CCR by the CCR unit.

(b) Annual i*nspections by a qualified professional engineer.*

(1) If the existing or new CCR surface impoundment or any lateral expansion of the CCR surface impoundment or legacy CCR surface impoundments is subject to the periodic structural stability assessment requirements under § 257.73(d) or § 257.74(d), the CCR unit must additionally be inspected on a periodic basis by a qualified professional engineer to ensure that the design, construction, operation, and maintenance of the CCR unit is consistent with recognized and generally accepted good engineering standards. The inspection must, at a minimum, include:

(i) A review of available information regarding the status and condition of the CCR unit, including, but not limited to, files available in the operating record (e.g., CCR unit design and construction information required by §§ 257.73(c)(1) and 257.74(c)(1), previous periodic structural stability assessments required under §§ 257.73(d) and 257.74(d), the results of inspections by a qualified person, and results of previous annual inspections);

(ii) A visual inspection of the CCR unit to identify signs of distress or malfunction of the CCR unit and appurtenant structures; and

(iii) A visual inspection of any hydraulic structures underlying the base of the CCR unit or passing through the dike of the CCR unit for structural integrity and continued safe and reliable operation.

(2) ***Inspection report.*** The qualified professional engineer must prepare a report following each inspection that addresses the following:

(i) Any changes in geometry of the impounding structure since the previous annual inspection;

(ii) The location and type of existing instrumentation and the maximum recorded readings of each instrument since the previous annual inspection;

(iii) The approximate minimum, maximum, and present depth and elevation of the impounded water and CCR since the previous annual inspection;

(iv) The storage capacity of the impounding structure at the time of the inspection;

(v) The approximate volume of the impounded water and CCR at the time of the inspection;

(vi) Any appearances of an actual or potential structural weakness of the CCR unit, in addition to any existing conditions that are disrupting or have the potential to disrupt the operation and safety of the CCR unit and appurtenant structures; and

(vii) Any other change(s) which may have affected the stability or operation of the impounding structure since the previous annual inspection.

(3) ***Timeframes for conducting the initial inspection*** —

(i) ***Existing CCR surface impoundments.*** The owner or operator of the CCR unit must complete the initial inspection required by paragraphs (b)(1) and (2) of this section no later than January 19, 2016.

(ii) ***New CCR surface impoundments and any lateral expansion of a CCR surface impoundment.*** The owner or operator of the CCR unit must complete the initial annual inspection required by paragraphs (b)(1) and (2) of this section is completed no later than 14 months following the date of initial receipt of CCR in the CCR unit.

(4) ***Frequency of inspections.***

(i) Except as provided for in paragraph (b)(4)(ii) of this section, the owner or operator of the CCR unit must conduct the inspection required by paragraphs (b)(1) and (2) of this section on an annual basis. The date of completing the initial inspection report is the basis for establishing the deadline to complete the first subsequent inspection. Any required inspection may be conducted prior to the required deadline provided the owner or operator places the completed inspection report into the facility's operating record within a reasonable amount of time. In all cases, the deadline for completing subsequent inspection reports is based on the date of completing the previous inspection report. For purposes of this section, the owner or operator has completed an inspection when the inspection report has been placed in the facility's operating record as required by § 257.105(g)(6).

(ii) In any calendar year in which both the periodic inspection by a qualified professional engineer and the quinquennial (occurring every five years) structural stability assessment by a qualified professional engineer required by §§ 257.73(d) and 257.74(d) are required to be completed, the annual inspection is not required, provided the structural stability assessment is completed during the calendar year. If the annual inspection is not conducted in a year as provided by this paragraph (b)(4)(ii), the deadline for completing the next annual inspection is one year from the date of completing the quinquennial structural stability assessment.

(5) If a deficiency or release is identified during an inspection, the owner or operator must remedy the deficiency or release as soon as feasible and prepare documentation detailing the corrective measures taken.

(c) The owner or operator of the CCR unit must comply with the recordkeeping requirements specified in § 257.105(g), the notification requirements specified in § 257.106(g), and the internet requirements specified in § 257.107(g).

*[80 FR 21468, Apr. 17, 2015, as amended at 80 FR 37992, July 2, 2015; 89 FR 39103, May 8, 2024]*

## § 257.84 Inspection requirements for CCR landfills.

(a) ***Inspections by a qualified person.***

(1) All CCR landfills and any lateral expansion of a CCR landfill must be examined by a qualified person as follows:

(i) At intervals not exceeding seven days, inspect for any appearances of actual or potential structural weakness and other conditions which are disrupting or have the potential to disrupt the operation or safety of the CCR unit; and

(ii) The results of the inspection by a qualified person must be recorded in the facility's operating record as required by § 257.105(g)(8).

(2) ***Timeframes for inspections by a qualified person*** —

(i) ***Existing CCR landfills.*** The owner or operator of the CCR unit must initiate the inspections required under paragraph (a) of this section no later than October 19, 2015.

(ii) ***New CCR landfills and any lateral expansion of a CCR landfill.*** The owner or operator of the CCR unit must initiate the inspections required under paragraph (a) of this section upon initial receipt of CCR by the CCR unit.

(b) ***Annual inspections by a qualified professional engineer.***

(1) Existing and new CCR landfills and any lateral expansion of a CCR landfill must be inspected on a periodic basis by a qualified professional engineer to ensure that the design, construction, operation, and maintenance of the CCR unit is consistent with recognized and generally accepted good engineering standards. The inspection must, at a minimum, include:

(i) A review of available information regarding the status and condition of the CCR unit, including, but not limited to, files available in the operating record (e.g., the results of inspections by a qualified person, and results of previous annual inspections); and

(ii) A visual inspection of the CCR unit to identify signs of distress or malfunction of the CCR unit.

(2) ***Inspection report.*** The qualified professional engineer must prepare a report following each inspection that addresses the following:

(i) Any changes in geometry of the structure since the previous annual inspection;

(ii) The approximate volume of CCR contained in the unit at the time of the inspection;

(iii) Any appearances of an actual or potential structural weakness of the CCR unit, in addition to any existing conditions that are disrupting or have the potential to disrupt the operation and safety of the CCR unit; and

(iv) Any other change(s) which may have affected the stability or operation of the CCR unit since the previous annual inspection.

(3) ***Timeframes for conducting the initial inspection*** —

(i) ***Existing CCR landfills.*** The owner or operator of the CCR unit must complete the initial inspection required by paragraphs (b)(1) and (2) of this section no later than January 19, 2016.

(ii) ***New CCR landfills and any lateral expansion of a CCR landfill.*** The owner or operator of the CCR unit must complete the initial annual inspection required by paragraphs (b)(1) and (2) of this section no later than 14 months following the date of initial receipt of CCR in the CCR unit.

(4) ***Frequency of inspections.*** The owner or operator of the CCR unit must conduct the inspection required by paragraphs (b)(1) and (2) of this section on an annual basis. The date of completing the initial inspection report is the basis for establishing the deadline to complete the first subsequent inspection. Any required inspection may be conducted prior to the required deadline provided the owner or operator places the completed inspection report into the facility's operating record within a reasonable amount of time. In all cases, the deadline for completing subsequent inspection reports is based on the date of completing the previous inspection report. For purposes of this section, the owner or operator has completed an inspection when the inspection report has been placed in the facility's operating record as required by § 257.105(g)(9).

(5) If a deficiency or release is identified during an inspection, the owner or operator must remedy the deficiency or release as soon as feasible and prepare documentation detailing the corrective measures taken.

(c) The owner or operator of the CCR unit must comply with the recordkeeping requirements specified in § 257.105(g), the notification requirements specified in § 257.106(g), and the internet requirements specified in § 257.107(g).

*[80 FR 21468, Apr. 17, 2015, as amended at 80 FR 37992, July 2, 2015]*

GROUNDWATER MONITORING AND CORRECTIVE ACTION

## § 257.90 Applicability.

Link to an amendment published at 90 FR 4645, Jan. 16, 2025.

(a) ***Applicability.*** All CCR units are subject to the groundwater monitoring and corrective action requirements under §§ 257.90 through 257.98, except as provided in paragraph (g) of this section.

(b) *Initial timeframes* —

(1) ***Existing CCR landfills and existing CCR surface impoundments.*** No later than October 17, 2017, the owner or operator of the CCR unit must be in compliance with the following groundwater monitoring requirements:

(i) Install the groundwater monitoring system as required by § 257.91;

(ii) Develop the groundwater sampling and analysis program to include selection of the statistical procedures to be used for evaluating groundwater monitoring data as required by § 257.93;

(iii) Initiate the detection monitoring program to include obtaining a minimum of eight independent samples for each background and downgradient well as required by § 257.94(b); and

(iv) Begin evaluating the groundwater monitoring data for statistically significant increases over background levels for the constituents listed in appendix III of this part as required by § 257.94.

(2) ***New CCR landfills, new CCR surface impoundments, and all lateral expansions of CCR units.*** Prior to initial receipt of CCR by the CCR unit, the owner or operator must be in compliance with the groundwater monitoring requirements specified in paragraph (b)(1)(i) and (ii) of this section. In addition, the owner or operator of the CCR unit must initiate the detection monitoring program to include obtaining a minimum of eight independent samples for each background well as required by § 257.94(b).

(3) ***CCR management units.*** No later than Monday, May 8, 2028, the owner or operator of the CCR management unit must be in compliance with the following groundwater monitoring requirements:

(i) Install the groundwater monitoring system as required by § 257.91.

(ii) Develop the groundwater sampling and analysis program to include selection of the statistical procedures to be used for evaluating groundwater monitoring data as required by § 257.93.

(iii) Initiate the detection monitoring program to include obtaining a minimum of eight independent samples for each background and downgradient well, as required by § 257.94(b).

(iv) Begin evaluating the groundwater monitoring data for statistically significant increases over background levels for the constituents listed in appendix III of this part, as required by § 257.94.

(v) Begin evaluating the groundwater monitoring data for statistically significant levels over groundwater protection standards for the constituents listed in appendix IV of this part as required by § 257.95.

(c) ***Requirement to conduct groundwater monitoring and corrective action.*** Once a groundwater monitoring system and groundwater monitoring program has been established at the CCR unit as required by this subpart, the owner or operator must conduct groundwater monitoring and, if necessary, corrective action throughout the active life and post-closure care period of the CCR unit.

(d) ***Responding to a release from a CCR unit.*** In the event of a release from a CCR unit, the owner or operator must immediately take all necessary measures to control the source(s) of releases so as to reduce or eliminate, to the maximum extent feasible, further releases of contaminants into the environment. The owner or operator of the CCR unit must comply with all applicable requirements in §§ 257.96, 257.97, and 257.98.

(e) ***Annual groundwater monitoring and corrective action report.*** For existing CCR landfills and existing CCR surface impoundments, no later than January 31, 2018, and annually thereafter, the owner or operator must prepare an annual groundwater monitoring and corrective action report. For new CCR landfills, new CCR surface impoundments, and all lateral expansions of CCR units, the owner or operator must prepare the initial annual groundwater monitoring and corrective action report no later than January 31 of the year following the calendar year a groundwater monitoring system has been established for such CCR unit as required by this subpart, and annually thereafter. For CCR management units, the owner or operator must prepare the initial annual groundwater monitoring and corrective action report no later than January 31, 2029, and annually thereafter. For the preceding calendar year, the annual report must document the status of the groundwater monitoring and corrective action program for the CCR unit, summarize key actions completed, describe any problems encountered, discuss actions to resolve the problems, and project key activities for the upcoming year. For purposes of this section, the owner or operator has prepared the annual report when the report is placed in the facility's operating record as required by § 257.105(h)(1). At a minimum, the annual groundwater monitoring and corrective action report must contain the following information, to the extent available:

(1) A map, aerial image, or diagram showing the CCR unit and all background (or upgradient) and downgradient monitoring wells, to include the well identification numbers, that are part of the groundwater monitoring program for the CCR unit;

(2) Identification of any monitoring wells that were installed or decommissioned during the preceding year, along with a narrative description of why those actions were taken;

(3) In addition to all the monitoring data obtained under §§ 257.90 through 257.98, a summary including the number of groundwater samples that were collected for analysis for each background and downgradient well, the dates the samples were collected, and whether the sample was required by the detection monitoring or assessment monitoring programs;

(4) A narrative discussion of any transition between monitoring programs (*e.g.,* the date and circumstances for transitioning from detection monitoring to assessment monitoring in addition to identifying the constituent(s) detected at a statistically significant increase over background levels); and

(5) Other information required to be included in the annual report as specified in §§ 257.90 through 257.98.

(6) A section at the beginning of the annual report that provides an overview of the current status of groundwater monitoring and corrective action programs for the CCR unit. At a minimum, the summary must specify all of the following:

(i) At the start of the current annual reporting period, whether the CCR unit was operating under the detection monitoring program in § 257.94 or the assessment monitoring program in § 257.95;

(ii) At the end of the current annual reporting period, whether the CCR unit was operating under the detection monitoring program in § 257.94 or the assessment monitoring program in § 257.95;

(iii) If it was determined that there was a statistically significant increase over background for one or more constituents listed in appendix III to this part pursuant to § 257.94(e):

(A) Identify those constituents listed in appendix III to this part and the names of the monitoring wells associated with such an increase; and

(B) Provide the date when the assessment monitoring program was initiated for the CCR unit.

(iv) If it was determined that there was a statistically significant level above the groundwater protection standard for one or more constituents listed in appendix IV to this part pursuant to § 257.95(g) include all of the following:

(A) Identify those constituents listed in appendix IV to this part and the names of the monitoring wells associated with such an increase;

(B) Provide the date when the assessment of corrective measures was initiated for the CCR unit;

(C) Provide the date when the public meeting was held for the assessment of corrective measures for the CCR unit; and

(D) Provide the date when the assessment of corrective measures was completed for the CCR unit.

(v) Whether a remedy was selected pursuant to § 257.97 during the current annual reporting period, and if so, the date of remedy selection; and

(vi) Whether remedial activities were initiated or are ongoing pursuant to § 257.98 during the current annual reporting period.

(f) ***Recordkeeping, notification, and internet requirements.*** The owner or operator of the CCR unit must comply with the recordkeeping requirements specified in § 257.105(h), the notification requirements specified in § 257.106(h), and the internet requirements specified in § 257.107(h).

(g) ***Suspension of groundwater monitoring requirements.***

(1) The Participating State Director or EPA where EPA is the permitting authority may suspend the groundwater monitoring requirements under §§ 257.90 through 257.95 for a CCR unit for a period of up to ten years, if the owner or operator provides written documentation that, based on the characteristics of the site in which the CCR unit is located, there is no potential for migration of any of the constituents listed in appendices III and IV to this part from that CCR unit to the uppermost aquifer during the active life of the CCR unit and the post-closure care period. This demonstration must be certified by a qualified professional engineer and approved by the Participating State Director or EPA where EPA is the permitting authority, and must be based upon:

(i) Site-specific field collected measurements, sampling, and analysis of physical, chemical, and biological processes affecting contaminant fate and transport, including at a minimum, the information necessary to evaluate or interpret the effects of the following properties or processes on contaminant fate and transport:

(A) Aquifer Characteristics, including hydraulic conductivity, hydraulic gradient, effective porosity, aquifer thickness, degree of saturation, stratigraphy, degree of fracturing and secondary porosity of soils and bedrock, aquifer heterogeneity, groundwater discharge, and groundwater recharge areas;

(B) Waste Characteristics, including quantity, type, and origin;

(C) Climatic Conditions, including annual precipitation, leachate generation estimates, and effects on leachate quality;

(D) Leachate Characteristics, including leachate composition, solubility, density, the presence of immiscible constituents, Eh, and pH; and

(E) Engineered Controls, including liners, cover systems, and aquifer controls (*e.g.,* lowering the water table). These must be evaluated under design and failure conditions to estimate their long-term residual performance.

(ii) Contaminant fate and transport predictions that maximize contaminant migration and consider impacts on human health and the environment.

(2) The owner or operator of the CCR unit may renew this suspension for additional ten year periods by submitting written documentation that the site characteristics continue to ensure there will be no potential for migration of any of the constituents listed in Appendices III and IV of this part. The documentation must include, at a minimum, the information specified in paragraphs (g)(1)(i) and (ii) of this section and a certification by a qualified professional engineer and approved by the State Director or EPA where EPA is the permitting authority. The owner or operator must submit the documentation supporting their renewal request for the state's or EPA's review and approval of their extension one year before the groundwater monitoring suspension is due to expire. If the existing groundwater monitoring extension expires or is not approved, the owner or operator must begin groundwater monitoring according to paragraph (a) of this section within 90 days. The owner or operator may continue to renew the suspension for ten-year periods, provided the owner or operator demonstrate that the standard in paragraph (g)(1) of this section continues to be met for the unit. The owner or operator must place each completed demonstration in the facility's operating record.

(3) The owner or operator of the CCR unit must include in the annual groundwater monitoring and corrective action report required by § 257.90(e) or § 257.100(e)(5)(ii) any approved no migration demonstration.

*[89 FR 39103, May 8, 2024]*

## § 257.91 Groundwater monitoring systems.

(a) ***Performance standard.*** The owner or operator of a CCR unit must install a groundwater monitoring system that consists of a sufficient number of wells, installed at appropriate locations and depths, to yield groundwater samples from the uppermost aquifer that:

(1) Accurately represent the quality of background groundwater that has not been affected by leakage from a CCR unit. A determination of background quality may include sampling of wells that are not hydraulically upgradient of the CCR management area where:

(i) Hydrogeologic conditions do not allow the owner or operator of the CCR unit to determine what wells are hydraulically upgradient; or

(ii) Sampling at other wells will provide an indication of background groundwater quality that is as representative or more representative than that provided by the upgradient wells; and

(2) Accurately represent the quality of groundwater passing the waste boundary of the CCR unit. The downgradient monitoring system must be installed at the waste boundary that ensures detection of groundwater contamination in the uppermost aquifer. All potential contaminant pathways must be monitored.

(b) The number, spacing, and depths of monitoring systems shall be determined based upon site-specific technical information that must include thorough characterization of:

(1) Aquifer thickness, groundwater flow rate, groundwater flow direction including seasonal and temporal fluctuations in groundwater flow; and

(2) Saturated and unsaturated geologic units and fill materials overlying the uppermost aquifer, materials comprising the uppermost aquifer, and materials comprising the confining unit defining the lower boundary of the uppermost aquifer, including, but not limited to, thicknesses, stratigraphy, lithology, hydraulic conductivities, porosities and effective porosities.

(c) The groundwater monitoring system must include the minimum number of monitoring wells necessary to meet the performance standards specified in paragraph (a) of this section, based on the site-specific information specified in paragraph (b) of this section. The groundwater monitoring system must contain:

(1) A minimum of one upgradient and three downgradient monitoring wells; and

(2) Additional monitoring wells as necessary to accurately represent the quality of background groundwater that has not been affected by leakage from the CCR unit and the quality of groundwater passing the waste boundary of the CCR unit.

(d) The owner or operator of multiple CCR units may install a multiunit groundwater monitoring system instead of separate groundwater monitoring systems for each CCR unit.

(1) The multiunit groundwater monitoring system must be equally as capable of detecting monitored constituents at the waste boundary of the CCR unit as the individual groundwater monitoring system specified in paragraphs (a) through (c) of this section for each CCR unit based on the following factors:

(i) Number, spacing, and orientation of each CCR unit;

(ii) Hydrogeologic setting;

(iii) Site history; and

(iv) Engineering design of the CCR unit.

(2) [Reserved]

(e) Monitoring wells must be cased in a manner that maintains the integrity of the monitoring well borehole. This casing must be screened or perforated and packed with gravel or sand, where necessary, to enable collection of groundwater samples. The annular space (*i.e.,* the space between the borehole and well casing) above the sampling depth must be sealed to prevent contamination of samples and the groundwater.

(1) The owner or operator of the CCR unit must document and include in the operating record the design, installation, development, and decommissioning of any monitoring wells, piezometers and other measurement, sampling, and analytical devices. The qualified professional engineer must be given access to this documentation when completing the groundwater monitoring system certification required under paragraph (f) of this section.

(2) The monitoring wells, piezometers, and other measurement, sampling, and analytical devices must be operated and maintained so that they perform to the design specifications throughout the life of the monitoring program.

(f) The owner or operator must obtain a certification from a qualified professional engineer or approval from the Participating State Director or approval from EPA where EPA is the permitting authority stating that the groundwater monitoring system has been designed and constructed to meet the requirements of this section. If the groundwater monitoring system includes the minimum number of monitoring wells specified in paragraph (c)(1) of this section, the certification must document the basis supporting this determination.

(g) The owner or operator of the CCR unit must comply with the recordkeeping requirements specified in § 257.105(h), the notification requirements specified in § 257.106(h), and the internet requirements specified in § 257.107(h).

*[80 FR 21468, Apr. 17, 2015, as amended at 83 FR 36453, July 30, 2018; 85 FR 53561, Aug. 28, 2020]*

## § 257.92 [Reserved]

## § 257.93 Groundwater sampling and analysis requirements.

(a) The groundwater monitoring program must include consistent sampling and analysis procedures that are designed to ensure monitoring results that provide an accurate representation of groundwater quality at the background and downgradient wells required by § 257.91. The owner or operator of the CCR unit must develop a sampling and analysis program that includes procedures and techniques for:

(1) Sample collection;

(2) Sample preservation and shipment;

(3) Analytical procedures;

(4) Chain of custody control; and

(5) Quality assurance and quality control.

(b) The groundwater monitoring program must include sampling and analytical methods that are appropriate for groundwater sampling and that accurately measure hazardous constituents and other monitoring parameters in groundwater samples. For purposes of §§ 257.90 through 257.98, the term *constituent* refers to both hazardous constituents and other monitoring parameters listed in either appendix III or IV of this part.

(c) Groundwater elevations must be measured in each well immediately prior to purging, each time groundwater is sampled. The owner or operator of the CCR unit must determine the rate and direction of groundwater flow each time groundwater is sampled. Groundwater elevations in wells which monitor the same CCR management area must be measured within a period of time short enough to avoid temporal variations in groundwater flow which could preclude accurate determination of groundwater flow rate and direction.

(d) The owner or operator of the CCR unit must establish background groundwater quality in a hydraulically upgradient or background well(s) for each of the constituents required in the particular groundwater monitoring program that applies to the CCR unit as determined under § 257.94(a) or § 257.95(a). Background groundwater quality may be established at wells that are not located hydraulically upgradient from the CCR unit if it meets the requirements of § 257.91(a)(1).

(e) The number of samples collected when conducting detection monitoring and assessment monitoring (for both downgradient and background wells) must be consistent with the statistical procedures chosen under paragraph (f) of this section and the performance standards under paragraph (g) of this section. The sampling procedures shall be those specified under § 257.94(b) through (d) for detection monitoring, § 257.95(b) through (d) for assessment monitoring, and § 257.96(b) for corrective action.

(f) The owner or operator of the CCR unit must select one of the statistical methods specified in paragraphs (f)(1) through (5) of this section to be used in evaluating groundwater monitoring data for each specified constituent. The statistical test chosen shall be conducted separately for each constituent in each monitoring well.

(1) A parametric analysis of variance followed by multiple comparison procedures to identify statistically significant evidence of contamination. The method must include estimation and testing of the contrasts between each compliance well's mean and the background mean levels for each constituent.

(2) An analysis of variance based on ranks followed by multiple comparison procedures to identify statistically significant evidence of contamination. The method must include estimation and testing of the contrasts between each compliance well's median and the background median levels for each constituent.

(3) A tolerance or prediction interval procedure, in which an interval for each constituent is established from the distribution of the background data and the level of each constituent in each compliance well is compared to the upper tolerance or prediction limit.

(4) A control chart approach that gives control limits for each constituent.

(5) Another statistical test method that meets the performance standards of paragraph (g) of this section.

(6) The owner or operator of the CCR unit must obtain a certification from a qualified professional engineer or approval from the Participating State Director or approval from EPA where EPA is the permitting authority stating that the selected statistical method is appropriate for evaluating the groundwater monitoring data for the CCR management area. The certification must include a narrative description of the statistical method selected to evaluate the groundwater monitoring data.

(g) Any statistical method chosen under paragraph (f) of this section shall comply with the following performance standards, as appropriate, based on the statistical test method used:

(1) The statistical method used to evaluate groundwater monitoring data shall be appropriate for the distribution of constituents. Normal distributions of data values shall use parametric methods. Non-normal distributions shall use non-parametric methods. If the distribution of the constituents is shown by the owner or operator of the CCR unit to be inappropriate for a normal theory test, then the data must be transformed or a distribution-free (non-parametric) theory test must be used. If the distributions for the constituents differ, more than one statistical method may be needed.

(2) If an individual well comparison procedure is used to compare an individual compliance well constituent concentration with background constituent concentrations or a groundwater protection standard, the test shall be done at a Type I error level no less than 0.01 for each testing period. If a multiple comparison procedure is used, the Type I experiment wise error rate for each testing period

shall be no less than 0.05; however, the Type I error of no less than 0.01 for individual well comparisons must be maintained. This performance standard does not apply to tolerance intervals, prediction intervals, or control charts.

(3) If a control chart approach is used to evaluate groundwater monitoring data, the specific type of control chart and its associated parameter values shall be such that this approach is at least as effective as any other approach in this section for evaluating groundwater data. The parameter values shall be determined after considering the number of samples in the background data base, the data distribution, and the range of the concentration values for each constituent of concern.

(4) If a tolerance interval or a predictional interval is used to evaluate groundwater monitoring data, the levels of confidence and, for tolerance intervals, the percentage of the population that the interval must contain, shall be such that this approach is at least as effective as any other approach in this section for evaluating groundwater data. These parameters shall be determined after considering the number of samples in the background data base, the data distribution, and the range of the concentration values for each constituent of concern.

(5) The statistical method must account for data below the limit of detection with one or more statistical procedures that shall at least as effective as any other approach in this section for evaluating groundwater data. Any practical quantitation limit that is used in the statistical method shall be the lowest concentration level that can be reliably achieved within specified limits of precision and accuracy during routine laboratory operating conditions that are available to the facility.

(6) If necessary, the statistical method must include procedures to control or correct for seasonal and spatial variability as well as temporal correlation in the data.

(h) The owner or operator of the CCR unit must determine whether or not there is a statistically significant increase over background values for each constituent required in the particular groundwater monitoring program that applies to the CCR unit, as determined under § 257.94(a) or § 257.95(a).

(1) In determining whether a statistically significant increase has occurred, the owner or operator must compare the groundwater quality of each constituent at each monitoring well designated pursuant to § 257.91(a)(2) or (d)(1) to the background value of that constituent, according to the statistical procedures and performance standards specified under paragraphs (f) and (g) of this section.

(2) Within 90 days after completing sampling and analysis, the owner or operator must determine whether there has been a statistically significant increase over background for any constituent at each monitoring well.

(i) The owner or operator must measure “total recoverable metals” concentrations in measuring groundwater quality. Measurement of total recoverable metals captures both the particulate fraction and dissolved fraction of metals in natural waters. Groundwater samples shall not be field-filtered prior to analysis.

(j) The owner or operator of the CCR unit must comply with the recordkeeping requirements specified in § 257.105(h), the notification requirements specified in § 257.106(h), and the Internet requirements specified in § 257.107(h).

*[80 FR 21468, Apr. 17, 2015, as amended at 83 FR 36453, July 30, 2018]*

## § 257.94 Detection monitoring program.

(a) The owner or operator of a CCR unit must conduct detection monitoring at all groundwater monitoring wells consistent with this section. At a minimum, a detection monitoring program must include groundwater monitoring for all constituents listed in appendix III to this part.

(b) Except as provided in paragraph (d) of this section, the monitoring frequency for the constituents listed in appendix III to this part shall be at least semiannual during the active life of the CCR unit and the post-closure period. For existing CCR landfills and existing CCR surface impoundments, a minimum of eight independent samples from each background and downgradient well must be collected and analyzed for the constituents listed in appendix III and IV to this part no later than October 17, 2017. For new CCR landfills, new CCR surface impoundments, and all lateral expansions of CCR units, a minimum of eight independent samples for each background well must be collected and analyzed for the constituents listed in appendices III and IV to this part during the first six months of sampling.

(c) The number of samples collected and analyzed for each background well and downgradient well during subsequent semiannual sampling events must be consistent with § 257.93(e), and must account for any unique characteristics of the site, but must be at least one sample from each background and downgradient well.

(d) The owner or operator of a CCR unit may demonstrate the need for an alternative monitoring frequency for repeated sampling and analysis for constituents listed in appendix III to this part during the active life and the post-closure care period based on the availability of groundwater. If there is not adequate groundwater flow to sample wells semiannually, the alternative frequency shall be no less than annual. The need to vary monitoring frequency must be evaluated on a site-specific basis. The demonstration must be supported by, at a minimum, the information specified in paragraphs (d)(1) and (2) of this section.

(1) Information documenting that the need for less frequent sampling. The alternative frequency must be based on consideration of the following factors:

(i) Lithology of the aquifer and unsaturated zone;

(ii) Hydraulic conductivity of the aquifer and unsaturated zone; and

(iii) Groundwater flow rates.

(2) Information documenting that the alternative frequency will be no less effective in ensuring that any leakage from the CCR unit will be discovered within a timeframe that will not materially delay establishment of an assessment monitoring program.

(3) The owner or operator must obtain a certification from a qualified professional engineer or approval from the Participating State Director or approval from EPA where EPA is the permitting authority stating that the demonstration for an alternative groundwater sampling and analysis frequency meets the requirements of this section. The owner or operator must include the demonstration providing the basis for the alternative monitoring frequency and the certification by a qualified professional engineer or the approval from the Participating State Director or approval from EPA where EPA is the permitting authority in the annual groundwater monitoring and corrective action report required by § 257.90(e).

(e) If the owner or operator of the CCR unit determines, pursuant to § 257.93(h) that there is a statistically significant increase over background levels for one or more of the constituents listed in appendix III to this part at any monitoring well at the waste boundary specified under § 257.91(a)(2), the owner or operator must:

(1) Except as provided for in paragraph (e)(2) of this section, within 90 days of detecting a statistically significant increase over background levels for any constituent, establish an assessment monitoring program meeting the requirements of § 257.95.

(2) The owner or operator may demonstrate that a source other than the CCR unit caused the statistically significant increase over background levels for a constituent or that the statistically significant increase resulted from error in sampling, analysis, statistical evaluation, or natural variation in groundwater quality. The owner or operator must complete the written demonstration within 90 days of detecting a statistically significant increase over background levels to include obtaining a certification from a qualified professional engineer or approval from the Participating State Director or approval from EPA where EPA is the permitting authority verifying the accuracy of the information in the report. If a successful demonstration is completed within the 90-day period, the owner or operator of the CCR unit may continue with a detection monitoring program under this section. If a successful demonstration is not completed within the 90-day period, the owner or operator of the CCR unit must initiate an assessment monitoring program as required under § 257.95. The owner or operator must also include the demonstration in the annual groundwater monitoring and corrective action report required by § 257.90(e), in addition to the certification by a qualified professional engineer or approval from the Participating State Director or approval from EPA where EPA is the permitting authority.

(3) The owner or operator of a CCR unit must prepare a notification stating that an assessment monitoring program has been established. The owner or operator has completed the notification when the notification is placed in the facility's operating record as required by § 257.105(h)(5).

(f) The owner or operator of the CCR unit must comply with the recordkeeping requirements specified in § 257.105(h), the notification requirements specified in § 257.106(h), and the Internet requirements specified in § 257.107(h).

*[80 FR 21468, Apr. 17, 2015, as amended at 83 FR 36453, July 30, 2018]*

## § 257.95 Assessment monitoring program.

Link to an amendment published at 90 FR 4645, Jan. 16, 2025.

(a) Assessment monitoring is required whenever a statistically significant increase over background levels has been detected for one or more of the constituents listed in appendix III to this part.

(b)

(1) Within 90 days of triggering an assessment monitoring program, and annually thereafter:

(i) Except as provided by paragraph (b)(1)(ii) of this section, the owner or operator of the CCR unit must sample and analyze the groundwater for all constituents listed in appendix IV to this part.

(ii) The owner or operator of a CCR management unit must sample and analyze the groundwater for all constituents listed in appendix IV to this part no later than Monday, May 8, 2028.

(2) The number of samples collected and analyzed for each well during each sampling event must be consistent with § 257.93(e), and must account for any unique characteristics of the site, but must be at least one sample from each well.

(c) The owner or operator of a CCR unit may demonstrate the need for an alternative monitoring frequency for repeated sampling and analysis for constituents listed in appendix IV to this part during the active life and the post-closure care period based on the availability of groundwater. If there is not adequate groundwater flow to sample wells semiannually, the alternative frequency shall be no less than annual. The need to vary monitoring frequency must be evaluated on a site-specific basis. The demonstration must be supported by, at a minimum, the information specified in paragraphs (c)(1) and (2) of this section.

(1) Information documenting that the need for less frequent sampling. The alternative frequency must be based on consideration of the following factors:

(i) Lithology of the aquifer and unsaturated zone;

(ii) Hydraulic conductivity of the aquifer and unsaturated zone; and

(iii) Groundwater flow rates.

(2) Information documenting that the alternative frequency will be no less effective in ensuring that any leakage from the CCR unit will be discovered within a timeframe that will not materially delay the initiation of any necessary remediation measures.

(3) The owner or operator must obtain a certification from a qualified professional engineer or approval from the Participating State Director or approval from EPA where EPA is the permitting authority stating that the demonstration for an alternative groundwater sampling and analysis frequency meets the requirements of this section. The owner or operator must include the demonstration providing the basis for the alternative monitoring frequency and the certification by a qualified professional engineer or the approval from the Participating State Director or the approval from EPA where EPA is the permitting authority in the annual groundwater monitoring and corrective action report required by § 257.90(e).

(d) After obtaining the results from the initial and subsequent sampling events required in paragraph (b) of this section, the owner or operator must:

(1) Within 90 days of obtaining the results, and on at least a semiannual basis thereafter, resample all wells that were installed pursuant to the requirements of § 257.91, conduct analyses for all parameters in appendix III to this part and for those constituents in appendix IV to this part that are detected in response to paragraph (b) of this section, and record their concentrations in the facility operating record. The number of samples collected and analyzed for each background well and downgradient well during subsequent semiannual sampling events must be consistent with § 257.93(e), and must account for any unique characteristics of the site, but must be at least one sample from each background and downgradient well;

(2) Establish groundwater protection standards for all constituents detected pursuant to paragraph (b) or (d) of this section. The groundwater protection standards must be established in accordance with paragraph (h) of this section; and

(3) Include the recorded concentrations required by paragraph (d)(1) of this section, identify the background concentrations established under § 257.94(b), and identify the groundwater protection standards established under paragraph (d)(2) of this section in the annual groundwater monitoring and corrective action report required by § 257.90(e).

(e) If the concentrations of all constituents listed in appendices III and IV to this part are shown to be at or below background values, using the statistical procedures in § 257.93(g), for two consecutive sampling events, the owner or operator may return to detection monitoring of the CCR unit. The owner or operator must prepare a notification stating that detection monitoring is resuming for the CCR unit. The owner or operator has completed the notification when the notification is placed in the facility's operating record as required by § 257.105(h)(7).

(f) If the concentrations of any constituent in appendices III and IV to this part are above background values, but all concentrations are below the groundwater protection standard established under paragraph (h) of this section, using the statistical procedures in § 257.93(g), the owner or operator must continue assessment monitoring in accordance with this section.

(g) If one or more constituents in appendix IV to this part are detected at statistically significant levels above the groundwater protection standard established under paragraph (h) of this section in any sampling event, the owner or operator must prepare a notification identifying the constituents in appendix IV to this part that have exceeded the groundwater protection standard. The owner or operator has completed the notification when the notification is placed in the facility's operating record as required by § 257.105(h)(8). The owner or operator of the CCR unit also must:

(1) Characterize the nature and extent of the release and any relevant site conditions that may affect the remedy ultimately selected. The characterization must be sufficient to support a complete and accurate assessment of the corrective measures necessary to effectively clean up all releases from the CCR unit pursuant to § 257.96. Characterization of the release includes the following minimum measures:

(i) Install additional monitoring wells necessary to define the contaminant plume(s);

(ii) Collect data on the nature and estimated quantity of material released including specific information on the constituents listed in appendix IV of this part and the levels at which they are present in the material released;

(iii) Install at least one additional monitoring well at the facility boundary in the direction of contaminant migration and sample this well in accordance with paragraph (d)(1) of this section; and

(iv) Sample all wells in accordance with paragraph (d)(1) of this section to characterize the nature and extent of the release.

(2) Notify all persons who own the land or reside on the land that directly overlies any part of the plume of contamination if contaminants have migrated off-site if indicated by sampling of wells in accordance with paragraph (g)(1) of this section. The owner or operator has completed the notifications when they are placed in the facility's operating record as required by § 257.105(h)(8).

(3) Within 90 days of finding that any of the constituents listed in appendix IV to this part have been detected at a statistically significant level exceeding the groundwater protection standards the owner or operator must either:

(i) Initiate an assessment of corrective measures as required by § 257.96; or

(ii) Demonstrate that a source other than the CCR unit caused the contamination, or that the statistically significant increase resulted from error in sampling, analysis, statistical evaluation, or natural variation in groundwater quality. Any such demonstration must be supported by a report that includes the factual or evidentiary basis for any conclusions and must be certified to be accurate by a qualified professional engineer or approval from the Participating State Director or approval from EPA where EPA is the permitting authority. If a successful demonstration is made, the owner or operator must continue monitoring in accordance with the assessment monitoring program pursuant to this section, and may return to detection monitoring if the constituents in Appendix III and Appendix IV of this part are at or below background as specified in paragraph (e) of this section. The owner or operator must also include the demonstration in the annual groundwater monitoring and corrective action report required by § 257.90(e), in addition to the certification by a qualified professional engineer or the approval from the Participating State Director or the approval from EPA where EPA is the permitting authority.

(4) If a successful demonstration has not been made at the end of the 90 day period provided by paragraph (g)(3)(ii) of this section, the owner or operator of the CCR unit must initiate the assessment of corrective measures requirements under § 257.96.

(5) The owner or operator must prepare a notification stating that an assessment of corrective measures has been initiated.

(h) The owner or operator of the CCR unit must establish a groundwater protection standard for each constituent in appendix IV to this part detected in the groundwater. The groundwater protection standard shall be:

(1) For constituents for which a maximum contaminant level (MCL) has been established under §§ 141.62 and 141.66 of this title, the MCL for that constituent;

(2) For the following constituents:

(i) Cobalt 6 micrograms per liter (µg/l);

(ii) Lead 15 µg/l;

(iii) Lithium 40 µg/l; and

(iv) Molybdenum 100 µg/l.

(3) For constituents for which the background level is higher than the levels identified under paragraphs (h)(1) and (h)(2) of this section, the background concentration.

(i) The owner or operator of the CCR unit must comply with the recordkeeping requirements specified in § 257.105(h), the notification requirements specified in § 257.106(h), and the Internet requirements specified in § 257.107(h).

*[80 FR 21468, Apr. 17, 2015, as amended at 83 FR 36453, July 30, 2018; 85 FR 53561, Aug. 28, 2020; 89 FR 39105, May 8, 2024]*

## § 257.96 Assessment of corrective measures.

(a) Within 90 days of finding that any constituent listed in Appendix IV to this part has been detected at a statistically significant level exceeding the groundwater protection standard defined under § 257.95(h), or immediately upon detection of a release from a CCR unit, the owner or operator must initiate an

assessment of corrective measures to prevent further releases, to remediate any releases and to restore affected area to original conditions. The assessment of corrective measures must be completed within 90 days, unless the owner or operator demonstrates the need for additional time to complete the assessment of corrective measures due to site-specific conditions or circumstances. The owner or operator must obtain a certification from a qualified professional engineer or approval from the Participating State Director or approval from EPA where EPA is the permitting authority attesting that the demonstration is accurate. The 90-day deadline to complete the assessment of corrective measures may be extended for no longer than 60 days. The owner or operator must also include the demonstration in the annual groundwater monitoring and corrective action report required by § 257.90(e), in addition to the certification by a qualified professional engineer or the approval from the Participating State Director or the approval from EPA where EPA is the permitting authority.

(b) The owner or operator of the CCR unit must continue to monitor groundwater in accordance with the assessment monitoring program as specified in § 257.95.

(c) The assessment under paragraph (a) of this section must include an analysis of the effectiveness of potential corrective measures in meeting all of the requirements and objectives of the remedy as described under § 257.97 addressing at least the following:

(1) The performance, reliability, ease of implementation, and potential impacts of appropriate potential remedies, including safety impacts, cross-media impacts, and control of exposure to any residual contamination;

(2) The time required to begin and complete the remedy;

(3) The institutional requirements, such as state or local permit requirements or other environmental or public health requirements that may substantially affect implementation of the remedy(s).

(d) The owner or operator must place the completed assessment of corrective measures in the facility's operating record. The assessment has been completed when it is placed in the facility's operating record as required by § 257.105(h)(10).

(e) The owner or operator must discuss the results of the corrective measures assessment at least 30 days prior to the selection of remedy, in a public meeting with interested and affected parties.

(f) The owner or operator of the CCR unit must comply with the recordkeeping requirements specified in § 257.105(h), the notification requirements specified in § 257.106(h), and the Internet requirements specified in § 257.107(h).

*[80 FR 21468, Apr. 17, 2015, as amended at 83 FR 36454, July 30, 2018]*

## § 257.97 Selection of remedy.

(a) Based on the results of the corrective measures assessment conducted under § 257.96, the owner or operator must, as soon as feasible, select a remedy that, at a minimum, meets the standards listed in paragraph (b) of this section. This requirement applies in addition to, not in place of, any applicable standards under the Occupational Safety and Health Act. The owner or operator must prepare a semiannual report describing the progress in selecting and designing the remedy. Upon selection of a remedy, the owner or operator must prepare a final report describing the selected remedy and how it meets the standards specified in paragraph (b) of this section. The owner or operator must obtain a certification from a qualified professional engineer or approval from the Participating State Director or

approval from EPA where EPA is the permitting authority that the remedy selected meets the requirements of this section. The report has been completed when it is placed in the operating record as required by § 257.105(h)(12).

(b) Remedies must:

(1) Be protective of human health and the environment;

(2) Attain the groundwater protection standard as specified pursuant to § 257.95(h);

(3) Control the source(s) of releases so as to reduce or eliminate, to the maximum extent feasible, further releases of constituents in appendix IV to this part into the environment;

(4) Remove from the environment as much of the contaminated material that was released from the CCR unit as is feasible, taking into account factors such as avoiding inappropriate disturbance of sensitive ecosystems;

(5) Comply with standards for management of wastes as specified in § 257.98(d).

(c) In selecting a remedy that meets the standards of paragraph (b) of this section, the owner or operator of the CCR unit shall consider the following evaluation factors:

(1) The long- and short-term effectiveness and protectiveness of the potential remedy(s), along with the degree of certainty that the remedy will prove successful based on consideration of the following:

(i) Magnitude of reduction of existing risks;

(ii) Magnitude of residual risks in terms of likelihood of further releases due to CCR remaining following implementation of a remedy;

(iii) The type and degree of long-term management required, including monitoring, operation, and maintenance;

(iv) Short-term risks that might be posed to the community or the environment during implementation of such a remedy, including potential threats to human health and the environment associated with excavation, transportation, and re-disposal of contaminant;

(v) Time until full protection is achieved;

(vi) Potential for exposure of humans and environmental receptors to remaining wastes, considering the potential threat to human health and the environment associated with excavation, transportation, re-disposal, or containment;

(vii) Long-term reliability of the engineering and institutional controls; and

(viii) Potential need for replacement of the remedy.

(2) The effectiveness of the remedy in controlling the source to reduce further releases based on consideration of the following factors:

(i) The extent to which containment practices will reduce further releases; and

(ii) The extent to which treatment technologies may be used.

(3) The ease or difficulty of implementing a potential remedy(s) based on consideration of the following types of factors:

(i) Degree of difficulty associated with constructing the technology;

(ii) Expected operational reliability of the technologies;

(iii) Need to coordinate with and obtain necessary approvals and permits from other agencies;

(iv) Availability of necessary equipment and specialists; and

(v) Available capacity and location of needed treatment, storage, and disposal services.

(4) The degree to which community concerns are addressed by a potential remedy(s).

(d) The owner or operator must specify as part of the selected remedy a schedule(s) for implementing and completing remedial activities. Such a schedule must require the completion of remedial activities within a reasonable period of time taking into consideration the factors set forth in paragraphs (d)(1) through (6) of this section. The owner or operator of the CCR unit must consider the following factors in determining the schedule of remedial activities:

(1) Extent and nature of contamination, as determined by the characterization required under § 257.95(g);

(2) Reasonable probabilities of remedial technologies in achieving compliance with the groundwater protection standards established under § 257.95(h) and other objectives of the remedy;

(3) Availability of treatment or disposal capacity for CCR managed during implementation of the remedy;

(4) Potential risks to human health and the environment from exposure to contamination prior to completion of the remedy;

(5) Resource value of the aquifer including:

(i) Current and future uses;

(ii) Proximity and withdrawal rate of users;

(iii) Groundwater quantity and quality;

(iv) The potential damage to wildlife, crops, vegetation, and physical structures caused by exposure to CCR constituents;

(v) The hydrogeologic characteristic of the facility and surrounding land; and

(vi) The availability of alternative water supplies; and

(6) Other relevant factors.

(e) The owner or operator of the CCR unit must comply with the recordkeeping requirements specified in § 257.105(h), the notification requirements specified in § 257.106(h), and the Internet requirements specified in § 257.107(h).

*[80 FR 21468, Apr. 17, 2015, as amended at 83 FR 36454, July 30, 2018]*

## § 257.98 Implementation of the corrective action program.

(a) Within 90 days of selecting a remedy under § 257.97, the owner or operator must initiate remedial activities. Based on the schedule established under § 257.97(d) for implementation and completion of remedial activities the owner or operator must:

(1) Establish and implement a corrective action groundwater monitoring program that:

(i) At a minimum, meets the requirements of an assessment monitoring program under § 257.95;

(ii) Documents the effectiveness of the corrective action remedy; and

(iii) Demonstrates compliance with the groundwater protection standard pursuant to paragraph (c) of this section.

(2) Implement the corrective action remedy selected under § 257.97; and

(3) Take any interim measures necessary to reduce the contaminants leaching from the CCR unit, and/or potential exposures to human or ecological receptors. Interim measures must, to the greatest extent feasible, be consistent with the objectives of and contribute to the performance of any remedy that may be required pursuant to § 257.97. The following factors must be considered by an owner or operator in determining whether interim measures are necessary:

(i) Time required to develop and implement a final remedy;

(ii) Actual or potential exposure of nearby populations or environmental receptors to any of the constituents listed in appendix IV of this part;

(iii) Actual or potential contamination of drinking water supplies or sensitive ecosystems;

(iv) Further degradation of the groundwater that may occur if remedial action is not initiated expeditiously;

(v) Weather conditions that may cause any of the constituents listed in appendix IV to this part to migrate or be released;

(vi) Potential for exposure to any of the constituents listed in appendix IV to this part as a result of an accident or failure of a container or handling system; and

(vii) Other situations that may pose threats to human health and the environment.

(b) If an owner or operator of the CCR unit, determines, at any time, that compliance with the requirements of § 257.97(b) is not being achieved through the remedy selected, the owner or operator must implement other methods or techniques that could feasibly achieve compliance with the requirements.

(c) Remedies selected pursuant to § 257.97 shall be considered complete when:

(1) The owner or operator of the CCR unit demonstrates compliance with the groundwater protection standards established under § 257.95(h) has been achieved at all points within the plume of contamination that lie beyond the groundwater monitoring well system established under § 257.91.

(2) Compliance with the groundwater protection standards established under § 257.95(h) has been achieved by demonstrating that concentrations of constituents listed in appendix IV to this part have not exceeded the groundwater protection standard(s) for a period of three consecutive years using the statistical procedures and performance standards in § 257.93(f) and (g).

(3) All actions required to complete the remedy have been satisfied.

(d) All CCR that are managed pursuant to a remedy required under § 257.97, or an interim measure required under paragraph (a)(3) of this section, shall be managed in a manner that complies with all applicable RCRA requirements.

(e) Upon completion of the remedy, the owner or operator must prepare a notification stating that the remedy has been completed. The owner or operator must obtain a certification from a qualified professional engineer or approval from the Participating State Director or approval from EPA where EPA is the permitting authority attesting that the remedy has been completed in compliance with the requirements of paragraph (c) of this section. The report has been completed when it is placed in the operating record as required by § 257.105(h)(13).

(f) The owner or operator of the CCR unit must comply with the recordkeeping requirements specified in § 257.105(h), the notification requirements specified in § 257.106(h), and the internet requirements specified in § 257.107(h).

*[80 FR 21468, Apr. 17, 2015, as amended at 83 FR 36454, July 30, 2018]*

CLOSURE AND POST-CLOSURE CARE

## § 257.100 Inactive CCR surface impoundments and Legacy CCR surface impoundments.

Link to an amendment published at 90 FR 4645, Jan. 16, 2025.

(a) ***General.***

(1) Inactive CCR surface impoundments are subject to all of the requirements of this subpart applicable to existing CCR surface impoundments, except that an active electric utility or independent power producer that generates electricity without the use of fuel is subject to the compliance deadlines applicable to legacy CCR surface impoundments, provided the facility has not generated electricity using fuels on or after October 19, 2015.

(2) Legacy CCR surface impoundments are subject to all of the requirements of this subpart applicable to existing CCR surface impoundments, except for the requirements in §§ 257.60 through 257.64 and 257.71.

(b) through (d) [Reserved]

(e) ***Timeframes for certain inactive CCR surface impoundments.***

(1) An inactive CCR surface impoundment for which the owner or operator has completed the actions by the deadlines specified in paragraphs (e)(1)(i) through (iii) of this section is eligible for the alternative timeframes specified in paragraphs (e)(2) through (6) of this section. The owner or operator of the CCR unit must comply with the applicable recordkeeping, notification, and internet requirements associated with these provisions. For the inactive CCR surface impoundment:

(i) The owner or operator must have prepared and placed in the facility's operating record by December 17, 2015, a notification of intent to initiate closure of the inactive CCR surface impoundment pursuant to § 257.105(i)(1);

(ii) The owner or operator must have provided notification to the State Director and/or appropriate Tribal authority by January 19, 2016, of the intent to initiate closure of the inactive CCR surface impoundment pursuant to § 257.106(i)(1); and

(iii) The owner or operator must have placed on its CCR website by January 19, 2016, the notification of intent to initiate closure of the inactive CCR surface impoundment pursuant to § 257.107(i)(1).

(2) ***Location restrictions.***

(i) No later than April 16, 2020, the owner or operator of the inactive CCR surface impoundment must:

(A) Complete the demonstration for placement above the uppermost aquifer as set forth by § 257.60(a), (b), and (c)(3);

(B) Complete the demonstration for wetlands as set forth by § 257.61(a), (b), and (c)(3);

(C) Complete the demonstration for fault areas as set forth by § 257.62(a), (b), and (c)(3);

(D) Complete the demonstration for seismic impact zones as set forth by § 257.63(a), (b), and (c)(3); and

(E) Complete the demonstration for unstable areas as set forth by § 257.64(a), (b), (c), and (d)(3).

(ii) An owner or operator of an inactive CCR surface impoundment who fails to demonstrate compliance with the requirements of paragraph (e)(2)(i) of this section is subject to the closure requirements of § 257.101(b)(1).

(3) ***Design criteria.*** The owner or operator of the inactive CCR surface impoundment must:

(i) No later than April 17, 2018, complete the documentation of liner type as set forth by § 257.71(a) and (b).

(ii) No later than June 16, 2017, place on or immediately adjacent to the CCR unit the permanent identification marker as set forth by § 257.73(a)(1).

(iii) No later than October 16, 2018, prepare and maintain an Emergency Action Plan as set forth by § 257.73(a)(3).

(iv) No later than April 17, 2018, compile a history of construction as set forth by § 257.73(b) and (c).

(v) No later than April 17, 2018, complete the initial hazard potential classification, structural stability, and safety factor assessments as set forth by § 257.73(a)(2), (b), (d), (e), and (f).

(4) ***Operating criteria.*** The owner or operator of the inactive CCR surface impoundment must:

(i) No later than April 18, 2017, prepare the initial CCR fugitive dust control plan as set forth in § 257.80(b).

(ii) No later than April 17, 2018, prepare the initial inflow design flood control system plan as set forth in § 257.82(c).

(iii) No later than April 18, 2017, initiate the inspections by a qualified person as set forth by § 257.83(a).

(iv) No later than July 19, 2017, complete the initial annual inspection by a qualified professional engineer as set forth by § 257.83(b).

(5) ***Groundwater monitoring and corrective action.*** The owner or operator of the inactive CCR surface impoundment must:

(i) No later than April 17, 2019, comply with groundwater monitoring requirements set forth in §§ 257.90(b) and 257.94(b); and

(ii) No later than August 1, 2019, prepare the initial groundwater monitoring and corrective action report as set forth in § 257.90(e).

(6) ***Closure and post-closure care.*** The owner or operator of the inactive CCR surface impoundment must:

(i) No later than April 17, 2018, prepare an initial written closure plan as set forth in § 257.102(b); and

(ii) No later than April 17, 2018, prepare an initial written post-closure care plan as set forth in § 257.104(d).

(f) ***Timeframes for legacy CCR surface impoundments.*** Owners and operators of legacy CCR surface impoundments are subject to the requirements of paragraphs (f)(1) through (5) of this section, except as provided in paragraphs (g) through (i) of this section.

(1) ***Legacy CCR surface impoundment applicability report.***

(i) Except as provided in paragraph (f)(1)(iii) of this section, owners and operators of legacy CCR surface impoundments must prepare a report for each legacy CCR surface impoundment no later than Friday, November 8, 2024. The owner or operator has prepared the applicability report when the report has been placed in the facility's operating record as required by § 257.105(k)(1). At a minimum, the report for each legacy CCR surface impoundment must contain:

(A) The name and address of the person(s) owning and operating the legacy CCR surface impoundment with their business phone number and email address.

(B) The name associated with the legacy CCR surface impoundment.

(C) Information to identify the legacy CCR surface impoundment, including a figure of the facility and where the unit is located at the facility, facility address, and the latitude and longitude of the facility.

(D) The identification number of the legacy CCR surface impoundment if one has been assigned by the state.

(E) A description of the current site conditions, including the current use of the inactive facility.

(ii)

(A) The owner or operator of any legacy CCR surface impoundment must certify the applicability report required by paragraph (f)(1)(i) of this section with the following statement signed by the owner or operator or an authorized representative:

> I certify under penalty of law that I have personally examined and am familiar with the information submitted in this demonstration and all attached documents, and that, based on my inquiry of those individuals immediately responsible for obtaining the information, I believe

> that the submitted information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment.

(B) The owner or operator must notify the Agency of the establishment of the facility's CCR website and the applicability of the rule, using the procedures in § 257.107(a) via the "contact us" form on EPA's CCR website.

(iii)

(A) Notwithstanding the deadline to complete the applicability report under paragraph (f)(1)(i) of this section, an owner or operator may secure additional time to complete the report for the sole reason of determining through a field investigation whether the unit contains both CCR and liquids. The amount of additional time that can be secured is limited as specified in paragraph (f)(1)(iii)(B) of this section. For owners and operators following the procedures of this paragraph (f)(1)(iii), the compliance timeframes for the requirements specified under paragraphs (f)(2) through (5) of this section are adjusted by the length of the extension(s) justified under this paragraph (f)(1)(iii). To qualify for additional time, the owner or operator must prepare an applicability extension report consisting of the following:

(*1*) The information specified in paragraph (f)(1)(i)(A) through (C) of this section;

(*2*) A statement by the owner or operator that to the best of their knowledge or belief, existing and available information does not provide a sufficient basis to determine that the unit contained free liquids on or after October 19, 2015; and

(*3*) The details of a written field investigation work plan, including of the following:

(*i*) A detailed description of the approach to characterize the physical, topographic, geologic, hydrogeologic, and hydraulic properties of the CCR in the unit and native geologic materials beneath and surrounding the unit, and how those properties will be used to investigate for the presence of free liquids in the CCR unit.

(*ii*) A detailed description of the methods and tools that will be employed to determine whether the unit contains free liquids, the rationale for choosing these methods and tools, how these methods and tools will be implemented, and at what level of spatial resolution at the CCR unit to identify and monitor for the presence of free liquids.

(*iii*) A detailed description of how groundwater elevations will be determined, and at what level of spatial resolution, in relation to the sides and bottom of the CCR unit and how any intersection of the groundwater table with the CCR unit will be evaluated, and at what level of spatial resolution.

(*iv*) A plan for evaluating stormwater flow over the surface of the unit, stormwater drainage from the unit, and stormwater infiltration into the unit and how those processes may result in the formation of free liquids in the CCR unit. This plan must include a current topographic map showing surface water flow and any pertinent natural or man-made features present relevant to stormwater drainage, infiltration and related processes.

(*v*) An estimated timeline to complete the workplan and make a determination if the CCR unit contains free liquids.

(*vi*) A narrative discussion of how the results from implementing the workplan will determine whether the unit contains free liquids specified.

(*vii*) A narrative discussion describing any anticipated problems that may be encountered during implementation of the workplan and what actions will be taken to resolve the problems, and anticipated timeframes necessary for such a contingency.

(*viii*) The owner or operator of the CCR unit must obtain a written certification from a qualified professional engineer stating that the field investigation work plan meets the requirements of paragraph (f)(1)(iii)(A)(*3*) of this section.

(B) The maximum amount of additional time that can be secured under paragraph (f)(1)(iii) of this section is 18 months, secured in 6-month increments, provided each 6-month increment is supported by an applicability extension report.

(C) Owners and operator must prepare the initial applicability extension report no later than Friday, November 8, 2024. Subsequent applicability extension reports must be prepared no later than 6 months after completing the preceding applicability extension report. The owner or operator has prepared the applicability extension report when the report is placed in the facility's operating record as required by § 257.105(k)(2).

(D) No later than Friday, November 8, 2024, the owner or operator must notify the Agency of the establishment of a CCR website using the procedures in § 257.107(a) via the “contact us” form on EPA's CCR website.

(E) If the owner or operator determines that the unit contains free liquids during implementation of the written field investigation workplan, the owner or operator must cease operating under these extension provisions and prepare the applicability report required by paragraph (f)(1) of this section within 14 days of determining that the unit contains free liquids. The owner or operator must comply with the requirements specified under paragraphs (f)(2) through (5) of this section under new timeframes. The new timeframes are determined by adding the total length of the extension(s) justified under paragraph (f)(1)(iii) of this section to each of the deadlines specified under paragraphs (f)(2) through (5) of this section.

(F) If the owner or operator determines that the unit does not contain both CCR and liquids during implementation of the written field investigation work plan, the owner or operator must prepare a notification stating that the field investigation has concluded and that the owner or operator has determined that the unit does not contain both CCR and liquids and does not meet the definition of a legacy CCR surface impoundment. The owner or operator has prepared the notification when the report is placed in the facility's operating record as required by § 257.105(k)(3).

(G) If the owner or operator does not complete the field investigation work within the timeframes specified in paragraph (f)(1)(iii)(B) of this section, the unit shall be considered a legacy CCR surface impoundment and must comply with the requirements under paragraphs (f)(2) through (5) of this section pursuant to the timeframes specified under paragraph (f)(1)(iii)(E) of this section.

(2) ***Design criteria.*** The owner or operator of a legacy CCR surface impoundment must:

(i) Except for legacy CCR surface impoundments that are incised, no later than Wednesday, January 8, 2025, place on or immediately adjacent to the CCR unit the permanent identification marker as set forth by § 257.73(a)(1).

(ii) Except for legacy CCR surface impoundments that do not exceed the height and/or storage volume thresholds under § 257.73(b), no later than Monday, February 9, 2026, compile a history of construction as set forth by § 257.73(c).

(iii) Except for legacy CCR surface impoundments that are incised, no later than Friday, May 8, 2026, complete the initial hazard potential classification assessment as set forth by § 257.73(a)(2) and (f).

(iv) Except for legacy CCR surface impoundments that do not exceed the height and/or storage volume thresholds under § 257.73(b), no later than Friday, May 8, 2026, complete the structural stability and safety factor assessments as set forth by § 257.73(d), (e), and (f).

(v) Except for legacy CCR surface impoundments that are incised, no later than Friday, May 8, 2026, prepare and maintain an Emergency Action Plan as set forth by § 257.73(a)(3).

(3) ***Operating criteria.*** The owner or operator of the legacy CCR surface impoundment must:

(i) No later than Friday, November 8, 2024, prepare the initial CCR fugitive dust control plan as set forth in § 257.80(b).

(ii) No later than Friday, November 8, 2024, prevent the unknowing entry, and minimize the possibility for the unauthorized entry, of persons or livestock onto the legacy CCR surface impoundment.

(iii) No later than Friday, November 8, 2024, initiate the inspections by a qualified person as set forth by § 257.83(a).

(iv) No later than Monday, February 10, 2025, complete the initial annual inspection by a qualified professional engineer as set forth by § 257.83(b).

(v) No later than Friday, May 8, 2026, prepare the initial inflow design flood control system plan as set forth in § 257.82(c).

(vi) No later than Thursday, January 8, 2026, prepare the initial annual fugitive dust control report as set forth in § 257.80(c).

(4) ***Groundwater monitoring and corrective action.*** No later than Monday, May 10, 2027, the owner or operator of the legacy CCR surface impoundment must:

(i) Install the groundwater monitoring system as required by § 257.91.

(ii) Develop the groundwater sampling and analysis program, including the selection of the statistical procedures, that will be used for evaluating groundwater monitoring data as required by § 257.93.

(iii) Be in compliance with the following groundwater monitoring requirements:

(A) Initiate the detection monitoring program to include obtaining a minimum of eight independent samples for each background and downgradient well, as required by § 257.94(b).

(B) Begin evaluating the groundwater monitoring data for statistically significant increases over background levels for the constituents listed in appendix III of this part, as required by § 257.94.

(C) Begin evaluating the groundwater monitoring data for statistically significant levels over groundwater protection standards for the constituents listed in appendix IV of this part as required by § 257.95.

(iv) No later than January 31, 2027, prepare the initial groundwater monitoring and corrective action report as set forth in § 257.90(e).

(5) ***Closure and post-closure care.*** Except as provided in § 257.102(g), the owner or operator of the legacy CCR surface impoundment must:

(i) No later than Monday, November 8, 2027, prepare an initial written closure plan as set forth in § 257.102(b); and

(ii) No later than Monday, November 8, 2027, prepare an initial written post-closure care plan as set forth in § 257.104(d).

(g) For owners and operators of legacy CCR surface impoundments that completed closure of the CCR unit by removal of waste prior to Friday, November 8, 2024, no later than Friday, November 8, 2024, complete a closure certification that includes the following supporting information:

(1) The type and volume of CCR and all other materials in the unit prior to closure;

(2) The methods used to verify complete removal of all CCR and other contaminated materials from the unit, including any post-removal sampling and analysis;

(3) Documentation that all CCR and other contaminated materials were removed from the unit, including, the results of any post-removal sampling and analysis that was conducted;

(4) The methods used to verify complete decontamination of all areas affected by releases from the unit, including but not limited to post-decontamination sampling and analysis;

(5) Documentation that all areas affected by releases from the unit were decontaminated and that all groundwater affected by releases has achieved groundwater protection standards; and

(6) Document that groundwater monitoring concentrations do not exceed the groundwater protection standards established pursuant to § 257.95(h) for constituents listed in appendix IV to this part. The documentation must also include a demonstration that the groundwater monitoring system has met all of the following:

(i) Was capable of accurately representing background water quality unaffected by a CCR unit;

(ii) Was capable of accurately representing the quality of water passing the waste boundary of the unit;

(iii) Was capable of detecting contamination in the uppermost aquifer;

(iv) Monitored all potential contaminant pathways;

(v) Established groundwater background concentrations for appendix IV constituents and compared samples to those background concentrations;

(vi) Monitoring wells must have been cased in a manner that maintains the integrity of the monitoring well borehole. This casing must have been screened or perforated and packed with gravel or sand, where necessary, to enable collection of groundwater samples. The annular space (*i.e.,* the space between the borehole and well casing) above the sampling depth must have been sealed to prevent contamination of samples and the groundwater; and

(vii) The last groundwater monitoring sample used to document that the standard in paragraph (g)(3) of this section has been met must have been collected no earlier than one year prior to the initiation of closure.

(h) If the owner or operator of a legacy CCR surface impoundment is unable to complete the closure by removal certification by the date listed in paragraph (f)(1)(i) of this section, they may elect to conduct groundwater monitoring in accordance with §§ 257.90 through 257.95 to demonstrate there are no exceedances of the groundwater protection standards. If the owner or operator meets all the requirements of paragraph (h)(1) of this section, no further requirements under this subpart apply. If the owner or operator does not meet the requirements of paragraph (h)(1) of this section by Monday, May 8, 2028 or if one or more constituents in appendix IV to this part are detected at statistically significant levels above the groundwater protection standard established under § 257.95(h), they must proceed in accordance with paragraph (h)(2) of this section.

(1) In order to comply with this paragraph (h)(1), the owner or operator must complete all of the following:

(i) Prepare a notification of intent to certify closure no later than Friday, November 8, 2024. The owner or operator has prepared the notification when the report is placed in the facility's operating record as required by § 257.105(k)(4).

(ii) Conduct groundwater monitoring in accordance with §§ 257.90-257.95 for at least two consecutive sampling events to demonstrate that all constituents in appendix IV of this part have concentrations that do not exceed the groundwater protection standards listed in § 257.95(h).

(iii) Complete a closure by removal certification documenting compliance with paragraphs (g)(1) through (5) and (h)(1)(ii) of this section no later than Monday, May 8, 2028.

(2) If the owner or operator does not meet the requirements of paragraph (h)(1) of this section (*e.g.,* by the date or they detect an SSL of an appendix IV constituent), they must comply with all of the following:

(i) If a statistically significant level is detected, the corrective action provisions and proceed in accordance with § 257.102(c)(2).

(ii) The permanent marker requirements in § 257.73(a)(1) no later than 8 months from the date they became subject to this requirement.

(iii) The applicability report requirements of paragraph (f)(1)(i) of this section no later than 6 months from the date they became subject to this requirement.

(iv) The facility evaluation provisions for CCR management units under § 257.75 no later than 33 months from the date they became subject to this requirement.

(v) If any CCR management unit is discovered after completing the facility evaluation report, the fugitive dust requirements of § 257.80(b) no later than 6 months from the date of the facility evaluation report.

(vi) The groundwater monitoring requirements for CCR management units under § 257.90(b)(3)(i) through (iv) no later than 48 months from the date they became subject to this requirement.

(vii) The requirement to prepare an initial written closure plan for CCR management units consistent with the requirements specified in § 257.102(b)(1) no later than 54 months from the date they became subject to this requirement.

(viii) The requirement to prepare an initial post-closure plan for CCR management units consistent with the requirements specified in § 257.104(d)(2)(iii) no later than 54 months from the date they became subject to this requirement.

(ix) The requirement to initiate the closure of CCR management units in accordance with the requirements of § 257.102 no later than 60 months from the date they became subject to this requirement.

(i) Owners and operators of legacy CCR surface impoundments that completed closure of the unit in accordance with § 257.102(d) or that meet the requirements in § 257.101(g) prior to Friday, November 8, 2024 must only:

(1) Prepare the applicability report as set forth by § 257.100(f)(1);

(2) Prevent the unknowing entry, and minimize the possibility for the unauthorized entry, of persons or livestock onto the legacy CCR surface impoundment as set forth in § 257.100(f)(3)(ii);

(3) Place on or immediately adjacent to the unit the permanent identification marker as set forth by § 257.73(a)(1);

(4) Compile a history of construction as set forth by § 257.73(c);

(5) Prepare the initial CCR fugitive dust control plan as set forth in § 257.80(b);

(6) Prepare the initial annual fugitive dust control report as set forth in § 257.80(c);

(7)

(i) Install the groundwater monitoring system as required by § 257.91;

(ii) Develop the groundwater sampling and analysis program, including the selection of the statistical procedures, that will be used for evaluating groundwater monitoring data as required by § 257.93;

(iii) Be in compliance with the following groundwater monitoring requirements:

(A) Initiate the detection monitoring program to include obtaining a minimum of eight independent samples for each background and downgradient well, as required by § 257.94(b);

(B) Begin evaluating the groundwater monitoring data for statistically significant increases over background levels for the constituents listed in appendix III of this part, as required by § 257.94;

(C) Begin evaluating the groundwater monitoring data for statistically significant levels over groundwater protection standards for the constituents listed in appendix IV of this part as required by § 257.95;

(8) Include in the applicability report specified in § 257.100(f)(1) information on the completed closure, along with supporting documentation to demonstrate that the closure meets the performance standards in § 257.102(d) or the standards specified in § 257.101(g);

(9) Prepare an initial written post-closure care plan as set forth in § 257.104(d);

(10) Conduct post-closure care as set forth in § 257.104(b); and

(11) Comply with applicable recordkeeping, notification, and website posting requirements as set forth by §§ 257.105 through 257.107.

(j) The owner or operator of the legacy CCR surface impoundment must comply with the recordkeeping requirements specified in § 257.105(k), the notification requirements specified in § 257.106(k), and the internet requirements specified in § 257.107(k).

*[89 FR 39105, May 8, 2024]*

## § 257.101 Closure or retrofit of CCR units.

(a) The owner or operator of an existing unlined CCR surface impoundment, as determined under § 257.71(a), is subject to the requirements of paragraph (a)(1) of this section.

(1) Except as provided by paragraph (a)(3) of this section, as soon as technically feasible, but not later than April 11, 2021, an owner or operator of an existing unlined CCR surface impoundment must cease placing CCR and non-CCR wastestreams into such CCR surface impoundment and either retrofit or close the CCR unit in accordance with the requirements of § 257.102.

(2) An owner or operator of an existing unlined CCR surface impoundment that closes in accordance with paragraph (a)(1) of this section must include a statement in the notification required under § 257.102(g) or (k)(5) that the CCR surface impoundment is closing or retrofitting under the requirements of paragraph (a)(1) of this section.

(3) The timeframe specified in paragraph (a)(1) of this section does not apply if the owner or operator complies with the alternate liner demonstration provisions specified in § 257.71(d) or the alternative closure procedures specified in § 257.103.

(4) At any time after the initiation of closure under paragraph (a)(1) of this section, the owner or operator may cease closure activities and initiate a retrofit of the CCR unit in accordance with the requirements of § 257.102(k).

(b) The owner or operator of an existing CCR surface impoundment is subject to the requirements of paragraph (b)(1) of this section.

(1)

(i) ***Location standard under § 257.60.*** Except as provided by paragraph (b)(4) of this section, the owner or operator of an existing CCR surface impoundment that has not demonstrated compliance with the location standard specified in § 257.60(a) must cease placing CCR and non-CCR wastestreams into such CCR unit as soon as technically feasible, but no later than April 11, 2021, and close the CCR unit in accordance with the requirements of § 257.102.

(ii) ***Location standards under §§ 257.61 through 257.64.*** Except as provided by paragraph (b)(4) of this section, within six months of determining that an existing CCR surface impoundment has not demonstrated compliance with any location standard specified in §§ 257.61(a), 257.62(a), 257.63(a), and 257.64(a), the owner or operator of the CCR surface impoundment must cease placing CCR and non-CCR wastestreams into such CCR unit and close the CCR unit in accordance with the requirements of § 257.102.

(2) Within six months of either failing to complete the initial or any subsequent periodic safety factor assessment required by § 257.73(e) by the deadlines specified in § 257.73(f)(1) through (3) or failing to document that the calculated factors of safety for the existing CCR surface impoundment achieve the minimum safety factors specified in § 257.73(e)(1)(i) through (iv), the owner or operator of the CCR surface impoundment must cease placing CCR and non-CCR wastestreams into such CCR unit and close the CCR unit in accordance with the requirements of § 257.102.

(3) An owner or operator of an existing CCR surface impoundment that closes in accordance with paragraphs (b)(1) or (2) of this section must include a statement in the notification required under § 257.102(g) that the CCR surface impoundment is closing under the requirements of paragraphs (b)(1) or (2) of this section.

(4) The timeframe specified in paragraph (b)(1) of this section does not apply if the owner or operator complies with the alternative closure procedures specified in § 257.103.

(c) The owner or operator of a new CCR surface impoundment is subject to the requirements of paragraph (c)(1) of this section.

(1) Within six months of either failing to complete the initial or any subsequent periodic safety factor assessment required by § 257.74(e) by the deadlines specified in § 257.74(f)(1) through (3) or failing to document that the calculated factors of safety for the new CCR surface impoundment achieve the minimum safety factors specified in § 257.74(e)(1)(i) through (v), the owner or operator of the CCR surface impoundment must cease placing CCR and non-CCR wastestreams into such CCR unit and close the CCR unit in accordance with the requirements of § 257.102.

(2) An owner or operator of an new CCR surface impoundment that closes in accordance with paragraph (c)(1) of this section must include a statement in the notification required under § 257.102(g) that the CCR surface impoundment is closing under the requirements of paragraph (c)(1) of this section.

(d) The owner or operator of an existing CCR landfill is subject to the requirements of paragraph (d)(1) of this section.

(1) Except as provided by paragraph (d)(3) of this section, within six months of determining that an existing CCR landfill has not demonstrated compliance with the location restriction for unstable areas specified in § 257.64(a), the owner or operator of the CCR unit must cease placing CCR and non-CCR waste streams into such CCR landfill and close the CCR unit in accordance with the requirements of § 257.102.

(2) An owner or operator of an existing CCR landfill that closes in accordance with paragraph (d)(1) of this section must include a statement in the notification required under § 257.102(g) that the CCR landfill is closing under the requirements of paragraph (d)(1) of this section.

(3) The timeframe specified in paragraph (d)(1) of this section does not apply if the owner or operator complies with the alternative closure procedures specified in § 257.103.

(e) Except as provided in paragraph (g) of this section, the owner or operator of a legacy CCR surface impoundment is subject to the requirements of paragraphs (e)(1) and (2) of this section.

(1) No later than Monday, May 8, 2028, an owner or operator of a legacy CCR surface impoundment must initiate the closure of the legacy CCR surface impoundment in accordance with the requirements of § 257.102.

(2) An owner or operator of a legacy CCR surface impoundment that closes in accordance with paragraph (e)(1) of this section must include a statement in the notification required under § 257.102(g) that the legacy CCR surface impoundment is closing under the requirement of paragraph (e)(1) of this section.

(f) Except as provided in paragraphs (g) and (h) of this section, the owner or operator of a CCR management unit must comply with the requirements of paragraphs (f)(1) and (2) of this section.

(1) No later than Tuesday, May 8, 2029, an owner or operator of a CCR management unit must initiate the closure of the CCR management unit in accordance with the requirements of § 257.102.

(2) An owner or operator of a CCR management unit that closes in accordance with paragraph (f)(1) of this section must include a statement in the notification required under § 257.102(g) that the CCR management unit is closing under the requirements of paragraph (f)(1) of this section.

(g) Deferral to permitting for closures conducted under substantially equivalent regulatory authority. Notwithstanding the provisions of paragraphs (e) and (f) of this section, the owner or operator of a CCR management unit or a legacy CCR surface impoundment need not demonstrate compliance with the performance standards in § 257.102(c) or (d) provided they demonstrate that the closure of the CCR unit met the standards specified in paragraphs (g)(1) through (g)(6) of this section.

(1) The owner or operator of the CCR unit must document that a regulatory authority played an active role in overseeing and approving the closure and any necessary corrective action, pursuant to an enforceable requirement. This includes a State or Federal permit, an administrative order, or consent order issued after 2015 under CERCLA or by an EPA-approved RCRA State program.

(2) The owner or operator of the CCR unit must document that the regulatory authority required or conducted a site-specific risk assessment prior to (or as part of) approving the closure and any necessary corrective action.

(3) The owner or operator of the CCR unit must document that it installed a groundwater monitoring system and performed groundwater monitoring that meets all of the following:

(i) Was capable of accurately representing background water quality;

(ii) Was capable of accurately representing the quality of water passing the waste boundary;

(iii) Was capable of detecting contamination in the uppermost aquifer; and

(iv) Monitored all potential contaminant pathways.

(4) Must document that the closed unit meets either:

(i) The performance standard in § 257.60; or

(ii) The performance standard in § 257.102(d)(2)(i).

(5) The owner or operator must include the following statement, signed by the owner or operator or an authorized representative, in the facility evaluation report for CCR management units specified in § 257.75 or applicability report for legacy CCR surface impoundments specified in § 257.100(f)(1) along with all information required by paragraphs (g)(1) through (4) of the section:

> I certify under penalty of law that I have personally examined and am familiar with the information submitted in this demonstration and all attached documents, and that, based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the submitted information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment.

(6) Closure equivalency determination at permitting. The owner or operator must submit the following documentation to the permit authority.

(i) A permit application that contains sufficient information, including data on contaminant levels in groundwater, to demonstrate that the applicable § 257.102 standards have been met.

(ii) EPA will review the information to determine whether the "equivalency" of the closure has been successfully demonstrated. If EPA or a Participating State Director determines that the closure has met the appropriate part 257 closure standard, EPA or a Participating State Director will issue a permit to require compliance with applicable post-closure requirements. If EPA or a Participating State Director determines that the closure does not meet the part 257 standards, the owner or operator will be required to submit a complete permit application and obtain a permit that contains the specific requirements necessary for the closed unit to achieve compliance with § 257.102.

(h) Deferral for CCR management units under critical infrastructure. Notwithstanding the provisions of paragraph (f)(1) of this section, the owner or operator of a CCR management unit located beneath critical infrastructure need not initiate closure until the infrastructure is no longer needed, EPA or a Participating State Director determines closure is necessary to ensure that there is no reasonable probability of adverse effects on human health or the environment, or the closure or decommissioning of the facility, whichever occurs first. Owners and operators of CCR management units under active disposal units must meet either:

(1) Demonstrate that the CCR management unit complies with the performance standard in § 257.60; or

(2) Demonstrate that the CCR management unit complies with the performance standard in § 257.102(d)(2)(i).

*[80 FR 21468, Apr. 17, 2015, as amended at 83 FR 36454, July 30, 2018; 85 FR 53561, Aug. 28, 2020; 85 FR 72542, Nov. 12, 2020; 89 FR 39108, May 8, 2024]*

## § 257.102 Criteria for conducting the closure or retrofit of CCR units and closure of CCR management units.

Link to an amendment published at 90 FR 4649, Jan. 16, 2025.

(a) ***General.*** Closure of a CCR unit must be completed either by leaving the CCR in place and installing a final cover system or through removal of the CCR and decontamination of the CCR unit, as described in paragraphs (b) through (j) of this section. Retrofit of a CCR surface impoundment must be completed in accordance with the requirements in paragraph (k) of this section.

(b) ***Written closure plan*** —

(1) ***Content of the plan.*** The owner or operator of a CCR unit must prepare a written closure plan that describes the steps necessary to close the CCR unit at any point during the active life of the CCR unit consistent with recognized and generally accepted good engineering practices. The written closure plan must include, at a minimum, the information specified in paragraphs (b)(1)(i) through (vi) of this section.

(i) A narrative description of how the CCR unit will be closed in accordance with this section.

(ii) If closure of the CCR unit will be accomplished through removal of CCR from the CCR unit, a description of the procedures to remove the CCR and decontaminate the CCR unit in accordance with paragraph (c) of this section.

(iii) If closure of the CCR unit will be accomplished by leaving CCR in place, a description of the final cover system, designed in accordance with paragraph (d) of this section, and the methods and procedures to be used to install the final cover. The closure plan must also discuss how the final cover system will achieve the performance standards specified in paragraph (d) of this section.

(iv) An estimate of the maximum inventory of CCR ever on-site over the active life of the CCR unit.

(v) An estimate of the largest area of the CCR unit ever requiring a final cover as required by paragraph (d) of this section at any time during the CCR unit's active life.

(vi) A schedule for completing all activities necessary to satisfy the closure criteria in this section, including an estimate of the year in which all closure activities for the CCR unit will be completed. The schedule should provide sufficient information to describe the sequential steps that will be taken to close the CCR unit, including identification of major milestones such as coordinating with and obtaining necessary approvals and permits from other agencies, the dewatering and stabilization phases of CCR surface impoundment closure, or installation of the final cover system, and the estimated timeframes to complete each step or phase of CCR unit closure. When preparing the written closure plan, if the owner or operator of a CCR unit estimates that the time required to complete closure will exceed the timeframes specified in paragraph (f)(1) of this section, the written closure plan must include the site-specific information, factors and considerations that would support any time extension sought under paragraph (f)(2) of this section.

(2) ***Timeframes for preparing the initial written closure plan*** —

(i) ***Existing CCR landfills and existing CCR surface impoundments.*** No later than October 17, 2016, the owner or operator of the CCR unit must prepare an initial written closure plan consistent with the requirements specified in paragraph (b)(1) of this section.

(ii) ***New CCR landfills and new CCR surface impoundments, and any lateral expansion of a CCR unit.*** No later than the date of the initial receipt of CCR in the CCR unit, the owner or operator must prepare an initial written closure plan consistent with the requirements specified in paragraph (b)(1) of this section.

(iii) ***CCR management units.*** Except as provided for in paragraph (b)(2)(v) of this section, no later than November 8, 2028, the owner or operator of the CCR management unit must prepare an initial written closure plan consistent with the requirements specified in paragraph (b)(1) of this section.

(iv) ***Recordkeeping.*** The owner or operator has completed the written closure plan when the plan, including the certification required by paragraph (b)(4) of this section, has been placed in the facility's operating record as required by § 257.105(i)(4).

(v) ***Closure documentation for certain CCR management units.*** Owners and operators of a CCR management unit that completed closure of the unit in accordance with § 257.102(d) prior to Friday, November 8, 2024 or that meet the requirements in § 257.101(g) must include in the facility evaluation report specified in § 257.75 information on the completed closure, along with supporting documentation to demonstrate that the closure meets the performance standards in § 257.102(d) or the standards specified in § 257.101(g).

(3) ***Amendment of a written closure plan.***

(i) The owner or operator may amend the initial or any subsequent written closure plan developed pursuant to paragraph (b)(1) of this section at any time.

(ii) The owner or operator must amend the written closure plan whenever:

(A) There is a change in the operation of the CCR unit that would substantially affect the written closure plan in effect; or

(B) Before or after closure activities have commenced, unanticipated events necessitate a revision of the written closure plan.

(iii) The owner or operator must amend the closure plan at least 60 days prior to a planned change in the operation of the facility or CCR unit, or no later than 60 days after an unanticipated event requires the need to revise an existing written closure plan. If a written closure plan is revised after closure activities have commenced for a CCR unit, the owner or operator must amend the current closure plan no later than 30 days following the triggering event.

(4) ***Certification or approval.*** The owner or operator of the CCR unit must obtain a written certification from a qualified professional engineer or approval from the Participating State Director or approval from EPA where EPA is the permitting authority that the initial and any amendment of the written closure plan meets the requirements of this section.

(c) ***Closure by removal of CCR.*** An owner or operator that elects to close a CCR unit by-removal of CCR must follow the procedures specified in either paragraph (c)(1) or (2) of this section. Closure by removal is complete when CCR has been removed; any areas affected by releases from the CCR unit have been removed or decontaminated; and groundwater monitoring concentrations of the constituents listed in appendix IV to this part do not exceed groundwater protection standards established pursuant to § 257.95(h). Removal and decontamination activities include removing all CCR from the unit, CCR mixed with soils, and CCR included in berms, liners or other unit structures, and removing or decontaminating all areas affected by releases from the CCR unit.

(1) ***Complete all removal and decontamination activities during the active life of the CCR unit.*** Within the timeframes specified in paragraph (f) of this section the owner or operator must do all of the following:

(i) Complete removal of CCR and decontamination of all areas affected by releases from the CCR unit;

(ii) Document that the standards in paragraph (c) of this section have been met. Documentation that groundwater protection standards have been met for the constituents listed in appendix IV to this part must consist of groundwater monitoring results that show no constituents were detected at statistically significant levels above the groundwater protection standards for either:

(A) Two consecutive monitoring events; or

(B) Three years, in accordance with § 257.98(c); and

(iii) Obtain the completion of closure certification or approval required by paragraph (f)(3) of this section.

(2) ***Complete removal and decontamination activities during the active life and post-closure care period of the CCR unit.*** The owner or operator may close a CCR unit by completing all removal and decontamination activities, except for groundwater corrective action, during the active life of the CCR unit and by completing groundwater corrective action during the post-closure care period pursuant to the following procedures:

(i) Within the timeframes specified in paragraph (f) of this section, document that CCR has been removed from the unit and any areas affected by releases from the CCR unit have been removed or decontaminated;

(ii) Within the timeframes specified in paragraph (f) of this section, begin implementation of the remedy selected in accordance with § 257.97 such that all components of the remedy are constructed, or otherwise in place, and operating as intended unless the owner or operator documents both that:

(A) All applicable requirements in §§ 257.96 through 257.98 have been met; and

(B) The active life of the unit could not be extended until implementation of the remedy consistent with § 257.102(f);

(iii) Complete groundwater corrective action as a post-closure care requirement as specified in § 257.104(g);

(iv) Amend the written closure plan required by paragraph (b) of this section and the written post-closure care plan required by § 257.104(d);

(v) Within the timeframes specified in paragraph (f) of this section, obtain the completion of closure certification or approval required by paragraph (f)(3) of this section; and

(vi) Within the timeframes specified in paragraph (f) of this section, record the notation on the deed to the property required by paragraph (i) of this section.

(d) ***Closure performance standard when leaving CCR in place*** —

(1) ***General performance standard.*** The owner or operator of a CCR unit must ensure that, at a minimum, the CCR unit is closed in a manner that will:

(i) Control, minimize or eliminate, to the maximum extent feasible, post-closure infiltration of liquids into the waste and releases of CCR, leachate, or contaminated run-off to the ground or surface waters or to the atmosphere;

(ii) Preclude the probability of future impoundment of water, sediment, or slurry;

(iii) Include measures that provide for major slope stability to prevent the sloughing or movement of the final cover system during the closure and post-closure care period;

(iv) Minimize the need for further maintenance of the CCR unit; and

(v) Be completed in the shortest amount of time consistent with recognized and generally accepted good engineering practices.

(2) ***Drainage and stabilization of CCR units.*** The owner or operator of any CCR unit must meet the requirements of paragraphs (d)(2)(i) and (ii) of this section prior to installing the final cover system required under paragraph (d)(3) of this section.

(i) Free liquids must be eliminated by removing liquid wastes or solidifying the remaining wastes and waste residues.

(ii) Remaining wastes must be stabilized sufficient to support the final cover system.

(3) ***Final cover system.*** If a CCR unit is closed by leaving CCR in place, the owner or operator must install a final cover system that is designed to minimize infiltration and erosion, and at a minimum, meets the requirements of paragraph (d)(3)(i) of this section, or the requirements of the alternative final cover system specified in paragraph (d)(3)(ii) of this section.

(i) The final cover system must be designed and constructed to meet the criteria in paragraphs (d)(3)(i)(A) through (D) of this section. The design of the final cover system must be included in the written closure plan required by paragraph (b) of this section.

(A) The permeability of the final cover system must be less than or equal to the permeability of any bottom liner system or natural subsoils present, or a permeability no greater than $1 \times 10^{-5}$ cm/sec, whichever is less.

(B) The infiltration of liquids through the closed CCR unit must be minimized by the use of an infiltration layer that contains a minimum of 18 inches of earthen material.

(C) The erosion of the final cover system must be minimized by the use of an erosion layer that contains a minimum of six inches of earthen material that is capable of sustaining native plant growth.

(D) The disruption of the integrity of the final cover system must be minimized through a design that accommodates settling and subsidence.

(ii) The owner or operator may select an alternative final cover system design, provided the alternative final cover system is designed and constructed to meet the criteria in paragraphs (d)(3)(ii)(A) through (C) of this section. The design of the final cover system must be included in the written closure plan required by paragraph (b) of this section.

(A) The design of the final cover system must include an infiltration layer that achieves an equivalent reduction in infiltration as the infiltration layer specified in paragraphs (d)(3)(i)(A) and (B) of this section.

(B) The design of the final cover system must include an erosion layer that provides equivalent protection from wind or water erosion as the erosion layer specified in paragraph (d)(3)(i)(C) of this section.

(C) The disruption of the integrity of the final cover system must be minimized through a design that accommodates settling and subsidence.

(iii) The owner or operator of the CCR unit must obtain a written certification from a qualified professional engineer or approval from the Participating State Director or approval from EPA where EPA is the permitting authority that the design of the final cover system meets the requirements of this section.

(e) ***Initiation of closure activities.*** Except as provided for in paragraph (e)(4) of this section and § 257.103, the owner or operator of a CCR unit must commence closure of the CCR unit no later than the applicable timeframes specified in either paragraph (e)(1) or (2) of this section.

(1) The owner or operator must commence closure of the CCR unit no later than 30 days after the date on which the CCR unit either:

(i) Receives the known final receipt of waste, either CCR or any non-CCR waste stream; or

(ii) Removes the known final volume of CCR from the CCR unit for the purpose of beneficial use of CCR.

(2)

(i) Except as provided by paragraph (e)(2)(ii) of this section, the owner or operator must commence closure of a CCR unit that has not received CCR or any non-CCR waste stream or is no longer removing CCR for the purpose of beneficial use within two years of the last receipt of waste or within two years of the last removal of CCR material for the purpose of beneficial use.

(ii) Notwithstanding paragraph (e)(2)(i) of this section, the owner or operator of the CCR unit may secure an additional two years to initiate closure of the idle unit provided the owner or operator provides written documentation that the CCR unit will continue to accept wastes or will start removing CCR for the purpose of beneficial use. The documentation must be supported by, at a minimum, the information specified in paragraphs (e)(2)(ii)(A) and (B) of this section. The owner or operator may obtain two-year extensions provided the owner or operator continues to be able to demonstrate that there is reasonable likelihood that the CCR unit will accept wastes in the foreseeable future or will remove CCR from the unit for the purpose of beneficial use. The owner or operator must place each completed demonstration, if more than one time extension is sought, in the facility's operating record as required by § 257.105(i)(5) prior to the end of any two-year period.

(A) Information documenting that the CCR unit has remaining storage or disposal capacity or that the CCR unit can have CCR removed for the purpose of beneficial use; and

(B) Information demonstrating that that there is a reasonable likelihood that the CCR unit will resume receiving CCR or non-CCR waste streams in the foreseeable future or that CCR can be removed for the purpose of beneficial use. The narrative must include a best estimate as to when the CCR unit will resume receiving CCR or non-CCR waste streams. The situations listed in paragraphs (e)(2)(ii)(B)(*1*) through (*4*) of this section are examples of situations that would support a determination that the CCR unit will resume receiving CCR or non-CCR waste streams in the foreseeable future.

(*1*) Normal plant operations include periods during which the CCR unit does not receive CCR or non-CCR waste streams, such as the alternating use of two or more CCR units whereby at any point in time one CCR unit is receiving CCR while CCR is being removed from a second CCR unit after its dewatering.

(*2*) The CCR unit is dedicated to a coal-fired boiler unit that is temporarily idled (*e.g.,* CCR is not being generated) and there is a reasonable likelihood that the coal-fired boiler will resume operations in the future.

(*3*) The CCR unit is dedicated to an operating coal-fired boiler (*i.e.,* CCR is being generated); however, no CCR are being placed in the CCR unit because the CCR are being entirely diverted to beneficial uses, but there is a reasonable likelihood that the CCR unit will again be used in the foreseeable future.

(*4*) The CCR unit currently receives only non-CCR waste streams and those non-CCR waste streams are not generated for an extended period of time, but there is a reasonable likelihood that the CCR unit will again receive non-CCR waste streams in the future.

(iii) In order to obtain additional time extension(s) to initiate closure of a CCR unit beyond the two years provided by paragraph (e)(2)(i) of this section, the owner or operator of the CCR unit must include with the demonstration required by paragraph (e)(2)(ii) of this section the following statement signed by the owner or operator or an authorized representative:

> I certify under penalty of law that I have personally examined and am familiar with the information submitted in this demonstration and all attached documents, and that, based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the submitted information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment.

(3) For purposes of this subpart, closure of the CCR unit has commenced if the owner or operator has ceased placing waste and completes any of the following actions or activities:

(i) Taken any steps necessary to implement the written closure plan required by paragraph (b) of this section;

(ii) Submitted a completed application for any required state or agency permit or permit modification; or

(iii) Taken any steps necessary to comply with any state or other agency standards that are a prerequisite, or are otherwise applicable, to initiating or completing the closure of a CCR unit.

(4) The timeframes specified in paragraphs (e)(1) and (2) of this section do not apply to any of the following owners or operators:

(i) [Reserved]

(ii) An owner or operator of an existing unlined CCR surface impoundment closing the CCR unit as required by § 257.101(a);

(iii) An owner or operator of an existing CCR surface impoundment closing the CCR unit as required by § 257.101(b);

(iv) An owner or operator of a new CCR surface impoundment closing the CCR unit as required by § 257.101(c); or

(v) An owner or operator of an existing CCR landfill closing the CCR unit as required by § 257.101(d).

(f) ***Completion of closure activities.***

(1) Except as provided for in paragraph (f)(2) of this section, the owner or operator must complete closure of the CCR unit:

(i) For existing and new CCR landfills and any lateral expansion of a CCR landfill, within six months of commencing closure activities.

(ii) For existing and new CCR surface impoundments and any lateral expansion of a CCR surface impoundment, within five years of commencing closure activities.

(iii) For CCR management units, within five years of commencing closure activities.

(2)

(i) ***Extensions of closure timeframes.*** The timeframes for completing closure of a CCR unit specified under paragraphs (f)(1) of this section may be extended if the owner or operator can demonstrate that it was not feasible to complete closure of the CCR unit within the required timeframes due to factors beyond the facility's control. If the owner or operator is seeking a time extension beyond the time specified in the written closure plan as required by paragraph (b)(1) of this section, the demonstration must include a narrative discussion providing the basis for additional time beyond that specified in the closure plan. The owner or operator must place each completed demonstration, if more than one time extension is sought, in the facility's operating record as required by § 257.105(i)(6) prior to the end of any two-year period. Factors that may support such a demonstration include:

(A) Complications stemming from the climate and weather, such as unusual amounts of precipitation or a significantly shortened construction season;

(B) Time required to dewater a CCR unit due to the volume of CCR contained in the CCR unit or the characteristics of the CCR in the unit;

(C) The geology and terrain surrounding the CCR unit will affect the amount of material needed to close the CCR unit; or

(D) Time required or delays caused by the need to coordinate with and obtain necessary approvals and permits from a state or other agency.

(ii) ***Maximum time extensions.***

(A) CCR surface impoundments of 40 acres or smaller may extend the time to complete closure by no longer than two years.

(B) CCR surface impoundments larger than 40 acres may extend the timeframe to complete closure of the CCR unit multiple times, in two-year increments. For each two-year extension sought, the owner or operator must substantiate the factual circumstances demonstrating the need for the extension. No more than a total of five two-year extensions may be obtained for any CCR surface impoundment.

(C) Except as provided in paragraph (f)(2)(ii)(D) of this section, CCR landfills may extend the timeframe to complete closure of the CCR unit multiple times, in one-year increments. For each one-year extension sought, the owner or operator must substantiate the factual circumstances demonstrating the need for the extension. No more than a total of two one-year extensions may be obtained for any CCR landfill.

(D) CCR landfills that intersect with groundwater are eligible for the time extensions available to CCR units in paragraph (f)(2)(ii)(B) of this section, provided the owner or operator documents that groundwater intersects the CCR unit in the closure plan.

(E) CCR management units of 40 acres or smaller may extend the time to complete closure by no longer than two years.

(F) CCR management units larger than 40 acres may extend the timeframe to complete closure of the CCR management unit multiple times, in two-year increments. For each two-year extension sought, the owner or operator must substantiate the factual circumstances demonstrating the need for the extension. No more than a total of five two-year extensions may be obtained for any CCR management unit.

(iii) In order to obtain additional time extension(s) to complete closure of a CCR unit beyond the times provided by paragraph (f)(1) of this section, the owner or operator of the CCR unit must include with the demonstration required by paragraph (f)(2)(i) of this section the following statement signed by the owner or operator or an authorized representative:

> I certify under penalty of law that I have personally examined and am familiar with the information submitted in this demonstration and all attached documents, and that, based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the submitted information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment.

(3) Upon completion, the owner or operator of the CCR unit must obtain a certification from a qualified professional engineer or approval from the Participating State Director or approval from EPA where EPA is the permitting authority verifying that closure has been completed in accordance with the closure plan specified in paragraph (b) of this section and the requirements of this section.

(g) ***Notification of intent to close.*** No later than the date the owner or operator initiates closure of a CCR unit, the owner or operator must prepare a notification of intent to close a CCR unit. The notification must include the certification by a qualified professional engineer or the approval from the Participating State Director or the approval from EPA where EPA is the permitting authority for the design of the final cover system as required by § 257.102(d)(3)(iii), if applicable. The owner or operator has completed the notification when it has been placed in the facility's operating record as required by § 257.105(i)(7).

(h) ***Notification of completion of closure.*** Within 30 days of completion of closure of the CCR unit, the owner or operator must prepare a notification of closure of a CCR unit. The notification must include the certification by a qualified professional engineer or the approval from the Participating State Director or the approval from EPA where EPA is the permitting authority as required by § 257.102(f)(3). The owner or operator has completed the notification when it has been placed in the facility's operating record as required by § 257.105(i)(8).

(i) ***Deed notations.***

(1) Except as provided by paragraph (i)(4) of this section, following closure of a CCR unit, the owner or operator must record a notation on the deed to the property, or some other instrument that is normally examined during title search.

(2) The notation on the deed must in perpetuity notify any potential purchaser of the property that:

(i) The land has been used as a CCR unit; and

(ii) Its use is restricted under the post-closure care requirements as provided by § 257.104(d)(1)(iii).

(3) Within 30 days of recording a notation on the deed to the property, the owner or operator must prepare a notification stating that the notation has been recorded. The owner or operator has completed the notification when it has been placed in the facility's operating record as required by § 257.105(i)(9).

(4) An owner or operator that closes a CCR unit in accordance with paragraph (c)(1) of this section is not subject to the requirements of paragraphs (i)(1) through (3) of this section.

(j) ***Recordkeeping, notification, and internet requirements.*** The owner or operator of the CCR unit must comply with the closure recordkeeping requirements specified in § 257.105(i), the closure notification requirements specified in § 257.106(i), and the closure internet requirements specified in § 257.107(i).

(k) ***Criteria to retrofit an existing CCR surface impoundment.***

(1) To retrofit an existing CCR surface impoundment, the owner or operator must:

(i) First remove all CCR, including any contaminated soils and sediments from the CCR unit; and

(ii) Comply with the requirements in § 257.72.

(iii) A CCR surface impoundment undergoing a retrofit remains subject to all other requirements of this subpart, including the requirement to conduct any necessary corrective action.

(2) ***Written retrofit plan*** —

(i) ***Content of the plan.*** The owner or operator must prepare a written retrofit plan that describes the steps necessary to retrofit the CCR unit consistent with recognized and generally accepted good engineering practices. The written retrofit plan must include, at a minimum, all of the following information:

(A) A narrative description of the specific measures that will be taken to retrofit the CCR unit in accordance with this section.

(B) A description of the procedures to remove all CCR and contaminated soils and sediments from the CCR unit.

(C) An estimate of the maximum amount of CCR that will be removed as part of the retrofit operation.

(D) An estimate of the largest area of the CCR unit that will be affected by the retrofit operation.

(E) A schedule for completing all activities necessary to satisfy the retrofit criteria in this section, including an estimate of the year in which retrofit activities of the CCR unit will be completed.

(ii) ***Timeframes for preparing the initial written retrofit plan.***

(A) No later than 60 days prior to date of initiating retrofit activities, the owner or operator must prepare an initial written retrofit plan consistent with the requirements specified in paragraph (k)(2) of this section. For purposes of this subpart, initiation of retrofit activities has commenced if the owner or operator has ceased placing waste in the unit and completes any of the following actions or activities:

(*1*) Taken any steps necessary to implement the written retrofit plan;

(*2*) Submitted a completed application for any required state or agency permit or permit modification; or

(*3*) Taken any steps necessary to comply with any state or other agency standards that are a prerequisite, or are otherwise applicable, to initiating or completing the retrofit of a CCR unit.

(B) The owner or operator has completed the written retrofit plan when the plan, including the certification required by paragraph (k)(2)(iv) of this section, has been placed in the facility's operating record as required by § 257.105(j)(1).

(iii) ***Amendment of a written retrofit plan.***

(A) The owner or operator may amend the initial or any subsequent written retrofit plan at any time.

(B) The owner or operator must amend the written retrofit plan whenever:

(*1*) There is a change in the operation of the CCR unit that would substantially affect the written retrofit plan in effect; or

(*2*) Before or after retrofit activities have commenced, unanticipated events necessitate a revision of the written retrofit plan.

(C) The owner or operator must amend the retrofit plan at least 60 days prior to a planned change in the operation of the facility or CCR unit, or no later than 60 days after an unanticipated event requires the revision of an existing written retrofit plan. If a written retrofit plan is revised after retrofit activities have commenced for a CCR unit, the owner or operator must amend the current retrofit plan no later than 30 days following the triggering event.

(iv) ***Certification or approval.*** The owner or operator of the CCR unit must obtain a written certification from a qualified professional engineer or an approval from the Participating State Director or an approval from EPA where EPA is the permitting authority that the activities outlined in the written retrofit plan, including any amendment of the plan, meet the requirements of this section.

(3) ***Deadline for completion of activities related to the retrofit of a CCR unit.*** Any CCR surface impoundment that is being retrofitted must complete all retrofit activities within the same time frames and procedures specified for the closure of a CCR surface impoundment in § 257.102(f) or, where applicable, § 257.103.

(4) ***Certification or approval.*** Upon completion, the owner or operator must obtain a written certification from a qualified professional engineer or an approval from the Participating State Director or an approval from EPA where EPA is the permitting authority verifying that the retrofit activities have been completed in accordance with the retrofit plan specified in paragraph (k)(2) of this section and the requirements of this section.

(5) ***Notification of intent to retrofit.*** No later than the date the owner or operator initiates the retrofit of a CCR unit, the owner or operator must prepare a notification of intent to retrofit a CCR unit. The owner or operator has completed the notification when it has been placed in the facility's operating record as required by § 257.105(j)(5).

(6) ***Notification of completion of retrofit activities.*** Within 30 days of completing the retrofit activities specified in paragraph (k)(1) of this section, the owner or operator must prepare a notification of completion of retrofit activities. The notification must include the certification from a qualified professional engineer or an approval from the Participating State Director or an approval from EPA where EPA is the permitting authority has is required by paragraph (k)(4) of this section. The owner or operator has completed the notification when it has been placed in the facility's operating record as required by § 257.105(j)(6).

(7) ***Cease retrofit and initiation of closure.*** At any time after the initiation of a CCR unit retrofit, the owner or operator may cease the retrofit and initiate closure of the CCR unit in accordance with the requirements of § 257.102.

(8) ***Recordkeeping, notification, and internet requirements.*** The owner or operator of the CCR unit must comply with the retrofit recordkeeping requirements specified in § 257.105(j), the retrofit notification requirements specified in § 257.106(j), and the retrofit internet requirements specified in § 257.107(j).

*[89 FR 39109, May 8, 2024]*

## § 257.103 Alternative closure requirements.

The owner or operator of a CCR landfill, CCR surface impoundment, or any lateral expansion of a CCR unit that is subject to closure pursuant to § 257.101(a), (b)(1), or (d) may nevertheless continue to receive the wastes specified in either paragraph (a), (b), (f)(1), or (f)(2) of this section in the unit provided the owner or operator meets all of the requirements contained in the respective paragraph.

(a) ***CCR landfills*** —

(1) ***No alternative CCR disposal capacity.*** Notwithstanding the provisions of § 257.101(d), a CCR landfill may continue to recieve CCR if the owner or operator of the CCR landfill certifies that the CCR must continue to be managed in that CCR landfill due to the absence of alternative disposal capacity both on and off-site of the facility. To qualify under this paragraph, the owner or operator of the CCR landfill must document that all of the following conditions have been met:

(i) No alternative disposal capacity is available on or off-site. An increase in costs or the inconvenience of existing capacity is not sufficient to support qualification under this section;

(ii) The owner or operator has made, and continues to make, efforts to obtain additional capacity. Qualification under this paragraph (a) lasts only as long as no alternative capacity is available. Once alternative capacity is identified, the owner or operator must arrange to use such capacity as soon as feasible;

(iii) The owner or operator must remain in compliance with all other requirements of this subpart, including the requirement to conduct any necessary corrective action; and

(iv) The owner or operator must prepare the annual progress report specified in paragraph (c) of this section documenting the continued lack of alternative capacity and the progress towards the development of alternative CCR disposal capacity.

(2) Once alternative capacity is available, the CCR landfill must cease receiving CCR and initiate closure following the timeframes in § 257.102(e).

(3) If no alternative capacity is identified within five years after the initial certification, the CCR landfill must cease receiving CCR and close in accordance with the timeframes in § 257.102(e) and (f).

(b) ***CCR landfills*** —

(1) ***Permanent cessation of a coal-fired boiler(s) by a date certain.*** Notwithstanding the provisions of § 257.101(d), a CCR landfill may continue to receive CCR if the owner or operator certifies that the facility will cease operation of the coal-fired boilers within the timeframe specified in paragraph (b)(4) of this section, but in the interim period (prior to closure of the coal-fired boiler), the facility must continue to use the CCR landfill due to the absence of alternative disposal capacity both on and off-site of the facility. To qualify under this paragraph, the owner or operator of the CCR landfill must document that all of the following conditions have been met:

(i) No alternative disposal capacity is available on or off-site. An increase in costs or the inconvenience of existing capacity is not sufficient to support qualification under this section.

(ii) The owner or operator must remain in compliance with all other requirements of this subpart, including the requirement to conduct any necessary corrective action; and

(iii) The owner or operator must prepare the annual progress report specified in paragraph (c) of this section documenting the continued lack of alternative capacity and the progress towards the closure of the coal-fired boiler.

(2)-(3) [Reserved]

(4) For a CCR landfill, the coal-fired boiler must cease operation, and the CCR landfill must complete closure no later than April 19, 2021.

(c) ***Required notices and progress reports for CCR landfills.*** An owner or operator of a CCR landfill that closes in accordance with paragraph (a) or (b) of this section must complete the notices and progress reports specified in paragraphs (c)(1) through (3) of this section.

(1) Within six months of becoming subject to closure pursuant to § 257.101(d), the owner or operator must prepare and place in the facility's operating record a notification of intent to comply with the alternative closure requirements of this section. The notification must describe why the CCR landfill qualifies for the alternative closure provisions under either paragraph (a) or (b) of this section, in addition to providing the documentation and certifications required by paragraph (a) or (b) of this section.

(2) The owner or operator must prepare the periodic progress reports required by paragraph (a)(1)(iv) or (b)(1)(iii) of this section, in addition to describing any problems encountered and a description of the actions taken to resolve the problems. The annual progress reports must be completed according to the following schedule:

(i) The first annual progress report must be prepared no later than 13 months after completing the notification of intent to comply with the alternative closure requirements required by paragraph (c)(1) of this section.

(ii) The second annual progress report must be prepared no later than 12 months after completing the first annual progress report. Subsequent annual progress reports must be prepared within 12 months of completing the previous annual progress report.

(iii) The owner or operator has completed the progress reports specified in this paragraph (c)(2) when the reports are placed in the facility's operating record as required by § 257.105(i)(11).

(3) An owner or operator of a CCR landfill must also prepare the notification of intent to close a CCR landfill as required by § 257.102(g).

(d) ***CCR landfill recordkeeping.*** The owner or operator of the CCR landfill must comply with the recordkeeping requirements specified in § 257.105(i), the notification requirements specified in § 257.106(i), and the internet requirements specified in § 257.107(i).

(e) [Reserved]

(f) ***Site-specific alternative deadlines to initiate closure of CCR surface impoundments.*** Notwithstanding the provisions of § 257.101(a) and (b)(1), a CCR surface impoundment may continue to receive the waste specified in paragraph (f)(1) or (2) of this section, provided the owner or operator submits a demonstration that the criteria in either paragraph (f)(1) or (2) of this section have been met. The demonstration must be submitted to the Administrator or the Participating State Director no later than the relevant deadline in paragraph (f)(3) of this section. The Administrator or the Participating State Director will act on the submission in accordance with the procedures in paragraph (f)(3) of this section.

(1) ***Development of alternative capacity is technically infeasible.*** Notwithstanding the provisions of § 257.101(a) and (b)(1), a CCR surface impoundment may continue to receive the waste specified in paragraph (f)(1)(ii)(A) or (B) of this section, provided the owner or operator demonstrates the wastestream(s) must continue to be managed in that CCR surface impoundment because it was technically infeasible to complete the measures necessary to provide alternative disposal capacity on or off-site of the facility by April 11, 2021. To obtain approval under this paragraph all of the following criteria must be met:

(i) No alternative disposal capacity is available on or off-site. An increase in costs or the inconvenience of existing capacity is not sufficient to support qualification under this section;

(ii)

(A) For units closing pursuant to § 257.101(a) and (b)(1)(i), CCR and/or non-CCR wastestreams must continue to be managed in that CCR surface impoundment because it was technically infeasible to complete the measures necessary to obtain alternative disposal capacity either on or off-site of the facility by April 11, 2021.

(B) For units closing pursuant to § 257.101(b)(1)(ii), CCR must continue to be managed in that CCR surface impoundment because it was technically infeasible to complete the measures necessary to obtain alternative disposal capacity either on or off-site of the facility by April 11, 2021.

(iii) The facility is in compliance with all of the requirements of this subpart.

(iv) The owner or operator of the CCR surface impoundment must submit documentation that the criteria in paragraphs (f)(1)(i) through (iii) of this section have been met by submitting to the Administrator or the Participating State Director all of the following:

(A) To demonstrate that the criteria in paragraphs (f)(1)(i) and (ii) of this section have been met the owner or operator must submit a workplan that contains all of the following elements:

(*1*) A written narrative discussing the options considered both on and off-site to obtain alternative capacity for each CCR and/or non-CCR wastestreams, the technical infeasibility of obtaining alternative capacity prior to April 11, 2021, and the option selected and justification for the alternative capacity selected. The narrative must also include all of the following:

(*i*) An in-depth analysis of the site and any site-specific conditions that led to the decision to select the alternative capacity being developed;

(*ii*) An analysis of the adverse impact to plant operations if the CCR surface impoundment in question were to no longer be available for use; and

(*iii*) A detailed explanation and justification for the amount of time being requested and how it is the fastest technically feasible time to complete the development of the alternative capacity;

(*2*) A detailed schedule of the fastest technically feasible time to complete the measures necessary for alternative capacity to be available including a visual timeline representation. The visual timeline must clearly show all of the following:

(*i*) How each phase and the steps within that phase interact with or are dependent on each other and the other phases;

(*ii*) All of the steps and phases that can be completed concurrently;

(*iii*) The total time needed to obtain the alternative capacity and how long each phase and step within each phase will take; and

(*iv*) At a minimum, the following phases: Engineering and design, contractor selection, equipment fabrication and delivery, construction, and start up and implementation.;

(*3*) A narrative discussion of the schedule and visual timeline representation, which must discuss all of the following:

(*i*) Why the length of time for each phase and step is needed and a discussion of the tasks that occur during the specific step;

(*ii*) Why each phase and step shown on the chart must happen in the order it is occurring;

(*iii*) The tasks that occur during each of the steps within the phase; and

(*iv*) Anticipated worker schedules; and

(*4*) A narrative discussion of the progress the owner or operator has made to obtain alternative capacity for the CCR and/or non-CCR wastestreams. The narrative must discuss all the steps taken, starting from when the owner or operator initiated the design phase up to the steps occurring when the demonstration is being compiled. It must discuss where the facility currently is on the timeline and the efforts that are currently being undertaken to develop alternative capacity.

(B) To demonstrate that the criteria in paragraph (f)(1)(iii) of this section have been met, the owner or operator must submit all of the following:

(*1*) A certification signed by the owner or operator that the facility is in compliance with all of the requirements of this subpart;

(*2*) Visual representation of hydrogeologic information at and around the CCR unit(s) that supports the design, construction and installation of the groundwater monitoring system. This includes all of the following:

(*i*) Map(s) of groundwater monitoring well locations in relation to the CCR unit(s);

(*ii*) Well construction diagrams and drilling logs for all groundwater monitoring wells; and

(*iii*) Maps that characterize the direction of groundwater flow accounting for seasonal variations;

(*3*) Constituent concentrations, summarized in table form, at each groundwater monitoring well monitored during each sampling event;

(*4*) A description of site hydrogeology including stratigraphic cross-sections;

(*5*) Any corrective measures assessment conducted as required at § 257.96;

(*6*) Any progress reports on corrective action remedy selection and design and the report of final remedy selection required at § 257.97(a);

(*7*) The most recent structural stability assessment required at § 257.73(d); and

(*8*) The most recent safety factor assessment required at § 257.73(e).

(v) As soon as alternative capacity for any CCR or non-CCR wastestream is available, the CCR surface impoundment must cease receiving that CCR or non-CCR wastestream. Once the CCR surface impoundment ceases receipt of all CCR and/or non-CCR wastestreams, the CCR surface impoundment must initiate closure following the timeframes in § 257.102(e) and (f).

(vi) ***Maximum time frames.*** All CCR surface impoundments covered by paragraph (f)(1) must cease receiving waste by the deadlines specified in paragraphs (f)(1)(vi)(A) and (B) of this section and close in accordance with the timeframes in § 257.102(e) and (f).

(A) Except as provided by paragraph (f)(1)(vi)(B) of this section, no later than October 15, 2023.

(B) An eligible unlined CCR surface impoundment must cease receiving CCR and/or non-CCR wastestreams no later than October 15, 2024. In order to continue to operate until October 15, 2024, the owner or operator must demonstrate that the unit meets the definition of an eligible unlined CCR surface impoundment.

(vii) An owner or operator may seek additional time beyond the time granted in the initial approval by making the showing in paragraphs (f)(1)(i) through (iv) of this section, provided that no facility may be granted time to operate the impoundment beyond the maximum allowable time frames provided in § 257.103(f)(1)(vi).

(viii) The owner or operator at all times bears responsibility for demonstrating qualification under this section. Failure to remain in compliance with any of the requirements of this subpart will result in the automatic loss of authorization under this section.

(ix) The owner or operator must:

(A) Upon submission of the demonstration to the Administrator or the Participating State Director, prepare and place in the facility's operating record a notification that it has submitted the demonstration, along with a copy of the demonstration. An owner or operator that claims CBI in the demonstration may post a redacted version of the demonstration to its publicly accessible CCR internet site provided that it contains sufficient detail so that the public can meaningfully comment on the demonstration.

(B) Upon receipt of a decision pursuant to paragraph (f)(3) of this section, must prepare and place in the facility's operating record a copy of the decision.

(C) If an extension of an approved deadline pursuant to paragraph (f)(1)(vii) of this section has been requested, place a copy of the request submitted to the Administrator or the Participating State Director in the facility's operating record.

(x) The owner or operator must prepare semi-annual progress reports. The semi-annual progress reports must contain all of the following elements:

(A) Discussion of the progress made to date in obtaining alternative capacity, including:

(*1*) Discussion of the current stage of obtaining the capacity in reference to the timeline required under paragraph (f)(1)(iv)(A) of this section;

(*2*) Discussion of whether the owner or operator is on schedule for obtaining alternative capacity;

(*3*) If the owner or operator is not on or ahead of schedule for obtaining alternative capacity, the following must be included:

(*i*) Discussion of any problems encountered, and a description of the actions taken or planned to resolve the problems and get back on schedule; and

(*ii*) Discussion of the goals for the next six months and major milestones to be achieved for obtaining alternative capacity; and

(B) Discussion of any planned operational changes at the facility.

(xi) The progress reports must be completed according to the following schedule:

(A) The semi-annual progress reports must be prepared no later than April 30 and October 31 of each year for the duration of the alternative cease receipt of waste deadline.

(B) The first semi-annual progress report must be prepared by whichever date, April 30 or October 31, is soonest after receiving approval from the Administrator or the Participating State Director; and

(C) The owner or operator has completed the progress reports specified in paragraph (f)(1)(x) of this section when the reports have been placed in the facility's operating record as required by § 257.105(i)(17).

(xii) The owner or operator must prepare the notification of intent to close a CCR surface impoundment as required by § 257.102(g).

(xiii) The owner or operator must comply with the recordkeeping requirements specified in § 257.105(i), the notification requirements specified in § 257.106(i), and the internet posting requirements in § 257.107(i).

(2) ***Permanent cessation of a coal-fired boiler(s) by a date certain.*** Notwithstanding the provisions of § 257.101(a), and (b)(1), a CCR surface impoundment may continue to receive CCR and/or non-CCR wastestreams if the facility will cease operation of the coal-fired boiler(s) and complete closure of the impoundment within the timeframes specified in paragraph (f)(2)(iv) of this section, but in the interim period (prior to closure of the coal-fired boiler), the facility must continue to use the CCR surface impoundment due to the absence of alternative disposal capacity both on and off-site of the facility. To qualify under this paragraph all of the following criteria must be met:

(i) No alternative disposal capacity is available on or off-site. An increase in costs or the inconvenience of existing capacity is not sufficient to support qualification under this section.

(ii) Potential risks to human health and the environment from the continued operation of the CCR surface impoundment have been adequately mitigated;

(iii) The facility is in compliance with all other requirements of this subpart, including the requirement to conduct any necessary corrective action; and

(iv) The coal-fired boilers must cease operation and closure of the impoundment must be completed within the following timeframes:

(A) For a CCR surface impoundment that is 40 acres or smaller, the coal-fired boiler(s) must cease operation and the CCR surface impoundment must complete closure no later than October 17, 2023.

(B) For a CCR surface impoundment that is larger than 40 acres, the coal-fired boiler(s) must cease operation, and the CCR surface impoundment must complete closure no later than October 17, 2028.

(v) The owner or operator of the CCR surface impoundment must submit the following documentation that the criteria in paragraphs (f)(2)(i) through (iv) of this section have been met as specified in paragraphs (f)(2)(v)(A) through (D) of this section.

(A) To demonstrate that the criteria in paragraph (f)(2)(i) of this section have been met the owner or operator must submit a narrative that explains the options considered to obtain alternative capacity for CCR and/or non-CCR wastestreams both on and off-site.

(B) To demonstrate that the criteria in paragraph (f)(2)(ii) of this section have been met the owner or operator must submit a risk mitigation plan describing the measures that will be taken to expedite any required corrective action, and that contains all of the following elements:

(*1*) A discussion of any physical or chemical measures a facility can take to limit any future releases to groundwater during operation.

(*2*) A discussion of the surface impoundment's groundwater monitoring data and any found exceedances; the delineation of the plume (if necessary based on the groundwater monitoring data); identification of any nearby receptors that might be exposed to current or future groundwater contamination; and how such exposures could be promptly mitigated.

(*3*) A plan to expedite and maintain the containment of any contaminant plume that is either present or identified during continued operation of the unit.

(C) To demonstrate that the criteria in paragraph (f)(2)(iii) of this section have been met, the owner or operator must submit all of the following:

(*1*) A certification signed by the owner or operator that the facility is in compliance with all of the requirements of this subpart;

(*2*) Visual representation of hydrogeologic information at and around the CCR unit(s) that supports the design, construction and installation of the groundwater monitoring system. This includes all of the following:

(*i*) Map(s) of groundwater monitoring well locations in relation to the CCR unit;

(*ii*) Well construction diagrams and drilling logs for all groundwater monitoring wells; and

(*iii*) Maps that characterize the direction of groundwater flow accounting for seasonal variations;

(*3*) Constituent concentrations, summarized in table form, at each groundwater monitoring well monitored during each sampling event;

(*4*) Description of site hydrogeology including stratigraphic cross-sections;

(*5*) Any corrective measures assessment required at § 257.96;

(*6*) Any progress reports on remedy selection and design and the report of final remedy selection required at § 257.97(a);

(*7*) The most recent structural stability assessment required at § 257.73(d); and

(*8*) The most recent safety factor assessment required at § 257.73(e).

(D) To demonstrate that the criteria in paragraph (f)(2)(iv) of this section have been met, the owner or operator must submit the closure plan required by § 257.102(b) and a narrative that specifies and justifies the date by which they intend to cease receipt of waste into the unit in order to meet the closure deadlines.

(vi) The owner or operator at all times bears responsibility for demonstrating qualification for authorization under this section. Failure to remain in compliance with any of the requirements of this subpart will result in the automatic loss of authorization under this section.

(vii) The owner or operator must comply with the recordkeeping requirements specified in § 257.105(i), the notification requirements specified in § 257.106(i), and the internet posting requirements in § 257.107(i).

(viii) Upon submission of the demonstration to the Administrator or the Participating State Director the owner or operator must prepare and place in the facility's operating record and on its publicly accessible CCR internet site a notification that is has submitted a demonstration along with a copy of the demonstration.

(ix) Upon receipt of a decision pursuant to paragraph (f)(3) of this section, the owner or operator must place a copy of the decision in the facility's operating record and on the facility's publicly accessible CCR internet site.

(x) The owner or operator must prepare an annual progress report documenting the continued lack of alternative capacity and the progress towards the closure of the CCR surface impoundment. The owner or operator has completed the progress report when the report has been placed in the facility's operating record as required by § 257.105(i)(20).

(3) ***Process to Obtain Authorization.***

(i) ***Deadlines for Submission.***

(A) Except as provided by § 257.71(d)(2)(iii)(E) and (viii), the owner or operator must submit the demonstration required under paragraph (f)(1)(iv) of this section, for an alternative deadline to cease receipt of waste pursuant to paragraph (f)(1) of this section, to the Administrator or the Participating State Director for approval no later than November 30, 2020.

(B) An owner or operator may seek additional time beyond the time granted in the initial approval, in accordance with paragraph (f)(1)(vii) of this section, by submitting a new demonstration, as required under paragraph (f)(1)(iv) of this section, to the Administrator or the Participating State Director for approval, no later than fourteen days from determining that the cease receipt of waste deadline will not be met.

(C) Except as provided by § 257.71(d)(2)(iii)(E) and (viii), the owner or operator must submit the demonstration required under paragraph (f)(2)(v) of this section to the Administrator for approval no later than November 30, 2020.

(ii) EPA will evaluate the demonstration and may request additional information to complete its review. Submission of a complete demonstration will toll the facility's deadline to cease receipt of waste until issuance of a decision under paragraph (f)(3)(iv) of this section. Incomplete submissions will not toll the facility's deadline and will be rejected without further process. All decisions issued under this paragraph or paragraph (f)(3)(iv) of this section will contain the facility's deadline to cease receipt of waste.

(iii) EPA will publish its proposed decision on a complete demonstration in a docket on *www.regulations.gov* for a 15-day comment period. If the demonstration is particularly complex, EPA will provide a comment period of 20 to 30 days.

(iv) After consideration of the comments, EPA will issue its decision on the alternative compliance deadline within four months of receiving a complete demonstration.

(4) ***Transferring between site-specific alternatives.*** An owner or operator authorized to continue operating a CCR surface impoundment under this section may at any time request authorization to continue operating the impoundment pursuant to another paragraph of subsection (f), by submitting the information in paragraph (f)(4)(i) or (ii) of this section.

(i) ***Transfer from § 257.103(f)(1) to § 257.103(f)(2).*** The owner or operator of a surface impoundment authorized to operate pursuant to paragraph (f)(1) of this section may request authorization to instead operate the surface impoundment in accordance with the requirements of paragraph (f)(2) of this section, by submitting a new demonstration that meets the requirements of paragraph (f)(2)(v) of this section to the Administrator or the Participating State Director. EPA will approve the request only upon determining that the criteria at paragraphs (f)(2)(i) through (iv) have been met.

(ii) ***Transfer from § 257.103(f)(2) to § 257.103(f)(1).*** The owner or operator of a surface impoundment authorized to operate pursuant to paragraph (f)(2) of this section may request authorization to instead operate the surface impoundment in accordance with the requirements of paragraph (f)(1) of this section, by submitting a new demonstration that meets the requirements of paragraph (f)(1)(iv) of this section to the Administrator or the Participating State Director. EPA will approve the request only upon determining that the criteria at paragraphs (f)(1)(i) through (iii) and (vi) of this section have been met.

(iii) The procedures in paragraph (f)(3) of this section will apply to all requests for transfer under this paragraph.

*[85 FR 53561, Aug. 28, 2020, as amended at 85 FR 72542, Nov. 12, 2020]*

## § 257.104 Post-closure care requirements.

(a) ***Applicability.***

(1) Except as provided by paragraph (a)(2) of this section, § 257.104 applies to the owners or operators of CCR units that are subject to the closure criteria under § 257.102.

(2) An owner or operator of a CCR unit that elects to close a CCR unit by removing CCR as provided by § 257.102(c)(1) is not subject to the post-closure care criteria under this section.

(b) ***Post-closure care maintenance requirements.*** Following closure of the CCR unit, the owner or operator must conduct post-closure care for the CCR unit, which must consist of at least the following:

(1) Maintaining the integrity and effectiveness of the final cover system, including making repairs to the final cover as necessary to correct the effects of settlement, subsidence, erosion, or other events, and preventing run-on and run-off from eroding or otherwise damaging the final cover;

(2) If the CCR unit is subject to the design criteria under § 257.70, maintaining the integrity and effectiveness of the leachate collection and removal system and operating the leachate collection and removal system in accordance with the requirements of § 257.70; and

(3) Maintaining the groundwater monitoring system and monitoring the groundwater in accordance with the requirements of §§ 257.90 through 257.98.

(c) ***Post-closure care period.***

(1) Except as provided by paragraph (c)(2) and (3) of this section, the owner or operator of the CCR unit must conduct post-closure care for 30 years.

(2) If at the end of the post-closure care period the owner or operator of the CCR unit is operating under assessment monitoring in accordance with § 257.95, the owner or operator must continue to conduct post-closure care until the owner or operator returns to detection monitoring in accordance with § 257.95.

(3) An owner or operator closing a unit pursuant to § 257.102(c)(2) must complete groundwater corrective action in accordance with § 257.98(c).

(d) ***Written post-closure plan*** —

(1) ***Content of the plan.*** The owner or operator of a CCR unit must prepare a written post-closure plan that includes, at a minimum, the information specified in paragraphs (d)(1)(i) through (iii) of this section.

(i) A description of the monitoring and maintenance activities required in paragraph (b) of this section for the CCR unit, and the frequency at which these activities will be performed;

(ii) The name, address, telephone number, and email address of the person or office to contact about the facility during the post-closure care period; and

(iii) A description of the planned uses of the property during the post-closure period. Post-closure use of the property shall not disturb the integrity of the final cover, liner(s), or any other component of the containment system, or the function of the monitoring systems unless necessary to comply with the requirements in this subpart. Any other disturbance is allowed if the owner or operator of the CCR unit demonstrates that disturbance of the final cover, liner, or other component of the containment system, including any removal of CCR, will not increase the potential threat to human health or the environment. The demonstration must be certified by a qualified professional engineer or approved by the Participating State Director or approved from EPA where EPA is the permitting authority, and notification shall be provided to the State Director that the demonstration has been placed in the operating record and on the owners or operator's publicly accessible internet site.

(2) ***Deadline to prepare the initial written post-closure plan*** —

(i) ***Existing CCR landfills and existing CCR surface impoundments.*** No later than October 17, 2016, the owner or operator of the CCR unit must prepare an initial written post-closure plan consistent with the requirements specified in paragraph (d)(1) of this section.

(ii) ***New CCR landfills, new CCR surface impoundments, and any lateral expansion of a CCR unit.*** No later than the date of the initial receipt of CCR in the CCR unit, the owner or operator must prepare an initial written post-closure plan consistent with the requirements specified in paragraph (d)(1) of this section.

(iii) ***CCR management units.*** No later than Wednesday, November 8, 2028, the owner or operator of a CCR management unit must prepare an initial written post-closure care plan as set forth in paragraph (d)(1) of this section.

(iv) ***Recordkeeping.*** The owner or operator has completed the written post-closure plan when the plan, including the certification required by paragraph (d)(4) of this section, has been placed in the facility's operating record as required by § 257.105(i)(4).

(3) ***Amendment of a written post-closure plan.***

(i) The owner or operator may amend the initial or any subsequent written post-closure plan developed pursuant to paragraph (d)(1) of this section at any time.

(ii) The owner or operator must amend the written closure plan whenever:

(A) There is a change in the operation of the CCR unit that would substantially affect the written post-closure plan in effect; or

(B) After post-closure activities have commenced, unanticipated events necessitate a revision of the written post-closure plan.

(iii) The owner or operator must amend the written post-closure plan at least 60 days prior to a planned change in the operation of the facility or CCR unit, or no later than 60 days after an unanticipated event requires the need to revise an existing written post-closure plan. If a written post-closure plan is revised after post-closure activities have commenced for a CCR unit, the owner or operator must amend the written post-closure plan no later than 30 days following the triggering event.

(4) The owner or operator of the CCR unit must obtain a written certification from a qualified professional engineer or an approval from the Participating State Director or an approval from EPA where EPA is the permitting authority that the initial and any amendment of the written post-closure plan meets the requirements of this section.

(e) ***Notification of completion of post-closure care period.*** No later than 60 days following the completion of the post-closure care period, the owner or operator of the CCR unit must prepare a notification verifying that post-closure care has been completed. The notification must include the certification by a qualified professional engineer or the approval from the Participating State Director or the approval from EPA where EPA is the permitting authority verifying that post-closure care has been completed in accordance with the closure plan specified in paragraph (d) of this section and the requirements of this section. The owner or operator has completed the notification when it has been placed in the facility's operating record as required by § 257.105(i)(13).

(f) The owner or operator of the CCR unit must comply with the recordkeeping requirements specified in § 257.105(i), the notification requirements specified in § 257.106(i), and the Internet requirements specified in § 257.107(i).

(g) ***Removal of a deed notation.*** The owner or operator of a CCR unit closed pursuant to §§ 257.102(c)(2) and 257.104 may remove the notation from the deed specified in § 257.102(i) upon:

(1) Completion of groundwater corrective action demonstrating that any areas affected by releases from the CCR unit do not exceed the groundwater protection standards established pursuant to § 257.95(h) for constituents listed in appendix IV to this part; and

(2) Completion of the notification of completion of post-closure care period required by paragraph (e) of this section.

*[80 FR 21468, Apr. 17, 2015, as amended at 81 FR 51808, Aug. 5, 2016; 83 FR 36455, July 30, 2018; 89 FR 39114, May 8, 2024]*

RECORDKEEPING, NOTIFICATION, AND POSTING OF INFORMATION TO THE INTERNET

## § 257.105 Recordkeeping requirements.

Link to an amendment published at 89 FR 88653, Nov. 8, 2024.

(a) ***Operating Record.*** Each owner or operator of a CCR unit subject to the requirements of this subpart must date and maintain files of all information required by this section in a written operating record at their facility. Each file must indicate the date the file was placed in the operating record.

(b) ***Document Retention.*** Unless specified otherwise, each file must be retained for at least five years following the date of each occurrence, measurement, maintenance, corrective action, report, record, or study.

(c) ***Recordkeeping for multiple CCR units.*** An owner or operator of more than one CCR unit subject to the provisions of this subpart may comply with the requirements of this section in one recordkeeping system provided the system identifies each file by the name of each CCR unit. The files may be maintained on microfilm, on a computer, on computer disks, on a storage system accessible by a computer, on magnetic tape disks, or on microfiche.

(d) ***State Director and/or appropriate Tribal authority notification.*** The owner or operator of a CCR unit must submit to the State Director and/or appropriate Tribal authority any demonstration or documentation required by this subpart, if requested, when such information is not otherwise available on the owner or operator's CCR website.

(e) ***Location restrictions.*** The owner or operator of a CCR unit subject to this subpart must place the demonstrations documenting whether or not the CCR unit is in compliance with the requirements under §§ 257.60(a), 257.61(a), 257.62(a), 257.63(a), and 257.64(a), as it becomes available, in the facility's operating record, except each location restrictions demonstration must be maintained for five years after completion of closure by removal in accordance with § 257.102(c) or until completion of post-closure care in accordance with § 257.104(e) or (g).

(f) ***Design criteria.*** The owner or operator of a CCR unit subject to this subpart must place the following information, as it becomes available, in the facility's operating record:

(1) The design and construction certifications as required by § 257.70(e) and (f), except each certification must be maintained for five years after completion of closure by removal in accordance with § 257.102(c) or until completion of post-closure care in accordance with § 257.104(e) or (g) irrespective of the time requirement specified in paragraph (b) of this section.

(2) The documentation of liner type as required by § 257.71(a), except each liner type documentation must be maintained for five years after completion of closure by removal in accordance with § 257.102(c) or until completion of post-closure care in accordance with § 257.104(e) or (g) irrespective of the time requirement specified in paragraph (b) of this section.

(3) The design and construction certifications as required by § 257.72(c) and (d), except each certification must be maintained for five years after completion of closure by removal in accordance with § 257.102(c) or until completion of post-closure care in accordance with § 257.104(e) or (g) irrespective of the time requirement specified in paragraph (b) of this section.

(4) Documentation prepared by the owner or operator stating that the permanent identification marker was installed as required by §§ 257.73(a)(1) and 257.74(a)(1), except each document must be maintained for five years after completion of closure by removal in accordance with § 257.102(c)(1) or until completion of post-closure care in accordance with § 257.104(e) irrespective of the time requirement specified in paragraph (b) of this section.

(5) The initial and periodic hazard potential classification assessments as required by §§ 257.73(a)(2) and 257.74(a)(2), except each hazard potential classification must be maintained for five years after completion of closure by removal in accordance with § 257.102(c) or until completion of post-closure care in accordance with § 257.104(e) or (g) irrespective of the time requirement specified in paragraph (b) of this section.

(6) The emergency action plan (EAP), and any amendment of the EAP, as required by §§ 257.73(a)(3) and 257.74(a)(3), except each EAP must be maintained for five years after completion of closure by removal in accordance with § 257.102(c) or until completion of post-closure care in accordance with § 257.104(e) or (g) irrespective of the time requirement specified in paragraph (b) of this section.

(7) Documentation prepared by the owner or operator recording the annual face-to-face meeting or exercise between representatives of the owner or operator of the CCR unit and the local emergency responders as required by §§ 257.73(a)(3)(i)(E) and 257.74(a)(3)(i)(E), except each document must be maintained for five years after completion of closure by removal in accordance with § 257.102(c)(1) or (2) or until completion of post-closure care in accordance with § 257.104(e) or (g) irrespective of the time requirement specified in paragraph (b) of this section.

(8) Documentation prepared by the owner or operator recording all activations of the emergency action plan as required by §§ 257.73(a)(3)(v) and 257.74(a)(3)(v), except each documentation of EAP activations must be maintained for five years after completion of closure by removal in accordance with § 257.102(c)(1) or (2) or until completion of post-closure care in accordance with § 257.104(e) or (g) irrespective of the time requirement specified in paragraph (b) of this section.

(9) The history of construction, and any revisions of it, as required by § 257.73(c), except each history of construction must be maintained for five years after completion of closure by removal in accordance with § 257.102(c)(1) or (2) or until completion of post-closure care in accordance with § 257.104(e) or (g) irrespective of the time requirement specified in paragraph (b) of this section.

(10) The initial and periodic structural stability assessments as required by §§ 257.73(d) and 257.74(d), except each structural stability assessment must be maintained for five years after completion of closure by removal in accordance with § 257.102(c)(1) or (2) or until completion of post-closure care in accordance with § 257.104(e) or (g) irrespective of the time requirement specified in paragraph (b) of this section.

(11) Documentation detailing the corrective measures taken to remedy the deficiency or release as required by §§ 257.73(d)(2) and 257.74(d)(2), except each document must be maintained for five years after completion of closure by removal in accordance with § 257.102(c)(1) or (2) or until completion of post-closure care in accordance with § 257.104(e) or (g) irrespective of the time requirement specified in paragraph (b) of this section.

(12) The initial and periodic safety factor assessments as required by §§ 257.73(e) and 257.74(e), except each safety factor assessment must be maintained for five years after completion of closure by removal in accordance with § 257.102(c)(1) or (2) or until completion of post-closure care in accordance with § 257.104(e) or (g) irrespective of the time requirement specified in paragraph (b) of this section.

(13) The design and construction plans, and any revisions of it, as required by § 257.74(c), except the design and construction plans must be maintained for five years after completion of closure by removal in accordance with § 257.102(c)(1) or (2) or until completion of post-closure care in accordance with § 257.104(e) or (g) irrespective of the time requirement specified in paragraph (b) of this section.

(14) The application and any supplemental materials submitted in support of the application as required by § 257.71(d)(1)(i)(E), except each application and supplemental materials must be maintained for five years after completion of closure by removal in accordance with § 257.102(c)(1) or (2) or until completion of post-closure care in accordance with § 257.104(e) or (g) irrespective of the time requirement specified in paragraph (b) of this section.

(15) The alternative liner demonstration as required by § 257.71(d)(1)(ii)(D).

(16) The alternative liner demonstration extension request as required by § 257.71(d)(2)(ii)(D).

(17) The documentation prepared for the preliminary demonstration as required by § 257.71(d)(2)(ii)(E).

(18) The notification of an incomplete application as required by § 257.71(d)(2)(iii)(B).

(19) The decision on the application as required by § 257.71(d)(2)(iii)(F), except each decision must be maintained for five years after completion of closure by removal in accordance with § 257.102(c)(1) or (2) or until completion of post-closure care in accordance with § 257.104(e) or (g) irrespective of the time requirement specified in paragraph (b) of this section.

(20) The final decision on the alternative liner demonstration as required by § 257.71(d)(2)(vii).

(21) The alternative source demonstration as required under § 257.71(d)(2)(ix)(A)(*4*).

(22) The final decision on the alternative source demonstration as required under § 257.71(d)(2)(ix)(A)(*5*).

(23) The final decision on the trend analysis as required under § 257.71(d)(2)(ix)(B)(*3*).

(24) The decision that the alternative source demonstration has been withdrawn as required under § 257.71(d)(2)(ix)(C).

(25) The facility evaluation report part 1 as required by § 257.75(c), except the facility evaluation report part 1 must be maintained for five years after completion of closure by removal in accordance with § 257.102(c)(1) or (2) or until completion of post-closure care in accordance with § 257.104(e) or (g) irrespective of the time requirement specified in paragraph (b) of this section.

(26) The facility evaluation report part 2 as required by § 257.75(d), except the facility evaluation report part 2 must be maintained for five years after completion of closure by removal in accordance with § 257.102(c)(1) or (2) or until completion of post-closure care in accordance with § 257.104(e) or (g) irrespective of the time requirement specified in paragraph (b) of this section.

(g) ***Operating criteria.*** The owner or operator of a CCR unit subject to this subpart must place the following information, as it becomes available, in the facility's operating record:

(1) The CCR fugitive dust control plan, and any subsequent amendment of the plan, required by § 257.80(b), except each fugitive dust control plan must be maintained for five years after closure by removal in accordance with § 257.102(c)(1) or (2) or completes post-closure care in accordance with § 257.104(e) or (g) is completed at the last CCR unit at the facility irrespective of the time requirement specified in paragraph (b) of this section.

(2) The annual CCR fugitive dust control report required by § 257.80(c), except each fugitive dust control report must be maintained for five years after closure by removal in accordance with § 257.102(c)(1) or (2) or post-closure care in accordance with § 257.104(e) or (g) is completed at the last CCR unit at the facility irrespective of the time requirement specified in paragraph (b) of this section.

(3) The initial and periodic run-on and run-off control system plans as required by § 257.81(c), except each plan must be maintained for five years after completion of closure by removal in accordance with § 257.102(c)(1) or (2) or until completion of post-closure care in accordance with § 257.104(e) or (g) irrespective of the time requirement specified in paragraph (b) of this section.

(4) The initial and periodic inflow design flood control system plan as required by § 257.82(c), except each plan must be maintained for five years after completion of closure by removal in accordance with § 257.102(c)(1) or (2) or until completion of post-closure care in accordance with § 257.104(e) or (g) irrespective of the time requirement specified in paragraph (b) of this section.

(5) Documentation recording the results of each inspection and instrumentation monitoring by a qualified person as required by § 257.83(a), except each document must be maintained for five years after completion of closure by removal in accordance with § 257.102(c)(1) or (2) or until completion of post-closure care in accordance with § 257.104(e) or (g) irrespective of the time requirement specified in paragraph (b) of this section.

(6) The periodic inspection report as required by § 257.83(b)(2), except each inspection report must be maintained for five years after completion of closure by removal in accordance with § 257.102(c)(1) or (2) or until completion of post-closure care in accordance with § 257.104(e) or (g) irrespective of the time requirement specified in paragraph (b) of this section.

(7) Documentation detailing the corrective measures taken to remedy the deficiency or release as required by §§ 257.83(b)(5) and 257.84(b)(5), except each document must be maintained for five years after completion of closure by removal in accordance with § 257.102(c)(1) or (2) or until completion of post-closure care in accordance with § 257.104(e) or (g) irrespective of the time requirement specified in paragraph (b) of this section.

(8) Documentation recording the results of the weekly inspection by a qualified person as required by § 257.84(a), except each inspection report must be maintained for five years after completion of closure by removal in accordance with § 257.102(c)(1) or (2) or until completion of post-closure care in accordance with § 257.104(e) or (g) irrespective of the time requirement specified in paragraph (b) of this section.

(9) The periodic inspection report as required by § 257.84(b)(2), except each inspection report must be maintained for five years after completion of closure by removal in accordance with § 257.102(c)(1) or (2) or until completion of post-closure care in accordance with § 257.104(e) or (g) irrespective of the time requirement specified in paragraph (b) of this section.

(h) ***Groundwater monitoring and corrective action.*** The owner or operator of a CCR unit subject to this subpart must place the following information, as it becomes available, in the facility's operating record:

(1) The annual groundwater monitoring and corrective action report as required by § 257.90(e), except each annual groundwater monitoring and corrective action report must be maintained for five years after the last CCR unit at the facility either completes closure by removal in accordance with § 257.102(c)(1) or completes post-closure care in accordance with § 257.104(e) irrespective of the time requirement specified in paragraph (b) of this section.

(2) Documentation of the design, installation, development, and decommissioning of any monitoring wells, piezometers and other measurement, sampling, and analytical devices as required by § 257.91(e)(1), except each document must be maintained for five years after completion of closure by removal in accordance with § 257.102(c)(1) or completion of post-closure care in accordance with § 257.104(e) irrespective of the time requirement specified in paragraph (b) of this section.

(3) The groundwater monitoring system certification as required by § 257.91(f), except each certification must be maintained for five years after completion of closure by removal in accordance with § 257.102(c)(1) or completion of post-closure care in accordance with § 257.104(e) irrespective of the time requirement specified in paragraph (b) of this section.

(4) The selection of a statistical method certification as required by § 257.93(f)(6), except each certification must be maintained for five years after completion of closure by removal in accordance with § 257.102(c)(1) or completion of post-closure care in accordance with § 257.104(e) irrespective of the time requirement specified in paragraph (b) of this section.

(5) Within 30 days of establishing an assessment monitoring program, the notification as required by § 257.94(e)(3).

(6) The results of appendices III and IV to this part constituent concentrations measured as required by § 257.95(d)(1).

(7) Within 30 days of returning to a detection monitoring program, the notification as required by § 257.95(e).

(8) Within 30 days of detecting one or more constituents in appendix IV to this part at statistically significant levels above the groundwater protection standard, the notifications as required by § 257.95(g).

(9) Within 30 days of initiating the assessment of corrective measures requirements, the notification as required by § 257.95(g)(5).

(10) The completed assessment of corrective measures as required by § 257.96(d), except each certification must be maintained for five years after completion of closure by removal in accordance with § 257.102(c)(1) or completion of post-closure care in accordance with § 257.104(e) irrespective of the time requirement specified in paragraph (b) of this section.

(11) Documentation prepared by the owner or operator recording the public meeting for the corrective measures assessment as required by § 257.96(e), except each certification must be maintained for five years after completion of closure by removal in accordance with § 257.102(c)(1) or completion of post-closure care in accordance with § 257.104(e) irrespective of the time requirement specified in paragraph (b) of this section.

(12) The semiannual report describing the progress in selecting and designing the remedy and the selection of remedy report as required by § 257.97(a), except that the selection of remedy report must be maintained until the remedy has been completed.

(13) Within 30 days of completing the remedy, the notification as required by § 257.98(e), except each notification must be maintained for five years after completion of the remedy selected pursuant to § 257.97 irrespective of the time requirement specified in paragraph (b) of this section.

(14) The demonstration, including long-term performance data, supporting the suspension of groundwater monitoring requirements as required by § 257.90(g), except each document must be maintained for five years after the last unit at the facility completes post-closure care in accordance with § 257.104(e) irrespective of the time requirement specified in paragraph (b) of this section.

(i) ***Closure and post-closure care.*** The owner or operator of a CCR unit subject to this subpart must place the following information, as it becomes available, in the facility's operating record:

(1) The notification of intent to initiate closure of the CCR unit as required by § 257.100(c)(1).

(2) The annual progress reports of closure implementation as required by § 257.100(c)(2)(i) and (ii).

(3) The notification of closure completion as required by § 257.100(c)(3).

(4) The written closure plan, and any amendment of the plan, as required by § 257.102(b), except that only the most recent closure plan must be maintained for five years after completion of closure by removal in accordance with § 257.102(c)(1) or completion of post-closure care in accordance with § 257.104(e) irrespective of the time requirement specified in paragraph (b) of this section.

(5) The written demonstration(s), including the certification required by § 257.102(e)(2)(iii), for a time extension for initiating closure as required by § 257.102(e)(2)(ii), except each demonstration must be maintained until notice of completion of closure is placed in the operating record in accordance with § 257.102(h) irrespective of the time requirement specified in paragraph (b) of this section.

(6) The written demonstration(s), including the certification required by § 257.102(f)(2)(iii), for a time extension for completing closure as required by § 257.102(f)(2)(i), except each demonstration must be maintained for five years after completion of closure in accordance with § 257.102(c) or (d) irrespective of the time requirement specified in paragraph (b) of this section.

(7) The notification of intent to close a CCR unit as required by § 257.102(g), except each notification must be maintained for five years after completion of closure in accordance with § 257.102(c) or (d) irrespective of the time requirement specified in paragraph (b) of this section.

(8) The notification of completion of closure of a CCR unit as required by § 257.102(h), except each notification must be maintained for five years after completion of closure by removal in accordance with § 257.102(c)(1) or completion of post-closure care in accordance with § 257.104(e) irrespective of the time requirement specified in paragraph (b) of this section.

(9) The notification recording a notation on the deed as required by § 257.102(i), except each notification must be maintained for five years after completion of post-closure care in accordance with § 257.104(e) irrespective of the time requirement specified in paragraph (b) of this section.

(10) The notification of intent to comply with the alternative closure requirements as required by § 257.103(c)(1), except each notification must be maintained for five years after completion of closure in accordance with § 257.102(c) or (d) irrespective of the time requirement specified in paragraph (b) of this section.

(11) The annual progress reports under the alternative closure requirements as required by § 257.103(c)(2), except each report must be maintained for five years after completion of closure in accordance with § 257.102(c) or (d) irrespective of the time requirement specified in paragraph (b) of this section.

(12) The written post-closure plan, and any amendment of the plan, as required by § 257.104(d), except that only the most recent post-closure plan must be maintained for five years after completion of post-closure care in accordance with § 257.104(e) irrespective of the time requirement specified in paragraph (b) of this section.

(13) The notification of completion of post-closure care period as required by § 257.104(e), except each notification must be maintained for five years after completion of post-closure care in accordance with § 257.104(e) irrespective of the time requirement specified in paragraph (b) of this section.

(14) The notification of intent to comply with the site-specific alternative to initiation of closure due to development of alternative capacity infeasible as required by § 257.103(f)(1)(ix)(A), except each notification must be maintained for five years after completion of closure by removal in accordance with § 257.102(c)(1) or (2) or until completion of post-closure care in accordance with § 257.104(e) or (g) irrespective of the time requirement specified in paragraph (b) of this section.

(15) The approved or denied demonstration for the site-specific alternative to initiation of closure due to development of alternative capacity infeasible as required by § 257.103(f)(1)(ix)(B), except each approval or denial must be maintained for five years after completion of closure by removal in accordance with § 257.102(c)(1) or (2) or until completion of post-closure care in accordance with § 257.104(e) or (g) irrespective of the time requirement specified in paragraph (b) of this section.

(16) The notification for requesting additional time to the alternative cease receipt of waste deadline as required by § 257.103(f)(1)(ix)(C), except each notification must be maintained for five years after completion of closure by removal in accordance with § 257.102(c)(1) or (2) or until completion of post-closure care in accordance with § 257.104(e) or (g) irrespective of the time requirement specified in paragraph (b) of this section.

(17) The semi-annual progress reports for the site-specific alternative to initiation of closure due to development of alternative capacity being infeasible as required by § 257.103(f)(1)(xi), except each semi-annual progress report must be maintained for five years after completion of closure by removal in accordance with § 257.102(c)(1) or (2) or until completion of post-closure care in accordance with § 257.104(e) or (g) irrespective of the time requirement specified in paragraph (b) of this section.

(18) The notification of intent to comply with the site-specific alternative to initiation of closure due to permanent cessation of a coal-fired boiler(s) by a date certain as required by § 257.103(f)(2)(viii), except each notification must be maintained for five years after completion of closure by removal in accordance with § 257.102(c)(1) or (2) or until completion of post-closure care in accordance with § 257.104(e) or (g) irrespective of the time requirement specified in paragraph (b) of this section.

(19) The approved or denied demonstration for the site-specific alternative to initiation of closure due to permanent cessation of a coal-fired boiler(s) by a date certain as required by § 257.103(f)(2)(ix), except each demonstration must be maintained for five years after completion of closure by removal in accordance with § 257.102(c)(1) or (2) or until completion of post-closure care in accordance with § 257.104(e) or (g) irrespective of the time requirement specified in paragraph (b) of this section.

(20) The annual progress report for the site-specific alternative to initiation of closure due to permanent cessation of a coal-fired boiler(s) by a date certain as required by § 257.103(f)(2)(x), except each annual progress report must be maintained for five years after completion of closure by removal in accordance with § 257.102(c)(1) or (2) or until completion of post-closure care in accordance with § 257.104(e) or (g) irrespective of the time requirement specified in paragraph (b) of this section.

(k) ***Legacy CCR surface impoundments.*** In addition to the information specified in paragraphs (e) through (j) of this section, the owner or operator of a legacy CCR surface impoundment subject to this subpart must place the following information, as it becomes available, in the facility's operating record:

(1) The applicability report required by § 257.100(f)(1), including the certification required by § 257.100(f)(1)(i), except each report must be maintained for five years after completion of closure by removal in accordance with § 257.102(c) or until completion of post-closure care in accordance with § 257.104(e) or (g) irrespective of the time requirement specified in paragraph (b) of this section.

(2) The applicability extension reports required by § 257.100(f)(1)(iii)(C), except each report must be maintained for five years after completion of closure by removal in accordance with § 257.102(c) or until completion of post-closure care in accordance with § 257.104(e) or (g) irrespective of the time requirement specified in paragraph (b) of this section.

(3) The notification of field investigation conclusion required by § 257.100(f)(1)(iii)(F), except the notification must be maintained for five years after completion of closure by removal in accordance with § 257.102(c) or until completion of post-closure care in accordance with § 257.104(e) or (g) irrespective of the time requirement specified in paragraph (b) of this section.

(4) The notification of intent to certify closure required by § 257.100(h)(1)(i), except the notification must be maintained for five years after completion of closure by removal in accordance with § 257.100(h)(1) or § 257.102(c)(2) irrespective of the time requirement specified in paragraph (b) of this section.

*[89 FR 39114, May 8, 2024]*

## § 257.106 Notification requirements.

(a) ***Deadline to submit notification to the relevant State Director and/or appropriate Tribal authority.*** The notifications required under paragraphs (e) through (i) of this section must be sent to the relevant State Director and/or appropriate Tribal authority before the close of business on the day the notification is required to be completed. For purposes of this section, *before the close of business* means the notification must be postmarked or sent by electronic mail (email). If a notification deadline falls on a weekend or federal holiday, the notification deadline is automatically extended to the next business day.

(b) ***Notifications to Tribal authority.*** If any CCR unit is located in its entirety within Indian Country, the notifications of this section must be sent to the appropriate Tribal authority. If any CCR unit is located in part within Indian Country, the notifications of this section must be sent both to the appropriate State Director and Tribal authority.

(c) ***Combining notifications.*** Notifications may be combined as long as the deadline requirement for each notification is met.

(d) ***Notification deadline after placement in operating record.*** Unless otherwise required in this section, the notifications specified in this section must be sent to the State Director and/or appropriate Tribal authority within 30 days of placing in the operating record the information required by § 257.105.

(e) ***Location restrictions.*** The owner or operator of a CCR unit subject to the requirements of this subpart must notify the State Director and/or appropriate Tribal authority that each demonstration specified under § 257.105(e) has been placed in the operating record and on the owner or operator's publicly accessible internet site.

(f) ***Design criteria.*** The owner or operator of a CCR unit subject to this subpart must notify the State Director and/or appropriate Tribal authority when information has been placed in the operating record and on the owner or operator's publicly accessible internet site. The owner or operator must:

(1) Within 60 days of commencing construction of a new CCR unit, provide notification of the availability of the design certification specified under § 257.105(f)(1) or (3). If the owner or operator of the CCR unit elects to install an alternative composite liner, the owner or operator must also submit to the State Director and/or appropriate Tribal authority a copy of the alternative composite liner design.

(2) No later than the date of initial receipt of CCR by a new CCR unit, provide notification of the availability of the construction certification specified under § 257.105(f)(1) or (3).

(3) Provide notification of the availability of the documentation of liner type specified under § 257.105(f)(2).

(4) Provide notification of the availability of the initial and periodic hazard potential classification assessments specified under § 257.105(f)(5).

(5) Provide notification of the availability of emergency action plan (EAP), and any revisions of the EAP, specified under § 257.105(f)(6).

(6) Provide notification of the availability of documentation prepared by the owner or operator recording the annual face-to-face meeting or exercise between representatives of the owner or operator of the CCR unit and the local emergency responders specified under § 257.105(f)(7).

(7) Provide notification of documentation prepared by the owner or operator recording all activations of the emergency action plan specified under § 257.105(f)(8).

(8) Provide notification of the availability of the history of construction, and any revision of it, specified under § 257.105(f)(9).

(9) Provide notification of the availability of the initial and periodic structural stability assessments specified under § 257.105(f)(10).

(10) Provide notification of the availability of the documentation detailing the corrective measures taken to remedy the deficiency or release specified under § 257.105(f)(11).

(11) Provide notification of the availability of the initial and periodic safety factor assessments specified under § 257.105(f)(12).

(12) Provide notification of the availability of the design and construction plans, and any revision of them, specified under § 257.105(f)(13).

(13) Provide notification of the availability of the application and any supplemental materials submitted in support of the application specified under § 257.105(f)(14).

(14) Provide notification of the availability of the alternative liner demonstration specified under § 257.105(f)(15).

(15) Provide notification of the availability of the alternative liner demonstration extension request specified under § 257.105(f)(16).

(16) Provide notification of the availability of the documentation prepared for the preliminary demonstration specified under § 257.105(f)(17).

(17) Provide notification of the availability of the notification of an incomplete application specified under § 257.105(f)(18).

(18) Provide notification of the availability of the decision on the application specified under § 257.105(f)(19).

(19) Provide notification of the availability of the final decision on the alternative liner demonstration specified under § 257.105(f)(20).

(20) Provide notification of the availability of the alternative source demonstration specified under § 257.105(f)(21).

(21) Provide notification of the availability of the final decision on the alternative source demonstration specified under § 257.105(f)(22).

(22) Provide notification of the final decision on the trend analysis specified under § 257.105(f)(23).

(23) Provide notification of the decision that the alternative source demonstration has been withdrawn specified under § 257.105(f)(24).

(24) Provide notification of the availability of the facility evaluation report part 1 as specified by § 257.105(f)(25).

(25) Provide notification of the availability of the facility evaluation report part 2 as specified by § 257.105(f)(26).

(g) ***Operating criteria.*** The owner or operator of a CCR unit subject to this subpart must notify the State Director and/or appropriate Tribal authority when information has been placed in the operating record and on the owner or operator's publicly accessible internet site. The owner or operator must:

(1) Provide notification of the availability of the CCR fugitive dust control plan, or any subsequent amendment of the plan, specified under § 257.105(g)(1).

(2) Provide notification of the availability of the annual CCR fugitive dust control report specified under § 257.105(g)(2).

(3) Provide notification of the availability of the initial and periodic run-on and run-off control system plans specified under § 257.105(g)(3).

(4) Provide notification of the availability of the initial and periodic inflow design flood control system plans specified under § 257.105(g)(4).

(5) Provide notification of the availability of the periodic inspection reports specified under § 257.105(g)(6).

(6) Provide notification of the availability of the documentation detailing the corrective measures taken to remedy the deficiency or release specified under § 257.105(g)(7).

(7) Provide notification of the availability of the periodic inspection reports specified under § 257.105(g)(9).

(h) ***Groundwater monitoring and corrective action.*** The owner or operator of a CCR unit subject to this subpart must notify the State Director and/or appropriate Tribal authority when information has been placed in the operating record and on the owner or operator's publicly accessible internet site. The owner or operator must:

(1) Provide notification of the availability of the annual groundwater monitoring and corrective action report specified under § 257.105(h)(1).

(2) Provide notification of the availability of the groundwater monitoring system certification specified under § 257.105(h)(3).

(3) Provide notification of the availability of the selection of a statistical method certification specified under § 257.105(h)(4).

(4) Provide notification that an assessment monitoring programs has been established specified under § 257.105(h)(5).

(5) Provide notification that the CCR unit is returning to a detection monitoring program specified under § 257.105(h)(7).

(6) Provide notification that one or more constituents in appendix IV to this part have been detected at statistically significant levels above the groundwater protection standard and the notifications to land owners specified under § 257.105(h)(8).

(7) Provide notification that an assessment of corrective measures has been initiated specified under § 257.105(h)(9).

(8) Provide notification of the availability of assessment of corrective measures specified under § 257.105(h)(10).

(9) Provide notification of the availability of the semiannual report describing the progress in selecting and designing the remedy and the selection of remedy report specified under § 257.105(h)(12).

(10) Provide notification of the completion of the remedy specified under § 257.105(h)(13).

(11) Provide the demonstration supporting the suspension of groundwater monitoring requirements specified under § 257.105(h)(14).

(i) ***Closure and post-closure care.*** The owner or operator of a CCR unit subject to this subpart must notify the State Director and/or appropriate Tribal authority when information has been placed in the operating record and on the owner or operator's publicly accessible Internet site. The owner or operator must:

(1) Provide notification of the intent to initiate closure of the CCR unit specified under § 257.105(i)(1).

(2) Provide notification of the availability of the annual progress reports of closure implementation specified under § 257.105(i)(2).

(3) Provide notification of closure completion specified under § 257.105(i)(3).

(4) Provide notification of the availability of the written closure plan, and any amendment of the plan, specified under § 257.105(i)(4).

(5) Provide notification of the availability of the demonstration(s) for a time extension for initiating closure specified under § 257.105(i)(5).

(6) Provide notification of the availability of the demonstration(s) for a time extension for completing closure specified under § 257.105(i)(6).

(7) Provide notification of intent to close a CCR unit specified under § 257.105(i)(7).

(8) Provide notification of completion of closure of a CCR unit specified under § 257.105(i)(8).

(9) Provide notification of the deed notation as required by § 257.105(i)(9).

(10) Provide notification of intent to comply with the alternative closure requirements specified under § 257.105(i)(10).

(11) The annual progress reports under the alternative closure requirements as required by § 257.105(i)(11).

(12) Provide notification of the availability of the written post-closure plan, and any amendment of the plan, specified under § 257.105(i)(12).

(13) Provide notification of completion of post-closure care specified under § 257.105(i)(13).

(14) Provide the notification of intent to comply with the site-specific alternative to initiation of closure due to development of alternative capacity infeasible as specified under § 257.105(i)(14).

(15) Provide the approved or denied demonstration for the site-specific alternative to initiation of closure due to development of alternative capacity infeasible as required by as specified under § 257.105(i)(15).

(16) Provide the notification for requesting additional time to the alternative cease receipt of waste deadline as required by § 257.105(i)(16).

(17) The semi-annual progress reports for the site-specific alternative to initiation of closure due to development of alternative capacity infeasible as specified under § 257.105(i)(17).

(18) Provide the notification of intent to comply with the site-specific alternative to initiation of closure due to permanent cessation of a coal-fired boiler(s) by a date certain as specified under § 257.105(i)(18).

(19) Provide the approved or denied demonstration for the site-specific alternative to initiation of closure due to permanent cessation of a coal-fired boiler(s) by a date certain as required by § 257.105(i)(19).

(20) The annual progress report for the site-specific alternative to initiation of closure due to permanent cessation of a coal-fired boiler(s) by a date certain as required by § 257.105(i)(20).

(j) ***Retrofit criteria.*** The owner or operator of a CCR unit subject to this subpart must notify the State Director and/or appropriate Tribal authority when information has been placed in the operating record and on the owner or operator's publicly accessible Internet site. The owner or operator must:

(1) Provide notification of the availability of the written retrofit plan, and any amendment of the plan, specified under § 257.105(j)(1).

(2) Provide notification of intent to comply with the alternative retrofit requirements specified under § 257.105(j)(2).

(3) The annual progress reports under the alternative retrofit requirements as required by § 257.105(j)(3).

(4) Provide notification of the availability of the demonstration(s) for a time extension for completing retrofit activities specified under § 257.105(j)(4).

(5) Provide notification of intent to initiate retrofit of a CCR unit specified under § 257.105(j)(5).

(6) Provide notification of completion of retrofit activities specified under § 257.105(j)(6).

(k) ***Legacy CCR surface impoundments.*** In addition to the information specified in paragraphs (e) through (j) of this section, the owner or operator of a legacy CCR surface impoundment subject to this subpart must notify the State Director and/or appropriate Tribal authority when information has been placed in the operating record and on the owner or operator's publicly accessible internet site. The owner or operator must:

(1) Provide notification of the availability of the applicability documentation as specified under § 257.105(k)(1).

(2) Provide notification of the availability of the applicability extension report as specified under § 257.105(k)(2).

(3) Provide notification of the availability of the notification as specified under § 257.105(k)(3).

(4) Provide notification of the availability of the intent to certify closure by removal certification as specified under § 257.105(k)(4).

*[80 FR 21468, Apr. 17, 2015, as amended at 83 FR 36456, July 30, 2018; 85 FR 53565, Aug. 28, 2020; 85 FR 72543, Nov. 12, 2020; 89 FR 39118, May 8, 2024]*

## § 257.107 Publicly accessible internet site requirements.

(a) ***CCR website requirement.*** Each owner or operator of a CCR unit subject to the requirements of this subpart must maintain a publicly accessible internet site (CCR website) containing the information specified in this section. The owner or operator's website must be titled “CCR Rule Compliance Data and Information.” The website must ensure that all information required to be posted is immediately available to anyone visiting the site, without requiring any prerequisite, such as registration or a requirement to submit a document request. All required information must be clearly identifiable and must be able to be immediately printed and downloaded by anyone accessing the site. If the owner/operator changes the web address (*i.e.,* Uniform Resource Locator (URL)) at any point, they must notify EPA via the “contact us” form on EPA's CCR website and the state director within 14 days of making the change. The facility's CCR website must also have a “contact us” form or a specific email address posted on the website for the public to use to submit questions and issues relating to the availability of information on the website.

(b) ***CCR website for multiple CCR units or combined websites for multiple regulatory programs.***

(1) An owner or operator of more than one CCR unit subject to the provisions of this subpart may comply with the requirements of this section by using the same internet site for multiple CCR units provided the CCR website clearly delineates information by the name or identification number of each unit.

(2) An owner or operator may maintain one website combining the postings required under this subpart with the postings required by other regulatory programs (*e.g.,* the “ELG Rule Compliance Data and Information” website required pursuant to § 423.19 of this chapter), provided the postings required for each regulatory program are delineated under a separate heading on the website.

(c) ***Document retention on a CCR website.*** Unless otherwise required in this section, the information required to be posted to the CCR website must be made available to the public for at least five years following the date on which the information was first posted to the CCR website.

(d) ***Website posting deadline after placement in operating record.*** Unless otherwise required in this section, the information must be posted to the CCR website within 30 days of placing the pertinent information required by § 257.105 in the operating record.

(e) ***Location restrictions.*** The owner or operator of a CCR unit subject to this subpart must place each demonstration specified under § 257.105(e) on the owner or operator's CCR website except each location restrictions demonstration must be posted for five years after completion of closure by removal in accordance with § 257.102(c) or until completion of post-closure care in accordance with § 257.104(e) irrespective of the time requirement specified in paragraph (c) of this section.

(f) ***Design criteria.*** The owner or operator of a CCR unit subject to this subpart must place the following information on the owner or operator's CCR website:

(1) Within 60 days of commencing construction of a new unit, the design certification specified under § 257.105(f)(1) or (3), except each certification must be posted for five years after completion of closure by removal in accordance with § 257.102(c) or until completion of post-closure care in accordance with § 257.104(e) or (g) irrespective of the time requirement specified in paragraph (c) of this section.

(2) No later than the date of initial receipt of CCR by a new CCR unit, the construction certification specified under § 257.105(f)(1) or (3), except each certification must be posted for five years after completion of closure by removal in accordance with § 257.102(c) or until completion of post-closure care in accordance with § 257.104(e) or (g), or until the liner is removed irrespective of the time requirement specified in paragraph (c) of this section, whichever is later.

(3) The documentation of liner type specified under § 257.105(f)(2), except each document must be posted for five years after completion of closure by removal in accordance with § 257.102(c) or until completion of post-closure care in accordance with § 257.104(e) or (g), or until the liner is removed irrespective of the time requirement specified in paragraph (c) of this section, whichever is later.

(4) The initial and periodic hazard potential classification assessments specified under § 257.105(f)(5), except only the two most recent hazard potential classification assessments must be posted for five years after completion of closure by removal in accordance with § 257.102(c) or until completion of post-closure care in accordance with § 257.104(e) or (g) irrespective of the time requirement specified in paragraph (c) of this section.

(5) The emergency action plan (EAP) specified under § 257.105(f)(6), except that only the most recent EAP must be maintained on the CCR website irrespective of the time requirement specified in paragraph (c) of this section.

(6) Documentation prepared by the owner or operator recording the annual face-to-face meeting or exercise between representatives of the owner or operator of the CCR unit and the local emergency responders specified under § 257.105(f)(7), except only the most recent documentation must be posted on the CCR website irrespective of the time requirement specified in paragraph (c) of this section.

(7) Documentation prepared by the owner or operator recording any activation of the emergency action plan specified under § 257.105(f)(8); if no activation in the last five years, documentation that includes that information irrespective of the time requirement specified in paragraph (c) of this section.

(8) The history of construction, and any revisions of it, specified under § 257.105(f)(9), except the history of constructions, and any revisions of it, must be posted for five years after completion of closure by removal in accordance with § 257.102(c) or until completion of post-closure care in accordance with § 257.104(e) or (g) irrespective of the time requirement specified in paragraph (c) of this section.

(9) The initial and periodic structural stability assessments specified under § 257.105(f)(10), except only the two most recent structural stability assessments must be posted for five years after completion of closure by removal in accordance with § 257.102(c) or until completion of post-closure care in accordance with § 257.104(e) or (g) irrespective of the time requirement specified in paragraph (c) of this section.

(10) The documentation detailing the corrective measures taken to remedy the deficiency or release specified under § 257.105(f)(11), except each document must be posted for five years after completion of closure by removal in accordance with § 257.102(c) or until completion of post-closure care in accordance with § 257.104(e) or (g) irrespective of the time requirement specified in paragraph (c) of this section.

(11) The initial and periodic safety factor assessments specified under § 257.105(f)(12), except only the two most recent safety factor assessments must be posted for five years after completion of closure by removal in accordance with § 257.102(c) or until completion of post-closure care in accordance with § 257.104(e) or (g) irrespective of the time requirement specified in paragraph (c) of this section.

(12) The design and construction plans, and any revisions of them, specified under § 257.105(f)(13), except each plan must be posted for five years after completion of closure by removal in accordance with § 257.102(c) or until completion of post-closure care in accordance with § 257.104(e) or (g) irrespective of the time requirement specified in paragraph (c) of this section.

(13) The application and any supplemental materials submitted in support of the application specified under § 257.105(f)(14), except each application must be posted for five years after completion of closure by removal in accordance with § 257.102(c) or until completion of post-closure care in accordance with § 257.104(e) or (g) irrespective of the time requirement specified in paragraph (c) of this section.

(14) The alternative liner demonstration specified under § 257.105(f)(15).

(15) The alternative liner demonstration specified under § 257.105(f)(16).

(16) The documentation prepared for the preliminary demonstration specified under § 257.105(f)(17).

(17) The notification of an incomplete application specified under § 257.105(f)(18).

(18) The decision on the application specified under § 257.105(f)(19), except each decision must be posted for five years after completion of closure by removal in accordance with § 257.102(c) or until completion of post-closure care in accordance with § 257.104(e) or (g) irrespective of the time requirement specified in paragraph (c) of this section.

(19) The final decision on the alternative liner demonstration specified under § 257.105(f)(20).

(20) The alternative source demonstration specified under § 257.105(f)(21).

(21) The final decision on the alternative source demonstration specified under § 257.105(f)(22).

(22) The final decision on the trend analysis specified under § 257.105(f)(23).

(23) The decision that the alternative source demonstration has been withdrawn specified under § 257.105(f)(24).

(24) The facility evaluation report part 1 as specified under § 257.105(f)(25), except each report must be posted for five years after completion of closure by removal in accordance with § 257.102(c) or until completion of post-closure care in accordance with § 257.104(e) or (g) irrespective of the time requirement specified in paragraph (c) of this section.

(25) The facility evaluation report part 2 as specified under § 257.105(f)(26), except each report must be posted for five years after completion of closure by removal in accordance with § 257.102(c) or until completion of post-closure care in accordance with § 257.104(e) or (g) irrespective of the time requirement specified in paragraph (c) of this section.

(g) ***Operating criteria.*** The owner or operator of a CCR unit subject to this subpart must place the following information on the owner or operator's CCR website:

(1) The CCR fugitive dust control plan, or any subsequent amendment of the plan, specified under § 257.105(g)(1) except that only the most recent plan must be maintained on the CCR website irrespective of the time requirement specified in paragraph (c) of this section until the last CCR unit at the facility completes closure by removal in accordance with § 257.102(c) or completes post-closure care in accordance with § 257.104(e) or (g) irrespective of the time requirement specified in paragraph (c) of this section.

(2) The annual CCR fugitive dust control report specified under § 257.105(g)(2). Each report must be posted for the duration specified in paragraph (c) of this section, except that the final report must be posted for five years after completion of closure by removal in accordance with § 257.102(c) or until completion of post-closure care in accordance with § 257.104(e) or (g) irrespective of the time requirement specified in paragraph (c) of this section.

(3) The initial and periodic run-on and run-off control system plans specified under § 257.105(g)(3), except each plan must be posted for five years after completion of closure by removal in accordance with § 257.102(c) or until completion of post-closure care in accordance with § 257.104(e) or (g) irrespective of the time requirement specified in paragraph (c) of this section.

(4) The initial and periodic inflow design flood control system plans specified under § 257.105(g)(4), except each plan must be posted for five years after completion of closure by removal in accordance with § 257.102(c) or until completion of post-closure care in accordance with § 257.104(e) or (g) irrespective of the time requirement specified in paragraph (c) of this section.

(5) The periodic inspection reports specified under § 257.105(g)(6). Each report must be posted for the duration specified in paragraph (c) of this section, except that the final report must be posted for five years after completion of closure by removal in accordance with § 257.102(c) or until completion of post-closure care in accordance with § 257.104(e) or (g) irrespective of the time requirement specified in paragraph (c) of this section.

(6) The documentation detailing the corrective measures taken to remedy the deficiency or release specified under § 257.105(g)(7). Each report must be posted for the duration specified in paragraph (c) of this section, except that the final documentation must be posted for five years after

completion of closure by removal in accordance with § 257.102(c) or until completion of post-closure care in accordance with § 257.104(e) or (g) irrespective of the time requirement specified in paragraph (c) of this section.

(7) The periodic inspection reports specified under § 257.105(g)(9). Each report must be posted for the duration specified in paragraph (c) of this section, except that the final report must be posted for five years after completion of closure by removal in accordance with § 257.102(c) or until completion of post-closure care in accordance with § 257.104(e) or (g) irrespective of the time requirement specified in paragraph (c) of this section.

(h) ***Groundwater monitoring and corrective action.*** The owner or operator of a CCR unit subject to this subpart must place the following information on the owner or operator's CCR website:

(1) The annual groundwater monitoring and corrective action report specified under § 257.105(h)(1). Each report must be posted for the duration specified in paragraph (c) of this section, except that the final report must be posted for five years after completion of closure by removal in accordance with § 257.102(c) or until completion of post-closure care in accordance with § 257.104(e) or (g) irrespective of the time requirement specified in paragraph (c) of this section.

(2) The groundwater monitoring system certification specified under § 257.105(h)(3), except each certification must be posted for five years after completion of closure by removal in accordance with § 257.102(c) or until completion of post-closure care in accordance with § 257.104(e) or (g) irrespective of the time requirement specified in paragraph (c) of this section.

(3) The selection of a statistical method certification specified under § 257.105(h)(4), except each certification must be posted for five years after completion of closure by removal in accordance with § 257.102(c) or until completion of post-closure care in accordance with § 257.104(e) or (g) irrespective of the time requirement specified in paragraph (c) of this section.

(4) The notification that an assessment monitoring programs has been established specified under § 257.105(h)(5).

(5) The notification that the CCR unit is returning to a detection monitoring program specified under § 257.105(h)(7).

(6) The notification that one or more constituents in appendix IV to this part have been detected at statistically significant levels above the groundwater protection standard and the notifications to land owners specified under § 257.105(h)(8).

(7) The notification that an assessment of corrective measures has been initiated specified under § 257.105(h)(9).

(8) The assessment of corrective measures specified under § 257.105(h)(10), except each assessment must be posted for five years after completion of closure by removal in accordance with § 257.102(c) or until completion of post-closure care in accordance with § 257.104(e) or (g) irrespective of the time requirement specified in paragraph (c) of this section.

(9) The semiannual reports describing the progress in selecting and designing remedy and the selection of remedy report specified under § 257.105(h)(12), except that the selection of the remedy report must be maintained until the remedy has been completed.

(10) The notification that the remedy has been completed specified under § 257.105(h)(13), except each notification must be posted for five years after completion of the remedy selected pursuant to in § 257.97 irrespective of the time requirement specified in paragraph (c) of this section.

(11) The demonstration supporting the suspension of groundwater monitoring requirements specified under § 257.105(h)(14), except each demonstration must be posted for five years after completion of closure by removal in accordance with § 257.102(c) or until completion of post-closure care in accordance with § 257.104(e) or (g) irrespective of the time requirement specified in paragraph (c) of this section.

(i) ***Closure and post-closure care.*** The owner or operator of a CCR unit subject to this subpart must place the following information on the owner or operator's CCR website:

(1) The notification of intent to initiate closure of the CCR unit specified under § 257.105(i)(1).

(2) The annual progress reports of closure implementation specified under § 257.105(i)(2).

(3) The notification of closure completion specified under § 257.105(i)(3).

(4) The written closure plan, and any amendment of the plan, specified under § 257.105(i)(4), except that only the most recent closure plan must be posted on the CCR website irrespective of the time requirement specified in paragraph (c) of this section and each closure plan must be maintained for five years after completion of closure by removal in accordance with § 257.102(c)(1) or completion of post-closure care in accordance with § 257.104(e) irrespective of the time requirement specified in paragraph (c) of this section.

(5) The demonstration(s) for a time extension for initiating closure specified under § 257.105(i)(5), except each demonstration must be posted until notice of completion of closure is placed in the operating record in accordance with § 257.102(h) irrespective of the time requirement specified in paragraph (c) of this section.

(6) The demonstration(s) for a time extension for completing closure specified under § 257.105(i)(6), except each demonstration must be posted for five years after completion of closure in accordance with § 257.102(c) or (d) irrespective of the time requirement specified in paragraph (c) of this section.

(7) The notification of intent to close a CCR unit specified under § 257.105(i)(7), except each notification must be posted for five years after completion of closure in accordance with § 257.102(c) or (d) irrespective of the time requirement specified in paragraph (c) of this section.

(8) The notification of completion of closure of a CCR unit specified under § 257.105(i)(8), except each notification must be posted for five years after completion of closure by removal in accordance with § 257.102(c)(1) or completion of post-closure care in accordance with § 257.104(e) irrespective of the time requirement specified in paragraph (c) of this section.

(9) The notification recording a notation on the deed as required by § 257.105(i)(9), except each notification must be posted for five years after completion of post-closure care in accordance with § 257.104(e) irrespective of the time requirement specified in paragraph (c) of this section.

(10) The notification of intent to comply with the alternative closure requirements as required by § 257.105(i)(10), except the notification must be posted for five years after completion of closure in accordance with § 257.102(c) or (d) irrespective of the time requirement specified in paragraph (c) of this section.

(11) The annual progress reports under the alternative closure requirements as required by § 257.105(i)(11), except the notification must be posted for five years after completion of closure in accordance with § 257.102(c) or (d) irrespective of the time requirement specified in paragraph (c) of this section.

(12) The written post-closure plan, and any amendment of the plan, specified under § 257.105(i)(12), except that only the most recent post-closure plan must be maintained for five years after completion of post-closure care in accordance with § 257.104(e) irrespective of the time requirement specified in paragraph (c) of this section.

(13) The notification of completion of post-closure care specified under § 257.105(i)(13), except that only the most recent post-closure plan must be maintained for five years after completion of post-closure care in accordance with § 257.104(e) irrespective of the time requirement specified in paragraph (c) of this section.

(14) The notification of intent to comply with the site-specific alternative to initiation of closure due to development of alternative capacity infeasible as specified under § 257.105(i)(14), except each notification must be posted for five years after completion of closure by removal in accordance with § 257.102(c)(1) or completion of post-closure care in accordance with § 257.104(e) irrespective of the time requirement specified in paragraph (c) of this section.

(15) The approved or denied demonstration for the site-specific alternative to initiation of closure due to development of alternative capacity infeasible as required by as specified under § 257.105(i)(15), except each approval or denial must be maintained for five years after completion of closure by removal in accordance with § 257.102(c) or until completion of post-closure care in accordance with § 257.104(e) or (g) irrespective of the time requirement specified in paragraph (c) of this section.

(16) The notification for requesting additional time to the alternative cease receipt of waste deadline as required by § 257.105(i)(16), except the notification must be maintained for five years after completion of closure by removal in accordance with § 257.102(c) or until completion of post-closure care in accordance with § 257.104(e) or (g) irrespective of the time requirement specified in paragraph (c) of this section.

(17) The semi-annual progress reports for the site-specific alternative to initiation of closure due to development of alternative capacity infeasible as specified under § 257.105(i)(17), except the progress report must be maintained for five years after completion of closure by removal in accordance with § 257.102(c) or until completion of post-closure care in accordance with § 257.104(e) or (g) irrespective of the time requirement specified in paragraph (c) of this section.

(18) The notification of intent to comply with the site-specific alternative to initiation of closure due to permanent cessation of a coal-fired boiler(s) by a date certain as specified under § 257.105(i)(18), except the notification must be maintained for five years after completion of closure by removal in accordance with § 257.102(c) or until completion of post-closure care in accordance with § 257.104(e) or (g) irrespective of the time requirement specified in paragraph (c) of this section.

(19) The approved or denied demonstration for the site-specific alternative to initiation of closure due to permanent cessation of a coal-fired boiler(s) by a date certain as required by § 257.105(i)(19), except the approval or denial must be maintained for five years after completion of closure by removal in accordance with § 257.102(c) or until completion of post-closure care in accordance with § 257.104(e) or (g) irrespective of the time requirement specified in paragraph (c) of this section.

(20) The annual progress report for the site-specific alternative to initiation of closure due to permanent cessation of a coal-fired boiler(s) by a date certain as required by § 257.105(i)(20), except the progress reports must be maintained for five years after completion of closure by removal in accordance with § 257.102(c) or until completion of post-closure care in accordance with § 257.104(e) or (g) irrespective of the time requirement specified in paragraph (c) of this section.

(j) ***Retrofit criteria.*** The owner or operator of a CCR unit subject to this subpart must place the following information on the owner or operator's CCR website:

(1) The written retrofit plan, and any amendment of the plan, specified under § 257.105(j)(1).

(2) The notification of intent to comply with the alternative retrofit requirements as required by § 257.105(j)(2).

(3) The annual progress reports under the alternative retrofit requirements as required by § 257.105(j)(3).

(4) The demonstration(s) for a time extension for completing retrofit activities specified under § 257.105(j)(4).

(5) The notification of intent to retrofit a CCR unit specified under § 257.105(j)(5).

(6) The notification of completion of retrofit activities specified under § 257.105(j)(6).

(k) ***Legacy CCR surface impoundments.*** In addition to the information specified in paragraphs (e) through (j) of this section, the owner or operator of a legacy CCR surface impoundment subject to this subpart must place the following information on the owner or operator's CCR website:

(1) The applicability report as specified under § 257.105(k)(1), except each report must be posted for five years after completion of closure by removal in accordance with § 257.102(c) or until completion of post-closure care in accordance with § 257.104(e) or (g) irrespective of the time requirement specified in paragraph (c) of this section.

(2) The applicability extension reports as specified under § 257.105(k)(2), except each report must be posted for five years after completion of closure by removal in accordance with § 257.102(c) or until completion of post-closure care in accordance with § 257.104(e) or (g) irrespective of the time requirement specified in paragraph (c) of this section.

(3) The notification of field investigation conclusion as specified under § 257.105(k)(3), except each notification must be posted for five years after completion of closure by removal in accordance with § 257.102(c) or until completion of post-closure care in accordance with § 257.104(e) or (g) irrespective of the time requirement specified in paragraph (c) of this section.

(4) The notification of intent to certify closure as specified under § 257.105(k)(4), except each notification must be posted for five years after completion of closure by removal in accordance with § 257.102(c) or until completion of post-closure care in accordance with § 257.104(e) or (g) irrespective of the time requirement specified in paragraph (c) of this section.

*[89 FR 39118, May 8, 2024]*

# ARROWHEAD LANDFILL
# 2025 VERTICAL EXPANSION

FOR

# ARROWHEAD ENVIRONMENTAL PARTNERS, LLC

PERRY COUNTY, ALABAMA

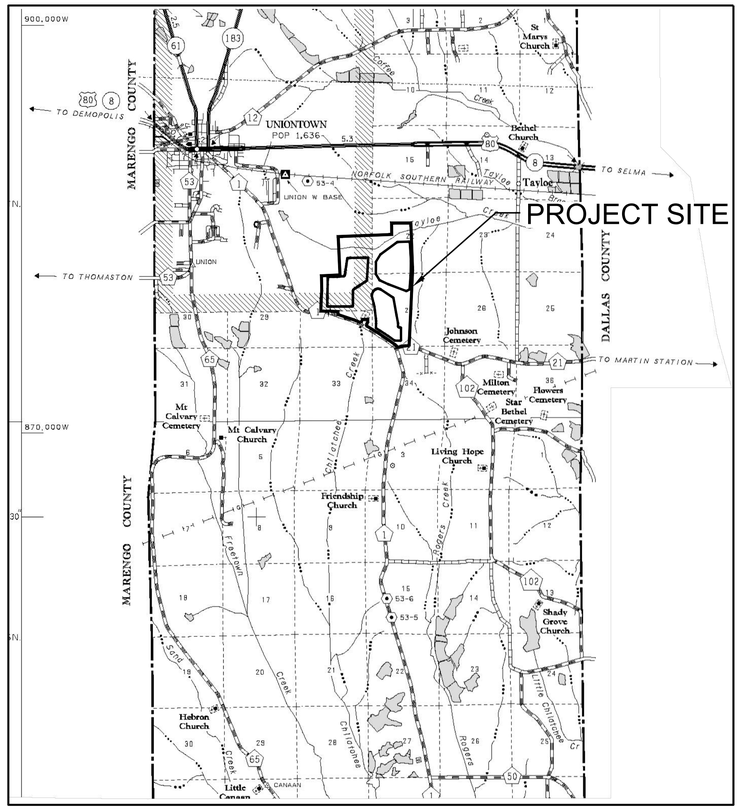
JANUARY 2025

## OWNER/OPERATOR

ARROWHEAD ENVIRONMENTAL PARTNERS, LLC
35 CHALLENGER ROAD, SUITE 312
RIDGEFIELD PARK, NJ

## PERMITTEE

PERRY COUNTY ASSOCIATES, LLC
35 CHALLENGER ROAD, SUITE 312
RIDGEFIELD PARK, NJ




PROJECT SITE LOCATION

SCALE: 1" = 1 MILE

ALABAMA LICENSED No. 31308 PROFESSIONAL ENGINEER K. MATTHEW CHEEK 1-31-25

HHNT

HODGES, HARBIN, NEWBERRY & TRIBBLE, INC.

*Consulting Engineers*

3920 ARKWRIGHT ROAD, SUITE 101
MACON, GEORGIA 31210
(478) 743-7175

ALABAMA LICENSED NO. 32851 PROFESSIONAL ENGINEER KEVIN GEORGE BERRY 1-31-2025

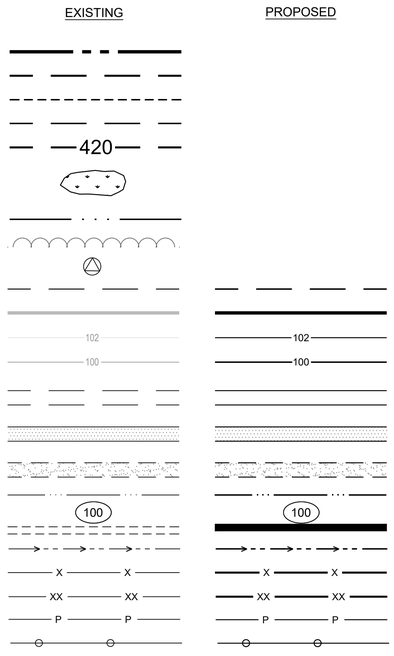
## REVISION HISTORY

| DATE | SHEET NO. |
|---|---|
| | |
| | |
| | |
| | |
| | |

# INDEX TO DRAWINGS

| SHEET NO. | DESCRIPTION |
|---|---|
| - | TITLE SHEET |
| 1 | INDEX TO DRAWINGS AND LEGEND |
| 2 | BOUNDARY SURVEY |
| 3 | EXISTING TOPOGRAPHIC CONDITIONS - TRACTS 1, 2, & 3 |
| 4 | TOP OF CLAY LINER GRADING PLAN - TRACTS 1, 2, & 3 |
| 5 | TOP OF CLAY LINER GRADING PLAN AND LEACHATE COLLECTION PLAN - TRACT 1 |
| 6 | TOP OF CLAY LINER GRADING PLAN AND LEACHATE COLLECTION PLAN - TRACT 2 |
| 7 | TOP OF CLAY LINER GRADING PLAN AND LEACHATE COLLECTION PLAN - TRACT 3 |
| 8 | FINAL GRADING PLAN - TRACTS 1, 2, & 3 |
| 9 | FINAL GRADING AND DRAINAGE PLAN - TRACT 1 |
| 10 | FINAL GRADING AND DRAINAGE PLAN - TRACT 2 |
| 11 | FINAL GRADING AND DRAINAGE PLAN - TRACT 3 |
| 12 | CROSS SECTIONS A&B - TRACT 1 |
| 13 | CROSS SECTIONS A&B - TRACT 2 |
| 14 | CROSS SECTION C - TRACT 2 |
| 15 | CROSS SECTION A - TRACT 3 |
| 16 | CROSS SECTION B - TRACT 3 |
| 17 | WASTE SOLIDIFICATION PLAN |
| 18-20 | MISCELLANEOUS DETAILS |
| EMP-1 | ENVIRONMENTAL MONITORING NETWORK |

## LEGEND




| | EXISTING | PROPOSED |
|---|---|---|
| PROPERTY LINE | | BUILDING |
| UNDISTURBED PROPERTY BUFFER | | |
| STREAM AND WETLAND BUFFER | GWC-2 | GWC-21 GROUNDWATER MONITORING WELL |
| FLOODPLAIN | MM-10 | MM-2 METHANE MONITORING PROBE |
| GROUNDWATER CONTOUR | MM-10 | MM-10 METHANE MONITORING BAR HOLE PUNCH |
| JURISDICTIONAL WETLAND | SWC-7TL | SWC-2 SURFACE WATER MONITORING POINT |
| JURISDICTIONAL STREAM | | OUTLET PROTECTION |
| TREELINE | | STONE CHECK DAM |
| BENCHMARK | | HAY BALE CHECK DAM |
| EASEMENT | | FLARED END SECTION |
| EDGE OF CELL | | INLET PROTECTION |
| 2' CONTOUR | | CONSTRUCTION EXIT |
| 10' CONTOUR | | NPDES SAMPLING POINT |
| UNPAVED ROAD | | HEADWALL |
| PAVED ROAD | | DROP INLET |
| GRAVEL ROAD | | OVERFLOW STRUCTURE |
| DITCH CENTERLINE | | GATE |
| STORM DRAINAGE PIPE | PZ-1 | PZ-1 PIEZOMETER |
| STORM WATER DIVERSION BERM | 100.00 | 100.00 SPOT ELEVATION |
| SINGLE ROW SILT FENCE | | MARKER POST |
| DOUBLE ROW SILT FENCE | | DOWNDRAIN PIPE AND SLOPED PAVED INLET HEADWALL (INLET EL. 500, 20, INLET EL. 480, 1) |
| POWER LINE | | SEDIMENT TRAP |
| FENCE | | EXCELSIOR SLOPE MATTING |
| | | STORM MH |

ALABAMA LICENSED No. 31360 PROFESSIONAL ENGINEER MATTHEW CHEEK 1-31-25

ALABAMA LICENSED NO. 22951 PROFESSIONAL ENGINEER KEVIN GEORGE BERRY

INDEX TO DRAWINGS AND LEGEND

# ARROWHEAD LANDFILL
# 2025 VERTICAL EXPANSION

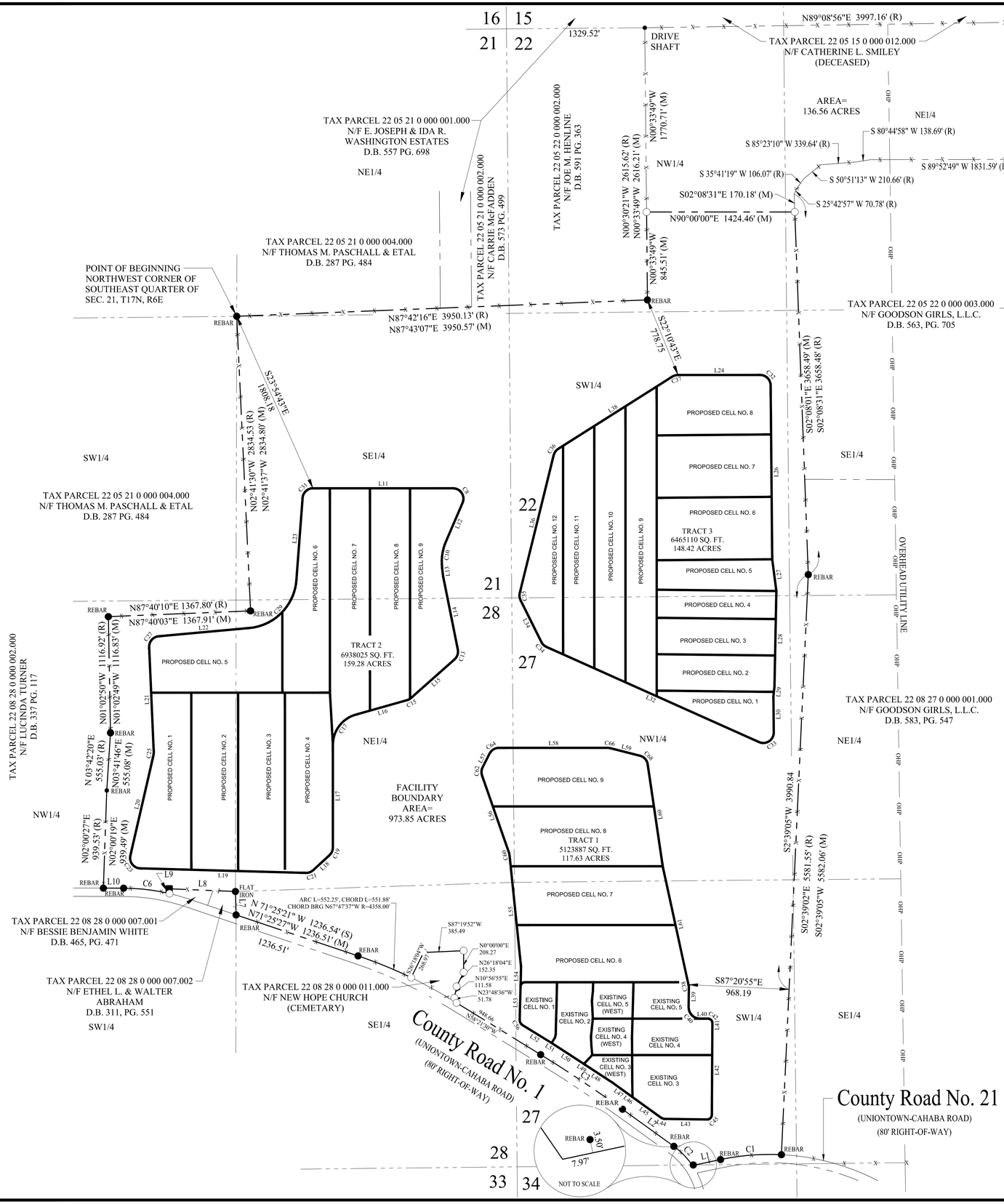
FOR

ARROWHEAD ENVIRONMENTAL PARTNERS, LLC

PERRY COUNTY, ALABAMA


HHNT
HODGES, HARBIN, NEWBERRY & TRIBBLE, INC.
Consulting Engineers
(478) 743-7175
(478) 743-7175 (FAX)
3920 ARKWRIGHT RD.
SUITE 101
MACON, GEORGIA 31210


| | | | |
|---|---|---|---|
| PROJ. NO. | 6215-018-01 | AH-2025VE-1-INDEX.DWG | EDIT 1-29-2025 |
| SCALE | N.T.S. | SHEET 1 OF 20 | |
| DATE | JANUARY 2025 | | |




## REFERENCES

D.B. 581, PG. 378
PLAT BY AUTERY LAND SURVEYING, TITLED "BOUNDARY SURVEY SEC. 21, 22, 23, 26, 27 & 28, T17N, R6E", DATED AUGUST 3, 2006.

## NOTES

1. THE BEARING BASIS IS FROM SITE MONUMENTATION/DEED REFERENCE.
2. NO UNDERGROUND UTILITIES WERE LOCATED AS PART OF THIS SURVEY.

## LEGEND

- 3/4" REBAR FOUND
- 1/2" REBAR SET
- CONCRETE MONUMENT FOUND
- PROPERTY LINE
- UTILITY POLE
- FENCE
- OVERHEAD POWER, TELEPHONE AND CATV (OHP,T,TV)
- ASPHALT

| RECORD CALLS | | |
|---|---|---|
| LINE | BEARING | DISTANCE |
| L1 | S 77°59'12" W | 275.30'(S) |
| L2 | N 54°11'26" W | 609.21'(S) |
| L7 | N 01°38'32" W | 225.19'(S) |
| L8 | N 87°41'01" W | 637.54'(S) |
| L9 | S 05°04'19" E | 45.35'(S) |
| L10 | N 89°51'10" W | 195.21'(S) |

| RECORD CALLS | | | | |
|---|---|---|---|---|
| CURVE | RADIUS | ARC LENGTH | CHORD LENGTH | CHORD BEARING |
| C1 | 2265.00' | 588.56' | 586.91' | S 85°25'51" W |
| C2 | 745.00' | 258.63' | 257.33' | N 44°15'34" W |
| C3 | 13040.00' | 945.79' | 945.58' | N 56°17'06" W |
| C6 | 1960.00' | 445.19' | 444.23' | N 83°20'45" W |

| MEASURED CALLS | | |
|---|---|---|
| LINE | BEARING | DISTANCE |
| L1 | S77°58'49"W | 275.27(M) |
| L2 | N54°10'16"W | 609.05(M) |
| L7 | N01°36'46"W | 225.40(M) |
| L8 | N87°40'45"W | 637.42(M) |
| L9 | S04°49'43"E | 45.84(M) |
| L10 | N89°49'51"W | 195.19(M) |

| MEASURED CALLS | | | | |
|---|---|---|---|---|
| CURVE | RADIUS | ARC LENGTH | CHORD LENGTH | CHORD BEARING |
| C1 | 2265.00' | 588.61' | 586.95' | N85°27'01"E |
| C2 | 745.00' | 258.63' | 257.33' | N44°14'52"W |
| C3 | 13040.00' | 945.76' | 945.56' | N56°16'33"W |
| C6 | 1960.00' | 445.19' | 444.23' | N83°19'26"W |

"I HEREBY CERTIFY (OR STATE) THAT ALL PARTS OF THIS SURVEY AND DRAWING HAVE BEEN COMPLETED IN ACCORDANCE WITH THE CURRENT REQUIREMENTS OF THE STANDARDS OF PRACTICE FOR SURVEYING IN THE STATE OF ALABAMA TO THE BEST OF MY KNOWLEDGE, INFORMATION, AND BELIEF."

SURVOR'S SIGNATURE:
ALABAMA LICENSE NUMBER: 29992
DATE: 1-25-16

ALABAMA LICENSED No. 29992 PROFESSIONAL LAND SURVEYOR CARL B. LEVI

500 0 500 1000 1500
GRAPHIC SCALE IN FEET

| NO. | DATE | DESCRIPTION |
|---|---|---|
| 1 | 1-25-16 | SHOWED NEW PROPERT LINE FOR NEW HOPE CHURCH |

THESE DOCUMENTS, AS INSTRUMENTS OF SERVICE, REMAIN THE PROPERTY OF WELLSTON ASSOCIATES LAND SURVEYORS, INC., AND SHALL NOT BE REUSED OR MODIFIED WITHOUT WRITTEN CONSENT.


WELLSTON ASSOCIATES
LAND SURVEYORS, LLC
506 OSIGIAN BOULEVARD, SUITE 2
WARNER ROBINS, GEORGIA 31088
OFFICE (478) 971-3382
FAX (478) 971-1400


BOUNDARY SURVEY

ARROWHEAD LANDFILL
PERRY COUNTY ASSOCIATES, LLC
OF
SECTIONS 21, 22, 23, 26, 27 & 28 T17N R6E

PERRY COUNTY
SEC. 21, 22, 27 & 28

ALABAMA
R-16-E

T-17-N

Pr: 1 2
Dr: 1 2
Dr: B
C: d B
S.H.:
R.L.S. N: 2
D: UL: 1 2.11
S: 1"=5
S: N:
1 2

Plotted By: SHAWN
Plot Date: Jan 25, 2016
File Name: H:\Projects\2015-3311\EXPANSION2\Arrowhead Landfill Boundary Survey Sec 21, 22, 27 & 28.dwg

| Line Table | | |
|---|---|---|
| Line # | Length | Direction |
| L11 | 1346.184 | S89° 59' 27.81"E |
| L12 | 403.279 | S23° 17' 07.90"W |
| L13 | 76.080 | S6° 56' 35.81"E |
| L14 | 720.985 | S11° 19' 08.56"E |
| L15 | 559.193 | S48° 25' 28.87"W |
| L16 | 512.074 | S74° 15' 40.30"W |
| L17 | 987.779 | S0° 00' 00.00"E |
| L18 | 213.569 | S47° 22' 36.81"W |
| L19 | 1592.574 | N88° 25' 34.11"W |
| L20 | 990.691 | N12° 57' 43.19"E |
| L21 | 1013.509 | N2° 29' 13.14"W |
| L22 | 874.298 | N84° 49' 29.76"E |
| L23 | 793.345 | N4° 18' 15.77"E |
| L24 | 789.881 | N90° 00' 00.00"E |
| L26 | 1672.579 | S0° 30' 43.13"E |
| L27 | 307.988 | S7° 29' 45.36"E |
| L28 | 920.511 | S1° 09' 22.44"W |
| L29 | 93.208 | S6° 02' 58.90"W |
| L30 | 347.237 | S0° 30' 43.13"E |
| L32 | 2240.030 | N65° 52' 01.62"W |
| L34 | 449.526 | N26° 22' 01.25"W |
| L36 | 1364.778 | N13° 50' 36.96"E |
| L38 | 1298.819 | N57° 40' 56.84"E |

| Line Table | | |
|---|---|---|
| Line # | Length | Direction |
| L39 | 198.464 | S0° 35' 26.26"W |
| L40 | 77.975 | N90° 00' 00.00"E |
| L41 | 26.790 | S0° 18' 03.79"W |
| L42 | 857.279 | S0° 18' 03.79"W |
| L43 | 414.674 | N89° 12' 23.72"W |
| L44 | 24.090 | N71° 40' 53.04"W |
| L45 | 352.712 | N54° 09' 22.35"W |
| L46 | 22.923 | N54° 09' 22.35"W |
| L47 | 205.016 | N54° 09' 22.35"W |
| L48 | 324.009 | N56° 49' 50.60"W |
| L49 | 6.281 | N56° 56' 28.05"W |
| L50 | 355.158 | N56° 56' 28.05"W |
| L51 | 14.350 | N58° 23' 23.01"W |
| L52 | 327.283 | N58° 23' 23.01"W |
| L53 | 320.669 | N1° 35' 08.66"E |
| L54 | 188.801 | N1° 16' 56.15"E |
| L55 | 1074.664 | N5° 51' 09.67"W |
| L56 | 790.265 | N19° 12' 21.65"W |
| L57 | 148.797 | N26° 56' 09.56"E |
| L58 | 1047.369 | N90° 00' 00.00"E |
| L59 | 293.376 | S75° 39' 22.58"E |
| L60 | 990.158 | S8° 21' 48.78"E |
| L61 | 1165.297 | S12° 15' 40.57"E |

| Curve Table | | | |
|---|---|---|---|
| Curve # | Length | Radius | Delta |
| C8 | 197.705 | 100.000 | 113.2766 |
| C10 | 263.796 | 500.000 | 30.2288 |
| C13 | 104.272 | 100.000 | 59.7437 |
| C15 | 45.093 | 100.000 | 25.8365 |
| C17 | 388.831 | 300.000 | 74.2612 |
| C19 | 82.688 | 100.000 | 47.3769 |
| C21 | 77.138 | 100.000 | 44.1970 |
| C23 | 176.956 | 100.000 | 101.3881 |
| C25 | 26.964 | 100.000 | 15.4490 |
| C27 | 152.388 | 100.000 | 87.3119 |
| C29 | 702.674 | 500.000 | 80.5206 |
| C31 | 149.583 | 100.000 | 85.7046 |
| C32 | 156.186 | 100.000 | 89.4880 |
| C33 | 200.093 | 100.000 | 114.6449 |

| Curve Table | | | |
|---|---|---|---|
| Curve # | Length | Radius | Delta |
| C34 | 68.941 | 100.000 | 39.5001 |
| C35 | 70.181 | 100.000 | 40.2106 |
| C36 | 76.513 | 100.000 | 43.8389 |
| C37 | 56.405 | 100.000 | 32.3175 |
| C38 | 17.945 | 40.000 | 25.7038 |
| C40 | 173.922 | 110.000 | 90.5906 |
| C42 | 63.042 | 40.000 | 90.3011 |
| C45 | 71.073 | 45.000 | 90.4924 |
| C56 | 62.806 | 60.000 | 59.9755 |
| C60 | 23.306 | 100.000 | 13.3533 |
| C62 | 80.533 | 100.000 | 46.1420 |
| C64 | 110.067 | 100.000 | 63.0640 |
| C66 | 25.035 | 100.000 | 14.3437 |
| C68 | 117.448 | 100.000 | 67.2927 |

## LEGALS

**SURVEY LEGAL DESCRIPTION FACILITY BOUNDARY**

BEGINNING AT A REBAR FOUND AT THE NORTH EAST CORNER OF THE SOUTHEAST QUARTER OF SECTION 21, T17N, R6E, PERRY COUNTY, ALABAMA; THENCE N87°43'07"E FOR A DISTANCE OF 3950.57 FEET TO A REBAR FOUND; THENCE N00°33'49"W FOR A DISTANCE OF 845.51 FEET TO A REBAR SET; THENCE S90°00'00"E FOR A DISTANCE OF 1424.46 FEET TO A REBAR SET; THENCE S02°08'01"E FOR A DISTANCE OF 3488.31 FEET TO A REBAR FOUND; THENCE S02°39'05"W FOR A DISTANCE OF 5582.06 FEET TO A REBAR FOUND ON THE NORHTERLY MARGIN OF COUNTY ROAD 21; THENCE ALONG AN ARC TO THE LEFT ON THE NORTHERLY MARGIN OF COUNTY ROAD 21, A CHORD BEARING OF S85°27'01"W AND A CHORD DISTANCE OF 586.95 FEET WITH AN ARC DISTANCE OF 588.62 FEET HAVING A RADIUS OF 2265.00 FEET TO A REBAR FOUND, THENCE S77°58'49"W FOR A DISTANCE OF 275.27 FEET TO A POINT AT THE INTERSECTION OF THE NORTHERLY MARGIN OF COUNTY ROAD 21 AND THE NORTHERLY MARGIN OF COUNTY ROAD 1; THENCE ALONG AN ARC TO THE LEFT ON THE NORTHERLY MARGIN OF COUNTY ROAD 1, A CHORD BEARING OF N44°14'52"W AND A CHORD DISTANCE OF 257.33 FEET WITH AN ARC DISTANCE OF 258.63 FEET HAVING A RADIUS OF 745.00 FEET TO A REBAR FOUND; THENCE N54°10'16"W FOR A DISTANCE OF 609.05 FEET TO A REBAR FOUND; THENCE ALONG AN ARC TO THE LEFT ON THE NORTHERLY MARGIN OF COUNTY ROAD 1, A CHORD BEARING OF N56°16'33"W AND A CHORD DISTANCE OF 945.56 FEET WITH AN ARC DISTANCE OF 945.77 FEET HAVING A RADIUS OF 13040.00 FEET TO A REBAR FOUND; THENCE N58°21'30"W FOR A DISTANCE OF 948.66 FEET TO A REBAR SET; THENCE LEAVING THE NORTHERLY MARGIN OF COUNTY ROAD 1 N23°48'36"W FOR A DISTANCE OF 51.78 FEET TO A REBAR SET; THENCE N10°56'55"E FOR A DISTANCE OF 111.58 FEET TO A REBAR SET; THENCE N26°18'04"E FOR A DISTANCE OF 152.35 FEET TO A REBAR SET; THENCE N0°00'00"E FOR A DISTANCE OF 208.27 FEET TO REBAR SET; THENCE S87°19'52"W FOR A DISTANCE OF 385.49 FEET TO A REBAR SET; THENCE S26°18'04"W FOR A DISTANCE OF 268.97 FEET TO A REBAR SET ON THE NORTHERLY MARGIN OF COUNTY ROAD 1; THENCE ALONG AN ARC TO THE LEFT ON THE NORTHERLY MARGIN OF COUNTY ROAD 1, A CHORD BEARING OF N67°47'37"W AND A CHORD DISTANCE OF 551.88 FEET WITH AN ARC DISTANCE OF 552.25 FEET HAVING A RADIUS OF 4358.00 FEET TO A REBAR FOUND; THENCE N71°25'27"W FOR A DISTANCE OF 1236.51 FEET TO A REBAR FOUND; THENCE LEAVING THE NORTHERLY MARGIN OF COUNTY ROAD 1, N01°36'46"W FOR A DISTANCE OF 225.40 FEET TO A REBAR FOUND; THENCE N 87-40-45 W FOR A DISTANCE OF 637.42 FEET TO A REBAR FOUND; THENCE S04°49'43"E FOR A DISTANCE OF 45.84 FEET TO A REBAR SET ON THE NORHTERLY MARGIN OF COUNTY ROAD 1; THENCE ALONG AN ARC TO THE LEFT ON THE NORTHERLY MARGIN OF COUNTY ROAD 1, A CHORD BEARING OF N83°19'26"W AND A CHORD DISTANCE OF 444.23 FEET WITH AN ARC DISTANCE OF 445.19 FEET HAVING A RADIUS OF 1960.00 FEET TO A REBAR FOUND;THENCE N89°49'51"W FOR A DISTANCE OF 195.19 FEET TO A REBAR FOUND; THENCE LEAVING THE NORTHERLY MARGIN OF COUNTY ROAD 1, N02°00'19"E FOR A DISTANCE OF 939.49 FEET TO A REBAR FOUND; THENCE N03°41'46"E FOR A DISTANCE OF 555.08 FEET TO A REBAR FOUND; THENCE N01°02'49"W FOR A DISTANCE OF 1116.83 FEET TO A REBAR FOUND; THENCE N87°40'03"E FOR A DISTANCE OF 1367.91 FEET TO A REBAR FOUND; THENCE N02°41'37"W FOR A DISTANCE OF 2834.80 FEET TO THE POINT OF BEGINNING. SAID DESCRIBED PROPERTY CONTAINS 973.85 ACRES, MORE OR LESS AND LIES PARTLY IN SECTIONS 21, 22, 27, AND 28, ALL IN T17N, R6E, PERRY COUNTY, ALABAMA.

## LEGALS

**SURVEY LEGAL DESCRIPTION TRACT 1**

BEGINNING AT A REBAR FOUND AT THE NORTH EAST CORNER OF THE SOUTHEAST QUARTER OF SECTION 21, T17N, R6E, PERRY COUNTY, ALABAMA; THENCE N87°43'07"E FOR A DISTANCE OF 3950.57 FEET TO A REBAR FOUND; THENCE N00°33'49"W FOR A DISTANCE OF 845.51 FEET TO A REBAR SET; THENCE S90°00'00"E FOR A DISTANCE OF 1424.46 FEET TO A REBAR SET; THENCE S02°08'01"E FOR A DISTANCE OF 3488.32 FEET TO A REBAR FOUND; THENCE S02°39'05"W FOR A DISTANCE OF 3990.84 FEET TO A POINT, THENCE S87°20'55"E FOR A DISTANCE OF 968.19 FEET TO A POINT, SAID POINT BEING THE POINT OF BEGINNING;

FROM THE **POINT OF BEGINNING** THENCE ALONG A CURVE TURNING TO THE RIGHT THROUGH AN ANGLE OF 25° 42' 14", HAVING A RADIUS OF 40.00 FEET, AND WHOSE LONG CHORD BEARS S 12° 15' 41" E FOR A DISTANCE OF 17.79 FEET;
THENCE, S 00° 35' 26" W FOR A DISTANCE OF 198.46 FEET TO THE BEGINNING OF A CURVE, SAID CURVE TURNING TO THE LEFT THROUGH AN ANGLE OF 90° 35' 26", HAVING A RADIUS OF 110.00 FEET, AND WHOSE LONG CHORD BEARS S 44° 42' 17" E FOR A DISTANCE OF 156.36 FEET.
THENCE, N 90° 00' 00" E FOR A DISTANCE OF 77.98 FEET TO THE BEGINNING OF A CURVE, SAID CURVE TURNING TO THE RIGHT THROUGH AN ANGLE OF 90° 18' 04", HAVING A RADIUS OF 40.00 FEET, AND WHOSE LONG CHORD BEARS S 44° 50' 58" E FOR A DISTANCE OF 56.72 FEET;
THENCE, S 00° 18' 04" W FOR A DISTANCE OF 26.79 FEET TO A POINT;
THENCE, S 00° 18' 04" W FOR A DISTANCE OF 857.28 FEET TO THE BEGINNING OF A CURVE, SAID CURVE TURNING TO THE RIGHT THROUGH AN ANGLE OF 90° 29' 32", HAVING A RADIUS OF 45.00 FEET, AND WHOSE LONG CHORD BEARS S 45° 32' 50" W FOR A DISTANCE OF 63.91 FEET.
THENCE, N 89° 12' 24" W FOR A DISTANCE OF 414.67 FEET TO A POINT; THENCE, N 71° 40' 53" W FOR A DISTANCE OF 24.09 FEET TO A POINT; THENCE, N 54° 09' 22" W FOR A DISTANCE OF 352.71 FEET TO A POINT; THENCE, N 54° 09' 22" W FOR A DISTANCE OF 22.92 FEET TO A POINT; THENCE, N 54° 09' 22" W FOR A DISTANCE OF 205.02 FEET TO A POINT; THENCE, N 56° 49' 51" W FOR A DISTANCE OF 324.01 FEET TO A POINT; THENCE, N 56° 56' 28" W FOR A DISTANCE OF 6.28 FEET TO A POINT; THENCE, N 56° 56' 28" W FOR A DISTANCE OF 355.16 FEET TO A POINT; THENCE, N 58° 23' 23" W FOR A DISTANCE OF 14.35 FEET TO A POINT; THENCE, N 58° 23' 23" W FOR A DISTANCE OF 327.28 FEET TO THE BEGINNING OF A CURVE, SAID CURVE TURNING TO THE RIGHT THROUGH AN ANGLE OF 59° 58' 32", HAVING A RADIUS OF 60.00 FEET, AND WHOSE LONG CHORD BEARS N 28° 24' 07" W FOR A DISTANCE OF 59.98 FEET;
THENCE, N 01° 35' 09" E FOR A DISTANCE OF 320.67 FEET TO A POINT; THENCE, N 01° 16' 56" E FOR A DISTANCE OF 188.80 FEET TO A POINT; THENCE, N 05° 51' 10" W FOR A DISTANCE OF 1074.66 FEET TO THE BEGINNING OF A CURVE, SAID CURVE TURNING TO THE LEFT THROUGH AN ANGLE OF 13° 21' 12", HAVING A RADIUS OF 100.00 FEET, AND WHOSE LONG CHORD BEARS N 12° 31' 46" W FOR A DISTANCE OF 23.25 FEET;
THENCE, N 19° 12' 22" W FOR A DISTANCE OF 790.27 FEET TO THE BEGINNING OF A CURVE, SAID CURVE TURNING TO THE RIGHT THROUGH AN ANGLE OF 46° 08' 31", HAVING A RADIUS OF 100.00 FEET, AND WHOSE LONG CHORD BEARS N 03° 51' 54" E FOR A DISTANCE OF 78.37 FEET.
THENCE, N 26° 56' 10" E FOR A DISTANCE OF 148.80 FEET TO THE BEGINNING OF A CURVE, SAID CURVE TURNING TO THE RIGHT THROUGH AN ANGLE OF 63° 03' 50", HAVING A RADIUS OF 100.00 FEET, AND WHOSE LONG CHORD BEARS N 58° 28' 05" E FOR A DISTANCE OF 104.59 FEET TO A POINT;
THENCE, N 90° 00' 00" E FOR A DISTANCE OF 1047.37 FEET TO THE BEGINNING OF A CURVE, SAID CURVE TURNING TO THE RIGHT THROUGH AN ANGLE OF 14° 20' 37", HAVING A RADIUS OF 100.00 FEET, AND WHOSE LONG CHORD BEARS S 82° 49' 41" E FOR A DISTANCE OF 24.97 FEET.
THENCE, S 75° 39' 23" E FOR A DISTANCE OF 293.38 FEET TO THE BEGINNING OF A CURVE, SAID CURVE TURNING TO THE RIGHT THROUGH AN ANGLE OF 67° 17' 34", HAVING A RADIUS OF 100.00 FEET, AND WHOSE LONG CHORD BEARS S 42° 00' 36" E FOR A DISTANCE OF 110.81 FEET;
THENCE, S 08° 21' 49" E FOR A DISTANCE OF 990.16 FEET TO A POINT; THENCE S 12° 15' 41" E A DISTANCE OF 1165.30 FEET TO THE **POINT OF BEGINNING**.

SAID DESCRIBED PROPERTY CONTAINS 117.63 ACRES, MORE OR LESS AND LIES IN SECTIONS 27 & 28, ALL IN T17N, R6E, PERRY COUNTY, ALABAMA.

## LEGALS

**SURVEY LEGAL DESCRIPTION TRACT 2**

BEGINNING AT A REBAR FOUND AT THE NORTH EAST CORNER OF THE SOUTHEAST QUARTER OF SECTION 21, T17N, R6E, PERRY COUNTY, ALABAMA;

THENCE FROM SAID **POINT OF BEGINNING**, S 89° 59' 28" E FOR A DISTANCE OF 1346.18 FEET TO THE BEGINNING OF A CURVE, SAID CURVE TURNING TO THE RIGHT THROUGH AN ANGLE OF 113° 16' 36", HAVING A RADIUS OF 100.00 FEET, AND WHOSE LONG CHORD BEARS S 33° 21' 10" E FOR A DISTANCE OF 167.04 FEET,
THENCE, S 23° 17' 08" W FOR A DISTANCE OF 403.28 FEET TO THE BEGINNING OF A CURVE, SAID CURVE TURNING TO THE LEFT THROUGH AN ANGLE OF 30° 13' 44", HAVING A RADIUS OF 500.00 FEET, AND WHOSE LONG CHORD BEARS S 08° 10' 16" W FOR A DISTANCE OF 260.75 FEET,
THENCE, S 06° 56' 36" E FOR A DISTANCE OF 76.08 FEET TO A POINT;
THENCE, S 11° 19' 09" E FOR A DISTANCE OF 720.98 FEET TO THE BEGINNING OF A CURVE, SAID CURVE TURNING TO THE RIGHT THROUGH AN ANGLE OF 59° 44' 37", HAVING A RADIUS OF 100.00 FEET, AND WHOSE LONG CHORD BEARS S 18° 33' 10" W FOR A DISTANCE OF 99.61 FEET;
THENCE, S 48° 25' 29" W FOR A DISTANCE OF 559.19 FEET TO THE BEGINNING OF A CURVE, SAID CURVE TURNING TO THE RIGHT THROUGH AN ANGLE OF 25° 50' 11", HAVING A RADIUS OF 100.00 FEET, AND WHOSE LONG CHORD BEARS S 61° 20' 35" W FOR A DISTANCE OF 44.71 FEET.
THENCE, S 74° 15' 40" W FOR A DISTANCE OF 512.07 FEET TO THE BEGINNING OF A CURVE, SAID CURVE TURNING TO THE LEFT THROUGH AN ANGLE OF 74° 15' 40", HAVING A RADIUS OF 300.00 FEET, AND WHOSE LONG CHORD BEARS S 37° 07' 50" W FOR A DISTANCE OF 362.18 FEET;
THENCE, S 00° 00' 00" W FOR A DISTANCE OF 987.78 FEET TO THE BEGINNING OF A CURVE, SAID CURVE TURNING TO THE RIGHT THROUGH AN ANGLE OF 47° 22' 37", HAVING A RADIUS OF 100.00 FEET, AND WHOSE LONG CHORD BEARS S 23° 41' 18" W FOR A DISTANCE OF 80.35 FEET.
THENCE, S 47° 22' 37" W FOR A DISTANCE OF 213.57 FEET TO THE BEGINNING OF A CURVE, SAID CURVE TURNING TO THE RIGHT THROUGH AN ANGLE OF 44° 11' 49", HAVING A RADIUS OF 100.00 FEET, AND WHOSE LONG CHORD BEARS S 69° 28' 31" W FOR A DISTANCE OF 75.24 FEET.
THENCE, N 88° 25' 34" W FOR A DISTANCE OF 1592.57 FEET TO THE BEGINNING OF A CURVE, SAID CURVE TURNING TO THE RIGHT THROUGH AN ANGLE OF 101° 23' 17", HAVING A RADIUS OF 100.00 FEET, AND WHOSE LONG CHORD BEARS N 37° 43' 55" W FOR A DISTANCE OF 154.75 FEET.
THENCE, N 12° 57' 43" E FOR A DISTANCE OF 990.69 FEET TO THE BEGINNING OF A CURVE, SAID CURVE TURNING TO THE LEFT THROUGH AN ANGLE OF 15° 26' 56", HAVING A RADIUS OF 100.00 FEET, AND WHOSE LONG CHORD BEARS N 05° 14' 15" E FOR A DISTANCE OF 26.88 FEET.
THENCE, N 02° 29' 13" W FOR A DISTANCE OF 1013.51 FEET TO THE BEGINNING OF A CURVE, SAID CURVE TURNING TO THE RIGHT THROUGH AN ANGLE OF 87° 18' 43", HAVING A RADIUS OF 100.00 FEET, AND WHOSE LONG CHORD BEARS N 41° 10' 08" E FOR A DISTANCE OF 138.07 FEET.
THENCE, N 84° 49' 30" E FOR A DISTANCE OF 874.30 FEET TO THE BEGINNING OF A CURVE, SAID CURVE TURNING TO THE LEFT THROUGH AN ANGLE OF 80° 31' 14", HAVING A RADIUS OF 500.00 FEET, AND WHOSE LONG CHORD BEARS N 44° 33' 53" E FOR A DISTANCE OF 646.26 FEET;
THENCE, N 04° 18' 16" E FOR A DISTANCE OF 793.35 FEET TO THE BEGINNING OF A CURVE, SAID CURVE TURNING TO THE RIGHT THROUGH 85° 42' 16", HAVING A RADIUS OF 100.00 FEET, AND WHOSE LONG CHORD BEARS N 47° 09' 24" E FOR A DISTANCE OF 136.02 FEET TO THE **POINT OF BEGINNING**.

SAID DESCRIBED PROPERTY CONTAINS 159.28 ACRES, MORE OR LESS AND LIES PARTLY IN SECTIONS 21 & 28 ALL IN T17N, R6E, PERRY COUNTY, ALABAMA.

## LEGALS

**SURVEY LEGAL DESCRIPTION TRACT 3**

BEGINNING AT A REBAR FOUND AT THE NORTH EAST CORNER OF THE SOUTHEAST QUARTER OF SECTION 21, T17N, R6E, PERRY COUNTY, ALABAMA; THENCE N87°43'07"E FOR A DISTANCE OF 3950.57 FEET TO A REBAR FOUND, THENCE, S 22°10'43"E FOR A DISTANCE OF 778.75 TO A POINT, SAID POINT BEING THE POINT OF BEGINNING;

THENCE, FROM THE **POINT OF BEGINNING**, N 90° 00' 00" E FOR A DISTANCE OF 789.88 FEET TO THE BEGINNING OF A CURVE, SAID CURVE TURNING TO THE RIGHT THROUGH AN ANGLE OF 89° 29' 17", HAVING A RADIUS OF 100.00 FEET, AND WHOSE LONG CHORD BEARS S 45° 15' 22" E FOR A DISTANCE OF 140.79 FEET;
THENCE, S 00° 30' 43" E FOR A DISTANCE OF 1672.58 FEET TO A POINT;
THENCE, S 07° 29' 45" E FOR A DISTANCE OF 307.99 FEET TO A POINT; THENCE, S 01° 09' 22" W FOR A DISTANCE OF 920.51 FEET TO A POINT; THENCE, S 06° 02' 59" W FOR A DISTANCE OF 93.21 FEET TO A POINT; THENCE, S 00° 30' 43" E FOR A DISTANCE OF 347.24 FEET TO THE BEGINNING OF A CURVE, SAID CURVE TURNING TO THE RIGHT THROUGH AN ANGLE OF 114° 38' 42", HAVING A RADIUS OF 100.00 FEET, AND WHOSE LONG CHORD BEARS S 56° 48' 38" W FOR A DISTANCE OF 168.34 FEET;
THENCE, N 65° 52' 02" W FOR A DISTANCE OF 2240.03 FEET TO THE BEGINNING OF A CURVE, SAID CURVE TURNING TO THE RIGHT THROUGH AN ANGLE OF 39° 30' 00", HAVING A RADIUS OF 100.00 FEET, AND WHOSE LONG CHORD BEARS N 46° 07' 01" W FOR A DISTANCE OF 67.58 FEET;
THENCE, N 26° 22' 01" W FOR A DISTANCE OF 449.53 FEET TO THE BEGINNING OF A CURVE, SAID CURVE TURNING TO THE RIGHT THROUGH AN ANGLE OF 40° 12' 38", HAVING A RADIUS OF 100.00 FEET, AND WHOSE LONG CHORD BEARS N 06° 15' 42" W FOR A DISTANCE OF 68.75 FEET;
THENCE, N 13° 50' 37" E FOR A DISTANCE OF 1364.78 FEET TO THE BEGINNING OF A CURVE, SAID CURVE TURNING TO THE RIGHT THROUGH AN ANGLE OF 43° 50' 20", HAVING A RADIUS OF 100.00 FEET, AND WHOSE LONG CHORD BEARS N 35° 45' 47" E FOR A DISTANCE OF 74.66 FEET;
THENCE, N 57° 40' 57" E FOR A DISTANCE OF 1298.82 FEET TO THE BEGINNING OF A CURVE, SAID CURVE TURNING TO THE RIGHT THROUGH 32° 19' 03", HAVING A RADIUS OF 100.00 FEET, AND WHOSE LONG CHORD BEARS N 73° 50' 28" E FOR A DISTANCE OF 55.66 FEET TO THE **POINT OF BEGINNING**.

SAID DESCRIBED PROPERTY CONTAINS 148.42 ACRES, MORE OR LESS AND LIES IN SECTIONS 22 & 27, ALL IN T17N, R6E, PERRY COUNTY, ALABAMA.


WELLSTON ASSOCIATES
LAND SURVEYORS, LLC
506 OSIGIAN BOULEVARD, SUITE 2
WARNER ROBINS, GEORGIA 31088
OFFICE (478) 971-3382
FAX (478) 971-1400


R□ □□□□□□□□

| No. | Date | |
|---|---|---|
| 1 | 1.26.1□ | SHOWED NEW PROPERT□ LINE FOR NEW HOPE CHURCH |

THESE DOCUMENTS, AS INSTRUMENTS OF SERVICE, REMAIN THE PROPERTY OF WELLSTON ASSOCIATES LAND SURVEYORS, INC. AND SHALL NOT BE USED OR REPRODUCED IN ANY FORM WITHOUT WRITTEN PERMISSION.

BOUNDAR□ SUR□E□

ARROWHEAD LANDFILL
PERR□ COUNT□ ASSOCIATES□ LLC.
OF
SECTIONS 21□22□2□□ 2□□T1□N□R□E
PERRY COUNTY
SEC. 21, 22, 27 & 28

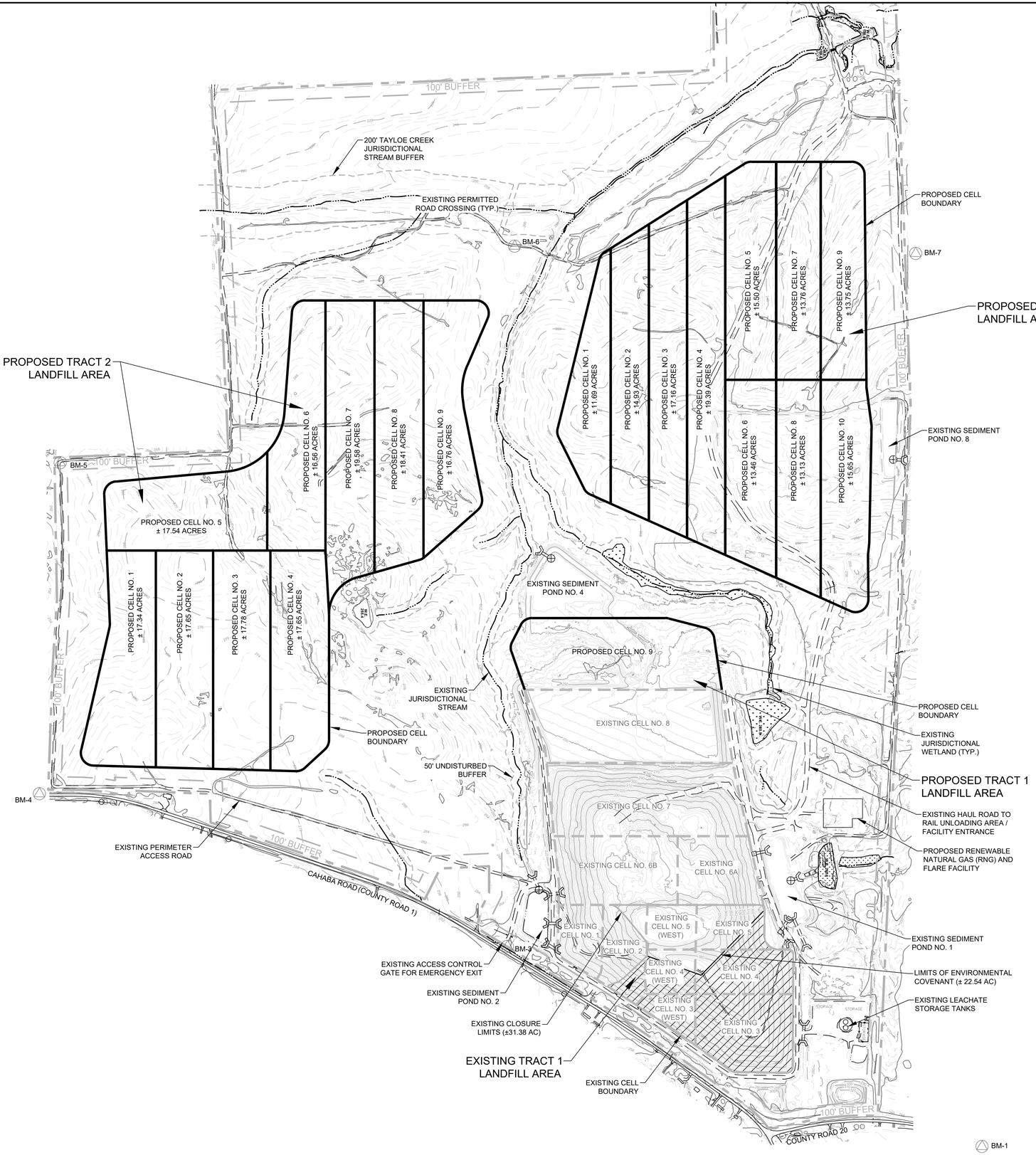
ALABAMA
R-16-E
T-17-N

Pr□□□□N□□ 1□□2□□□□
Dr□□□□N□□ 1□□2□□□□D2
Dr□□□B□□ C.B.L.
C□□□□d B□□ S.H.□□
R.L.S. N□□ 2□□□2

D□□□□ □UL□ 1□□2□11
S□□□□□ 1"=5□□'

S□□□□N□□

2 □□2




## BENCHMARK

| BENCHMARK | NORTHING | EASTING | ELEVATION |
|---|---|---|---|
| BM-1 | 876210.33 | 1980424.75 | 294.38 |
| BM-2 | 878163.34 | 1977770.88 | 282.98 |
| BM-3 | 877782.48 | 1976696.51 | 291.40 |
| BM-4 | 878981.35 | 1973019.78 | 278.93 |
| BM-5 | 881582.13 | 1973182.74 | 294.32 |
| BM-6 | 883283.04 | 1976752.92 | 206.20 |
| BM-7 | 883226.17 | 1979903.25 | 219.42 |

REFERENCE NOTES:

1. TOPOGRAPHIC INFORMATION FOR TRACT 1 WAS PROVIDED BY SAM COMPANIES LLC (FORMERLY KNOWN AS WELLSTON ASSOCIATES LAND SURVEYORS LLC) DATED JULY 5, 2024.
2. TOPOGRAPHIC INFORMATION FOR THE AREA SURROUNDING TRACT 1 WAS PROVIDED BY SAM COMPANIES LLC (FORMERLY KNOWN AS WELLSTON ASSOCIATES LAND SURVEYORS LLC) DATED FEBRUARY 9, 2024.
3. TOPOGRAPHIC INFORMATION FOR TRACT 3 CELLS NO. 6, 8, AND 10 ALONG WITH A PORTION OF CELL 4 WAS PROVIDED BY SOUTHERN RESOURCES MAPPING CORPORATION. DATE OF PHOTOGRAPHY DECEMBER 12, 2015.
4. REMAINING TOPOGRAPHIC INFORMATION PROVIDED BY SOUTHERN RESOURCES MAPPING CORPORATION. DATE OF PHOTOGRAPHY APRIL 30, 2010.
5. PERMITTED WETLAND BOUNDARY WAS TAKEN FROM THE INDIVIDUAL PERMIT APPLICATION PREPARED BY RICHARDSON, SMITH, GARDNER & ASSOCIATES. THE DRAWING ENTITLED "EXISTING CONDITIONS STREAMS AND WETLANDS" DATED MARCH 2008.

ALABAMA LICENSED No. 31360 PROFESSIONAL ENGINEER MATTHEW CHEEK 1-27-25

ALABAMA LICENSED NO. 32001 PROFESSIONAL ENGINEER KEVIN GEORGE BERRY 1-27-25

400 200 0 400 800
GRAPHIC SCALE IN FEET

EXISTING TOPOGRAPHIC CONDITIONS - TRACTS 1, 2, & 3

# ARROWHEAD LANDFILL
# 2025 VERTICAL EXPANSION

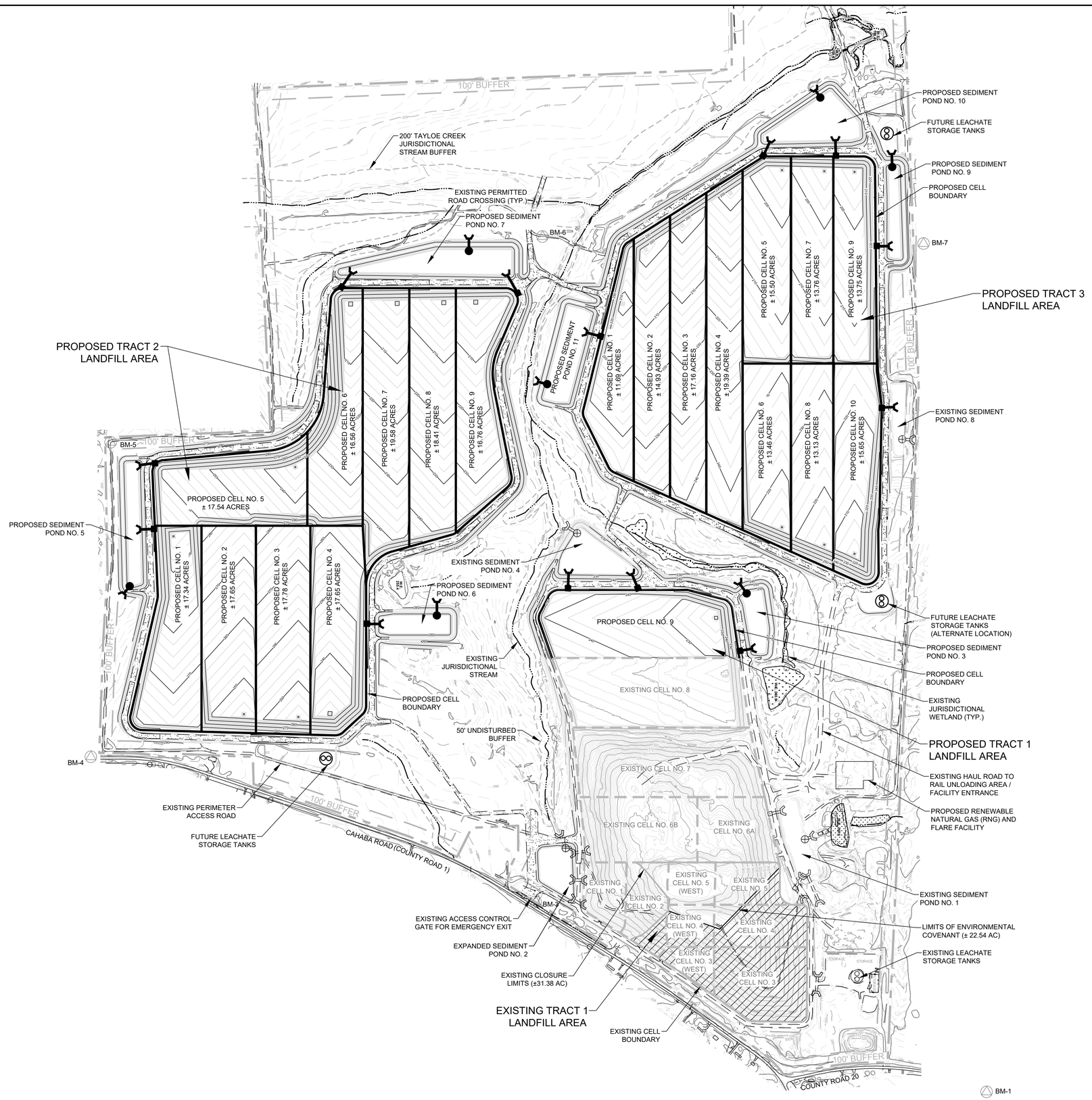
FOR

ARROWHEAD ENVIRONMENTAL PARTNERS, LLC

PERRY COUNTY, ALABAMA


HHNT
HODGES, HARBIN, NEWBERRY & TRIBBLE, INC.
Consulting Engineers
(478) 743-7175
(478) 743-7175 (FAX)
3920 ARKWRIGHT RD.
SUITE 101
MACON, GEORGIA 31210


| | | | |
|---|---|---|---|
| PROJ. NO. | 6215-018-01 | AH-2025VE-BASE-OVERALL.DWG | EDIT 1-29-2025 |
| SCALE | 1" = 400' | SHEET 3 OF 20 | |
| DATE | JANUARY 2025 | | |




BENCHMARK

| BENCHMARK | NORTHING | EASTING | ELEVATION |
|---|---|---|---|
| BM-1 | 876210.33 | 1980424.75 | 294.38 |
| BM-2 | 878163.34 | 1977770.88 | 282.98 |
| BM-3 | 877782.48 | 1976696.51 | 291.40 |
| BM-4 | 878981.35 | 1973019.78 | 278.93 |
| BM-5 | 881582.13 | 1973182.74 | 294.32 |
| BM-6 | 883283.04 | 1976752.92 | 206.20 |
| BM-7 | 883226.17 | 1979903.25 | 219.42 |

REFERENCE NOTES:

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2. TOPOGRAPHIC INFORMATION FOR THE AREA SURROUNDING TRACT 1 WAS PROVIDED BY SAM COMPANIES LLC (FORMERLY KNOWN AS WELLSTON ASSOCIATES LAND SURVEYORS LLC) DATED FEBRUARY 9, 2024.
3. TOPOGRAPHIC INFORMATION FOR TRACT 3 CELLS NO. 6, 8, AND 10 ALONG WITH A PORTION OF CELL 4 WAS PROVIDED BY SOUTHERN RESOURCES MAPPING CORPORATION. DATE OF PHOTOGRAPHY DECEMBER 12, 2015.
4. REMAINING TOPOGRAPHIC INFORMATION PROVIDED BY SOUTHERN RESOURCES MAPPING CORPORATION. DATE OF PHOTOGRAPHY APRIL 30, 2010.
5. PERMITTED WETLAND BOUNDARY WAS TAKEN FROM THE INDIVIDUAL PERMIT APPLICATION PREPARED BY RICHARDSON, SMITH, GARDNER & ASSOCIATES. THE DRAWING ENTITLED "EXISTING CONDITIONS STREAMS AND WETLANDS" DATED MARCH 2008.

ALABAMA LICENSED No. 31388 PROFESSIONAL ENGINEER MATTHEW CHECK 1-31-25

ALABAMA LICENSED NO. 32951 PROFESSIONAL ENGINEER KEVIN GEORGE BERRY

400 200 0 400 800
GRAPHIC SCALE IN FEET

TOP OF CLAY LINER GRADING PLAN - TRACTS 1, 2, & 3

# ARROWHEAD LANDFILL 2025 VERTICAL EXPANSION

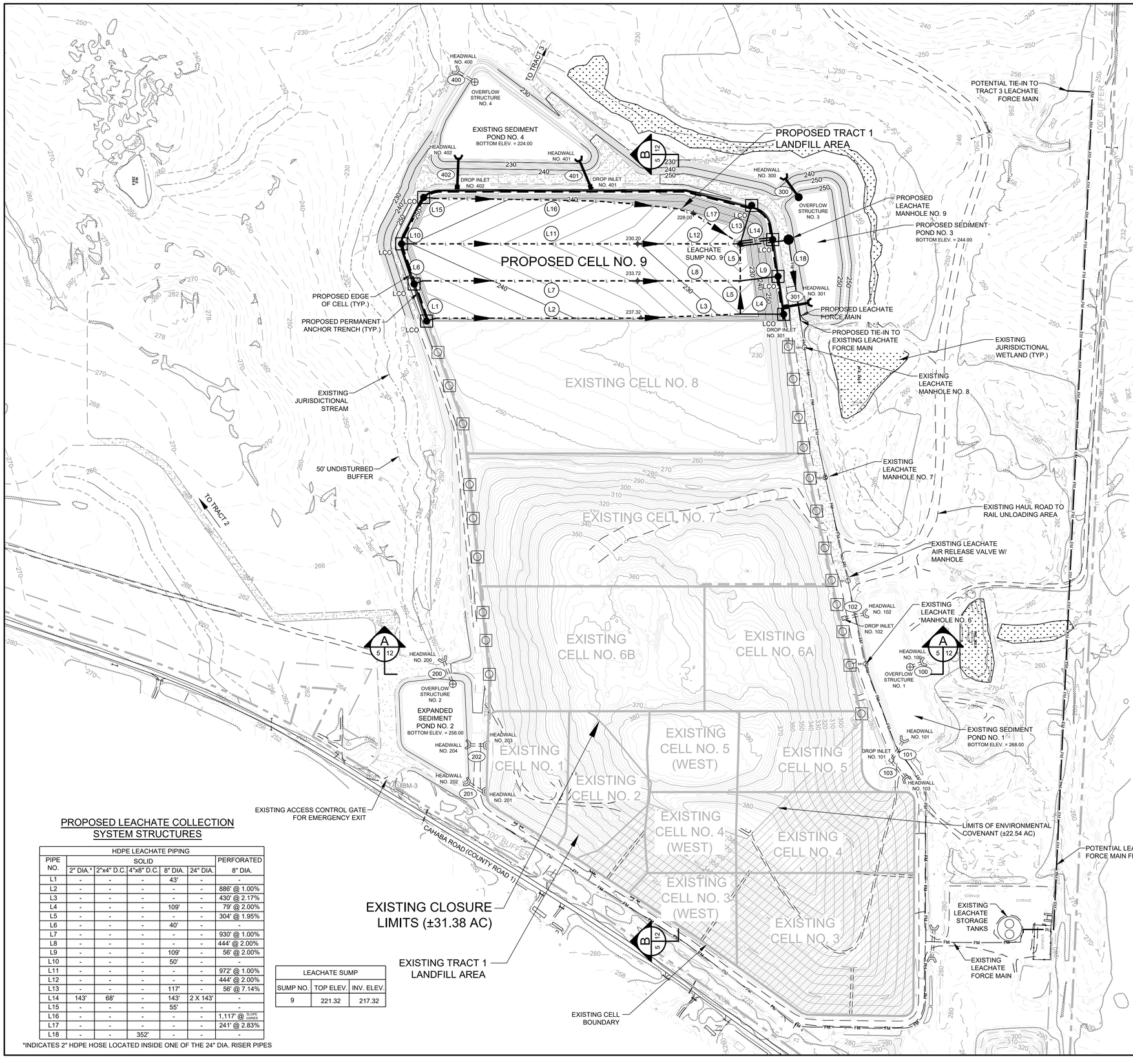
FOR

ARROWHEAD ENVIRONMENTAL PARTNERS, LLC

PERRY COUNTY, ALABAMA


HHNT
HODGES, HARBIN, NEWBERRY & TRIBBLE, INC.
*Consulting Engineers*
(478) 743-7175
(478) 743-7175 (FAX)
3920 ARKWRIGHT RD, SUITE 101
MACON, GEORGIA 31210


| | | | |
|---|---|---|---|
| PROJ. NO. | 6215-018-01 | AH-2025VE-BASE-OVERALL.DWG | EDIT 1-29-2025 |
| SCALE | 1" = 400' | SHEET 4 OF 20 | |
| DATE | JANUARY 2025 | | |



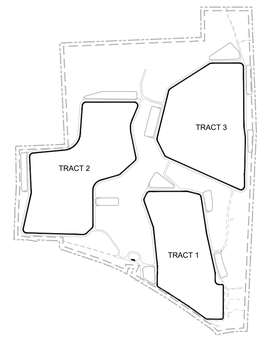

## PROPOSED LEACHATE COLLECTION SYSTEM STRUCTURES

| HDPE LEACHATE PIPING | | | | | | |
|---|---|---|---|---|---|---|
| PIPE NO. | SOLID | | | | | PERFORATED |
| | 2" DIA. * | 2"x4" D.C. | 4"x8" D.C. | 8" DIA. | 24" DIA. | 8" DIA. |
| L1 | - | - | - | 43' | - | - |
| L2 | - | - | - | - | - | 886' @ 1.00% |
| L3 | - | - | - | - | - | 430' @ 2.17% |
| L4 | - | - | - | 109' | - | 79' @ 2.00% |
| L5 | - | - | - | - | - | 304' @ 1.95% |
| L6 | - | - | - | 40' | - | - |
| L7 | - | - | - | - | - | 930' @ 1.00% |
| L8 | - | - | - | - | - | 444' @ 2.00% |
| L9 | - | - | - | 109' | - | 56' @ 2.00% |
| L10 | - | - | - | 50' | - | - |
| L11 | - | - | - | - | - | 972' @ 1.00% |
| L12 | - | - | - | - | - | 444' @ 2.00% |
| L13 | - | - | - | 117' | - | 56' @ 7.14% |
| L14 | 143' | 68' | - | 143' | 2 X 143' | - |
| L15 | - | - | - | 55' | - | - |
| L16 | - | - | - | - | - | 1,117' @ SLOPE VARIES |
| L17 | - | - | - | - | - | 241' @ 2.83% |
| L18 | - | - | 352' | - | - | - |

*INDICATES 2" HDPE HOSE LOCATED INSIDE ONE OF THE 24" DIA. RISER PIPES

| LEACHATE SUMP | | |
|---|---|---|
| SUMP NO. | TOP ELEV. | INV. ELEV. |
| 9 | 221.32 | 217.32 |

2000 1000 0 2000 4000
GRAPHIC SCALE IN FEET




SITE MAP
SCALE: 1" = 2000'

## BENCHMARK

| BENCHMARK | NORTHING | EASTING | ELEVATION |
|---|---|---|---|
| BM-1 | 876210.33 | 1980424.75 | 294.38 |
| BM-2 | 878163.34 | 1977770.88 | 282.98 |
| BM-3 | 877782.48 | 1976696.51 | 291.40 |
| BM-4 | 878981.35 | 1973019.78 | 278.93 |
| BM-5 | 881582.13 | 1973182.74 | 294.32 |
| BM-6 | 883283.04 | 1976752.92 | 206.20 |
| BM-7 | 883226.17 | 1979903.25 | 219.42 |

REFERENCE NOTES:

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2. TOPOGRAPHIC INFORMATION FOR THE AREA SURROUNDING TRACT 1 WAS PROVIDED BY SAM COMPANIES LLC (FORMERLY KNOWN AS WELLSTON ASSOCIATES LAND SURVEYORS LLC) DATED FEBRUARY 9, 2024.
3. TOPOGRAPHIC INFORMATION FOR TRACT 3 CELLS NO. 8, 9, AND 10 ALONG WITH A PORTION OF CELL 4 WAS PROVIDED BY SOUTHERN RESOURCES MAPPING CORPORATION. DATE OF PHOTOGRAPHY DECEMBER 12, 2015.
4. REMAINING TOPOGRAPHIC INFORMATION PROVIDED BY SOUTHERN RESOURCES MAPPING CORPORATION. DATE OF PHOTOGRAPHY APRIL 30, 2010.
5. PERMITTED WETLAND BOUNDARY WAS TAKEN FROM THE INDIVIDUAL PERMIT APPLICATION PREPARED BY RICHARDSON, SMITH, GARDNER & ASSOCIATES. THE DRAWING ENTITLED "EXISTING CONDITIONS STREAMS AND WETLANDS" DATED MARCH 2008.

OPERATION NOTES:

1. PROPOSED CONTOURS WITHIN THE PROPOSED CELL LIMITS REPRESENT TOP OF GEOMEMBRANE LAYER.
2. ALL CELLS LABELED EXISTING HAVE BEEN CONSTRUCTED AND THEREFORE, CONTOURS SHOWN WITHIN THOSE BOUNDARIES REPRESENT TOP OF EXISTING CONDITIONS.
3. THE CELL SEQUENCE IS GENERALLY IDENTIFIED, BUT CELL SEQUENCE MAY BE MODIFIED DEPENDING ON FIELD CONDITIONS.

ALABAMA LICENSED No. 31360 PROFESSIONAL ENGINEER MATTHEW CHEEK 1-27-25

ALABAMA LICENSED NO. 32051 PROFESSIONAL ENGINEER KEVIN GEORGE BERRY 1-27-25

200 100 0 200 400
GRAPHIC SCALE IN FEET

TOP OF CLAY LINER GRADING PLAN AND LEACHATE COLLECTION PLAN - TRACT 1

# ARROWHEAD LANDFILL 2025 VERTICAL EXPANSION

FOR

ARROWHEAD ENVIRONMENTAL PARTNERS, LLC

PERRY COUNTY, ALABAMA


HHNT
HODGES, HARBIN, NEWBERRY & TRIBBLE, INC.
Consulting Engineers
(478) 743-7175
(478) 743-7175 (FAX)
3920 ARKWRIGHT RD.
SUITE 101
MACON, GEORGIA 31210

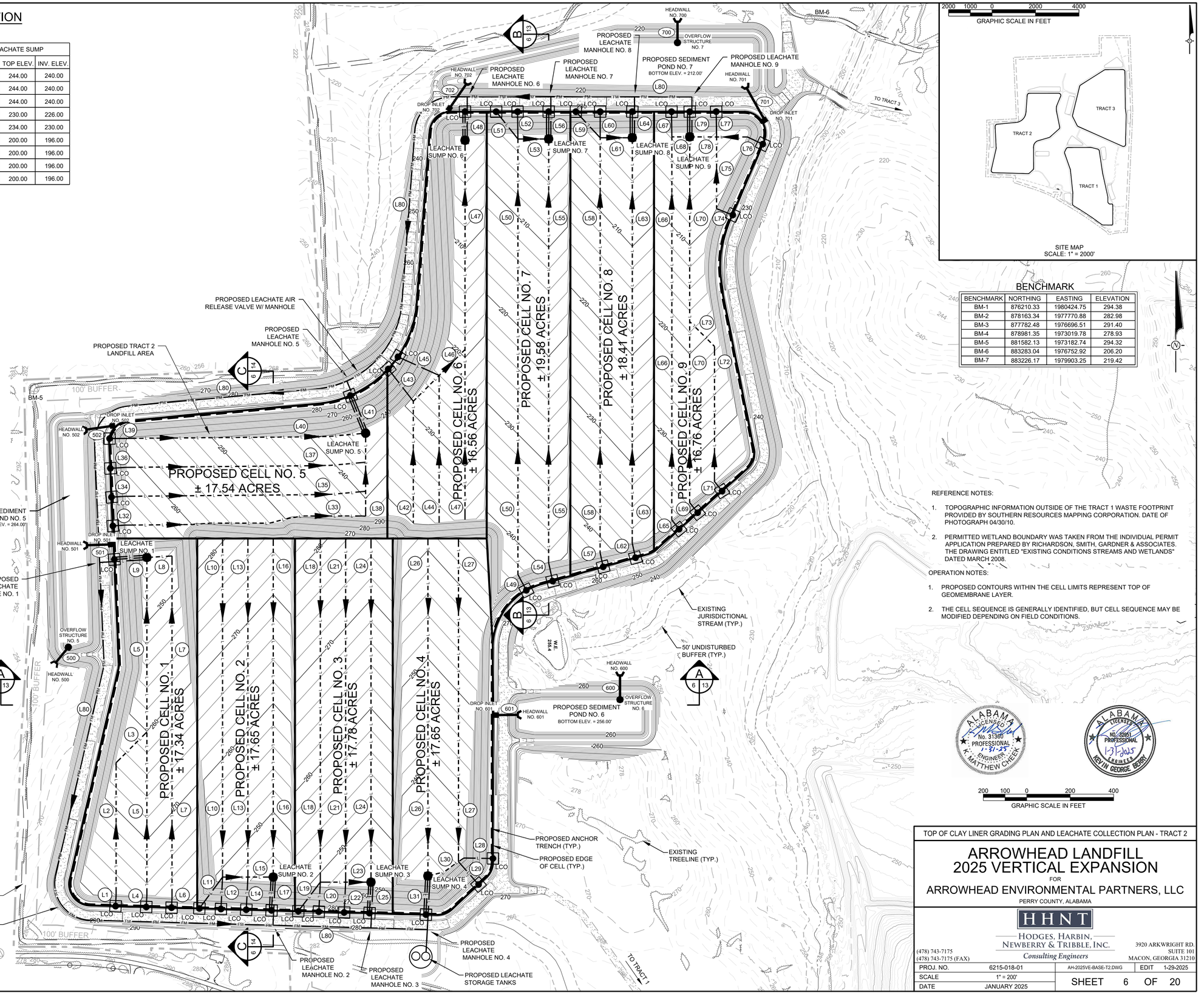

| | | | |
|---|---|---|---|
| PROJ. NO. | 6215-018-01 | AH-2025VE-BASE-T1.DWG | EDIT 1-29-2025 |
| SCALE | 1" = 200' | SHEET 5 OF 20 | |
| DATE | JANUARY 2025 | | |

# PROPOSED LEACHATE COLLECTION SYSTEM STRUCTURES

| PIPE NO. | HDPE LEACHATE PIPING | | | | | |
|---|---|---|---|---|---|---|
| | SOLID | | | | | PERFORATED |
| | "2" | 2" X 4" D.C. | 4" X 8" D.C. | 8" DIA. | 24" DIA. | 8" DIA. |
| L1 | - | - | - | 52' | - | - |
| L2 | - | - | - | - | - | 609' @ 2.00% |
| L3 | - | - | - | - | - | 200' @ 2.83% |
| L4 | - | - | - | 54' | - | - |
| L5 | - | - | - | - | - | 1555' @ 2.00% |
| L6 | - | - | - | 46' | - | - |
| L7 | - | - | - | - | - | 1573' @ 2.00% |
| L8 | - | - | - | - | - | 116' @ 2.20% |
| L9 | 150' | 68' | - | 150' | 2 - 150' | - |
| L10 | - | - | - | - | - | 1559' @ 2.00% |
| L11 | - | - | - | 180' | - | - |
| L12 | - | - | - | 147' | - | - |
| L13 | - | - | - | - | - | 1559' @ 2.00% |
| L14 | - | - | - | 150' | - | - |
| L15 | - | - | - | - | - | 233' @ 2.20% |
| L16 | - | - | - | - | - | 1559' @ 2.00% |
| L17 | 154' | 68' | - | 154' | 2 - 154' | - |
| L18 | - | - | - | - | - | 1582' @ 2.00% |
| L19 | - | - | - | 168' | - | - |
| L20 | - | - | - | 136' | - | - |
| L21 | - | - | - | - | - | 1582' @ 2.00% |
| L22 | - | - | - | 140' | - | - |
| L23 | - | - | - | - | - | 233' @ 2.20% |
| L24 | - | - | - | - | - | 1582' @ 2.00% |
| L25 | 143' | 68' | - | 143' | 2 - 143' | - |
| L26 | - | - | - | - | - | 1553' @ 2.00% |
| L27 | - | - | - | - | - | 1487' @ 2.00% |
| L28 | - | - | - | 133' | - | - |
| L29 | - | - | - | 140' | - | - |
| L30 | - | - | - | - | - | 188' @ SLOPE VARIES |
| L31 | 179' | 68' | - | 179' | 2 - 179' | - |
| L32 | - | - | - | 59' | - | - |
| L33 | - | - | - | - | - | 1109' @ SLOPE VARIES |
| L34 | - | - | - | 62' | - | - |
| L35 | - | - | - | - | - | 1108' @ 2.22% |
| L36 | - | - | - | 72' | - | - |
| L37 | - | - | - | - | - | 1104' @ 2.22% |
| L38 | - | - | - | - | - | 382' @ 2.00% |
| L39 | - | - | - | 82' | - | - |
| L40 | - | - | - | - | - | 1098' @ 2.22% |
| L41 | 187' | 68' | - | 187' | 2 - 187' | - |
| L42 | - | - | - | - | - | 561' @ 2.00% |
| L43 | - | - | - | 188' | - | - |
| L44 | - | - | - | - | - | 678' @ 2.00% |
| L45 | - | - | - | 208' | - | - |
| L46 | - | - | - | - | - | 337' @ 2.83% |
| L47 | - | - | - | - | - | 1747' @ 2.00% |
| L48 | 132' | 68' | - | 132' | 2 - 132' | - |
| L49 | - | - | - | 82' | - | - |
| L50 | - | - | - | - | - | 2005' @ 2.00% |
| L51 | - | - | - | 161' | - | - |
| L52 | - | - | - | 126' | - | - |
| L53 | - | - | - | - | - | 141' @ 2.00% |
| L54 | - | - | - | 87' | - | - |
| L55 | - | - | - | - | - | 1950' @ 2.00% |
| L56 | 126' | 68' | - | 126' | 2 - 126' | - |
| L57 | - | - | - | 66 | - | - |
| L58 | - | - | - | - | - | 1910' @ 2.00% |
| L59 | - | - | - | 164' | - | - |
| L60 | - | - | - | 120' | - | - |
| L61 | - | - | - | - | - | 148' @ 2.20% |
| L62 | - | - | - | 69' | - | - |
| L63 | - | - | - | - | - | 1865' @ 2.00% |
| L64 | 120' | 68' | - | 120' | 2 - 120' | - |
| L65 | - | - | - | 54' | - | - |
| L66 | - | - | - | - | - | 1763' @ 2.00% |
| L67 | - | - | - | 116' | - | - |
| L68 | - | - | - | - | - | 82' @ 2.20% |
| L69 | - | - | - | 59' | - | - |
| L70 | - | - | - | - | - | 1683' @ 2.00% |
| L71 | - | - | - | 56' | - | - |
| L72 | - | - | - | - | - | 622' @ 2.00% |
| L73 | - | - | - | - | - | 162' @ 2.83% |
| L74 | - | - | - | 80' | - | - |
| L75 | - | - | - | - | - | 330' @ 2.00% |
| L76 | - | - | - | 78' | - | - |
| L77 | - | - | - | 116' | - | - |
| L78 | - | - | - | - | - | 265' @ 2.00% |
| L79 | 116' | 68' | - | 116' | 2 - 116' | - |
| L80 | - | - | 7,876' | - | - | - |

*INDICATES 2" HDPE PIPE LOCATED INSIDE ONE OF THE 24" DIA. RISER PIPES

| LEACHATE SUMP | | |
|---|---|---|
| SUMP NO. | TOP ELEV. | INV. ELEV. |
| 1 | 244.00 | 240.00 |
| 2 | 244.00 | 240.00 |
| 3 | 244.00 | 240.00 |
| 4 | 230.00 | 226.00 |
| 5 | 234.00 | 230.00 |
| 6 | 200.00 | 196.00 |
| 7 | 200.00 | 196.00 |
| 8 | 200.00 | 196.00 |
| 9 | 200.00 | 196.00 |







## BENCHMARK

| BENCHMARK | NORTHING | EASTING | ELEVATION |
|---|---|---|---|
| BM-1 | 876210.33 | 1980424.75 | 294.38 |
| BM-2 | 878163.34 | 1977770.88 | 282.98 |
| BM-3 | 877782.48 | 1976696.51 | 291.40 |
| BM-4 | 878981.35 | 1973019.78 | 278.93 |
| BM-5 | 881582.13 | 1973182.74 | 294.32 |
| BM-6 | 883283.04 | 1976752.92 | 206.20 |
| BM-7 | 883226.17 | 1979903.25 | 219.42 |

REFERENCE NOTES:

1. TOPOGRAPHIC INFORMATION OUTSIDE OF THE TRACT 1 WASTE FOOTPRINT PROVIDED BY SOUTHERN RESOURCES MAPPING CORPORATION. DATE OF PHOTOGRAPH 04/30/10.
2. PERMITTED WETLAND BOUNDARY WAS TAKEN FROM THE INDIVIDUAL PERMIT APPLICATION PREPARED BY RICHARDSON, SMITH, GARDNER & ASSOCIATES. THE DRAWING ENTITLED "EXISTING CONDITIONS STREAMS AND WETLANDS" DATED MARCH 2008.

OPERATION NOTES:

1. PROPOSED CONTOURS WITHIN THE CELL LIMITS REPRESENT TOP OF GEOMEMBRANE LAYER.
2. THE CELL SEQUENCE IS GENERALLY IDENTIFIED, BUT CELL SEQUENCE MAY BE MODIFIED DEPENDING ON FIELD CONDITIONS.

ALABAMA LICENSED No. 31360 PROFESSIONAL ENGINEER MATTHEW CHER 1-31-25

ALABAMA LICENSED NO. 32951 PROFESSIONAL ENGINEER KEVIN GEORGE HENRY 1-31-2025

200 100 0 200 400
GRAPHIC SCALE IN FEET

TOP OF CLAY LINER GRADING PLAN AND LEACHATE COLLECTION PLAN - TRACT 2

# ARROWHEAD LANDFILL 2025 VERTICAL EXPANSION

FOR

ARROWHEAD ENVIRONMENTAL PARTNERS, LLC

PERRY COUNTY, ALABAMA


HHNT
HODGES, HARBIN, NEWBERRY & TRIBBLE, INC.
Consulting Engineers
3920 ARKWRIGHT RD.
SUITE 101
MACON, GEORGIA 31210
(478) 743-7175
(478) 743-7175 (FAX)

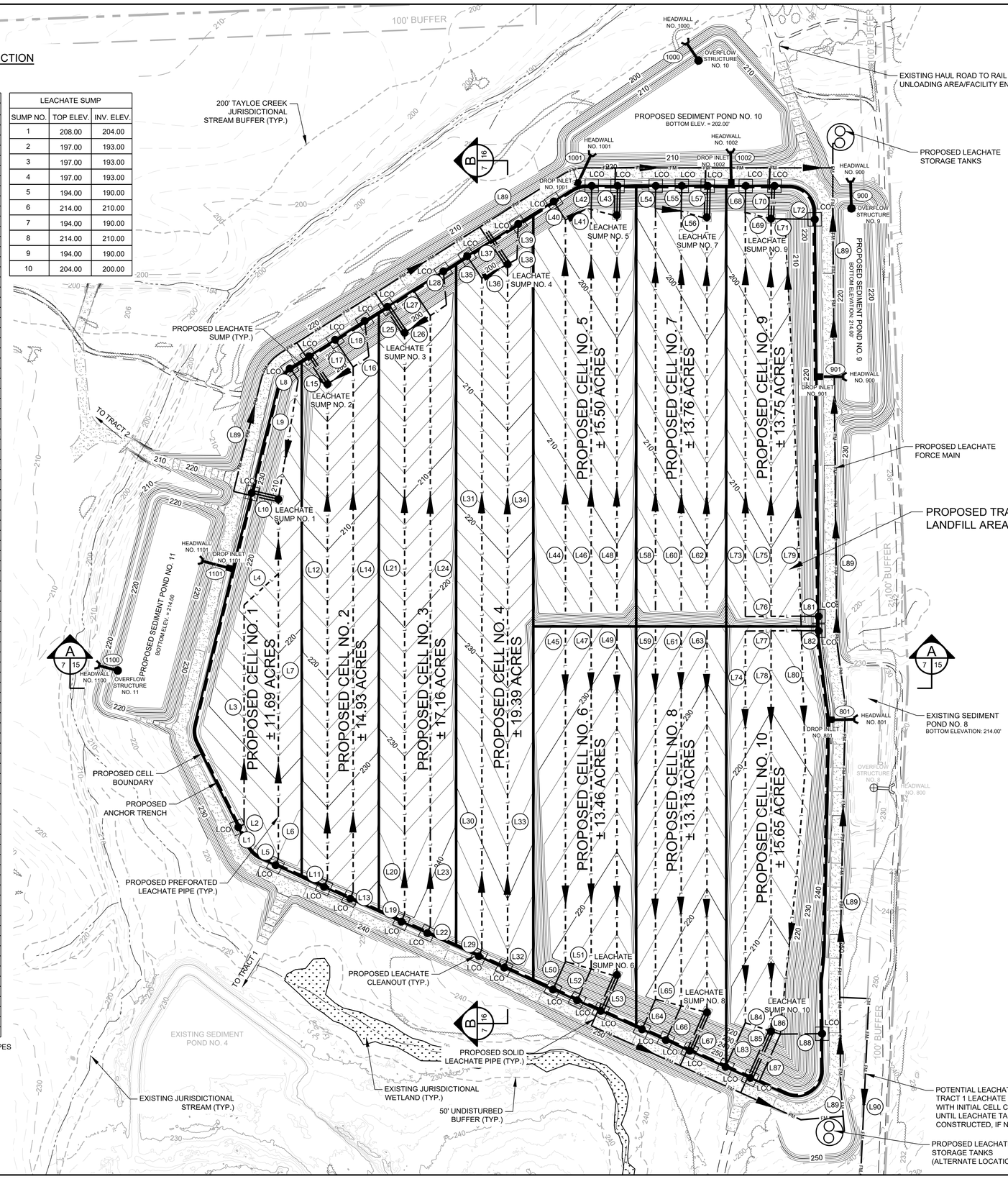

| | | | |
|---|---|---|---|
| PROJ. NO. | 6215-018-01 | AH-2025VE-BASE-T2.DWG | EDIT 1-29-2025 |
| SCALE | 1" = 200' | SHEET 6 OF 20 | |
| DATE | JANUARY 2025 | | |

## PROPOSED LEACHATE COLLECTION SYSTEM STRUCTURES

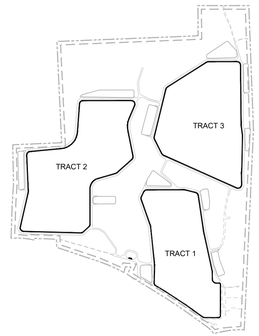
| PIPE NO. | HDPE LEACHATE PIPING | | | | | |
|---|---|---|---|---|---|---|
| | SOLID | | | | | PERFORATED |
| | "2" | 2" X 4" D.C. | 4" X 8" D.C. | 8" DIA. | 24" DIA. | 8" DIA. |
| L1 | - | - | - | 25' | - | - |
| L2 | - | - | - | - | - | 50' @ 1.62% |
| L3 | - | - | - | - | - | 802' @ 2.00% |
| L4 | - | - | - | - | - | 180' @ 2.97% |
| L5 | - | - | - | 29' | - | - |
| L6 | - | - | - | - | - | 183' @ 1.00% |
| L7 | - | - | - | - | - | 1213' @ 2.00% |
| L8 | - | - | - | 56' | - | - |
| L9 | - | - | - | - | - | 469' @ 2.00% |
| L10 | 106' | 71' | - | 106' | 2 X 106' | - |
| L11 | - | - | - | 35' | - | - |
| L12 | - | - | - | - | - | 1922' @ 2.00% |
| L13 | - | - | - | 30' | - | - |
| L14 | - | - | - | - | - | 2038' @ 2.00% |
| L15 | 130' | 70' | - | 130' | 2 X 130' | - |
| L16 | - | - | - | - | - | 194' @ 2.13% |
| L17 | - | - | - | 127' | - | - |
| L18 | - | - | - | 139' | - | - |
| L19 | - | - | - | 33' | - | - |
| L20 | - | - | - | - | - | 319' @ 1.00% |
| L21 | - | - | - | - | - | 1940' @ 2.00% |
| L22 | - | - | - | 31' | - | - |
| L23 | - | - | - | - | - | 365' @ 1.00% |
| L24 | - | - | - | - | - | 2006' @ 2.00% |
| L25 | 121' | 71' | - | 121' | 2 X 121' | - |
| L26 | - | - | - | - | - | 195' @ 2.13% |
| L27 | - | - | - | 119' | - | - |
| L28 | - | - | - | 134' | - | - |
| L29 | - | - | - | 31' | - | - |
| L30 | - | - | - | - | - | 836' @ 1.00% |
| L31 | - | - | - | - | - | 1770' @ 2.00% |
| L32 | - | - | - | 34' | - | - |
| L33 | - | - | - | - | - | 877' @ 1.00% |
| L34 | - | - | - | - | - | 1825' @ 2.00% |
| L35 | - | - | - | 103' | - | - |
| L36 | - | - | - | - | - | 114' @ 3.82% |
| L37 | 150' | 31' | - | - | 150' | 2 X 150' |
| L38 | - | - | - | - | - | 42' @ SLOPE VARIES |
| L39 | - | - | - | 137' | - | - |
| L40 | - | - | - | 85' | - | - |
| L41 | - | - | - | - | - | 220' @ 2.35% |
| L42 | - | - | - | 92' | - | - |
| L43 | 114' | 70' | - | 114' | 2 X 114' | - |
| L44 | - | - | - | - | - | 1522' @ 1.25% |
| L45 | - | - | - | - | - | 1291' @ 1.25% |
| L46 | - | - | - | - | - | 1564' @ 1.25% |
| L47 | - | - | - | - | - | 1320' @ 1.25% |
| L48 | - | - | - | - | - | 1538' @ 1.25% |
| L49 | - | - | - | - | - | 1345' @ 1.25% |
| L50 | - | - | - | 119' | - | - |
| L51 | - | - | - | - | - | 211' @ 2.37% |
| L52 | - | - | - | 133' | - | - |
| L53 | 153' | 67' | - | 153' | 2 X 153' | - |
| L54 | - | - | - | 88' | - | - |
| L55 | - | - | - | 98' | - | - |
| L56 | - | - | - | - | - | 201' @ 2.08% |
| L57 | 122' | 62' | - | 122' | 2 X122' | - |
| L58 | - | - | - | - | - | 1561' @ 1.25% |
| L59 | - | - | - | - | - | 1438' @ 1.25% |
| L60 | - | - | - | - | - | 1553' @ 1.25% |
| L61 | - | - | - | - | - | 1457' @ 1.25% |
| L62 | - | - | - | - | - | 1525' @ 1.25% |
| L63 | - | - | - | - | - | 1484' @ 1.25% |
| L64 | - | - | - | 130' | - | - |
| L65 | - | - | - | - | - | 206' @ 2.45% |
| L66 | - | - | - | 148' | - | - |
| L67 | 164' | 68' | - | 164' | 2 X164' | - |
| L68 | - | - | - | 104' | - | - |
| L69 | - | - | - | - | - | 103' @ SLOPE VARIES |
| L70 | 128' | 70' | - | 128' | 2 X128' | - |
| L71 | - | - | - | - | - | 57' @ SLOPE VARIES |
| L72 | - | - | - | 112' | - | - |
| L73 | - | - | - | - | - | 1570' @ 1.25% |
| L74 | - | - | - | - | - | 1522' @ 1.25% |
| L75 | - | - | - | - | - | 1540' @ 1.25% |
| L76 | - | - | - | - | - | 216' @ SLOPE VARIES |
| L77 | - | - | - | - | - | 217' @ SLOPE VARIES |
| L78 | - | - | - | - | - | 1557' @ 1.25% |
| L79 | - | - | - | - | - | 1585' @ 1.25% |
| L80 | - | - | - | - | - | 1573' @ 1.25% |
| L81 | - | - | - | 69' | - | - |
| L82 | - | - | - | 67' | - | - |
| L83 | - | - | - | 188' | - | - |
| L84 | - | - | - | - | - | 105' @ 2.48% |
| L85 | 198' | 68' | - | 198' | 2 X198' | - |
| L86 | - | - | - | - | - | 38' @ SLOPE VARIES |
| L87 | - | - | - | 208' | - | - |
| L88 | - | - | - | 162' | - | - |
| L89 | - | - | 7,845' | - | - | - |
| L90 | - | - | 3,889' | - | - | - |

*INDICATES 2" HDPE HOSE LOCATED INSIDE ONE OF THE 24" DIA. RISER PIPES

| LEACHATE SUMP | | |
|---|---|---|
| SUMP NO. | TOP ELEV. | INV. ELEV. |
| 1 | 208.00 | 204.00 |
| 2 | 197.00 | 193.00 |
| 3 | 197.00 | 193.00 |
| 4 | 197.00 | 193.00 |
| 5 | 194.00 | 190.00 |
| 6 | 214.00 | 210.00 |
| 7 | 194.00 | 190.00 |
| 8 | 214.00 | 210.00 |
| 9 | 194.00 | 190.00 |
| 10 | 204.00 | 200.00 |




2000 1000 0 2000 4000
GRAPHIC SCALE IN FEET




SITE MAP
SCALE: 1" = 2000'

N

### BENCHMARK

| BENCHMARK | NORTHING | EASTING | ELEVATION |
|---|---|---|---|
| BM-1 | 876210.33 | 1980424.75 | 294.38 |
| BM-2 | 878163.34 | 1977770.88 | 282.98 |
| BM-3 | 877782.48 | 1976696.51 | 291.40 |
| BM-4 | 878981.35 | 1973019.78 | 278.93 |
| BM-5 | 881582.13 | 1973182.74 | 294.32 |
| BM-6 | 883283.04 | 1976752.92 | 206.20 |
| BM-7 | 883226.17 | 1979903.25 | 219.42 |

REFERENCE NOTES:

1. TOPOGRAPHIC INFORMATION FOR TRACT 3 CELLS NO. 6, 8, AND 10 ALONG WITH A PORTION OF CELL 4 WAS PROVIDED BY SOUTHERN RESOURCES MAPPING CORPORATION. DATE OF PHOTOGRAPHY DECEMBER 12, 2015.
2. REMAINING TOPOGRAPHIC INFORMATION PROVIDED BY SOUTHERN RESOURCES MAPPING CORPORATION. DATE OF PHOTOGRAPHY APRIL 30, 2010.
3. PERMITTED WETLAND BOUNDARY WAS TAKEN FROM THE INDIVIDUAL PERMIT APPLICATION PREPARED BY RICHARDSON, SMITH, GARDNER & ASSOCIATES. THE DRAWING ENTITLED "EXISTING CONDITIONS STREAMS AND WETLANDS" DATED MARCH 2008.

OPERATION NOTES:

1. PROPOSED CONTOURS WITHIN THE PROPOSED CELL LIMITS REPRESENT TOP OF GEOMEMBRANE LAYER.
2. THE CELL SEQUENCE IS GENERALLY IDENTIFIED, BUT CELL SEQUENCE MAY BE MODIFIED DEPENDING ON FIELD CONDITIONS.

200 100 0 200 400
GRAPHIC SCALE IN FEET

ALABAMA LICENSED No. 31360 PROFESSIONAL ENGINEER MATTHEW CHEEK 1-31-25

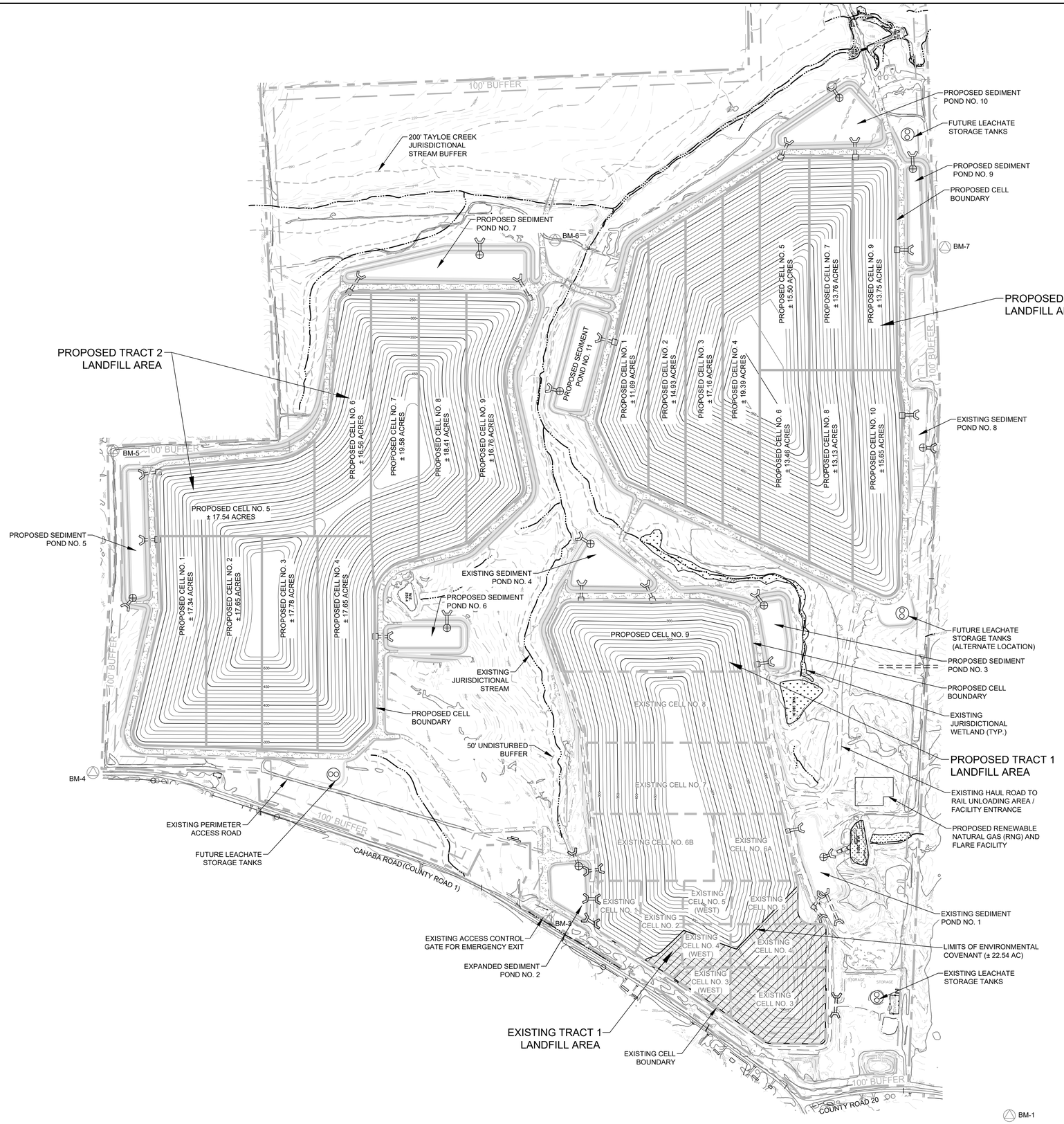
ALABAMA LICENSED NO. 29951 PROFESSIONAL ENGINEER KEVIN GEORGE BERRY

TOP OF CLAY LINER GRADING PLAN AND LEACHATE COLLECTION PLAN - TRACT 3

# ARROWHEAD LANDFILL
# 2025 VERTICAL EXPANSION
FOR
## ARROWHEAD ENVIRONMENTAL PARTNERS, LLC
PERRY COUNTY, ALABAMA


HHNT
HODGES, HARBIN, NEWBERRY & TRIBBLE, INC.
Consulting Engineers
(478) 743-7175
(478) 743-7175 (FAX)
3920 ARKWRIGHT RD.
SUITE 101
MACON, GEORGIA 31210


| | | | |
|---|---|---|---|
| PROJ. NO. | 6215-018-01 | AH-2025VE-BASE-T3.DWG | EDIT 1-29-2025 |
| SCALE | 1" = 200' | SHEET 7 OF 20 | |
| DATE | JANUARY 2025 | | |




## BENCHMARK

| BENCHMARK | NORTHING | EASTING | ELEVATION |
|---|---|---|---|
| BM-1 | 876210.33 | 1980424.75 | 294.38 |
| BM-2 | 878163.34 | 1977770.88 | 282.98 |
| BM-3 | 877782.48 | 1976696.51 | 291.40 |
| BM-4 | 878981.35 | 1973019.78 | 278.93 |
| BM-5 | 881582.13 | 1973182.74 | 294.32 |
| BM-6 | 883283.04 | 1976752.92 | 206.20 |
| BM-7 | 883226.17 | 1979903.25 | 219.42 |

REFERENCE NOTES:

1. TOPOGRAPHIC INFORMATION FOR TRACT 1 WAS PROVIDED BY SAM COMPANIES LLC (FORMERLY KNOWN AS WELLSTON ASSOCIATES LAND SURVEYORS LLC) DATED JULY 5, 2024.
2. TOPOGRAPHIC INFORMATION FOR THE AREA SURROUNDING TRACT 1 WAS PROVIDED BY SAM COMPANIES LLC (FORMERLY KNOWN AS WELLSTON ASSOCIATES LAND SURVEYORS LLC) DATED FEBRUARY 9, 2024.
3. TOPOGRAPHIC INFORMATION FOR TRACT 3 CELLS NO. 6, 8, AND 10 ALONG WITH A PORTION OF CELL 4 WAS PROVIDED BY SOUTHERN RESOURCES MAPPING CORPORATION. DATE OF PHOTOGRAPHY DECEMBER 12, 2015.
4. REMAINING TOPOGRAPHIC INFORMATION PROVIDED BY SOUTHERN RESOURCES MAPPING CORPORATION. DATE OF PHOTOGRAPHY APRIL 30, 2010.
5. PERMITTED WETLAND BOUNDARY WAS TAKEN FROM THE INDIVIDUAL PERMIT APPLICATION PREPARED BY RICHARDSON, SMITH, GARDNER & ASSOCIATES. THE DRAWING ENTITLED "EXISTING CONDITIONS STREAMS AND WETLANDS" DATED MARCH 2008.

ALABAMA LICENSED No. 31300 PROFESSIONAL ENGINEER MATTHEW CHEEK 1-31-25

ALABAMA LICENSED NO. 22951 PROFESSIONAL ENGINEER KEVIN GEORGE BERRY

400 200 0 400 800
GRAPHIC SCALE IN FEET

FINAL GRADING PLAN - TRACTS 1, 2, & 3

# ARROWHEAD LANDFILL 2025 VERTICAL EXPANSION

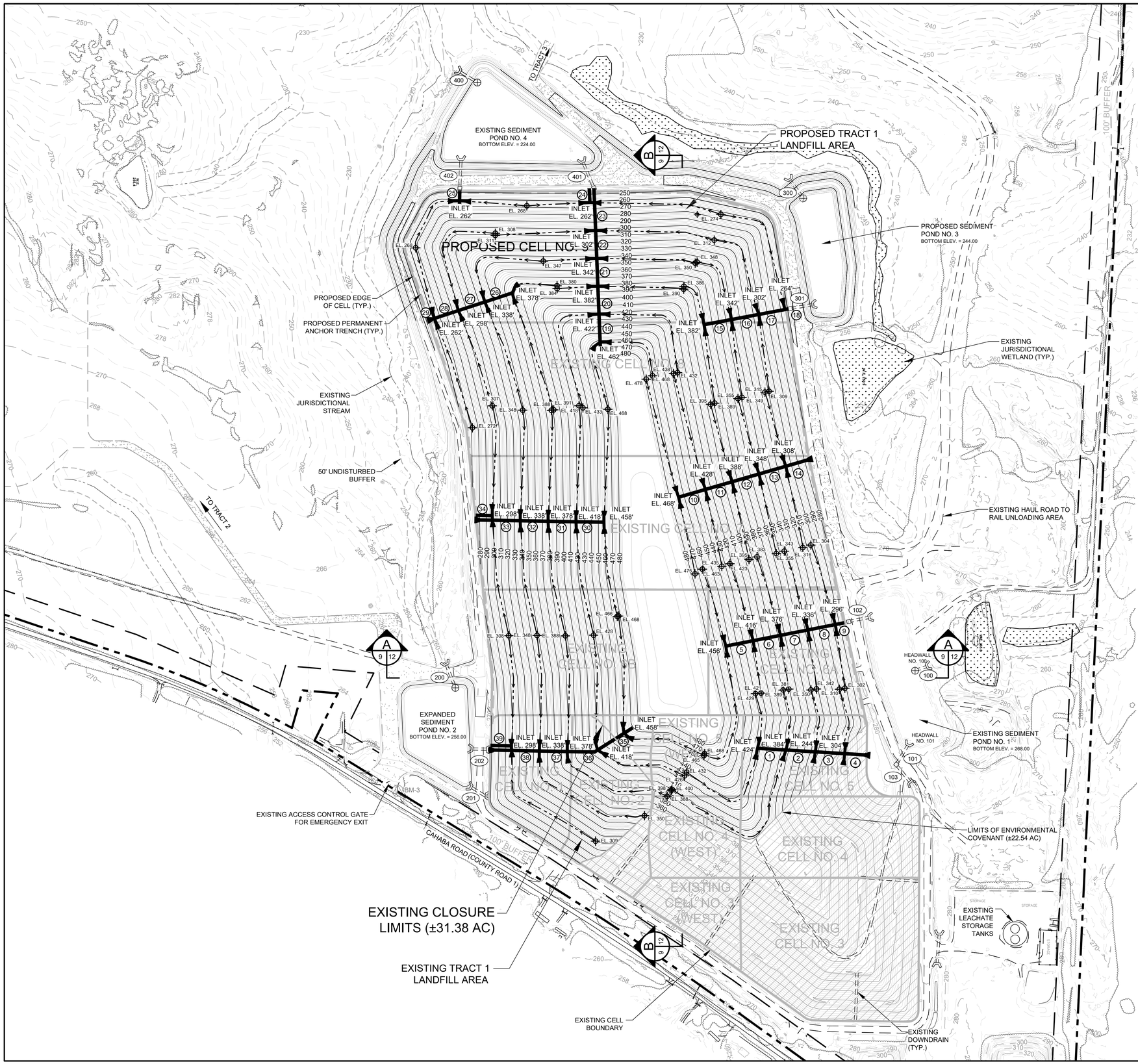
FOR

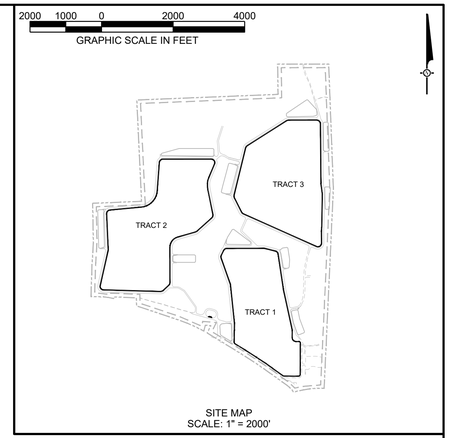
ARROWHEAD ENVIRONMENTAL PARTNERS, LLC

PERRY COUNTY, ALABAMA


HHNT
HODGES, HARBIN, NEWBERRY & TRIBBLE, INC.
Consulting Engineers
(478) 743-7175
(478) 743-7175 (FAX)
3920 ARKWRIGHT RD.
SUITE 101
MACON, GEORGIA 31210


| | | | |
|---|---|---|---|
| PROJ. NO. | 6215-018-01 | AH-2025VE-BASE-OVERALL.DWG | EDIT 1-29-2025 |
| SCALE | 1" = 400' | SHEET 8 OF 20 | |
| DATE | JANUARY 2025 | | |




SITE MAP
SCALE: 1" = 2000'

## BENCHMARK

| BENCHMARK | NORTHING | EASTING | ELEVATION |
|---|---|---|---|
| BM-1 | 876210.33 | 1980424.75 | 294.38 |
| BM-2 | 878163.34 | 1977770.88 | 282.98 |
| BM-3 | 877782.48 | 1976696.51 | 291.40 |
| BM-4 | 878981.35 | 1973019.78 | 278.93 |
| BM-5 | 881582.13 | 1973182.74 | 294.32 |
| BM-6 | 883283.04 | 1976752.92 | 206.20 |
| BM-7 | 883226.17 | 1979903.25 | 219.42 |

REFERENCE NOTES:

1. TOPOGRAPHIC INFORMATION FOR TRACT 1 WAS PROVIDED BY SAM COMPANIES LLC (FORMERLY KNOWN AS WELLSTON ASSOCIATES LAND SURVEYORS LLC) DATED JULY 5, 2024.
2. TOPOGRAPHIC INFORMATION FOR THE AREA SURROUNDING TRACT 1 WAS PROVIDED BY SAM COMPANIES LLC (FORMERLY KNOWN AS WELLSTON ASSOCIATES LAND SURVEYORS LLC) DATED FEBRUARY 9, 2024.
3. TOPOGRAPHIC INFORMATION FOR TRACT 3 CELLS NO. 8, 9, AND 10 ALONG WITH A PORTION OF CELL 4 WAS PROVIDED BY SOUTHERN RESOURCES MAPPING CORPORATION. DATE OF PHOTOGRAPHY DECEMBER 12, 2015.
4. REMAINING TOPOGRAPHIC INFORMATION PROVIDED BY SOUTHERN RESOURCES MAPPING CORPORATION. DATE OF PHOTOGRAPHY APRIL 30, 2010.
5. PERMITTED WETLAND BOUNDARY WAS TAKEN FROM THE INDIVIDUAL PERMIT APPLICATION PREPARED BY RICHARDSON, SMITH, GARDNER & ASSOCIATES. THE DRAWING ENTITLED "EXISTING CONDITIONS STREAMS AND WETLANDS" DATED MARCH 2008.

OPERATION NOTES:

1. PROPOSED CONTOURS WITHIN THE PROPOSED CELL LIMITS REPRESENT TOP OF FINAL COVER.
2. THE CELL SEQUENCE IS GENERALLY IDENTIFIED, BUT CELL SEQUENCE MAY BE MODIFIED DEPENDING ON FIELD CONDITIONS.
3. ALL DOWNDRAIN PIPES SHALL BE 24" DIA CORRUGATED PLASTIC PIPES.

ALABAMA LICENSED No. 31360 PROFESSIONAL ENGINEER 1-31-25 I. MATTHEW CHEEK

ALABAMA LICENSED No. 22951 PROFESSIONAL ENGINEER KEVIN GEORGE BERRY

200 100 0 200 400
GRAPHIC SCALE IN FEET

FINAL GRADING AND DRAINAGE PLAN - TRACT 1

# ARROWHEAD LANDFILL
# 2025 VERTICAL EXPANSION

FOR

ARROWHEAD ENVIRONMENTAL PARTNERS, LLC

PERRY COUNTY, ALABAMA


HHNT
HODGES, HARBIN, NEWBERRY & TRIBBLE, INC.
Consulting Engineers
(478) 743-7175
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3920 ARKWRIGHT RD.
SUITE 101
MACON, GEORGIA 31210


| | | | |
|---|---|---|---|
| PROJ. NO. | 6215-018-01 | AH-2025VE-BASE-T1.DWG | EDIT 1-29-2025 |
| SCALE | 1" = 200' | SHEET 9 OF 20 | |
| DATE | JANUARY 2025 | | |

PROPOSED SEDIMENT POND NO. 7
BOTTOM ELEV. = 212.00'

PROPOSED TRACT 2 LANDFILL AREA

PROPOSED SEDIMENT POND NO. 5
BOTTOM ELEV. = 264.00'

PROPOSED SEDIMENT POND NO. 6
BOTTOM ELEV. = 256.00'

PROPOSED CELL NO. 5
7.54 ACRES

100' BUFFER

BM-4

BM-5

BM-6

TO TRACT 3

TO TRACT 1

EXISTING JURISDICTIONAL STREAM (TYP.)

50' UNDISTURBED BUFFER (TYP.)

PROPOSED ANCHOR TRENCH (TYP.)

EXISTING EDGE OF CELL (TYP.)

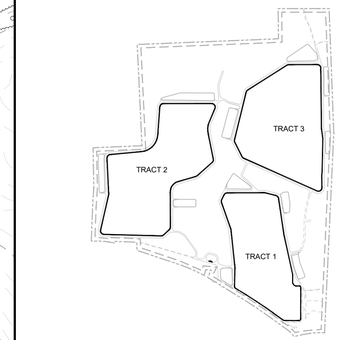
EXISTING TREELINE (TYP.)

EXISTING PERIMETER ACCESS ROAD

PROPOSED LEACHATE STORAGE TANKS

W.E. 256.4

2000 1000 0 2000 4000
GRAPHIC SCALE IN FEET




SITE MAP
SCALE: 1" = 2000'

## BENCHMARK

| BENCHMARK | NORTHING | EASTING | ELEVATION |
|---|---|---|---|
| BM-1 | 876210.33 | 1980424.75 | 294.38 |
| BM-2 | 878163.34 | 1977770.88 | 282.98 |
| BM-3 | 877782.48 | 1976696.51 | 291.40 |
| BM-4 | 878981.35 | 1973019.78 | 278.93 |
| BM-5 | 881582.13 | 1973182.74 | 294.32 |
| BM-6 | 883283.04 | 1976752.92 | 206.20 |
| BM-7 | 883226.17 | 1979903.25 | 219.42 |

REFERENCE NOTES:

1. TOPOGRAPHIC INFORMATION OUTSIDE OF THE TRACT 1 WASTE FOOTPRINT PROVIDED BY SOUTHERN RESOURCES MAPPING CORPORATION. DATE OF PHOTOGRAPH 04/30/10.
2. PERMITTED WETLAND BOUNDARY WAS TAKEN FROM THE INDIVIDUAL PERMIT APPLICATION PREPARED BY RICHARDSON, SMITH, GARDNER & ASSOCIATES. THE DRAWING ENTITLED "EXISTING CONDITIONS STREAMS AND WETLANDS" DATED MARCH 2008.

OPERATION NOTES:

1. PROPOSED CONTOURS WITHIN THE CELL LIMITS REPRESENT TOP OF FINAL COVER.
2. THE CELL SEQUENCE IS GENERALLY IDENTIFIED, BUT CELL SEQUENCE MAY BE MODIFIED DEPENDING ON FIELD CONDITIONS.
3. ALL DOWNDRAIN PIPES SHALL BE 24" DIA. CORRUGATED PLASTIC PIPES.

ALABAMA LICENSED No. 31308 PROFESSIONAL ENGINEER K. MATTHEW CHEEK 1-31-25

ALABAMA LICENSED No. 32951 PROFESSIONAL ENGINEER KEVIN GEORGE ISBERY 1-31-2025

200 100 0 200 400
GRAPHIC SCALE IN FEET

FINAL GRADING AND DRAINAGE PLAN - TRACT 2

# ARROWHEAD LANDFILL
# 2025 VERTICAL EXPANSION

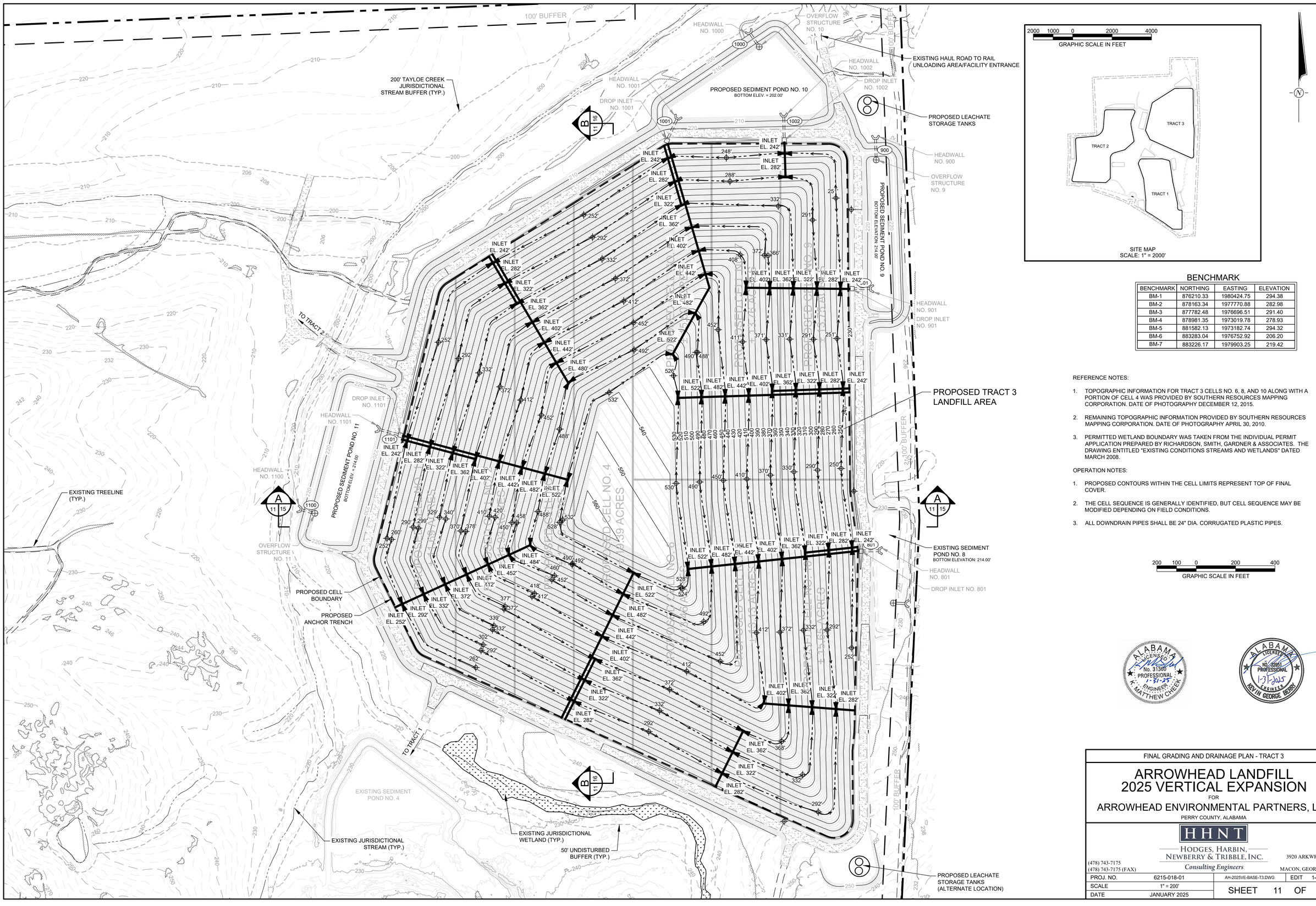
FOR

ARROWHEAD ENVIRONMENTAL PARTNERS, LLC

PERRY COUNTY, ALABAMA

HHNT
HODGES, HARBIN, NEWBERRY & TRIBBLE, INC.
Consulting Engineers
(478) 743-7175
(478) 743-7175 (FAX)
3920 ARKWRIGHT RD.
SUITE 101
MACON, GEORGIA 31210

| | | | |
|---|---|---|---|
| PROJ. NO. | 6215-018-01 | AH-2025VE-BASE-T2.DWG | EDIT 1-29-2025 |
| SCALE | 1" = 200' | SHEET 10 OF 20 | |
| DATE | JANUARY 2025 | | |




## BENCHMARK

| BENCHMARK | NORTHING | EASTING | ELEVATION |
|---|---|---|---|
| BM-1 | 876210.33 | 1980424.75 | 294.38 |
| BM-2 | 878163.34 | 1977770.88 | 282.98 |
| BM-3 | 877782.48 | 1976696.51 | 291.40 |
| BM-4 | 878981.35 | 1973019.78 | 278.93 |
| BM-5 | 881582.13 | 1973182.74 | 294.32 |
| BM-6 | 883283.04 | 1976752.92 | 206.20 |
| BM-7 | 883226.17 | 1979903.25 | 219.42 |

REFERENCE NOTES:

1. TOPOGRAPHIC INFORMATION FOR TRACT 3 CELLS NO. 6, 8, AND 10 ALONG WITH A PORTION OF CELL 4 WAS PROVIDED BY SOUTHERN RESOURCES MAPPING CORPORATION. DATE OF PHOTOGRAPHY DECEMBER 12, 2015.
2. REMAINING TOPOGRAPHIC INFORMATION PROVIDED BY SOUTHERN RESOURCES MAPPING CORPORATION. DATE OF PHOTOGRAPHY APRIL 30, 2010.
3. PERMITTED WETLAND BOUNDARY WAS TAKEN FROM THE INDIVIDUAL PERMIT APPLICATION PREPARED BY RICHARDSON, SMITH, GARDNER & ASSOCIATES. THE DRAWING ENTITLED "EXISTING CONDITIONS STREAMS AND WETLANDS" DATED MARCH 2008.

OPERATION NOTES:

1. PROPOSED CONTOURS WITHIN THE CELL LIMITS REPRESENT TOP OF FINAL COVER.
2. THE CELL SEQUENCE IS GENERALLY IDENTIFIED, BUT CELL SEQUENCE MAY BE MODIFIED DEPENDING ON FIELD CONDITIONS.
3. ALL DOWNDRAIN PIPES SHALL BE 24" DIA. CORRUGATED PLASTIC PIPES.

ALABAMA LICENSED No. 31360 PROFESSIONAL ENGINEER MATTHEW CHEEK 1-31-25

ALABAMA LICENSED NO. 32951 PROFESSIONAL ENGINEER KEVIN GEORGE DESORT 1/31/2025

FINAL GRADING AND DRAINAGE PLAN - TRACT 3

# ARROWHEAD LANDFILL 2025 VERTICAL EXPANSION

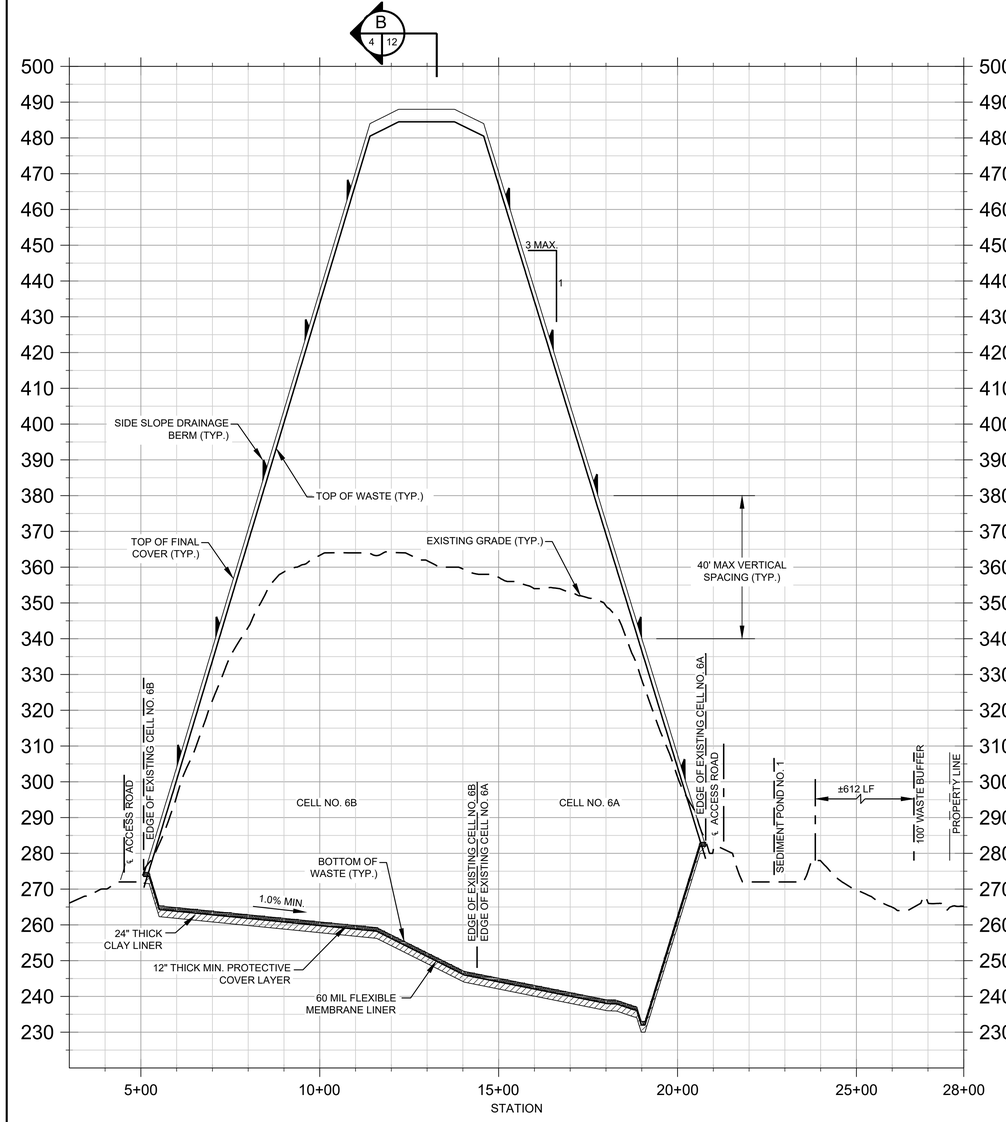
FOR

ARROWHEAD ENVIRONMENTAL PARTNERS, LLC

PERRY COUNTY, ALABAMA

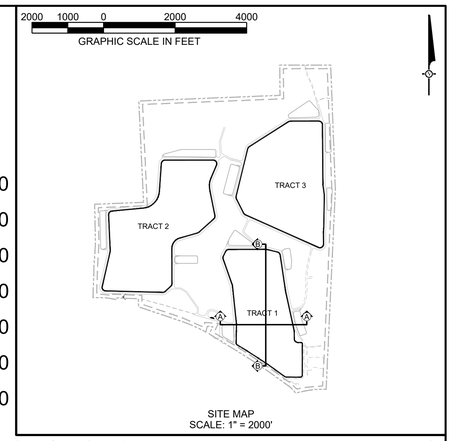
HHNT
HODGES, HARBIN, NEWBERRY & TRIBBLE, INC.
Consulting Engineers
(478) 743-7175
(478) 743-7175 (FAX)
3920 ARKWRIGHT RD.
SUITE 101
MACON, GEORGIA 31210

| | | | |
|---|---|---|---|
| PROJ. NO. | 6215-018-01 | AH-2025VE-BASE-T3.DWG | EDIT 1-29-2025 |
| SCALE | 1" = 200' | SHEET 11 OF 20 | |
| DATE | JANUARY 2025 | | |




CROSS SECTION A

CROSS SECTION B




NOTE:
1. LEACHATE LINES ARE NOT SHOWN FOR CLARITY.
2. 8 OSY NON-WOVEN CUSHION GEOTEXTILE FABRIC NOT SHOWN UNDER 12" THICK PROTECTIVE COVER LAYER FOR CLARITY.
3. EXISTING GRADE ELEVATIONS TAKEN FROM AERIAL SURVEYS PREPARED BY SAM COMPANIES LLC (FORMERLY KNOWN AS WELLSTON ASSOCIATES LAND SURVEYORS LLC), DATE OF PHOTOGRAPHY JULY 5, 2024 AND FEBRUARY 9, 2024.

200 100 0 200 400
GRAPHIC SCALE IN FEET
HORIZONTAL SCALE: 1" = 200'

20 10 0 20 40
GRAPHIC SCALE IN FEET
VERTICAL SCALE: 1" = 20'

ALABAMA LICENSED No. 31360 PROFESSIONAL ENGINEER K. MATTHEW CHEEK 1-31-25

ALABAMA LICENSED NO. 29351 PROFESSIONAL ENGINEER KEVIN GEORGE BERRY 1-31-25

CROSS SECTIONS A&B - TRACT 1

# ARROWHEAD LANDFILL
# 2025 VERTICAL EXPANSION

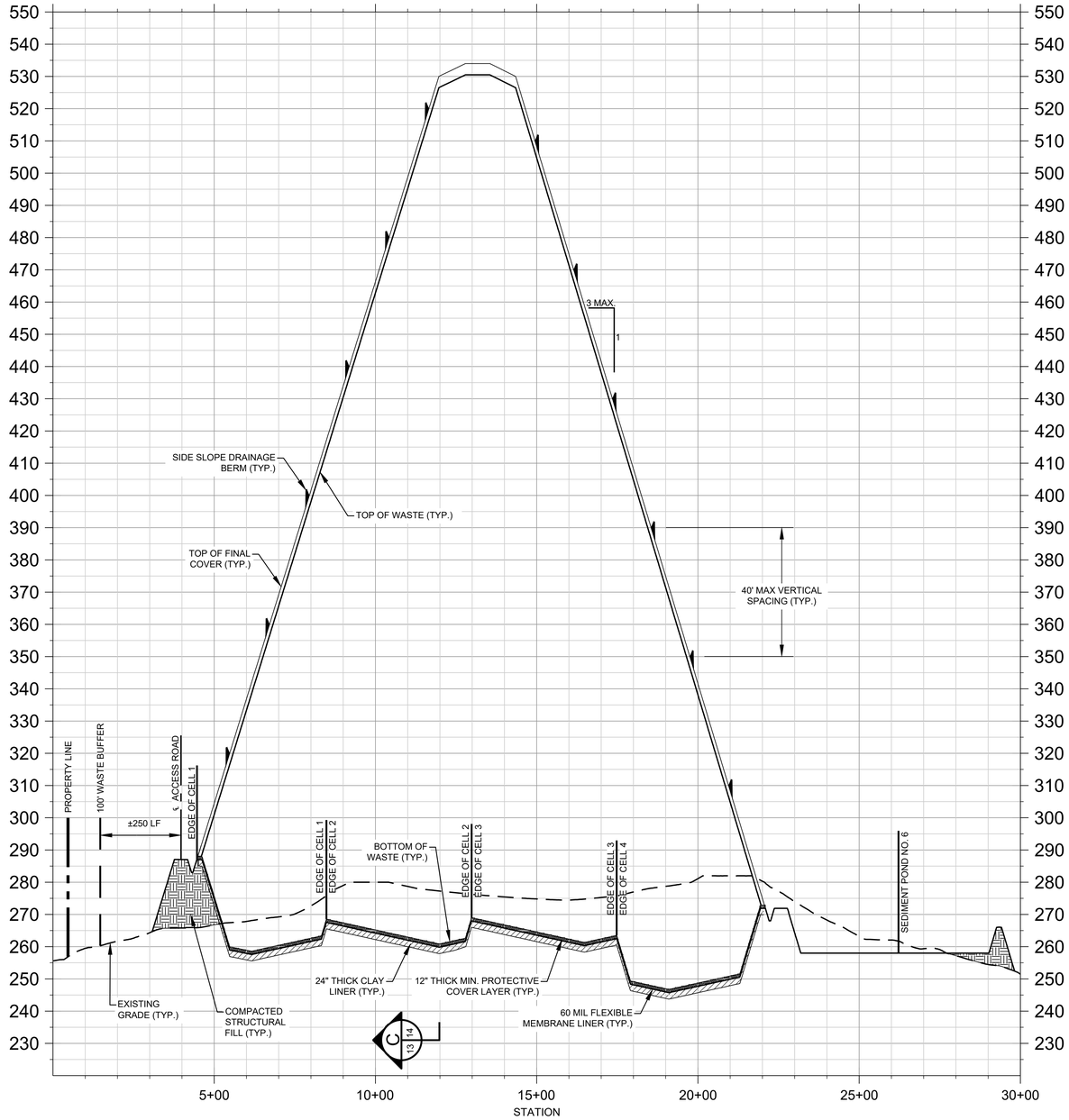
FOR

ARROWHEAD ENVIRONMENTAL PARTNERS, LLC

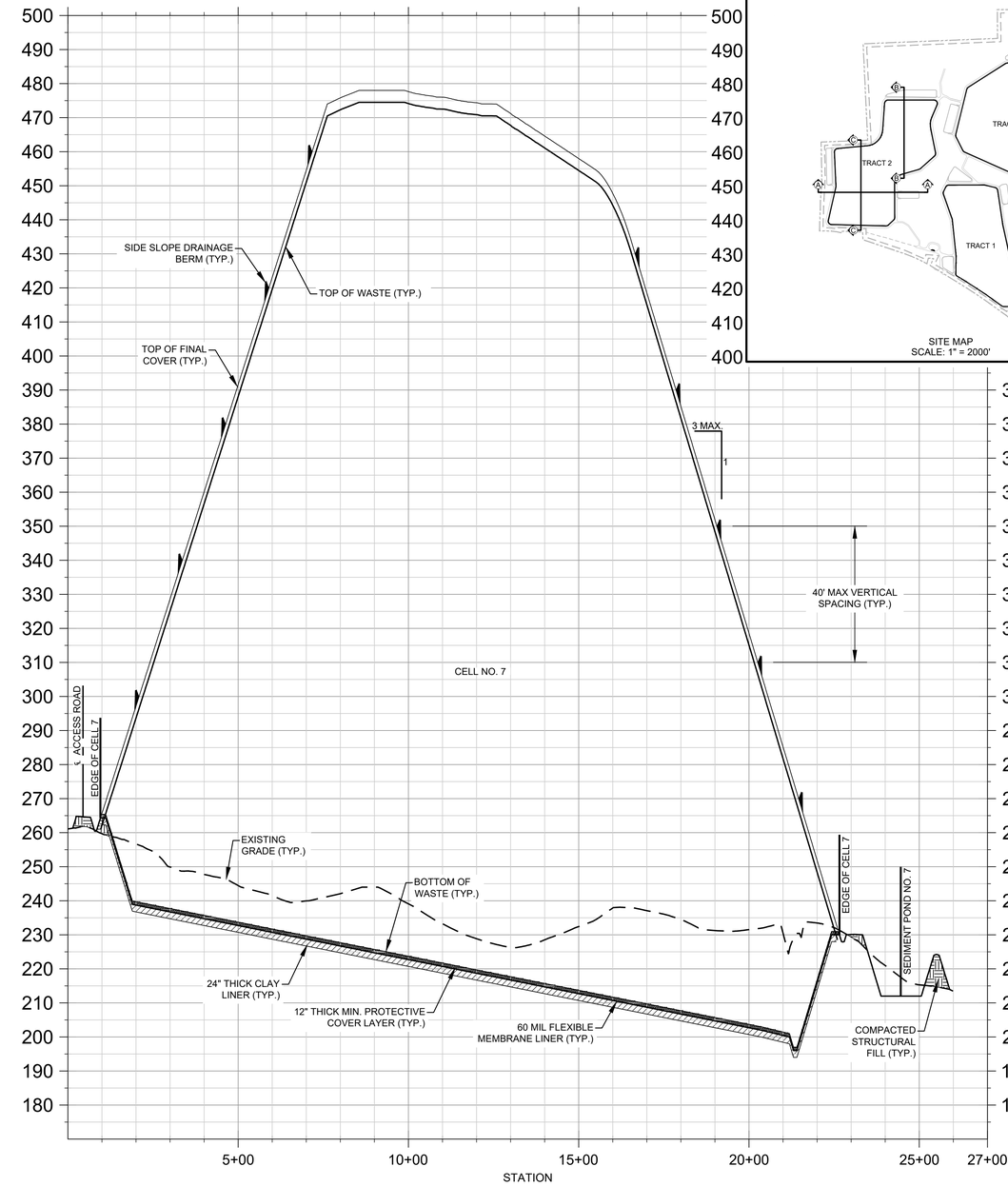
PERRY COUNTY, ALABAMA

HHNT
HODGES, HARBIN, NEWBERRY & TRIBBLE, INC.
Consulting Engineers
3920 ARKWRIGHT RD, SUITE 101
MACON, GEORGIA 31210
(478) 743-7175
(478) 743-7175 (FAX)

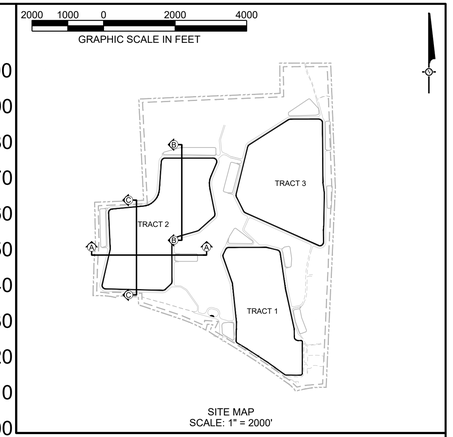
| | | | |
|---|---|---|---|
| PROJ. NO. | 6215-018-01 | AH-2025VE-XSEC-T1.DWG | EDIT 1-29-2025 |
| SCALE | H: 1" = 200'; V: 1" = 20' | SHEET 12 OF 20 | |
| DATE | JANUARY 2025 | | |




CROSS SECTION A




CROSS SECTION B




NOTE:
1. LEACHATE LINES ARE NOT SHOWN FOR CLARITY.
2. 8 OSY NON-WOVEN CUSHION GEOTEXTILE FABRIC NOT SHOWN UNDER 12" THICK PROTECTIVE COVER LAYER FOR CLARITY.
3. EXISTING GRADE ELEVATIONS TAKEN FROM AERIAL SURVEY PREPARED BY SOUTHERN RESOURCES MAPPING CORPORATION, DATE OF PHOTOGRAPHY APRIL 30, 2010.

200 100 0 200 400
GRAPHIC SCALE IN FEET
HORIZONTAL SCALE: 1" = 200'

20 10 0 20 40
GRAPHIC SCALE IN FEET
VERTICAL SCALE: 1" = 20'

ALABAMA LICENSED PROFESSIONAL ENGINEER No. 31360 K. MATTHEW CHEEK 1-31-25

ALABAMA LICENSED PROFESSIONAL ENGINEER NO. 32951 KEVIN GEORGE BERRY 1-31-2025

CROSS SECTIONS A&B - TRACT 2

# ARROWHEAD LANDFILL
# 2025 VERTICAL EXPANSION

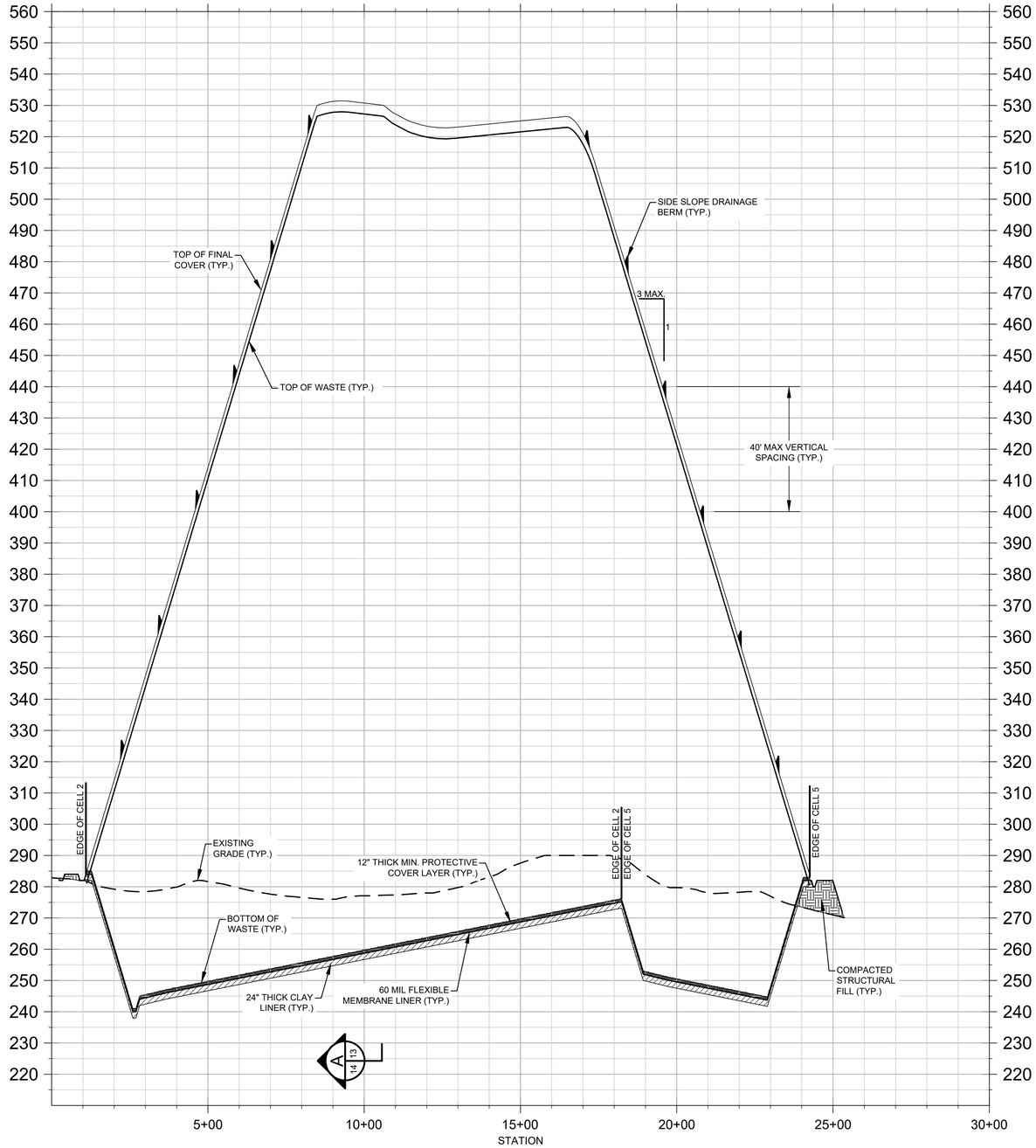
FOR

ARROWHEAD ENVIRONMENTAL PARTNERS, LLC

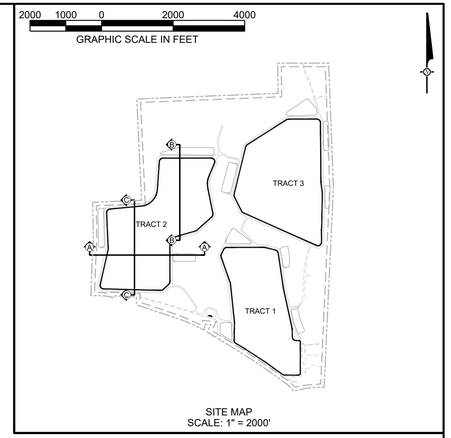
PERRY COUNTY, ALABAMA

HHNT
HODGES, HARBIN, NEWBERRY & TRIBBLE, INC.
Consulting Engineers
(478) 743-7175
(478) 743-7175 (FAX)
3920 ARKWRIGHT RD.
SUITE 101
MACON, GEORGIA 31210

| | | | |
|---|---|---|---|
| PROJ. NO. | 6215-018-01 | AH-2025VE-XSEC-T2.DWG | EDIT 1-29-2025 |
| SCALE | H: 1" = 200'; V: 1" = 20' | SHEET 13 OF 20 | |
| DATE | JANUARY 2025 | | |




CROSS SECTION C




NOTE:
1. LEACHATE LINES ARE NOT SHOWN FOR CLARITY.
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3. EXISTING GRADE ELEVATIONS TAKEN FROM AERIAL SURVEY PREPARED BY SOUTHERN RESOURCES MAPPING CORPORATION, DATE OF PHOTOGRAPHY APRIL 30, 2010.

200 100 0 200 400
GRAPHIC SCALE IN FEET
HORIZONTAL SCALE: 1" = 200'

20 10 0 20 40
GRAPHIC SCALE IN FEET
VERTICAL SCALE: 1" = 20'

ALABAMA LICENSED No. 31380 PROFESSIONAL ENGINEER K. MATTHEW CHEEK 1-31-25

ALABAMA LICENSED NO. 22051 PROFESSIONAL ENGINEER KEVIN GEORGE BENOIT 1-31-2025

CROSS SECTION C - TRACT 2

# ARROWHEAD LANDFILL
# 2025 VERTICAL EXPANSION

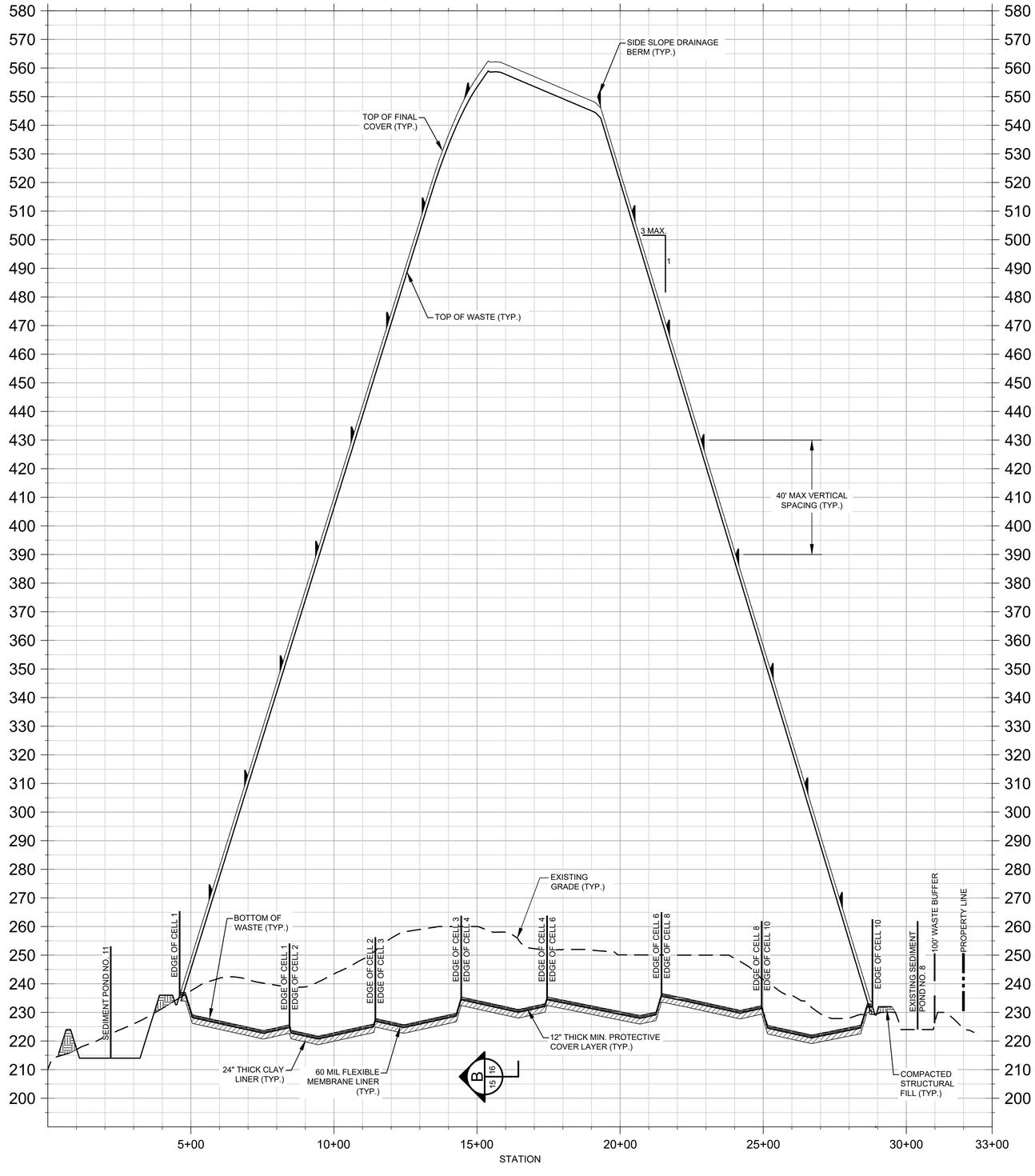
FOR

ARROWHEAD ENVIRONMENTAL PARTNERS, LLC

PERRY COUNTY, ALABAMA

HHNT
HODGES, HARBIN, NEWBERRY & TRIBBLE, INC.
Consulting Engineers
(478) 743-7175
(478) 743-7175 (FAX)
3920 ARKWRIGHT RD, SUITE 101
MACON, GEORGIA 31210

| | | | |
|---|---|---|---|
| PROJ. NO. | 6215-018-01 | AH-2025VE-XSEC-T2.DWG | EDIT 1-29-2025 |
| SCALE | H: 1" = 200'; V: 1" = 20' | SHEET 14 OF 20 | |
| DATE | JANUARY 2025 | | |

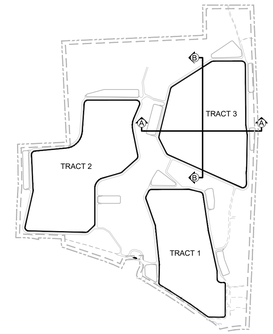



CROSS SECTION A

200 100 0 200 400
GRAPHIC SCALE IN FEET
HORIZONTAL SCALE: 1" = 200'

20 10 0 20 40
GRAPHIC SCALE IN FEET
VERTICAL SCALE: 1" = 20'

2000 1000 0 2000 4000
GRAPHIC SCALE IN FEET




SITE MAP
SCALE: 1" = 2000'

NOTE:
1. LEACHATE LINES ARE NOT SHOWN FOR CLARITY.
2. 8 OSY NON-WOVEN CUSHION GEOTEXTILE FABRIC NOT SHOWN UNDER 12" THICK PROTECTIVE COVER LAYER FOR CLARITY.
3. EXISTING GRADE ELEVATIONS TAKEN FROM AERIAL SURVEY PREPARED BY SOUTHERN RESOURCES MAPPING CORPORATION, DATE OF PHOTOGRAPHY APRIL 30, 2010.
4. TOPOGRAPHIC INFORMATION FOR TRACT 3 CELLS NO. 6, 8, AND 10 ALONG WITH A PORTION OF CELL 4 WAS PROVIDED BY SOUTHERN RESOURCES MAPPING CORPORATION. DATE OF PHOTOGRAPHY DECEMBER 12, 2015.

ALABAMA LICENSED No. 31300 PROFESSIONAL ENGINEER K. MATTHEW CHEEK 1-31-25

ALABAMA LICENSED No. 32951 PROFESSIONAL ENGINEER KEVIN GEORGE IBERT 1-31-2025

CROSS SECTION A - TRACT 3

# ARROWHEAD LANDFILL
# 2025 VERTICAL EXPANSION

FOR

ARROWHEAD ENVIRONMENTAL PARTNERS, LLC

PERRY COUNTY, ALABAMA

HHNT
HODGES, HARBIN, NEWBERRY & TRIBBLE, INC.
Consulting Engineers
(478) 743-7175
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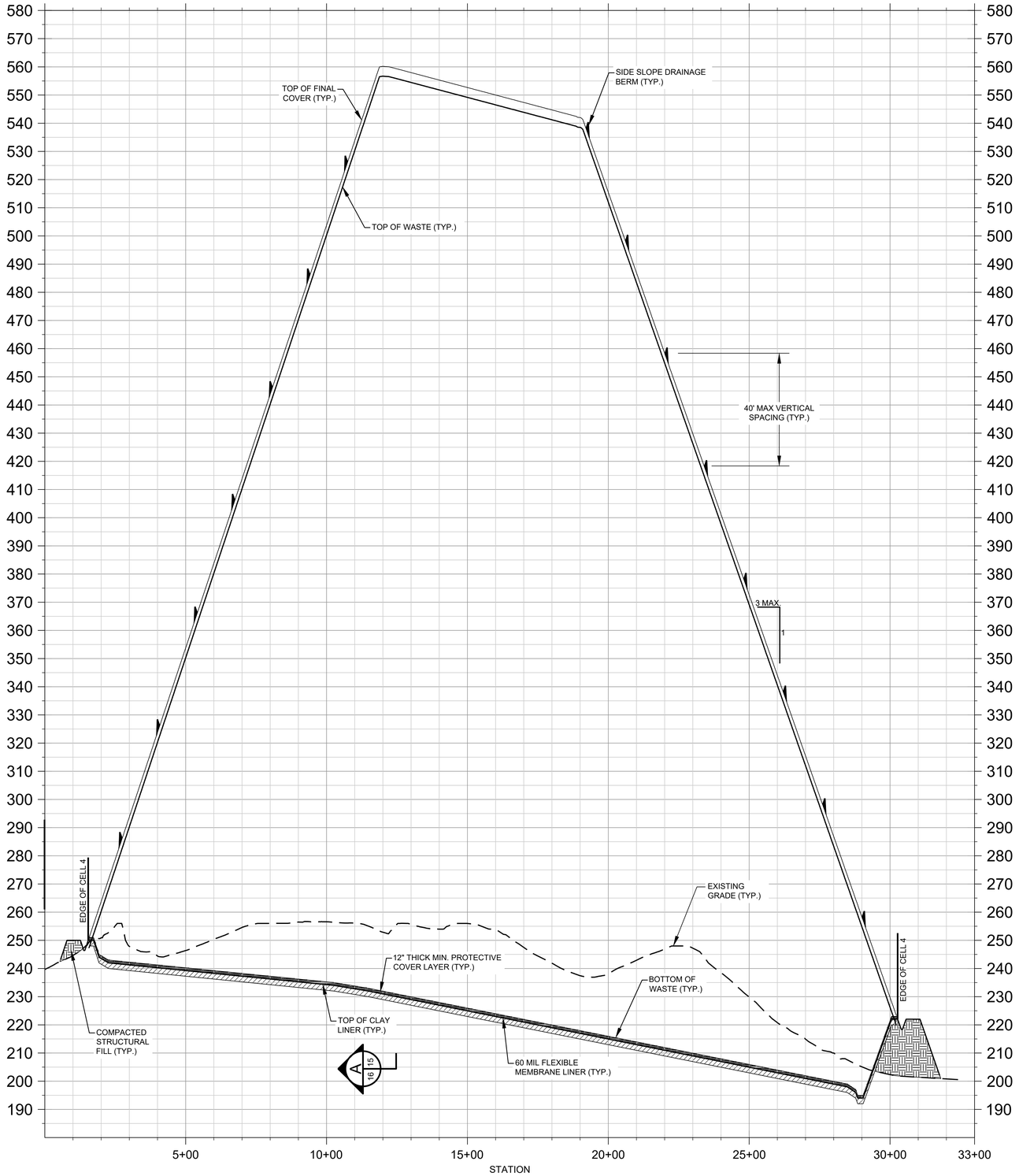
3920 ARKWRIGHT RD, SUITE 101
MACON, GEORGIA 31210

| | | | |
|---|---|---|---|
| PROJ. NO. | 6215-018-01 | AH-2025VE-XSEC-T3.DWG | EDIT 1-29-2025 |
| SCALE | H: 1" = 200'; V: 1" = 20' | SHEET 15 OF 20 | |
| DATE | JANUARY 2025 | | |

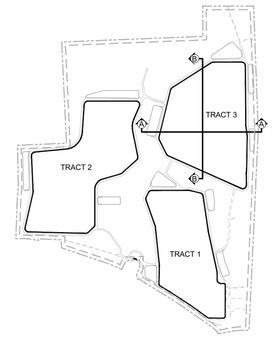



CROSS SECTION B

200 100 0 200 400
GRAPHIC SCALE IN FEET
HORIZONTAL SCALE: 1" = 200'

20 10 0 20 40
GRAPHIC SCALE IN FEET
VERTICAL SCALE: 1" = 20'

2000 1000 0 2000 4000
GRAPHIC SCALE IN FEET




SITE MAP
SCALE: 1" = 2000'

NOTE:
1. LEACHATE LINES ARE NOT SHOWN FOR CLARITY.
2. 8 OSY NON-WOVEN CUSHION GEOTEXTILE FABRIC NOT SHOWN UNDER 12" THICK PROTECTIVE COVER LAYER FOR CLARITY.
3. EXISTING GRADE ELEVATIONS TAKEN FROM AERIAL SURVEY PREPARED BY SOUTHERN RESOURCES MAPPING CORPORATION, DATE OF PHOTOGRAPHY APRIL 30, 2010.
4. TOPOGRAPHIC INFORMATION FOR TRACT 3 CELLS NO. 6, 8, AND 10 ALONG WITH A PORTION OF CELL 4 WAS PROVIDED BY SOUTHERN RESOURCES MAPPING CORPORATION. DATE OF PHOTOGRAPHY DECEMBER 12, 2015.

ALABAMA LICENSED No. 31308 PROFESSIONAL ENGINEER MATTHEW CHECK 1-31-25

ALABAMA LICENSED NO. 32951 PROFESSIONAL ENGINEER KEVIN GEORGE BERRY 1-31-2025

CROSS SECTION B - TRACT 3

# ARROWHEAD LANDFILL
# 2025 VERTICAL EXPANSION

FOR

ARROWHEAD ENVIRONMENTAL PARTNERS, LLC

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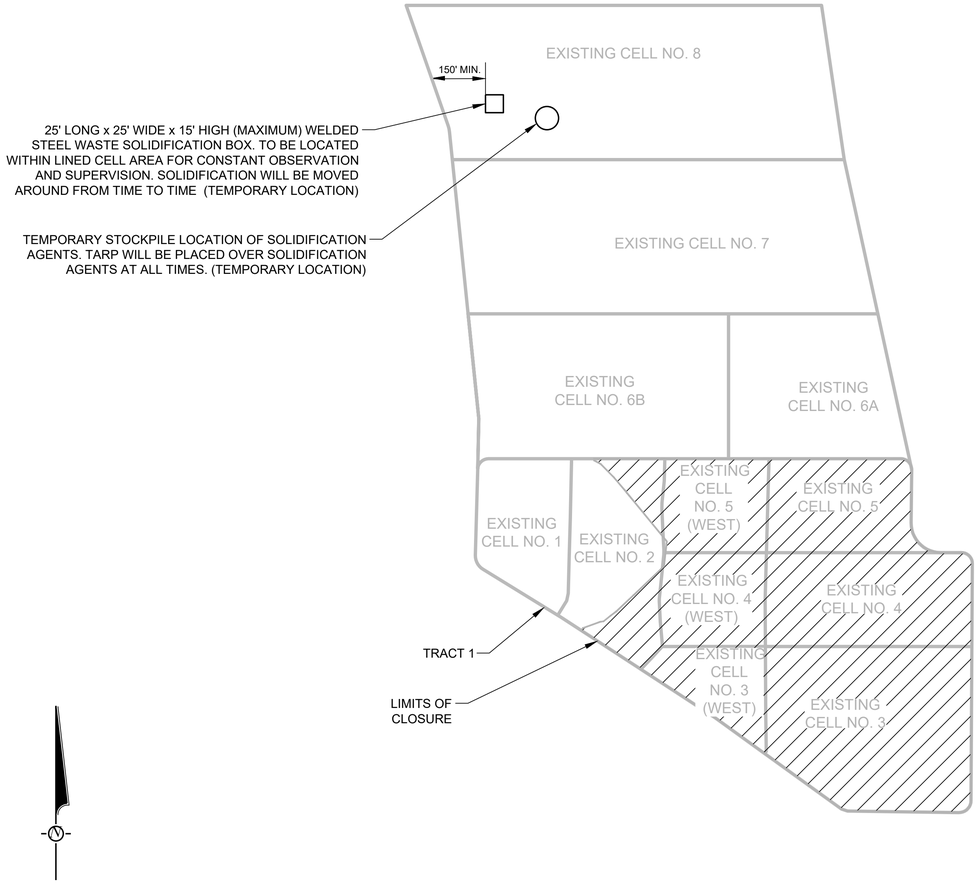
| | | | |
|---|---|---|---|
| PROJ. NO. | 6215-018-01 | AH-2025VE-XSEC-T3.DWG | EDIT 1-29-2025 |
| SCALE | H: 1" = 200'; V: 1" = 20' | SHEET 16 OF 20 | |
| DATE | JANUARY 2025 | | |

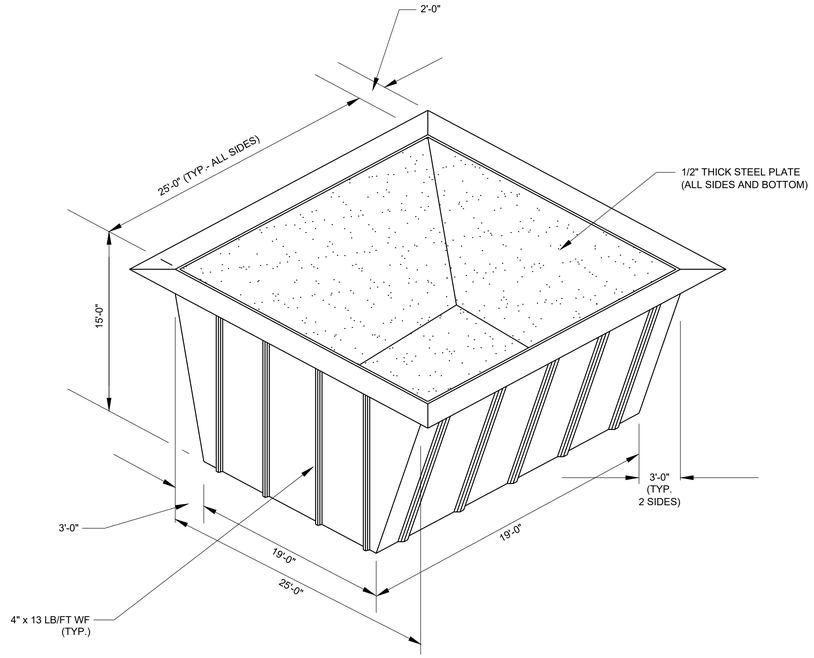



## TYPICAL CELL - PLAN VIEW

1" = 150'

NOTE:

1. TWO SIDES SHOULD BE TAPERED.
2. ALL DIMENSIONS ARE APPROXIMATE.
3. STEEL MIXING BASIN WILL BE EQUIPPED WITH EYE BOLTS SO THAT IT CAN BE MOVED EASILY BY LANDFILL EQUIPMENT.




## WASTE SOLIDIFICATION MIXING PIT

N.T.S.

## OPERATION AND GENERAL NOTES NARRATIVE

OPERATION NOTES:

1. THE WASTE SOLIDIFICATION BOX SHALL BE INITIALLY LOCATED IN A LINED LANDFILL CELL SO THAT CONSTANT OBSERVATION AND SUPERVISION CAN BE PROVIDED DURING THE MIXING OF THE LIQUID / SEMI-SOLID MATERIAL WITH THE SOLIDIFYING AGENT(S).

2. THE STEEL WASTE SOLIDIFICATION BOX WILL SERVE AS THE PRIMARY CONTAINMENT FOR THE MIXING OPERATION.

3. A MINIMUM 2' HIGH EARTHEN BERM ON ALL SIDES OF THE OPERATION WILL SERVE AS THE SECONDARY CONTAINMENT FOR THE MIXING OPERATION.

4. ALL LOADS OF MATERIAL TO BE SOLIDIFIED WILL FIRST BE APPROVED BY THE LANDFILL AS NON-HAZARDOUS MATERIAL THAT IS ACCEPTABLE FOR DISPOSAL ACCORDING TO THE PERMIT CONDITIONS FOR THIS SITE.

5. EACH LOAD TO BE SOLIDIFIED, ONCE APPROVED, WILL BE PLACED INSIDE THE WASTE SOLIDIFICATION BOX WHICH WILL BE LOCATED INSIDE A LINED LANDFILL CELL. ALL WASTE TO BE SOLIDIFIED WILL BE PROCESSED ACCORDING TO THE PROHIBITED WASTE EXCLUSION PLAN APPLICABLE TO THIS SITE. IF A LIQUID WASTE IS RECEIVED, IT MUST BE PROCESSED AND DISPOSED OF THAT DAY. NO LIQUID WASTE WILL BE ALLOWED TO REMAIN OVERNIGHT.

6. SOLIDIFICATION AGENTS TO BE USED WILL INCLUDE ONE OR MORE OF THE FOLLOWING: WOOD BARK, WOOD CHIPS, SAW DUST, FLY ASH, BOTTOM ASH, KILN DUST, AUTOFLUFF, SOILS, OR OTHER SIMILAR ABSORBENT MATERIALS. SOLIDIFICATION AGENTS WILL THEN BE ADDED TO THE LIQUID OR SEMI-SOLID WASTE MATERIAL AND STIRRED AND THOROUGHLY MIXED WITH A BACKHOE, EXCAVATOR, OR SIMILAR PIECE OF EQUIPMENT. SINCE DUSTY MATERIALS MAY BE UTILIZED AS SOLIDIFICATION AGENTS, PROPER TARPING AND DUST CONTROL PROCEDURES WILL BE USED TO ASSURE DUST IS MINIMIZED. NO MORE THAN 5 DAYS (120 HOURS) WORTH OF DRYING AGENT MAY BE STORED ON-SITE AT ANY ONE-TIME. AT ALL TIMES (EXCEPT WHEN ACTIVELY MIXING) THE DRYING AGENT WILL BE STORED UNDER TARPS THAT COMPLETELY COVER THE DRYING AGENT AND ARE ANCHORED PROPERLY.

7. ONCE SOLIDIFIED, EACH LOAD WILL BE SUBJECTED TO A "PAINT FILTER TEST" (EPA TEST METHOD 9095) BY QUALIFIED PERSONNEL TO ASSURE ITS ACCEPTABILITY FOR DISPOSAL.

8. A LOG WILL BE KEPT AT THE LANDFILL WHICH WILL HAVE AT A MINIMUM THE FOLLOWING INFORMATION:
   A. WASTE MATERIAL DESCRIPTION
   B. SOLIDIFICATION AGENT(S) UTILIZED
   C. TIME OF SOLIDIFICATION
   D. APPROXIMATE VOLUME OF SOLIDIFIED WASTE
   E. DATE OF SOLIDIFICATION

THIS LOG WILL BE MADE PART OF THE FACILITY OPERATING RECORD AND WILL BE MADE AVAILABLE TO ADEM UPON REQUEST.

9. ONCE APPROVED FOR DISPOSAL, THE WASTE SHALL BE PLACED IN THE ACTIVE LINED LANDFILL CELL ALONGSIDE OTHER MUNICIPAL SOLID WASTE.

GENERAL NOTES:

1. THIS DESIGN AND OPERATION PLAN IS DESIGNED TO PROVIDE FOR THE SOLIDIFICATION OF NON-HAZARDOUS WASTE MATERIALS FOR DISPOSAL IN A MUNICIPAL SOLID WASTE LANDFILL.

2. WASTE SOLIDIFICATION BOX (MAXIMUM DIMENSIONS) SHALL BE 25' IN LENGTH x 25' IN WIDTH x 15' IN HEIGHT (±345 C.Y. CONTAINER). ROLLOFF CONTAINERS WHICH HAVE WELDED CORNERS MAY ALSO BE USED AS AN ALTERNATIVE. THIS SITE MAY USE MULTIPLE MIXING BOXES.

3. THE WASTE SOLIDIFICATION BOX SHALL BE MADE OF STEEL (WELDED AT CORNERS) WITH AN OPEN TOP.

4. THE WASTE SOLIDIFICATION BOX SHALL BE LOCATED INSIDE A LINED CELL AREA AT ALL TIMES. IT SHALL ALWAYS BE PLACED INSIDE AN EARTHEN SECONDARY CONTAINMENT BERM. THE WASTE SOLIDIFICATION BOX SHALL NOT BE LOCATED OUTSIDE OF A LINED LANDFILL CELL.

5. REMOVABLE RAILING WILL BE INSTALLED ON TOP OF THE CONTAINER. LINKS OF CHAIN OR ORANGE PLASTIC LITTER FENCE WILL ALSO BE ATTACHED TO RAILINGS. TEMPORARY RAILING WILL ALSO BE INSTALLED AROUND OUTSIDE OF WASTE SOLIDIFICATION BOX WHEN THE MIXING OPERATION IS NOT ON-GOING. SIGNS STATING "OPEN PIT" WILL ALSO BE PLACED AROUND THE WASTE SOLIDIFICATION BOX.

6. WASTE SOLIDIFICATION BOX SHALL BE TESTED FOR LEAKS BEFORE INITIAL USE AND AS NECESSARY AFTER BEING INSPECTED EACH TIME IT IS RELOCATED. THE LEAK TEST WILL CONSIST OF A MINIMUM OF A TWO HOUR HYDROSTATIC TEST. THE WASTE SOLIDIFICATION BOX WILL BE FILLED WITH WATER FOR A MINIMUM OF TWO HOURS. THE WASTE SOLIDIFICATION BOX WILL BE EXAMINED FOR ANY LEAKS FOR THIS TIME PERIOD. NO LEAKAGE RATE IS PERMISSIBLE. IF ANY LEAK IS DISCOVERED, THE WASTE SOLIDIFICATION BOX WILL BE REPAIRED AND THE HYDROSTATIC TEST WILL BE REPEATED.

7. THE WASTE SOLIDIFICATION BOX WILL BE MOVED BY LIFTING THE STEEL BOX WITH A BACKHOE, EXCAVATOR OR SIMILAR PIECE OF EQUIPMENT. AT NO TIME WILL THE WASTE SOLIDIFICATION BOX BE DRAGGED ALONG THE TOP OF THE GROUND.

8. THE WASTE SOLIDIFICATION BOX WILL BE MOVED AS OPERATIONS DICTATE AND WILL ALWAYS BE WITHIN A LINED LANDFILL CELL. THE WASTE SOLIDIFICATION BOX SHOULD NEVER BE LOCATED CLOSER THAN 150' FROM THE EDGE OF LINER.

9. THE SOLIDIFICATION OPERATION WILL MOVE TO THE PERMITTED TRACTS ONCE CELLS ARE APPROVED BY ADEM AND OPERATIONS DICTATE A CHANGE.

ALABAMA LICENSED No. 31300 PROFESSIONAL ENGINEER MATTHEW CHEEK 1-31-25

ALABAMA LICENSED NO. 32951 PROFESSIONAL ENGINEER KEVIN GEORGE GERRY 1/31/2025

WASTE SOLIDIFICATION PLAN

# ARROWHEAD LANDFILL
# 2025 VERTICAL EXPANSION

FOR

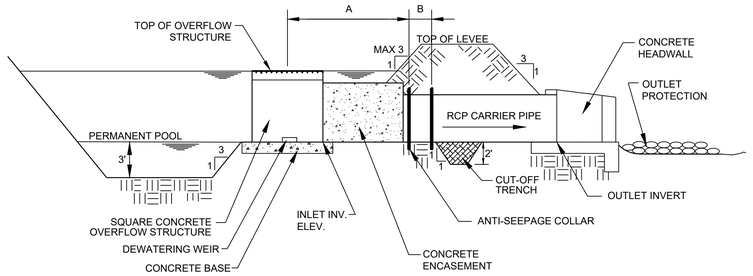
ARROWHEAD ENVIRONMENTAL PARTNERS, LLC

PERRY COUNTY, ALABAMA

HHNT
HODGES, HARBIN, NEWBERRY & TRIBBLE, INC.
Consulting Engineers
(478) 743-7175
(478) 743-7175 (FAX)
3920 ARKWRIGHT RD.
SUITE 101
MACON, GEORGIA 31210

| | | | |
|---|---|---|---|
| PROJ. NO. | 6215-018-01 | AH-2025VE-17-WSTSOLID | EDIT 1-29-2025 |
| SCALE | 1" = 200' | SHEET 17 OF 20 | |
| DATE | JANUARY 2025 | | |

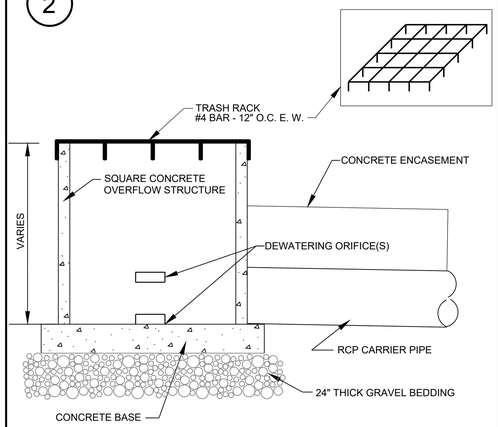
1




NOTE:
1. ALL FILL MATERIAL SHALL BE COMPACTED TO 95% STD. PROCTOR DENSITY
2. CONSTRUCTION SHALL BE IN ACCORDANCE WITH ALABAMA MANUAL FOR EROSION AND SEDIMENT CONTROL.

## SEDIMENT POND

2




NOTES:
1. THE LOCATION OF THE DEWATERING ORIFICES ARE SHOWN OUT OF POSITION FOR CLARITY.
2. EXACT NUMBER AND DIMENSIONS OF THE DEWATERING ORIFICES FOR EACH OVERFLOW STRUCTURE ARE PROVIDED IN THE CHART FOUND ON DETAIL NO. 3

## OVERFLOW STRUCTURE

3

### SEDIMENT POND DATA

| | POND NO. 2 | POND NO. 3 | POND NO. 5 | POND NO. 6 | POND NO. 7 | POND NO. 9 | POND NO. 10 | POND NO. 11 |
|---|---|---|---|---|---|---|---|---|
| DRAINAGE AREA TO POND (ACRES) | 38.00 | 25.00 | 51.00 | 46.00 | 95.00 | 30.00 | 50.00 | 66.00 |
| SEDIMENT STORAGE VOLUME REQUIRED AT 67 CU. YD. PER DISTURBED ACRE (CU. YD.) | 2,546 | 1,675 | 3,417 | 3,082 | 6,365 | 2,010 | 3,350 | 4,422 |
| STORAGE VOLUME AT 3 FOOT LEVEL (CU. YD.) | 290,079 | 240,211 | 334,229 | 270,661 | 654,387 | 216,506 | 595,284 | 508,821 |
| BOTTOM OF POND AT ELEVATION (FT.) | 256.00 | 244.00 | 264.00 | 256.00 | 212.00 | 214.00 | 202.00 | 214.00 |
| PERMANENT POOL ELEVATION | 259.00 | 247.00 | 267.00 | 259.00 | 215.00 | 217.00 | 205.00 | 217.00 |
| TOP OF LEVEE (FT.) | 267.50 | 254.00 | 274.00 | 266.00 | 226.00 | 224.00 | 212.00 | 224.00 |
| WATER LEVEL DURING 25 YEAR STORM (FT.) | 262.98 | 250.35 | 270.90 | 262.95 | 219.97 | 220.86 | 208.08 | 220.50 |
| WATER LEVEL DURING 100 YEAR STORM (FT.) | 264.62 | 251.48 | 271.62 | 263.75 | 220.58 | 221.42 | 209.07 | 221.32 |

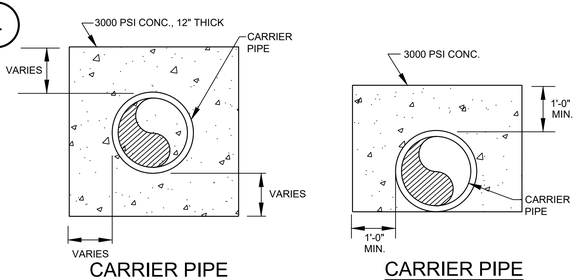
### CONCRETE BOX RISER STRUCTURE

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| SIZE (FT.) | 5' X 5' | 5' X 5' | 6' X 6' | 6' X 6' | 6' X 6' | 5' X 5' | 5' X 5' | 7' X 7' |
| INVERT ELEVATION BOTTOM OF RISER (FT.) | 259.00 | 247.00 | 266.00 | 258.00 | 215.00 | 217.00 | 205.00 | 215.00 |
| HEIGHT (FT.) | 5.50 | 4.50 | 5.00 | 5.00 | 5.00 | 4.00 | 4.00 | 5.75 |
| CONCRETE BASE DIMENSIONS LxWxH (FT.) | 10 x 10 x 2 | 10 x 10 x 3 | 11 x 11 x 3 | 12 x 12 x 3 | 11 x 11 x 3 | 10 x 10 x 3 | 10 x 10 x 2 | 12 x 12 x 3 |
| DEWATERING WEIR SIZE (IN.) | 6 x 18 | 1 - 6 x 12 | 2 - 6 x 16 & 1 - 6 x 24 | 2 - 6 x 24 & 2 - 6 x 12 | 2 - 6 x 16 | 2 - 6 x 10 | 2 - 6 x 10 | 2-6x24 & 2-6x24 |
| WEIR INVERT ELEVATION (FT.) | 259.00 | 247.00 | 267.00 & 269.50 | 259.00 & 261.00 | 215.00 | 217.00 | 205.00 | 217.00 & 219.00 |

### RCP CARRIER PIPE

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| DIAMETER (IN.) | 42 | 36 | 48 | 54 | 48 | 42 | 36 | 54 |
| LENGTH (FT.) | 120 | 100 | 92 | 87 | 109 | 93 | 87 | 75 |
| SLOPE (%) | 0.83% | 11.00% | 8.70% | 6.90% | 2.75% | 9.68% | 8.05% | 4.00% |
| INLET INVERT ELEVATION (FT.) | 259.00 | 247.00 | 266.00 | 258.00 | 215.00 | 217.00 | 205.00 | 212.00 |
| OUTLET INVERT ELEVATION (FT.) | 258.00 | 236.00 | 258.00 | 252.00 | 212.00 | 208.00 | 198.00 | 215.00 |
| NO. & SIZE OF ANTI-SEEP COLLARS (FT.) | 2 - 7 x 7 x 1 | 2 - 8 x 8 x 1 | 2 - 9 x 9 x 1 | 2 - 9 x 9 x 1 | 2 - 8 x 8 x 1 | 2 - 8 x 8 x 1 | 2 - 7 x 7 x 1 | 2 - 9 x 9 x 1 |
| CARRIER PIPE CONCRETE ENCASEMENT (FT.) | 5.5 x 3.5 x 25 | 4.0 x 5.0 x 18.5 | 5.0 x 6.0 x 40 | 6.0 x 7.0 x 30 | 5.0 x 7.0 x 20 | 4 x 6 x 18 | 4 x 6 x 17 | 5.75 x 8 x 26.5 |

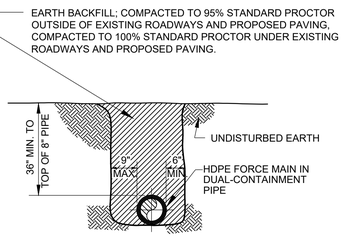
4




## CARRIER PIPE ANTI-SEEPAGE COLLAR

## CARRIER PIPE CONCRETE ENCASEMENT

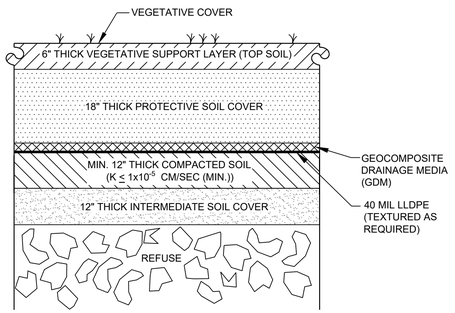
5




FORCE MAIN PIPING SHALL BE DUAL CONTAINED HDPE PIPE.

## FORCE MAIN

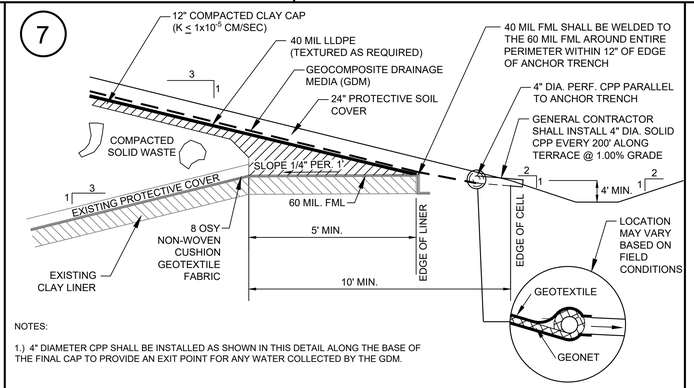
6




NOTE: GEOCOMPOSITE DRAINAGE MEDIA (GDM) SHALL CONSIST OF 6 OZ / SY NONWOVEN GEOTEXTILE HEAT BONDED TO BOTH SIDES OF GEONET.

## PERMANENT LANDFILL CAP SYSTEM (3H:1V)

7

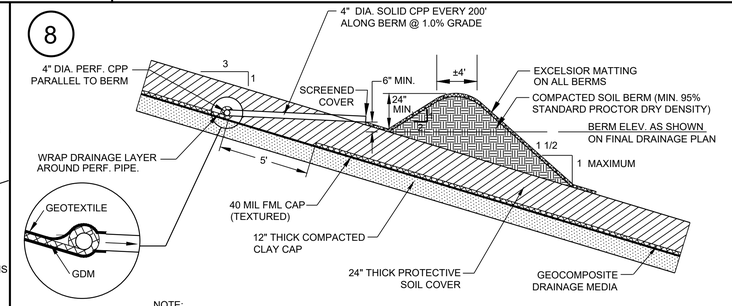



NOTES:

1.) 4" DIAMETER CPP SHALL BE INSTALLED AS SHOWN IN THIS DETAIL ALONG THE BASE OF THE FINAL CAP TO PROVIDE AN EXIT POINT FOR ANY WATER COLLECTED BY THE GDM.

## FINAL CAP / BASE LINER CONNECTION

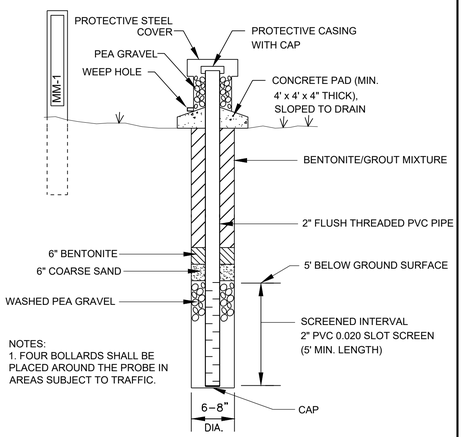
8




NOTE:
1. BERMS SHALL BE PROVIDED EVERY 40 VERTICAL FEET TO CONTROL EROSION.
2. BERMS SHOULD HAVE A MINIMUM SLOPE OF 2.0 PERCENT TO DOWNDRAIN LOCATIONS.
3. BERM DITCHES SHALL BE AT MINIMUM LINED WITH GRASS. TURF REINFORCING MATS MAY BE USED TO CONTROL EROSION.
4. GEOCOMPOSITE DRAINAGE MEDIA AND LATERAL PIPING IS NOT REQUIRED ON 3H:1V 12" THICK INTERMEDIATE COVER AREAS.

## SIDE SLOPE DRAINAGE BERM

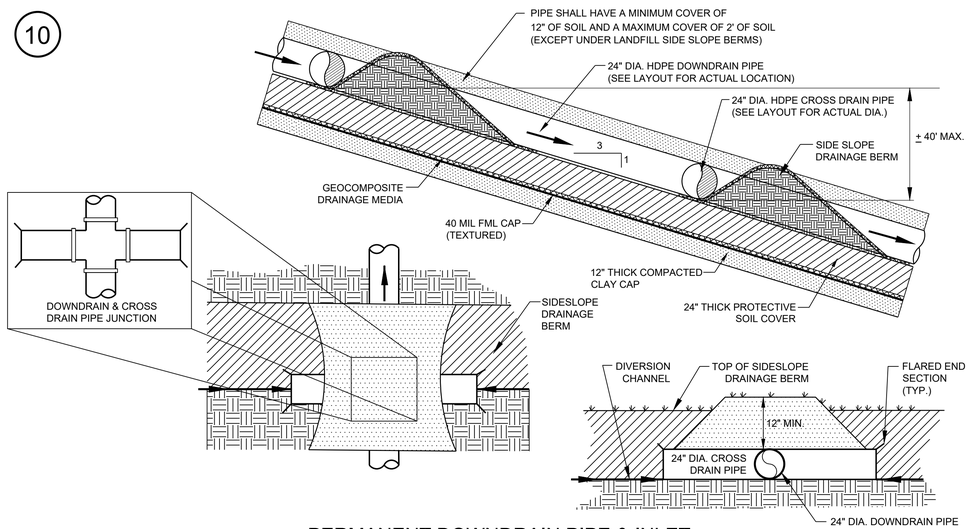
9




NOTES:
1. FOUR BOLLARDS SHALL BE PLACED AROUND THE PROBE IN AREAS SUBJECT TO TRAFFIC.

## METHANE GAS MONITORING PROBE (TYP.)

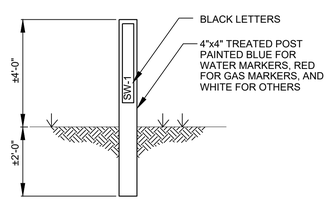
10




## PERMANENT DOWNDRAIN PIPE & INLET

11

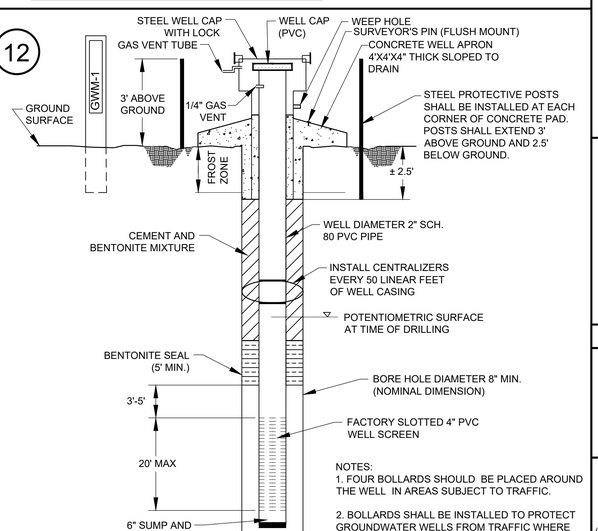
NARRATIVE
GWM = GROUNDWATER MONITORING WELL
SWM = SURFACE WATER MONITORING POINT
MM = METHANE MONITORING PROBE / BAREHOLE PUNCH
-EDGE OF CELL
-EDGE OF LINER
-LEACHATE CLEANOUT
-WASTE BUFFER
-FORCE MAIN




NOTES:
1. OTHER MARKER DESIGNS MAY BE UTILIZED AT THE OPERATOR'S DISCRETION.
2. MARKER POSTS SHALL BE PLACED AROUND THE EDGE OF THE WASTE DISPOSAL BOUNDARY ON 300' CENTERS (MAXIMUM) AND AT ALL CORNERS SUCH THAT ONE MARKER IS VISIBLE TO THE NEXT.

## MARKER POST

12




NOTES:
1. FOUR BOLLARDS SHOULD BE PLACED AROUND THE WELL IN AREAS SUBJECT TO TRAFFIC.
2. BOLLARDS SHALL BE INSTALLED TO PROTECT GROUNDWATER WELLS FROM TRAFFIC WHERE DIRECTED BY THE ENGINEER.

## GROUND WATER MONITORING DEEP WELL (TYP.)

N.T.S.

ALABAMA LICENSED No. 31360 PROFESSIONAL ENGINEER MATTHEW CHER — 1-31-25

ALABAMA LICENSED NO. 33261 PROFESSIONAL ENGINEER KEVIN GEORGE BERRY — 1-27-2025

MISCELLANEOUS DETAILS

# ARROWHEAD LANDFILL 2025 VERTICAL EXPANSION

FOR

ARROWHEAD ENVIRONMENTAL PARTNERS, LLC

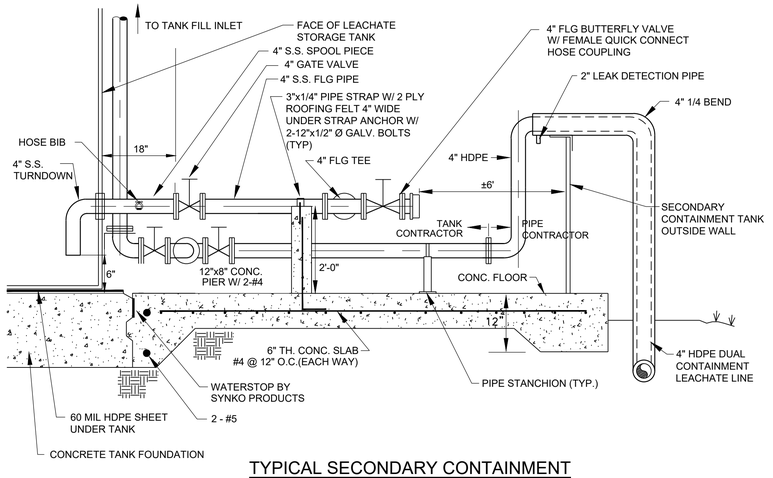
PERRY COUNTY, ALABAMA


HHNT
HODGES, HARBIN, NEWBERRY & TRIBBLE, INC.
Consulting Engineers
3920 ARKWRIGHT RD, SUITE 101
MACON, GEORGIA 31210
(478) 743-7175
(478) 743-7175 (FAX)


| | | | |
|---|---|---|---|
| PROJ. NO. | 6215-018-01 | AH-2025VE-DETAILS.DWG | EDIT 1-29-2025 |
| SCALE | VARIES | SHEET | 18 OF 20 |
| DATE | JANUARY 2025 | | |

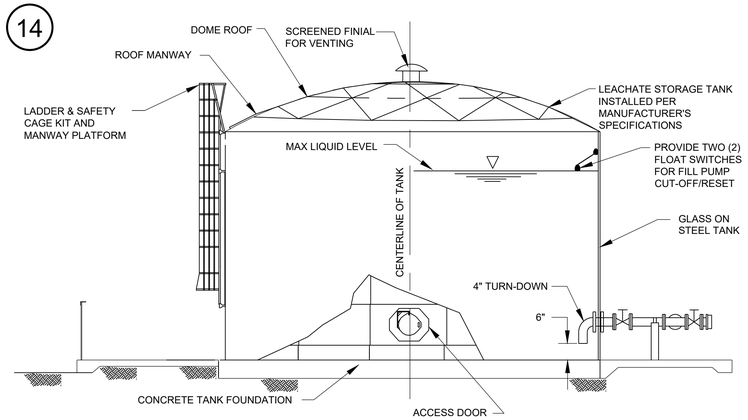
13

NOTES:
1. LIQUID LEVEL INDICATOR AND TRANSFER PUMP NOT SHOWN FOR CLARITY.
2. LEACHATE PIPING SHOWN OUT OF POSITION FOR CLARITY.




## TYPICAL SECONDARY CONTAINMENT PIPING LEACHATE STORAGE TANKS

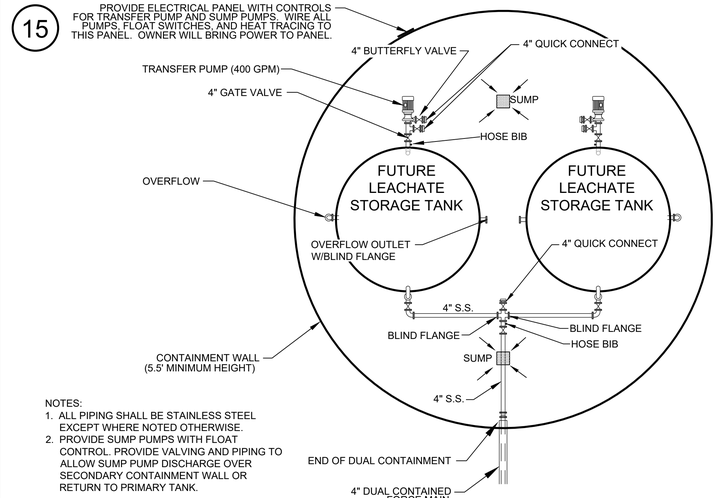
14




NOTES:
1. LIQUID LEVEL INDICATOR AND TRANSFER PUMP NOT SHOWN FOR CLARITY.
2. LEACHATE PIPING SHOWN OUT OF POSITION FOR CLARITY.

## TYPICAL LEACHATE STORAGE TANK

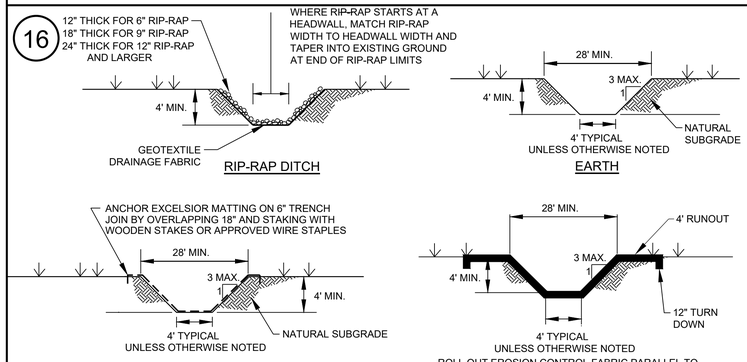
15




NOTES:
1. ALL PIPING SHALL BE STAINLESS STEEL EXCEPT WHERE NOTED OTHERWISE.
2. PROVIDE SUMP PUMPS WITH FLOAT CONTROL. PROVIDE VALVING AND PIPING TO ALLOW SUMP PUMP DISCHARGE OVER SECONDARY CONTAINMENT WALL OR RETURN TO PRIMARY TANK.

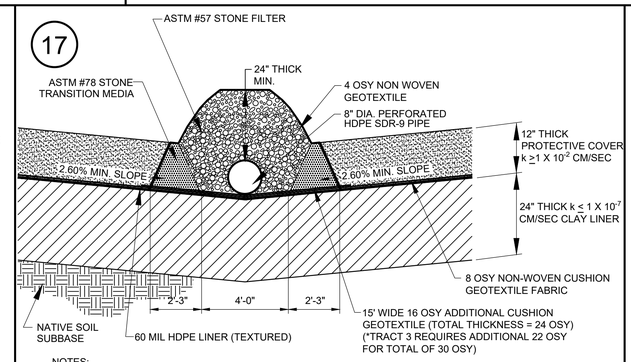
## TYPICAL LEACHATE TANK WITH SECONDARY CONTAINMENT LAYOUT

16




## DRAINAGE DITCH SECTIONS

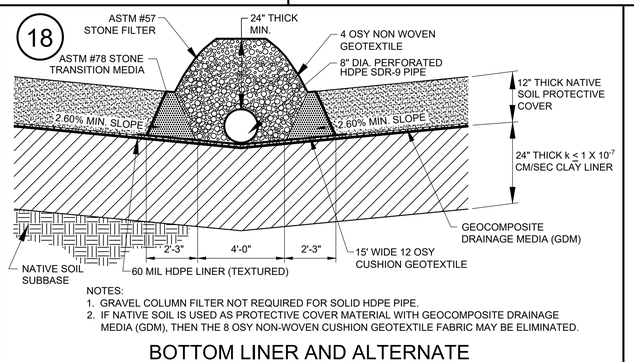
17




NOTES:
1. GRAVEL COLUMN FILTER NOT REQUIRED FOR SOLID HDPE PIPE.
2. 8 OSY NON-WOVEN CUSHION GEOTEXTILE FABRIC SHALL BE PLACED ON TOP OF 60 MIL HDPE LINER WHEN 12" THICK PROTECTIVE COVER MATERIAL IS USED. IF PROTECTIVE COVER MATERIAL THICKNESS INCREASES TO 24", THE 8 OSY NON-WOVEN CUSHION GEOTEXTILE FABRIC MAY BE ELIMINATED.

## BOTTOM LINER AND PROTECTIVE COVER SYSTEMS

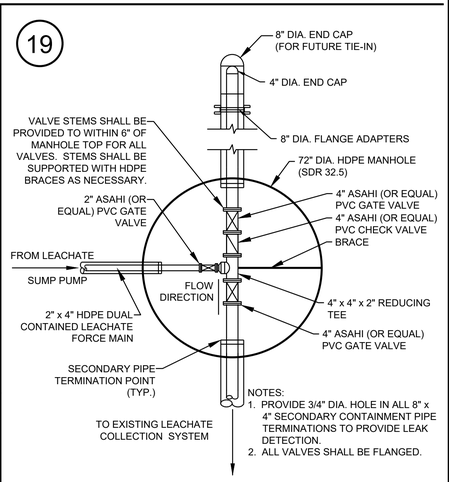
18




NOTES:
1. GRAVEL COLUMN FILTER NOT REQUIRED FOR SOLID HDPE PIPE.
2. IF NATIVE SOIL IS USED AS PROTECTIVE COVER MATERIAL WITH GEOCOMPOSITE DRAINAGE MEDIA (GDM), THEN THE 8 OSY NON-WOVEN CUSHION GEOTEXTILE FABRIC MAY BE ELIMINATED.

## BOTTOM LINER AND ALTERNATE PROTECTIVE COVER SYSTEMS

19

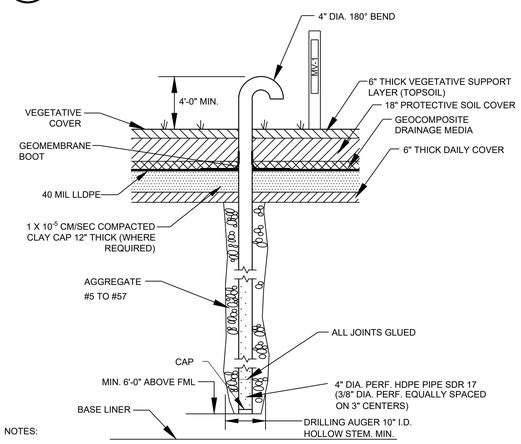



NOTES:
1. PROVIDE 3/4" DIA. HOLE IN ALL 8" x 4" SECONDARY CONTAINMENT PIPE TERMINATIONS TO PROVIDE LEAK DETECTION.
2. ALL VALVES SHALL BE FLANGED.

PLAN VIEW

## TYPICAL HDPE LEACHATE MANHOLE

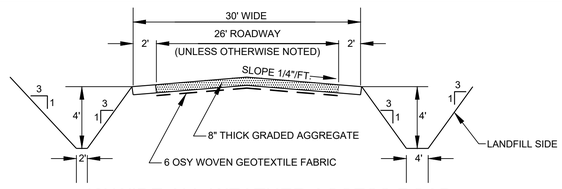
20




NOTES:
1. THIS DETAIL SHALL BE USED FOR ALL WELLS DESIGNATED AS GW-1 THROUGH GW-7. THESE WELLS SHALL BE LOCATED AS SHOWN ON THE CONSTRUCTION DRAWINGS IN AREAS WHERE ONLY ASH WASTE HAS BEEN DISPOSED.
2. ALL OF THESE METHANE GAS VENTS SHALL HAVE A TOTAL DEPTH OF 10 LF (AS MEASURED FROM THE TOP OF GROUND TO THE BOTTOM OF CAP).
3. VENT SHALL BE CONSTRUCTED TO ALLOW CONVERSION TO GAS EXTRACTION WELLS AT A LATER DATE.

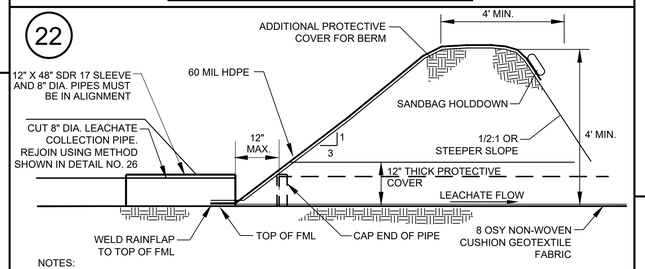
## PASSIVE METHANE GAS VENT

21




## 40' WIDE ALL-WEATHER ACCESS ROAD

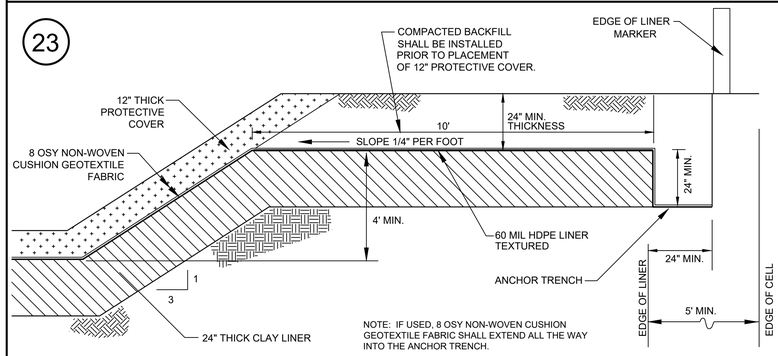
22




NOTES:
1. RAIN FLAP AND BERM ARE TO BE CONSTRUCTED AS PROTECTIVE COVER IS PLACED. COMPACTION NOT REQUIRED.
2. RAIN FLAPS AND BERMS SHALL BE INSTALLED SUCH THAT EACH AREA SEGMENTED BY THE FLAP IS APPROXIMATELY TWO OR THREE ACRES IN SIZE.

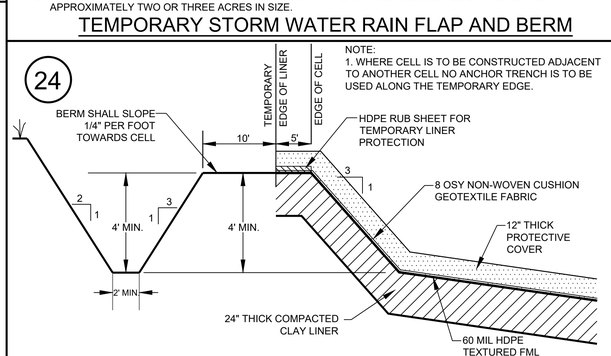
## TEMPORARY STORM WATER RAIN FLAP AND BERM

23




## ANCHOR TRENCH

24




## TEMPORARY EDGE OF LINER CONSTRUCTION

ALABAMA LICENSED PROFESSIONAL ENGINEER No. 31380 1-31-25 MATTHEW CHECK

ALABAMA LICENSED PROFESSIONAL ENGINEER No. 32057 1-31-2025 KEVIN GEORGE BERRY

MISCELLANEOUS DETAILS

# ARROWHEAD LANDFILL 2025 VERTICAL EXPANSION

FOR

ARROWHEAD ENVIRONMENTAL PARTNERS, LLC

PERRY COUNTY, ALABAMA


HHNT
HODGES, HARBIN, NEWBERRY & TRIBBLE, INC.
Consulting Engineers
(478) 743-7175
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3920 ARKWRIGHT RD.
SUITE 101
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| | | | |
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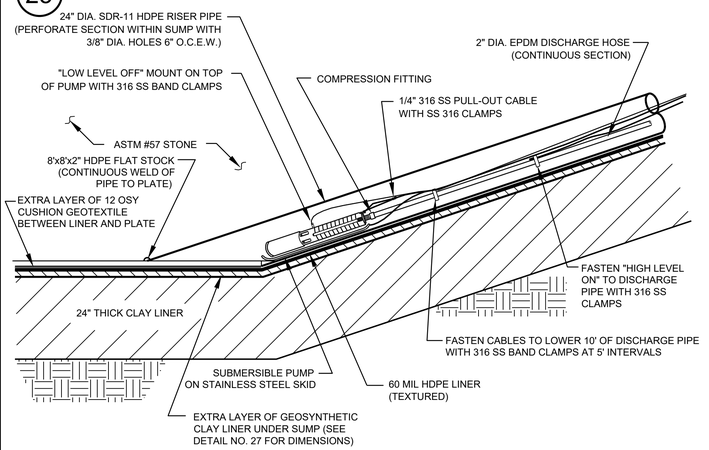
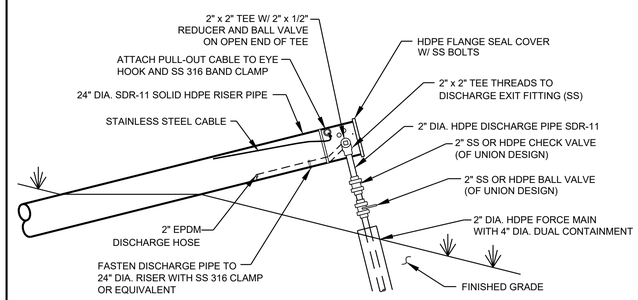
| SCALE | VARIES | SHEET 19 OF 20 | |
| DATE | JANUARY 2025 | | |

## 25




LEACHATE SUMP PUMP

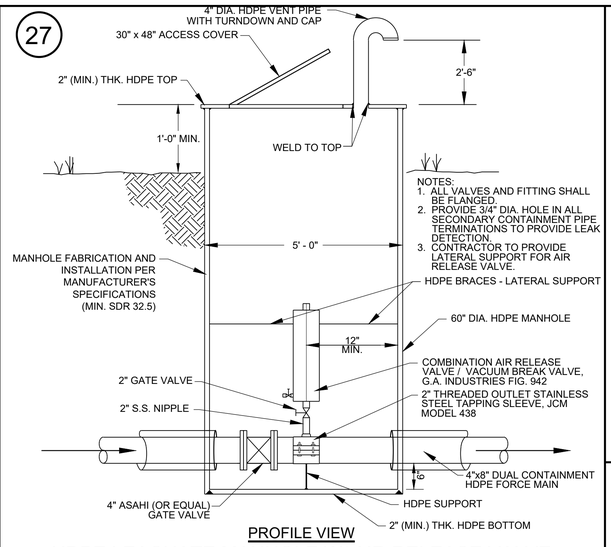
## 26




NOTES:
1. WRAP DISCHARGE PIPE AND FITTINGS WITH INSULATION AND HEAT TAPE, PROVIDE OUTLET FOR HEAT TAPE IN PANEL.
2. THE END OF ALL PIPES SHALL BE SEALED.

FORCE MAIN FITTINGS W/ FREEZE PROTECTION

## 27

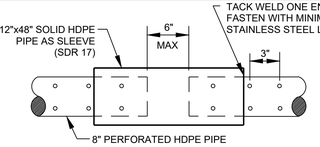



NOTES:
1. ALL VALVES AND FITTING SHALL BE FLANGED.
2. PROVIDE 3/4" DIA. HOLE IN ALL SECONDARY CONTAINMENT PIPE TERMINATIONS TO PROVIDE LEAK DETECTION.
3. CONTRACTOR TO PROVIDE LATERAL SUPPORT FOR AIR RELEASE VALVE.

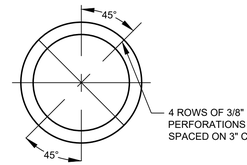
PROFILE VIEW

HDPE LEACHATE MANHOLE W/ AIR RELEASE VALVE

## 28



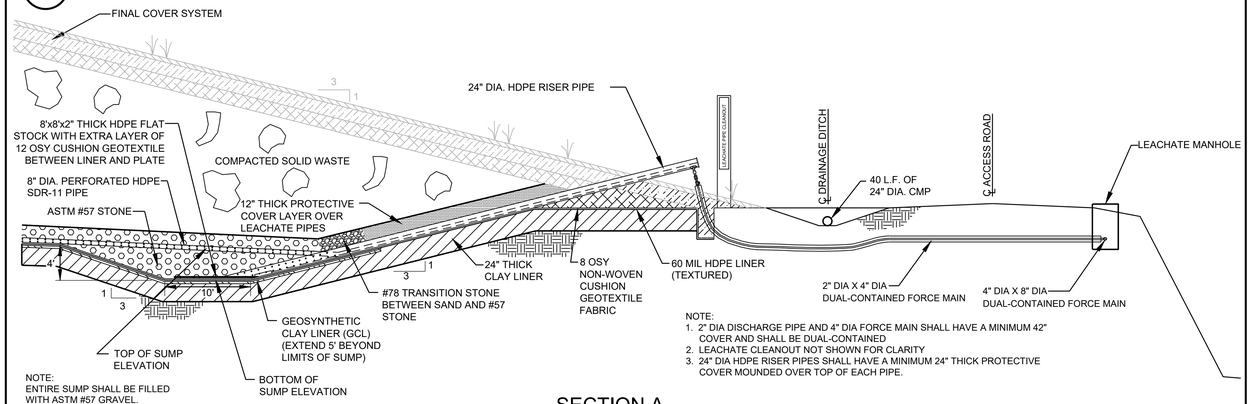

CONNECTION SLEEVE DETAIL




NOTES:
1. FUSION WELDED PIPE JOINTS WILL BE ACCEPTABLE.
2. 4" DIA. PERFORATED HDPE PIPES WILL USE SAME PERFORATION PATTERN.
3. 4" DIA. PERFORATED HDPE PIPE JOINTS SHALL BE WELDED TOGETHER.
4. IN AREAS WHERE THE WASTE HEIGHT WILL EXCEED 280 FEET, SDR 7 PIPE SHALL BE USED. IN ALL OTHER AREAS SDR 9 PIPE SHALL BE USED

4" & 8" DIA. PERFORATED HDPE PIPE

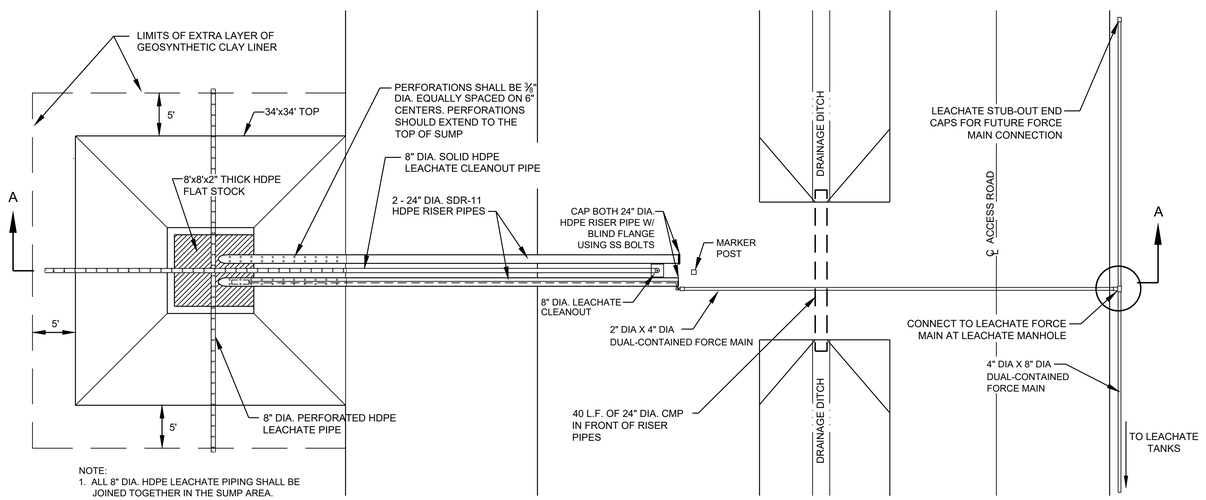
## 29




NOTE:
ENTIRE SUMP SHALL BE FILLED WITH ASTM #57 GRAVEL.

NOTE:
1. 2" DIA DISCHARGE PIPE AND 4" DIA FORCE MAIN SHALL HAVE A MINIMUM 42" COVER AND SHALL BE DUAL-CONTAINED
2. LEACHATE CLEANOUT NOT SHOWN FOR CLARITY
3. 24" DIA HDPE RISER PIPES SHALL HAVE A MINIMUM 24" THICK PROTECTIVE COVER MOUNDED OVER TOP OF EACH PIPE.

SECTION A

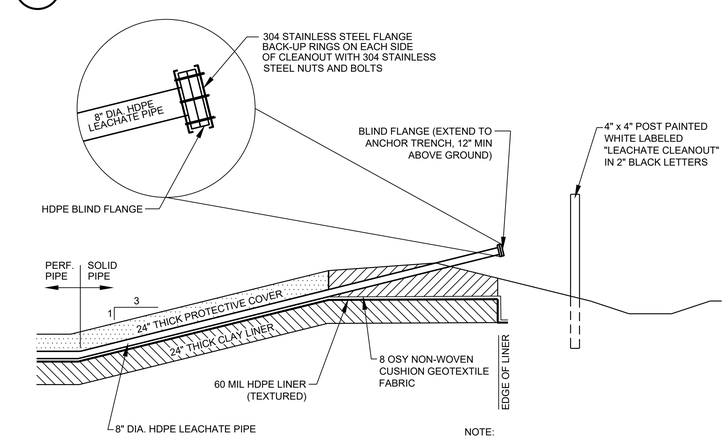



NOTE:
1. ALL 8" DIA. HDPE LEACHATE PIPING SHALL BE JOINED TOGETHER IN THE SUMP AREA.

PLAN VIEW

LEACHATE SUMP ASSEMBLY

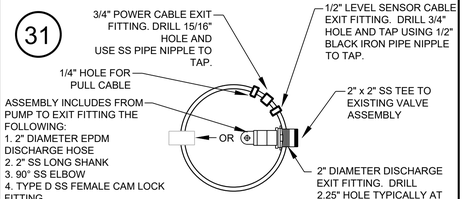
## 30



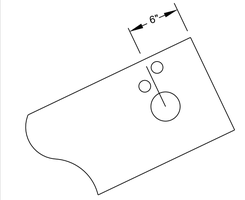

NOTE:
8" DIA. HDPE LEACHATE PIPE CLEANOUTS SHALL HAVE A MINIMUM 24" THICK PROTECTIVE COVER MOUNDED OVER EACH PIPE.

LEACHATE PIPE CLEANOUT

## 31




INTO 24" RISER VIEW



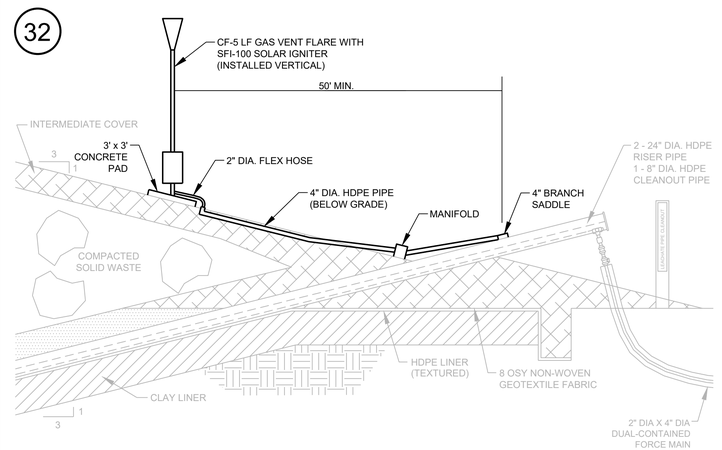

SIDE VIEW

NOTE:
1. EXIT FITTINGS SHOULD BE PLACED APPROXIMATELY 6" BELOW THE TOP OF THE RISER AND 10" MAX. TO ALLOW REACH TO FITTINGS.

NOTES:
1. DRILL HOLE TO CORRECT SIZE AT DESIRED LOCATION.
2. THREAD SS EXIT NIPPLE INTO DRILLED HOLE. HOLD AT NON-THREADED BOSS AREA OR ATTACH SS END CAP TO TURN. EXTEND INTO RISER APPROXIMATELY 2.5".
3. ATTACH MALE CAM AND GROOVE FITTING-USE THREAD PASTE.
4. BACK UP NIPPLE UNTIL SHOULDER OF CAM AND GROOVE FITTING IS AGAINST INSIDE OF RISER PIPE WALL.
5. POSITION CABLE EXIT FITTINGS AS REQUIRED-TYPICALLY ABOVE THE DISCHARGE EXIT FITTING.
6. ALL FITTINGS TO BE EITHER HDPE OR STAINLESS STEEL (SS).
7. ALL BOLD ITEMS IN THIS DETAIL TO BE STAINLESS STEEL.
8. THE 24" DIA. RISER PIPE SHALL BE CLEANED OF ALL HDPE PIPE SHAVINGS ONCE DRILLING IS COMPLETE. ALL SHAVINGS SHALL BE REMOVED FROM INSIDE THE PIPE PRIOR TO PLACING THE SYSTEM INTO OPERATION.

24" DIA. RISER SIDE EXIT

## 32




EXISTING LEACHATE COLLECTION SYSTEM GAS FLARE DETAIL

ALABAMA LICENSED PROFESSIONAL ENGINEER No. 31380 1-31-25 MATTHEW CHEEK

ALABAMA LICENSED No. 32167 PROFESSIONAL ENGINEER 1-31-2025 KEVIN GEORGE BERRY

MISCELLANEOUS DETAILS

# ARROWHEAD LANDFILL 2025 VERTICAL EXPANSION

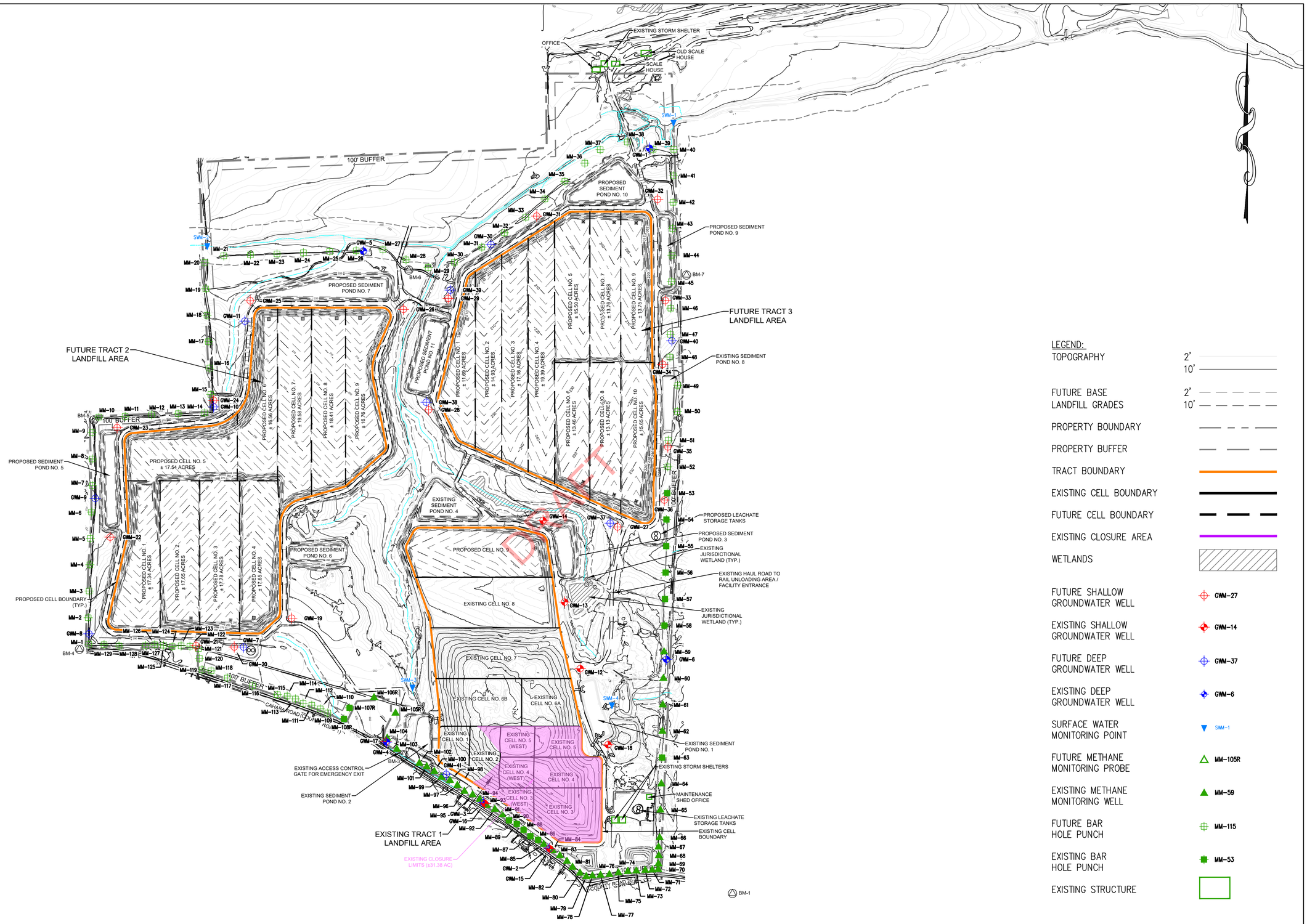
FOR

ARROWHEAD ENVIRONMENTAL PARTNERS, LLC

PERRY COUNTY, ALABAMA


HHNT
HODGES, HARBIN, NEWBERRY & TRIBBLE, INC.
Consulting Engineers
3920 ARKWRIGHT RD.
SUITE 101
MACON, GEORGIA 31210
(478) 743-7175
(478) 743-7175 (FAX)


| | | | |
|---|---|---|---|
| PROJ. NO. | 6215-018-01 | AH-2025VE-DETAILS.DWG | EDIT 1-29-2025 |
| SCALE | VARIES | SHEET 20 OF 20 | |
| DATE | JANUARY 2025 | | |




LEGEND:

| | |
|---|---|
| TOPOGRAPHY | 2' / 10' |
| FUTURE BASE LANDFILL GRADES | 2' / 10' |
| PROPERTY BOUNDARY | |
| PROPERTY BUFFER | |
| TRACT BOUNDARY | |
| EXISTING CELL BOUNDARY | |
| FUTURE CELL BOUNDARY | |
| EXISTING CLOSURE AREA | |
| WETLANDS | |
| FUTURE SHALLOW GROUNDWATER WELL | GWM-27 |
| EXISTING SHALLOW GROUNDWATER WELL | GWM-14 |
| FUTURE DEEP GROUNDWATER WELL | GWM-37 |
| EXISTING DEEP GROUNDWATER WELL | GWM-6 |
| SURFACE WATER MONITORING POINT | SWM-1 |
| FUTURE METHANE MONITORING PROBE | MM-105R |
| EXISTING METHANE MONITORING WELL | MM-59 |
| FUTURE BAR HOLE PUNCH | MM-115 |
| EXISTING BAR HOLE PUNCH | MM-53 |
| EXISTING STRUCTURE | |

| REVISIONS | | |
|---|---|---|
| No. | DESCRIPTION | BY |
| | | |
| | | |
| | | |

DRAWN: KLW
CHECKED: RLB
APPROVED: AWA

DATE: 11-15-24
CAD FILE: ARROWHLF-66HYDROPROD
JOB NO: J24-4999-66

BUNNELL LAMMONS ENGINEERING
6004 Ponders Court, Greenville, SC 29615
(864) 288-1255

ENVIRONMENTAL MONITORING NETWORK
ARROWHEAD LANDFILL
PERRY COUNTY, ALABAMA

FIGURE NO.
EMP-1