Alabama Department of Environmental Management

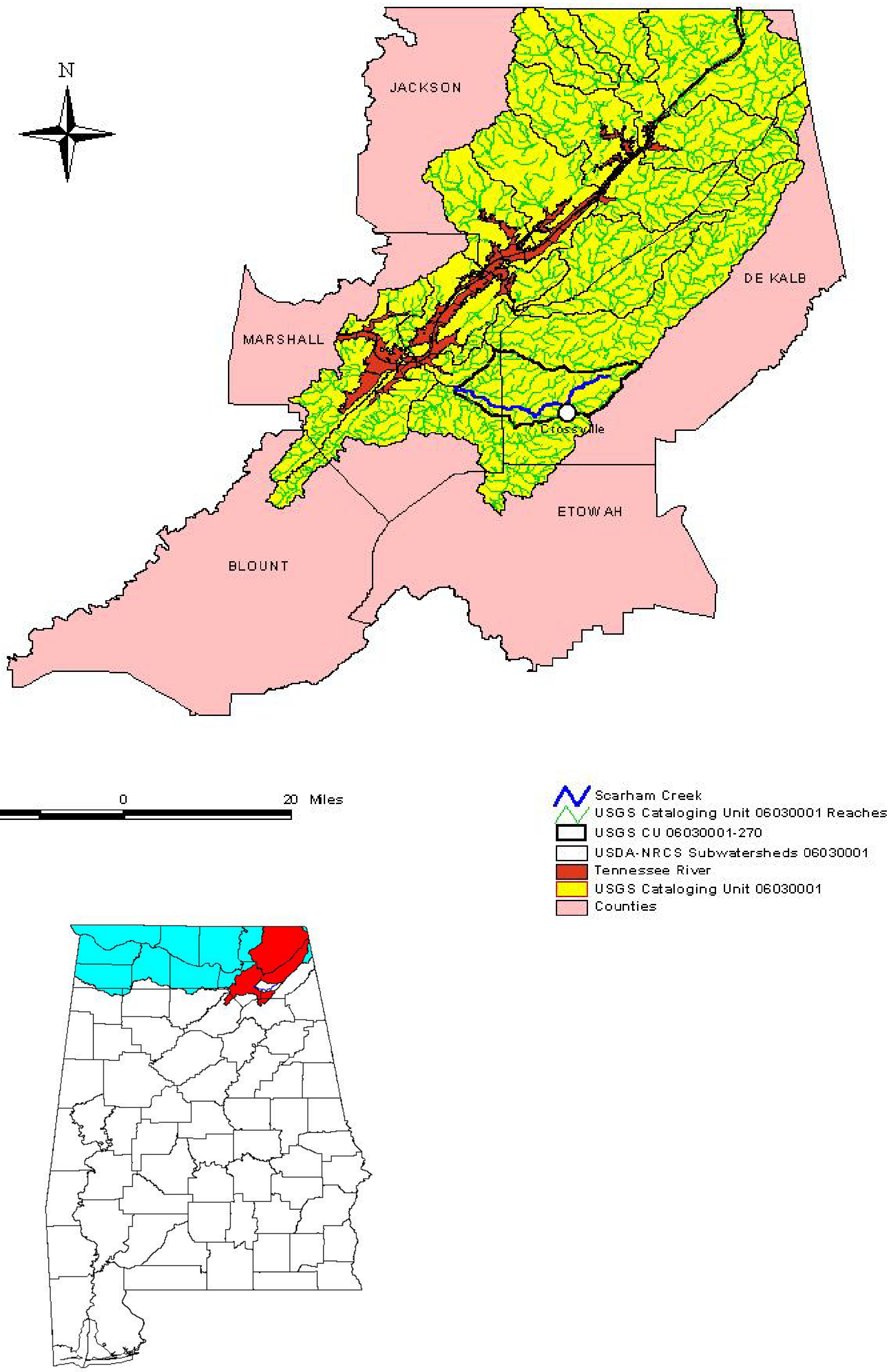
Final TMDL Development for

Scarham Creek AL/06030001-270_01

Low Dissolved Oxygen/Organic Loading
Ammonia as Nitrogen

Water Quality Branch
Water Division
February 2002

Scarham Creek Watershed in the Tennessee River Basin



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1.0 Executive Summary

This report contains one or more Total Maximum Daily Loads (TMDLs) for waterbody segments found on Alabama's 1996 and/or 1998 Section 303(d) List(s) of Impaired Waterbodies. Because of the accelerated schedule required by the consent decree, many of these TMDLs have been prepared out of sequence with the State's rotating basin approach. The implementation of the TMDLs contained herein will be prioritized within Alabama's rotating basin approach.

The amount and quality of data on which this report is based are limited. As additional information becomes available, the TMDLs may be updated. Such additional information may include water quality and quantity data, changes in pollutant loadings, or changes in land use within the watershed. In some cases, additional water quality data may indicate that no impairment exists.

Scarham Creek, a part of the Tennessee River basin, flows from its source, located in DeKalb County, to its mouth, located in Marshall County. It has been on the State of Alabama's §303(d) use impairment list since 1992 for organic enrichment/low dissolved oxygen (O.E./D.O.) and ammonia as nitrogen (NH_3-N). Its use classification is Fish and Wildlife.

Since D.O. and ammonia impairments generally occur during the summer months when stream flows are low and water temperatures are high, a steady state modeling approach was adopted as appropriate for this TMDL analysis. This modeling approach uses the stream's $7Q_{10}$ flow and $7Q_2$ flow. The $7Q_{10}$ flow represents the minimum 7-day flow that occurs, on average, over a 10-year recurrence interval. Likewise, the $7Q_2$ is the minimum 7-day flow that occurs, on average, over a 2-year period.

The following report addresses the results of the TMDL analysis for O.E./D.O and ammonia as nitrogen (NH_3-N). In accordance with ADEM water quality standards, the minimum dissolved oxygen concentration in a stream classified as Fish and Wildlife is 5.0 mg/l. In the absence of a numerical state water quality standard for ammonia as nitrogen, the EPA's ambient water quality chronic criterion for ammonia as nitrogen in a stream classified as Fish and Wildlife at a pH of 7 s.u. is 2.48 mg/l. For the purpose of this TMDL, a minimum dissolved oxygen level of 5.0 mg/l and an ammonia as nitrogen chronic toxicity criterion of 2.48 mg/l will be implemented allowing for an implicit margin of safety resulting from conservative assumptions used in the dissolved oxygen model.

A summary of the TMDL for the watershed is provided in the tables presented on the next page. The pollutants shown in the tables include ultimate carbonaceous biochemical oxygen demand ($CBOD_u$), nitrogenous biochemical oxygen demand (NBOD), and ammonia as nitrogen (NH_3-N), which is a component of NBOD. $CBOD_u$ and NBOD are the principle causes for observed low dissolved oxygen concentrations. $CBOD_u$ is a measure of the total amount of oxygen required to degrade the carbonaceous portion of the organic matter present in the water. NBOD is the amount of oxygen utilized by bacteria as they convert ammonia to nitrate. Because organic nitrogen can be converted to ammonia, its potential oxygen demand is included in the NBOD component of the TMDL. The first table lists allowable pollutant loadings by source (point and non-point sources) for the summer season (May through November). The second table lists the allowable pollutant loadings by source (point and non-point sources) for the winter season (December through April).

Table 1-1. Maximum Allowable Pollutant Loads by Source – Summer

Pollutant	Point Source Loads (lbs./day)	Non-point Source Loads (lbs./day)
$CBOD_u$	1.5	1.0
NBOD	1.1	2.4
Total	2.6	3.4
NH_3-N	0.1	0.1

Table 1-2. Maximum Allowable Pollutant Loads by Source – Winter

Pollutant	Point Source Loads (lbs./day)	Non-point Source Loads (lbs./day)
$CBOD_u$	2.0	93.7
NBOD	2.3	84.8
Total	4.3	178.5
NH_3-N	0.3	4.1

2.0 Basis for §303(d) Listing

2.1 Introduction

Section 303(d) of the Clean Water Act (CWA) as amended by the Water Quality Act of 1987 and EPA's Water Quality Planning and Management Regulations [(Title 40 of the Code of Federal Regulations (CFR), Part 130)] require states to identify waterbodies which are not meeting water quality standards applicable to their designated use classifications. The identified waters are prioritized based on severity of pollution with respect to designated use classifications. Total maximum daily loads (TMDLs) for all pollutants causing violation of applicable water quality standards are established for each identified water. Such loads are established at levels necessary to implement the applicable water quality standards with seasonal variations and margins of safety. The TMDL process establishes the allowable loading of pollutants, or other quantifiable parameters for a waterbody, based on the relationship between pollution sources and in-stream water quality conditions, so that states can establish water-quality based controls to reduce pollution from both point and non-point sources and restore and maintain the quality of their water resources (USEPA, 1991).

The State of Alabama has identified Scarham Creek as being impaired by organic loading (i.e., $CBOD_u$ and NBOD) and ammonia as nitrogen for a length of 23 miles, as reported on the 1996 and 1998 §303(d) list(s) of impaired waters. Scarham Creek is prioritized as "high" on the list(s). Scarham Creek is located in both Dekalb and Marshall County and lies within the Scarham Creek watershed of the Tennessee River basin.

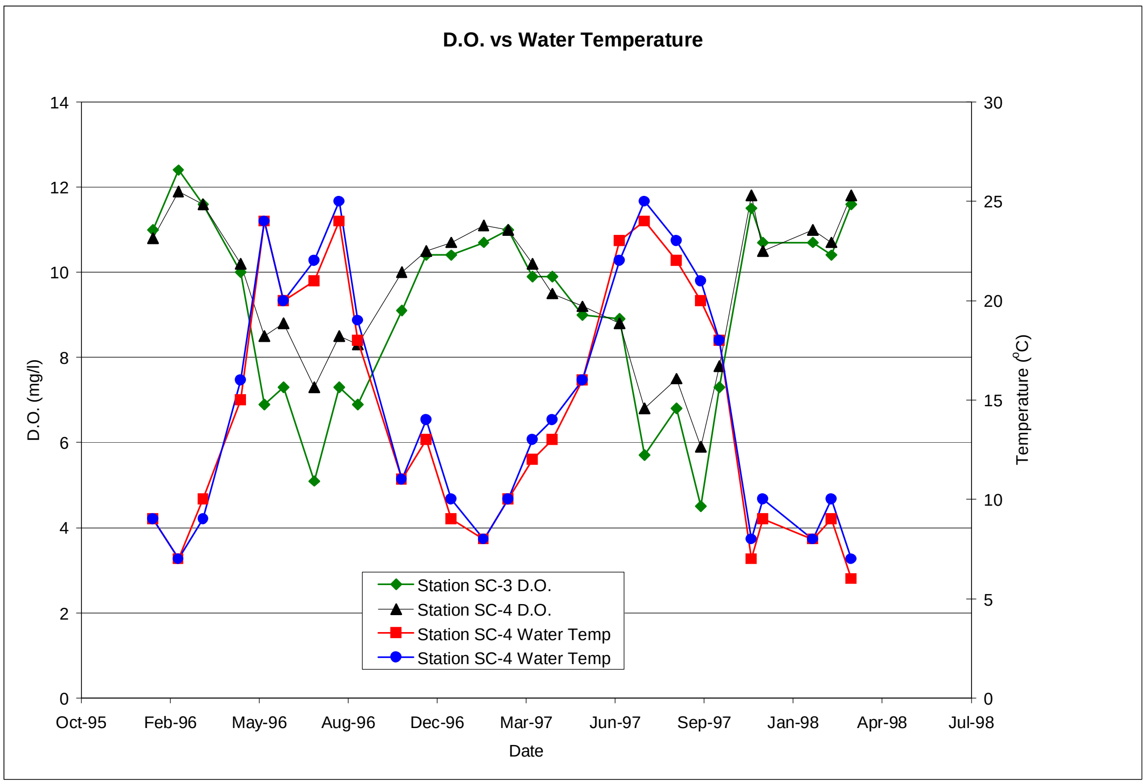
The TMDL developed for Scarham Creek illustrates the steps that can be taken to address a waterbody impaired by low dissolved oxygen levels and ammonia as nitrogen. The TMDL is consistent with a phased-approach: estimates are made of needed pollutant reductions, load reduction controls are implemented, and water quality is monitored for plan effectiveness. Flexibility is built into the plan so that load reduction targets and control actions can be reviewed if monitoring indicates continuing water quality problems.

2.2 Problem Definition

Scarham Creek has a drainage area of 91 square miles. Dry weather flows for the watershed are relatively low, or zero. Scarham Creek water quality and biological data is available for the years 1988-1998. From 1988-1998, ADEM sampled Scarham Creek at two stations, station SC-4 and SC-3, approximately once a month during each year as part of the Sand Mountain Nonpoint Source Monitoring Project. In this data, there were five D.O violations, all occurred at SC-3 with either zero flow or an estimated flow. In 1992, ADEM sampled Scarham Creek at two stations, SC-1 and SC-2, as part of Alabama's

Clean Water Strategy. The 1992 sampling event did not have any D.O. violations. Of the 10-year data span for Scarham Creek, less than ten percent of the available data showed D.O. violations, and the data with D.O. violations either had no flow or an estimated flow. Generally, depressed in-stream D.O. concentrations may be caused by several sources including the decay of oxygen demanding waste from both point and non-point sources, algal respiration, sediment oxygen demand or other sources. It is believed based on available data that the low dissolved oxygen concentrations observed in this watershed are not the result of algal dynamics.

The graph below shows the relationship between D.O. and water temperature using data from the 1996-1998 Sand Mountain Non-point Source Monitoring Project (ADEM).



Waterbody Impaired: Scarham Creek

Water Quality Standard Violation: Dissolved Oxygen /Ammonia as Nitrogen

Pollutant of Concern: Organic Enrichment ($CBOD_u$/NBOD) and Ammonia as nitrogen (NH_3-N)

Water Use Classification: Fish and Wildlife

The impaired stream segment, Scarham Creek, is classified as Fish and Wildlife. Usage of waters in this classification is described in ADEM Admin. Code R. 335-6-10-.09(5)(a), (b), (c), and (d).

(a) Best usage of waters:

Fishing, propagation of fish, aquatic life, and wildlife, and any other usage except for swimming and water-contact sports or as a source of water supply for drinking or food processing purposes.

(b) Conditions related to best usage:

The waters will be suitable for fish, aquatic life and wildlife propagation. The quality of salt and estuarine waters to which this classification is assigned will also be suitable for the propagation of shrimp and crabs.

(c) Other usage of waters:

It is recognized that the waters may be used for incidental water contact and recreation during June through September, except that water contact is strongly discouraged in the vicinity of discharges or other conditions beyond the control of the Department or the Alabama Department of Public Health.

(d) Conditions related to other usage:

The waters, under proper sanitary supervision by the controlling health authorities, will meet accepted standards of water quality for outdoor swimming places and will be considered satisfactory for swimming and other whole body water-contact sports.

Low D.O./Organic Loading Criteria:

Alabama's water quality criteria document (ADEM Admin. Code R. 335-6-10-.09-(5)(e)(4.)) states that for a diversified warm water biota, including game fish, daily dissolved oxygen concentrations shall not be less than 5 mg/l at all times; except under extreme conditions due to natural causes, it may range between 5 mg/l and 4 mg/l, provided that the water quality is favorable in all other parameters. The normal seasonal and daily fluctuations shall be maintained above these levels. In no event shall the dissolved oxygen level be less than 4 mg/l due to discharges from existing hydroelectric generation impoundments. All new hydroelectric generation impoundments, including addition of new hydroelectric generation units to existing impoundments, shall be designed so that the discharge will contain at least 5 mg/l dissolved oxygen where practicable and technologically possible. The Environmental Protection Agency, in cooperation with the State of Alabama and parties responsible for impoundments, shall develop a program to improve the design of existing facilities.

Ammonia as Nitrogen Criteria

Alabama's water quality criteria document (ADEM Admin. Code R. 335-6-10) does not contain a numeric water quality standard for ammonia as nitrogen. However, in applying the following narrative standard found at ADEM Admin. Code R. 335-6-10-.06(c) the Department has relied upon the United States Environmental Protection Agency's (EPA) latest water quality criteria for ammonia.

> (c) State waters shall be free from substances attributable to sewage, industrial wastes or other wastes in concentrations or combinations which are toxic or harmful to human, animal or aquatic life to the extent commensurate with the designated usage of such waters.

The Municipal Branch and the Industrial Section of the Water Division of ADEM have adopted as policy EPA's ammonia criteria for purposes of developing permit limits in National Pollutant Discharge Elimination System (NPDES) permits. The EPA's *1998 Update of Ambient Water Quality Criteria for Ammonia*, EPA 822-R-98-008, provides the following equation for calculating Criteria Continuous Concentration (CCC) or the chronic criterion. This criterion is applied in streams with a designated use of Fish and Wildlife or higher.

$$CCC = \frac{0.0577}{1+10^{7.688-pH}} + \frac{2.487}{1+10^{pH-7.688}},\ mg/l\ \ NH_3\text{-}N$$

This equation indicates that allowable in-stream ammonia concentration decreases as pH increases. For Scarham Creek, the maximum pH value measured was 7 s.u. which results in a CCC value of 2.48 mgl/l NH_3-N.

Another consideration in establishing an allowable in-stream ammonia concentration is its effect on the stream's dissolved oxygen (D.O.) concentration due to ammonia being converted to nitrite and then to nitrate. Oxygen is consumed in the process. A water quality model that accounts for this process, known as nitrification, is used to ensure that D.O. concentrations remain above the applicable water quality standard. For Scarham Creek the D.O. standard is 5.0 mg/l.

3.0 Technical Basis for TMDL Development

3.1 Water Quality Target Identification

The minimum dissolved oxygen concentration in a stream classified as Fish and Wildlife is 5.0 mg/l. For the purpose of this TMDL, a minimum dissolved oxygen level of 5.0 mg/l will be implemented allowing for an implicit margin of safety resulting from conservative assumptions used in the dissolved oxygen model. The target $CBOD_u$ and NBOD concentrations are concentrations that, in concert with the nitrification of ammonia, will not deplete the dissolved oxygen concentration below this level as a result of the decaying process.

The EPA's ambient water quality chronic criterion for ammonia as nitrogen in a stream classified as Fish and Wildlife at a pH of 7 s.u. is 2.48 mg/l. For the purposes of establishing a TMDL for ammonia as nitrogen both the CCC value and the ammonia as nitrogen concentration predicted by the dissolved oxygen model is considered and the lower concentration is used to compute allowable loading. For Scarham Creek in-stream D.O. concentrations controlled the allowable ammonia as nitrogen loading.

3.2 Source Assessment

3.2.1. General Sources of $CBOD_u$, NBOD, and NH_3-N

Both point and non-point sources may contribute $CBOD_u$ and NBOD, including the ammonia as nitrogen component, (i.e., organic loading) to a given waterbody. Potential sources of organic loading are numerous and often occur in combination. In rural areas, storm runoff from row crops, livestock pastures, animal waste application sites, and feedlots can transport significant loads of organic loading. Nationwide, poorly treated municipal sewage comprises a major source of organic compounds that are hydrolyzed to create additional organic loading. Urban storm water runoff, sanitary sewer overflows, and combined sewer overflows can be significant sources of organic loading.

All potential sources of organic loading in the watershed were identified based on an evaluation of current land use/cover information on watershed activities (e.g., agricultural management activities). The source assessment was used as the basis for development of the model and ultimate analysis of the TMDL allocations. The organic loading within the watershed included both point and non-point sources.

3.2.2. Point Sources in the Scarham Creek Watershed

ADEM maintains a database of current NPDES permits and GIS files that locate each permitted outfall. This database includes municipal, semi-public/private, industrial, mining, industrial storm water, and concentrated animal feeding operations (CAFOs) permits. Table 3-1, below, shows the permitted point sources in the watershed that discharge into or upstream of the impaired segment. Table 3-2 contains the permit limitations for the significant point sources that were considered in the model development. Figure 3-1 shows the location of each facility considered a significant source relative to the impaired segment.

Table 3-1. Contributing Point Sources in the Scarham Creek Watershed.

NPDES Permit	Type of Facility (e.g., CAFO, Industrial, Municipal, Semi-Public/Private, Mining, Industrial Storm Water)	Facility Name	Significant Contributor (Yes/No) (% of $7Q_{10}$)
AL 0048402	Semi-Public/Private	Crossville Health Care INC STP	Yes (100%)
AL 0051012	Semi-Public/Private	Crossville High School STP	Yes (100%)
AL 0050989	Semi-Public/Private	Geraldine High School STP	Yes (100%)
AL 0061549	Municipal	Crossville Industrial Park WWTP	No
ALA 000311	CAFO	B&B Farms	No
ALA 000089	CAFO	Circle H Farms	No
ALA 000055	CAFO	J & E Stogsdill Farm	No
ALA 000318	CAFO	W & E Stogsdill Farm	No
ALA 000091	CAFO	W. J. Buttram Farm	No

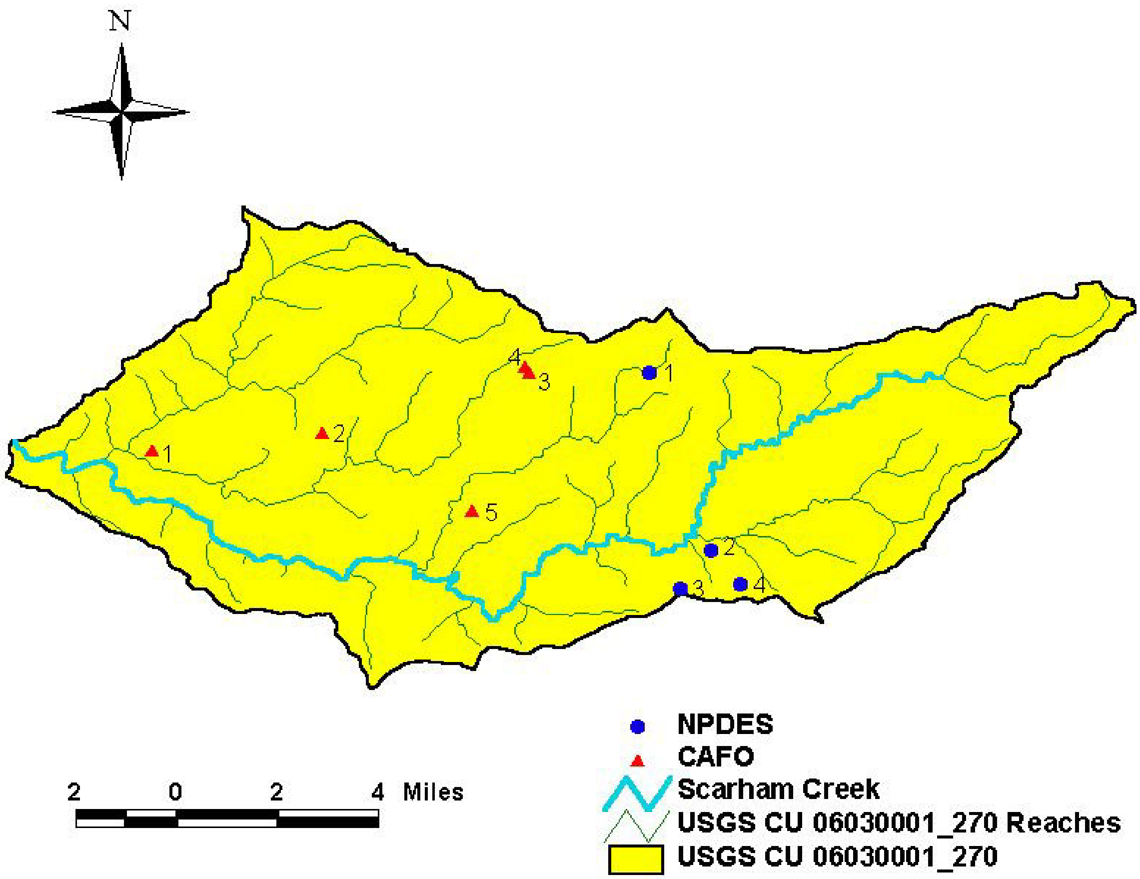
Note: The CAFO discharges listed in the above table were marked as not being significant contributors since their permitted discharge is zero. Also, the Crossville Industrial Park WWTP discharges to a lagoon and uses land application as a method of wastewater treatment and discharge.

Table 3-2. NPDES Permit Limits for Significant Contributing Point Sources

NPDES Permit	Facility Name	Permit Limitations - Summer					Permit Limitations - Winter					
		$CBOD_u$ (mg/L)	$CBOD_5$ (mg/L)	NH_3-N (MG/L)		DO (MG/L)	$CBOD_u$ (mg/L)	$CBOD_5$ (mg/L)	NH_3-N (MG/L)		DO (MG/L)	Flow (MGD)
		Max	Avg	Max	Avg	Min	Max	Avg	Max	Avg	Min	
AL 0048402	Crossville Health Care	37.5	25	7.5	5.0	6.0	37.5	25	7.5	5.0	6.0	0.014
AL 0050989	Geraldine High School	19.8	13.2	1.8	1.2	6.0	19.8	13.2	1.8	1.2	6.0	0.03
AL 0051012	Crossville High School	7.9	5.3	1.5	1.0	6.0	7.9	5.3	1.5	1.0	6.0	0.03

Notes: Flows listed are the facility design flows.

Figure 3-1. Location Map of Contributing Point Sources



NPDES			
Station	Name	Latitude	Longitude
1	GERALDINE HIGH SCHOOL STP	34° 21' 05"	86° 00' 19"
2	CROSSVILLE HEALTH CARE INC STP	34° 18' 02"	86° 59' 16"
3	CROSSVILLE HIGH SCHOOL STP	34° 17' 23"	85° 59' 47"

CAFO's			
Station	Name	Latitude	Longitude
1	W. J. Buttram Farms	34° 19' 46"	86° 08' 52"
2	B&B Farms	34° 20' 04"	86° 05' 57"
3	W & E Stogsdill	34° 21' 06"	86° 02' 23"
4	J & E Stogsdill Farm	34° 21' 11"	86° 02' 28"
5	Circle H Farms	34° 18' 44"	86° 03' 22"

3.2.3. Non-Point Sources in the Scarham Creek Watershed

Shown in Table 3-3, below, is a detailed summary of land usage in the Scarham Creek watershed. A land use map of the watershed is presented in Figure 3-2. Shown below Figure 3-2 is a pie chart depicting principal land uses. The predominant land uses within the watershed are forest, pasture/hay, and row crops. Their respective percentages of the total watershed are 44.5, 33.1, and 21.5%.

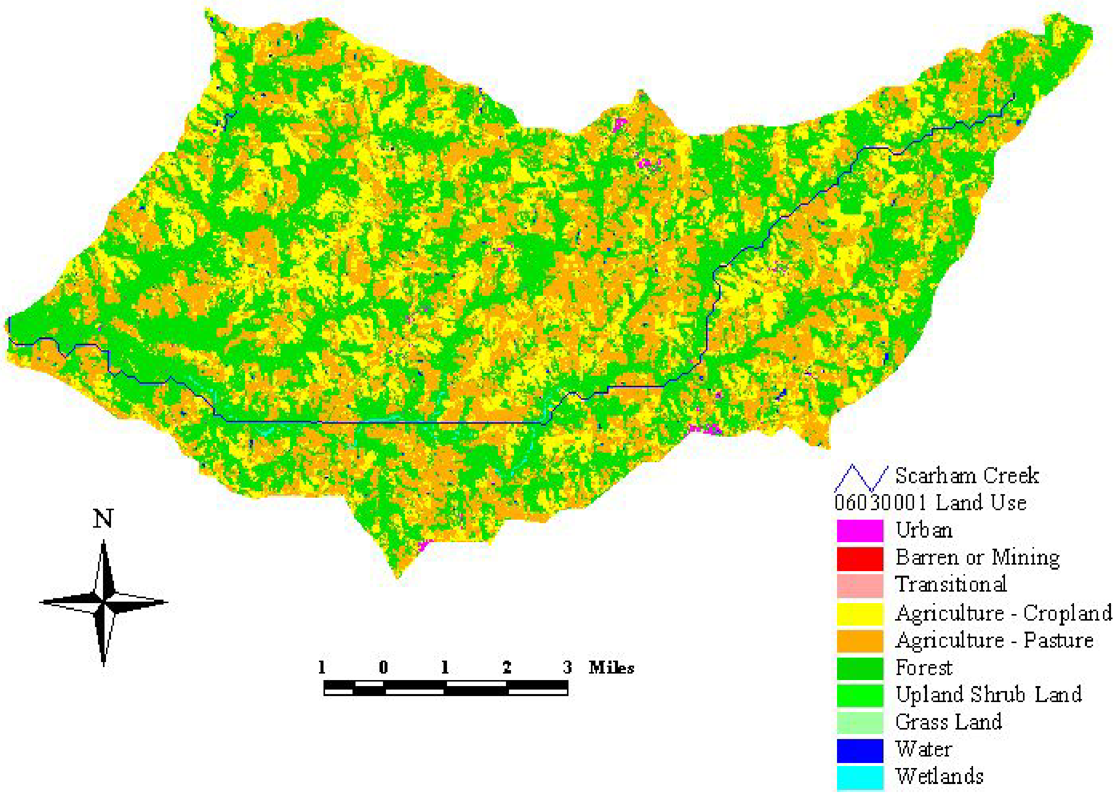
Table 3-3. Land Use in the Scarham Creek Watershed.

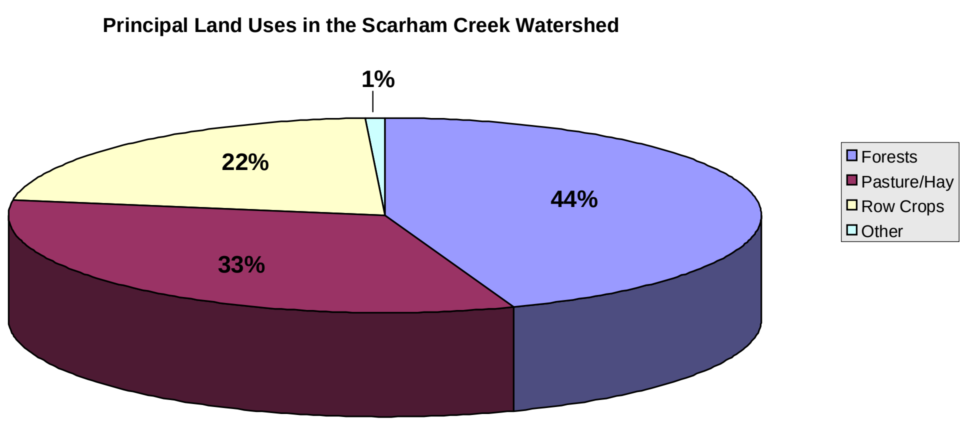
LAND USE	PERCENTAGE
Deciduous Forest	13.6
Evergreen Forest	11.3
Mixed Forest	19.6
Pasture/Hay	33.1
Row Crops	21.5
Open Water	0.2
Commercial/Industrial/Transport	0.2
Residential (High and Low-Intensity)	0.1
Other	0.4

The predominant land uses of forest, pasture/hay, and row crops make up 99% of the watershed. Each land use has the potential to contribute to the organic loading in the watershed due to organic material on the land surface that potentially can be washed off into the receiving waters of the watershed. Information on agricultural and management activities and watershed characteristics were obtained through coordination with the ADEM Mining and Non-Point Section, the Alabama Cooperative Extension System, and the USDA-Natural Resources Conservation Service (NRCS).

The major sources of organic enrichment from non-point sources within the Scarham Creek watershed are the forest, pasture/hay, and row crop land uses. Compared to other land uses organic enrichment from forested land is normally considered to be small. This is because forested land tends to serve as a filter of pollution originating within its drainage areas. However, organic loading can originate from forested areas due to the presence of wild animals such as deer, raccoons, turkeys, waterfowl, etc. Control of these sources is usually limited to land management best management practices (BMPs) and may be impracticable in most cases. In contrast to forested land, agricultural land can be a major source of organic loading. Runoff from pastures, animal operations, improper land application of animal wastes, and animals with access to streams are all mechanisms that can introduce organic loading to waterbodies.

Figure 3-2. Land Use Map for the Scarham Creek Watershed.





3.3 Loading Capacity – Linking Numeric Water Quality Targets and Pollutant Sources

EPA regulations define loading, or assimilative capacity, as the greatest amount of loading that a waterbody can receive without violating water quality standards (40 CFR Part 130.2(f)).

Alabama's water quality criteria document (ADEM Admin. Code R. 335-6-10-.09-(5)(e)(4.)) states that for a diversified warm water biota, including game fish, daily dissolved oxygen concentrations shall not be less than 5 mg/l at all times; except under extreme conditions due to natural causes, it may range between 5 mg/l and 4 mg/l, provided that the water quality is favorable in all other parameters. The normal seasonal and daily fluctuations shall be maintained above these levels.

The EPA's ambient water quality chronic criterion for ammonia as nitrogen in a stream classified as Fish and Wildlife at a pH of 7 s.u. is 2.48 mg/l. For the purposes of establishing a TMDL for ammonia as nitrogen both the CCC value and the ammonia as nitrogen concentration predicted by the dissolved oxygen model is considered and the lower concentration is used to compute allowable loading.

Using the D.O. water quality criterion of 5.0 mg/l and the ammonia as nitrogen chronic criterion of 2.48 mg/l as the numerical targets, a TMDL model analysis was performed at critical conditions (i.e., summer) to determine the loading capacity for the watershed. This was accomplished through a series of simulations aimed at meeting the dissolved oxygen target limit by varying source contributions. The final acceptable simulation represented the TMDL (and loading capacity of the waterbody). Since point sources were identified in the watershed, an additional model analysis was performed for the winter to determine the loading capacity during higher flow conditions.

In the TMDL model analysis, the pollutant concentrations from forestland were assumed to be at normal background concentrations. Specific values for background pollutant concentrations are as follows: 2 mg/l CBODu, 0.5 mg/l ammonia oxygen demand (NH3ODU), and 1 mg/l total organic nitrogen oxygen demand (TONODu). Pollutant concentrations for the other land uses in the watershed were assigned in proportion to measured concentrations and were set in the TMDL model at levels necessary to maintain dissolved oxygen concentrations greater than, or equal to, 5 mg/l.

3.4 Data Availability and Analysis

3.4.1. Watershed Characteristics

A. General Description: Scarham Creek, located in both DeKalb and Marshall County, is a tributary to the Short Creek. The Scarham Creek is a part of the Tennessee River basin. Scarham Creek is a part of the USGS (United States Geological Survey) 06030001 cataloging unit and the NRCS (Natural Resources Conservation Service) 270 sub-watershed. Cataloging unit 06030001 represents the Guntersville Lake. NRCS sub-watershed number 270 represents the Scarham Creek watershed.

   Scarham Creek begins approximately 6.5 miles northwest of the town of Crossville in Section 7, T. 8S., R. 7E. . It has a linear distance of 23 miles and a total drainage area of 91 square miles. Scarham Creek has a use classification of Fish & Wildlife (F&W).

B. Geological Description: In this region, the main rock type is sand, conglomerate, shale, siltstone, and coal. A Pottsville Formation may be found in the lower part of the region.

C. Eco-region Description: The Southern Table Plateaus include Sand Mountain, Lookout Mountain, and Brindley Mountain. While it has some similarities to the Cumberland Plateau of Tennessee with its Pennsylvanian-age sandstone caprock, this eco-region is lower in elevation, has a warmer climate, and contains more agriculture. It has higher elevation and more gentle topography with less dissection than the more forested eco-regions of the Dissected Plateau and the Shale Hills. Although the Georgia portion is mostly forested, elevations decrease to the southwest in Alabama and there is more cropland and pasture. It is a major poultry production region in Alabama.

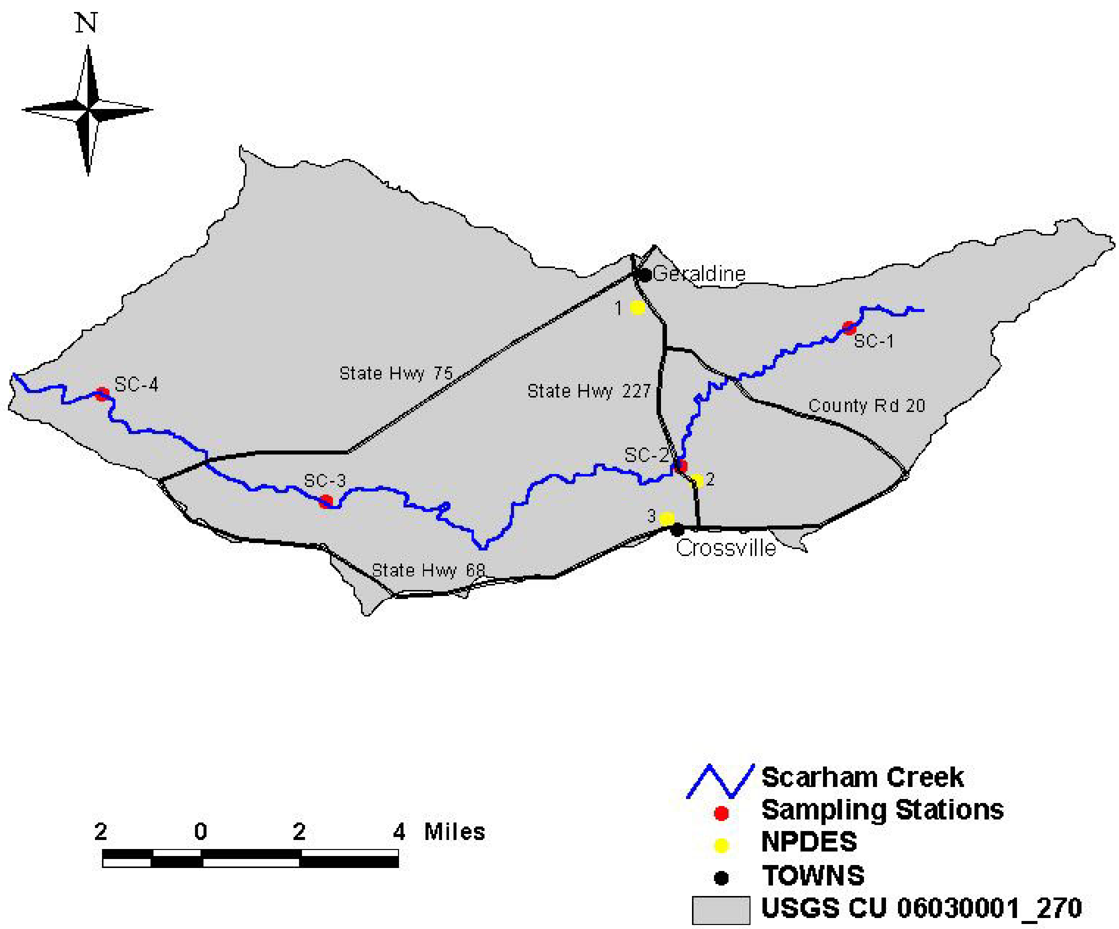
D. Other Notable Characteristics: The overall change in height for the 24 mile Scarham Creek segment is approximately 500 ft.

3.4.2 Available Water Quality and Biological Data

Water Quality and biological data for the Scarham Creek is available for the period of 1988-1998. From 1988-1998, ADEM sampled Scarham Creek at two stations, SC-3 and SC-4, approximately once a month during each year as part of the Sand Mountain Nonpoint Source Monitoring Project. In this data, there were five D.O violations, all occurred at SC-3 with either zero flow or an estimated flow. In 1992, ADEM sampled Scarham Creek at two stations, SC-1 and SC-2, as part of Alabama's Clean Water Strategy. The 1992 sampling event did not have any D.O. violations. Station SC-1 is located on light duty road northeast of the town of Crossville in Dekalb County. Station SC-2 is located on Alabama Highway 227 in Dekalb County. Station SC-3 is located at Dekalb County Road 1, which is northwest of the town of Kilpatrick. Station SC-4 is located at Marshall County Road 89 (Double Bridges), which is northeast of the town of Albertville, Alabama. A complete listing of the available data can be found in the appendix of this report.

A map indicating the location of sampling points relative to applicable point source discharges is presented in Figure 3-3.

Figure 3-3. Map of Sampling Locations and Point Source Discharges for the Scarham Creek Watershed.



Station	Name	Latitude	Longitude
1	GERALDINE HIGH SCHOOL STP	34° 21' 05"	86° 00' 19"
2	CROSSVILLE HEALTH CARE INC STP	34° 18' 02"	86° 59' 16"
3	CROSSVILLE HIGH SCHOOL STP	34° 17' 23"	85° 59' 47"
SC-1	SAMPLING STATION	34° 20' 44"	85° 56' 35"
SC-2	SAMPLING STATION	34° 18' 19"	85° 59' 34"
SC-3	SAMPLING STATION	34° 17' 41"	86° 05' 46"
SC-4	SAMPLING STATION	34° 19' 34"	86° 09' 40"

3.4.3. Flow data

For the purpose of this TMDL, annual $7Q_{10}$ stream flows for the summer season and annual $7Q_2$ stream flows for the winter season are employed. These flows represent worst-case scenarios for seasonal model evaluations. The use of worst-case conditions, in turn, creates a margin of safety in the final results.

The $7Q_{10}$ flow represents the minimum 7-day flow that occurs, on average, over a 10-year recurrence interval. Likewise, the $7Q_2$ is the minimum 7-day flow that occurs, on average, over a 2-year period.

The $7Q_{10}$ and $7Q_2$ can be calculated for the model using gage data from the United States Geological Survey (USGS) or by using the Bingham Equation (Bingham, 1982). The equation used to calculate the $7Q_{10}$ and $7Q_2$ flow for the stream and any associated tributaries was based on the USGS gaging continuous-record station (03573195) on Scarham Creek near Albertville, Alabama, and the equation is as follows (Adkins, 1994):

$$7Q_{10}\ (\text{cfs}) = \frac{(7Q_{10}\ @\ \text{USGS Station (cfs)}) * (\text{Watershed Drainage Area (mi}^2))}{(\text{Drainage Area @ USGS Station (mi}^2))}$$

$$7Q_{10} = \frac{(0.02) * (91.0\ \text{mi}^2)}{(58.7\ \text{mi}^2)}$$

$$7Q_{10} = 0.0\ \text{cfs}$$

$$7Q_2\ (\text{cfs}) = \frac{(7Q_2\ @\ \text{USGS Station (cfs)}) * (\text{Watershed Drainage Area (mi}^2))}{(\text{Drainage Area @ USGS Station (mi}^2))}$$

$$7Q_2 = \frac{(0.5) * (91.0\ \text{mi}^2)}{(58.7\ \text{mi}^2)}$$

$$7Q_2 = 0.77\ \text{cfs}$$

The method used to determine both the $7Q_{10}$ and $7Q_2$ flows for the Scarham Creek was by using gage data from the United States Geological Survey. The resulting $7Q_{10}$ and $7Q_2$ flow is 0.0 cfs and 0.77 cfs, respectively.

The calculated flow was distributed over Scarham Creek in the form of tributary flow or incremental inflow (identified on the modeled reach schematic as IF). The IF was distributed in proportion to the length of each segment.

3.5 Critical Conditions

Summer months (May – November) are generally considered critical conditions for dissolved oxygen in streams. This can be explained by the nature of storm events in the summer versus the winter. Periods of low precipitation allow for slower in-stream velocity, which increases the organic loading residence time and decreases stream re-aeration rates. This increased time permits more decay to occur which depletes the streams dissolved oxygen supply. Reaction rates for $CBOD_u$ and NBOD (i.e., organic loading) are temperature dependent and high summertime temperatures increase the decay process, which depletes the dissolved oxygen even further.

In winter, frequent low intensity rain events are more typical and do not allow for the build-up of organic loading on the land surface, resulting in a more uniform loading rate. Higher flows and lower temperatures create less residence time and lower decay rates. This pattern is evidenced in the output data of the model where the highest allowable loading achieved was for winter stream flows.

3.6 Margin of Safety (MOS)

There are two basic methods of incorporating the MOS (USEPA, 1991): 1) implicitly, using conservative model assumptions, or 2) explicitly specify a portion of the TMDL as the MOS.

The MOS is implicit in this TMDL process through the use of conservative model input parameters (**temperature, flow and D.O. concentrations**). Conservative temperature values are employed through the use of the highest average maximum temperature that would normally occur under critical stream flow conditions. The $7Q_{10}$ and $7Q_2$ stream flows employed for summer and winter, respectively, reflect the lowest flows that would normally occur under critical conditions. The D.O. concentration for incremental flow was set at 70% of the saturation concentration at the given temperature, which is 15% lower than the 85% normally assumed in a typical waste load allocation. Finally, the maximum pH value reported was used to determine the ammonia as nitrogen chronic criterion.

4.0 Water Quality Model Development

4.1 Water Quality Model Selection and Setup

Since the impairment noted by the available data occurred during periods of low flows, a steady-state modeling approach was adopted as appropriate to represent the relevant conditions in the impaired waterbody. The steady state TMDL spreadsheet water quality model (SWQM) developed by the ADEM was selected for the following reasons:

- It is a simplified approach without unnecessary complexity.
- It conforms to ADEM standard practices for developing wasteload allocations.
- It lends itself to being developed with limited data, which is the present situation for this waterbody.
- It has the ability to handle tributary inputs and both point and non-point source inputs.

The TMDL spreadsheet model also provides a complete spatial view of a stream, upstream to downstream, giving differences in stream behavior at various locations along the model reach. The model computes dissolved oxygen using a modified form of the Streeter-Phelps equation. The modified Streeter-Phelps equation takes into account the oxygen demand due to carbonaceous decay plus the oxygen demand generated from the nitrification process (ammonia decay). Each stream reach is divided into twenty elements, with each element assumed to be the functional equivalent of a completely mixed reactor.

The following assumptions were used in the spreadsheet TMDL model***:***

- D.O. concentrations for incremental flow were assumed @ 70% of the saturated value at the given temperature. **(MOS)**
- Incremental and tributary loading were apportioned to correlate with the land usage of the drainage basin.
- Ratios for $CBOD_u/NH_3OD_u$ and $CBOD_u/TONOD_u$ were calculated using water quality data for the waterbody. These ratios were assigned in the estimation of loading parameters for incremental flow and tributaries for all land uses, except forest and open water.
- $CBOD_u/BOD_5$ ratio for point and non-point sources was 1.5
- NH_3OD_u is equal to 4.57 times the ammonia nitrogen concentration.
- $TONOD_u$ is equal to 4.57 times the organic nitrogen concentration.
- Background conditions were assumed for forest incremental flow. Background conditions are typically the following ranges: 2-3 mg/l $CBOD_u$, 0.2-1 mg/l NH_3OD_u, 1-2 mg/l $TONOD_u$.
- The ammonia as nitrogen concentration was determined at maximum reported pH.
- The ammonia as nitrogen concentration is equal to the NH_3OD_u divided by 4.57. As 4.57 lbs. of oxygen is consumed per pound of ammonia as nitrogen.

Point source assessments:

- All of the point sources in the Scarham Creek watershed have had waste load allocations (WLA) prior to being permitted.
- Only Crossville High School discharges directly to Scarham Creek and was the only point source input.

- Crossville Health Care Inc. and Geraldine High School discharge to other streams that discharge to Scarham Creek.
- The results from the respective WLA for Crossville Health Care Inc. and Geraldine High School at the confluence of the point source discharge stream and Scarham Creek was used as input parameters as a tributary to Scarham Creek.
- While treating the point source as a tributary, all the loading from the point source is calculated as Load Allocations.

4.1.1. SOD Representation: Sediment oxygen demand (SOD) can be an important part of the oxygen demand budget in shallow streams. At this time, field SOD measurements for Scarham Creek are not available; therefore, in the absence of available field SOD measurements for the waterbody, SOD data was obtained from EPA Region IV's SOD database. The EPA SOD database represents mixed land uses and varying degrees of point source activity. A SOD value for a stream with similar characteristics was chosen from the database and applied to the model for Swan Creek. A SOD value of 0.05 gm-O_2 ft^2/day was chosen based on similar bottom characteristics of sand and gravel (USEPA, Region IV).

4.1.2. Calibration Data: Water Quality and biological data for the Scarham Creek is available for the period of 1988-1998. From 1988-1998, ADEM sampled Scarham Creek at two stations, SC-3 and SC-4, approximately once a month during each year as part of the Sand Mountain Nonpoint Source Monitoring Project. In this data, there were five D.O violations, all occurred at SC-3 with either zero flow or an estimated flow. In 1992, ADEM sampled Scarham Creek at two stations, SC-1 and SC-2, as part of Alabama's Clean Water Strategy. The 1992 sampling event did not have any D.O. violations. Of the 10-year data span for Scarham Creek, less than ten percent of the available data showed D.O. violations, and the data with D.O. violations either had no flow or an estimated flow; therefore, a calibration model was not performed.

4.2 Water Quality Model Summary

The summer and winter model reach each consists of 11 segments. The impaired portions of both model reaches consist of 11 segments. The length of the impaired portion and both model reaches is 23 miles. A schematic diagram of the model is presented in Figure 4-1. Assumed in-stream seasonal temperatures are based on historical model development. A guide for use of ADEM's TMDL water quality model can be found in the appendix. The guide also explains the theoretical basis for the physical/chemical mechanisms and principles that form the foundation of the model.

Figure 4-1. Schematic of the Modeled Reach.

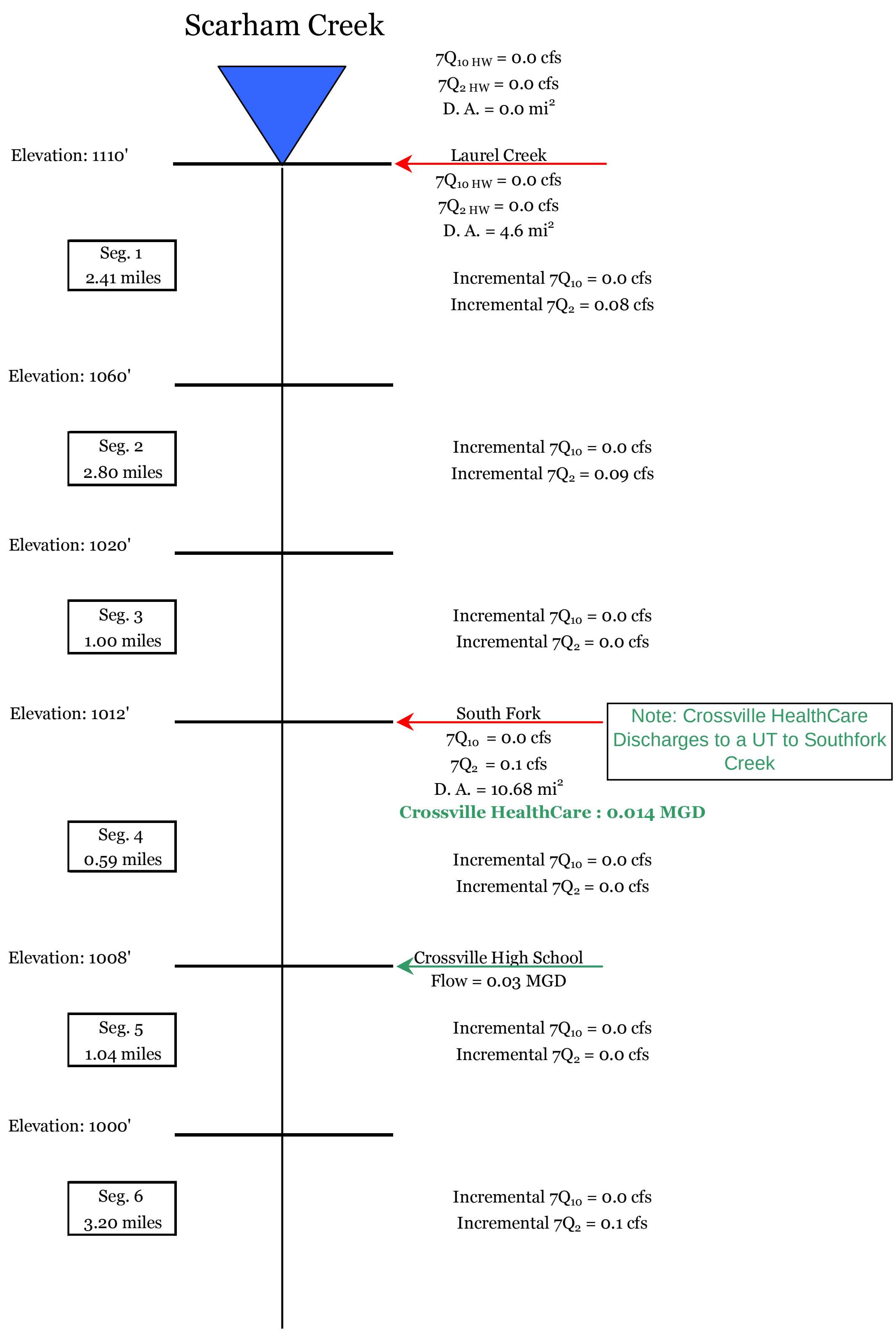
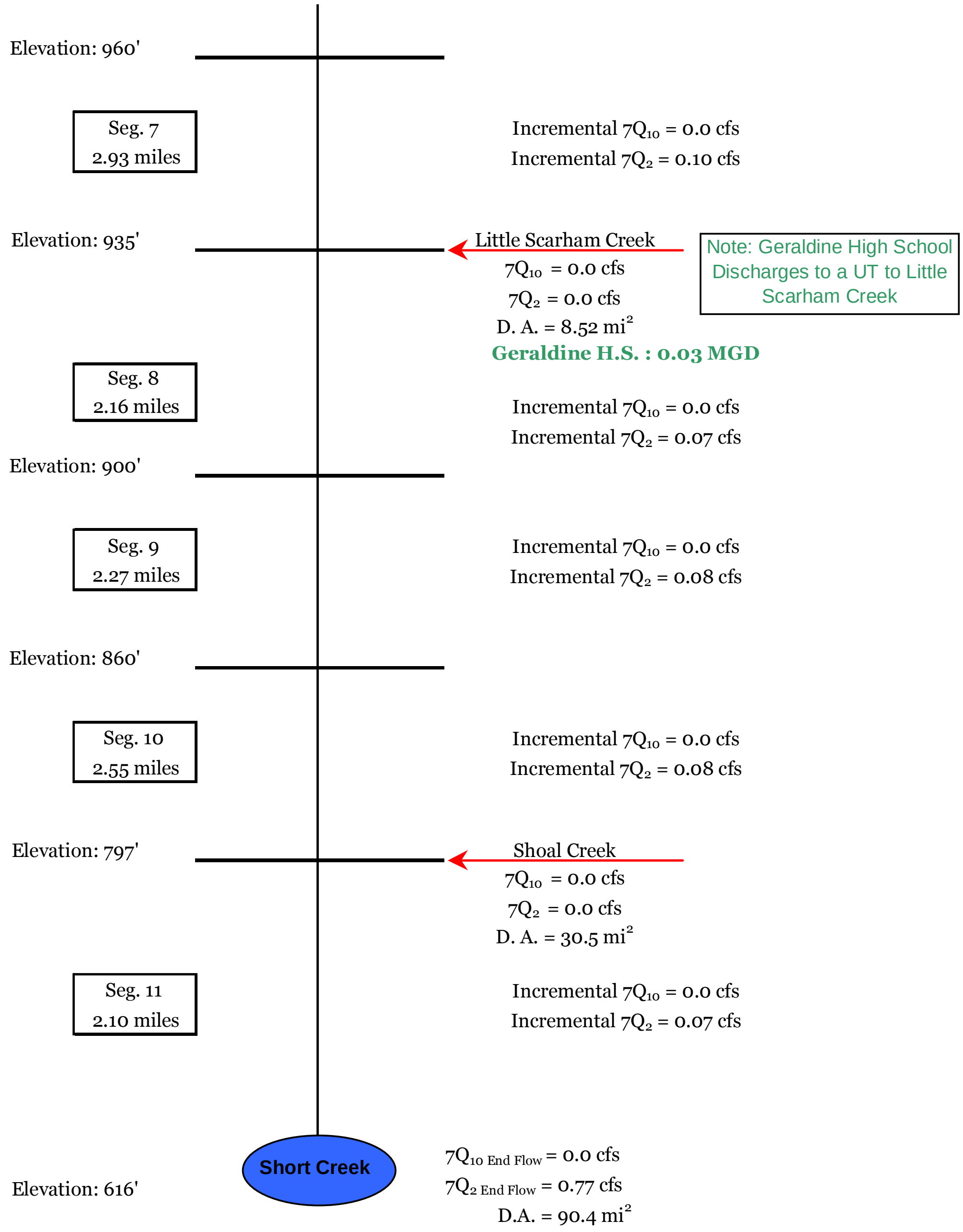


Figure 4-1. Schematic of the Modeled Reach.



Total Model Length: 23.05 miles
NOTE: The entire modeled reach is the 303 (d) segment

4.2.1. Summer (May – November) Model

Summer Stream Flow Parameters

Description	Flow (cfs)	DO (mg/l)	$CBOD_u$ (mg/l)	NH_3OD_u (mg/l)	$TONOD_u$ (mg/l)	Temp (^oC)
Headwaters	1E-23	6.65	1.92	0.34	1.35	28.0
Conditions @ Lowest D.O.	0.07	5.07	4.735	1.56	2.15	28.0
Flow @ End of Model	0.11	7.62	0.31	0.24	2.47	28.0

Summer Incremental Flow Parameters

Sections	$CBOD_u$ (mg/l)	NH_3OD_u (mg/l)	$TONOD_u$ (mg/l)	DO (mg/l)	Total Flow (cfs)	Temp. (^oC)
1	0.00	0.00	0.00	6.65	0.00	28.0
2	0.00	0.00	0.00	6.65	0.00	28.0
3	0.00	0.00	0.00	6.65	0.00	28.0
4	0.00	0.00	0.00	6.65	0.00	28.0
5	0.00	0.00	0.00	6.65	0.00	28.0
6	0.00	0.00	0.00	6.65	0.00	28.0
7	0.00	0.00	0.00	6.65	0.00	28.0
8	0.00	0.00	0.00	6.65	0.00	28.0
9	0.00	0.00	0.00	6.65	0.00	28.0
10	0.00	0.00	0.00	6.65	0.00	28.0
11	0.00	0.00	0.00	6.65	0.00	28.0

4.2.2 Winter (December – April) Model

Winter Stream Flow Parameters

Description	Flow (cfs)	DO (mg/l)	$CBOD_u$ (mg/l)	NH_3OD_u (mg/l)	$TONOD_u$ (mg/l)	Temp (^oC)
Headwaters	1E-23	8.05	1.92	10.27	40.13	18.0
Conditions @ Lowest D.O.	0.17	5.08	9.02	3.76	15.57	18.0
Flow @ End of Model	1.08	9.16	4.74	1.58	8.73	18.0

Winter Incremental Flow Parameters

Sections	$CBOD_u$ (mg/l)	NH_3OD_u (mg/l)	$TONOD_u$ (mg/l)	DO (mg/l)	Total Flow (cfs)	Temp. (^oC)
1	24.53	4.41	17.24	8.05	0.08	18.0
2	24.53	4.41	17.24	8.05	0.09	18.0
3	0.00	0.00	0.00	8.05	0.00	18.0
4	0.00	0.00	0.00	8.05	0.00	18.0
5	0.00	0.00	0.00	8.05	0.00	18.0
6	24.53	4.41	17.24	8.05	0.10	18.0
7	24.53	4.41	17.24	8.05	0.10	18.0
8	24.53	4.41	17.24	8.05	0.07	18.0
9	24.53	4.41	17.24	8.05	0.08	18.0
10	24.53	4.41	17.24	8.05	0.08	18.0
11	24.53	4.41	17.24	8.05	0.07	18.0

4.3 *Summer and Winter Models Predictions and Graphics*

Figure 4-2. Summer Model Predictions.

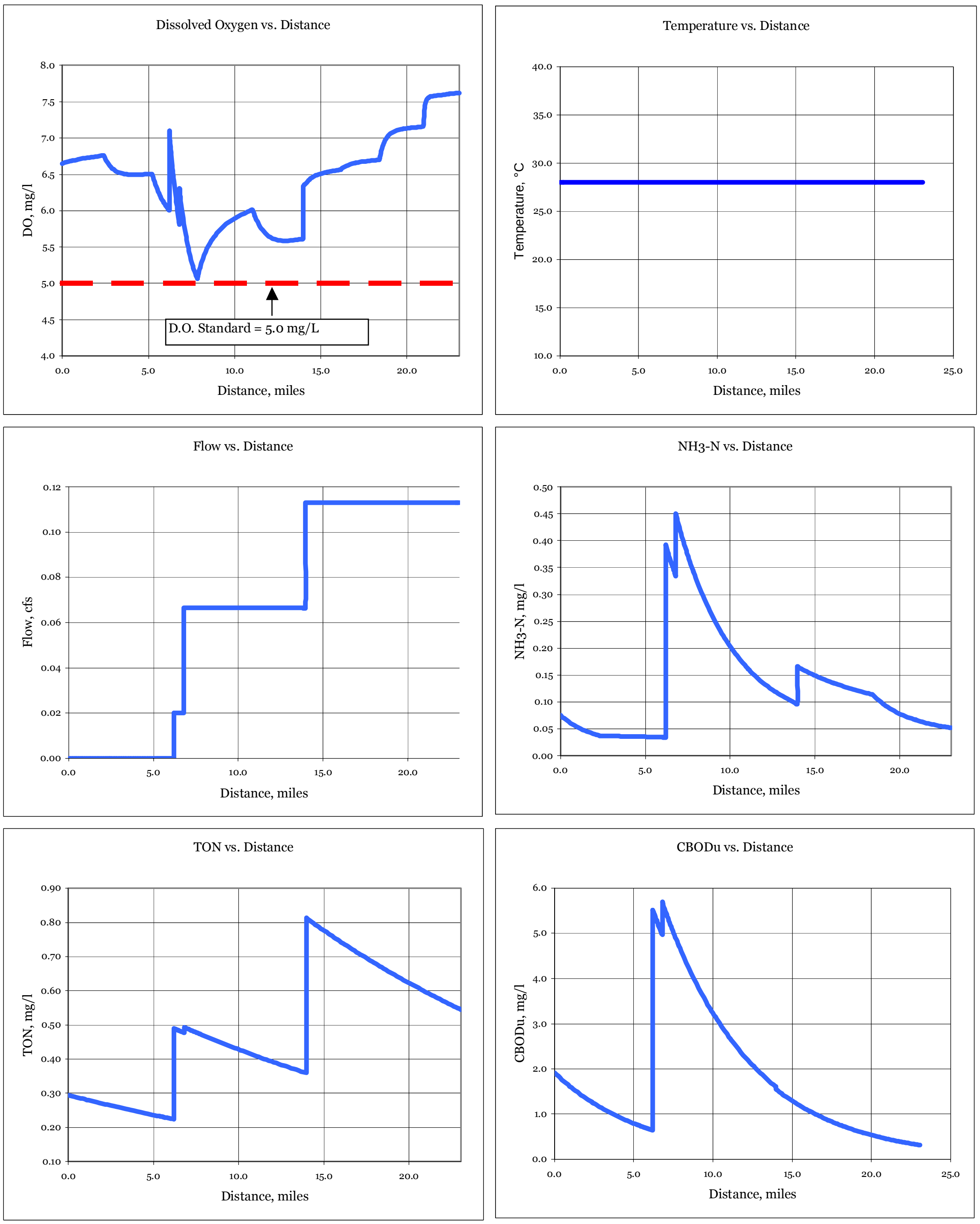
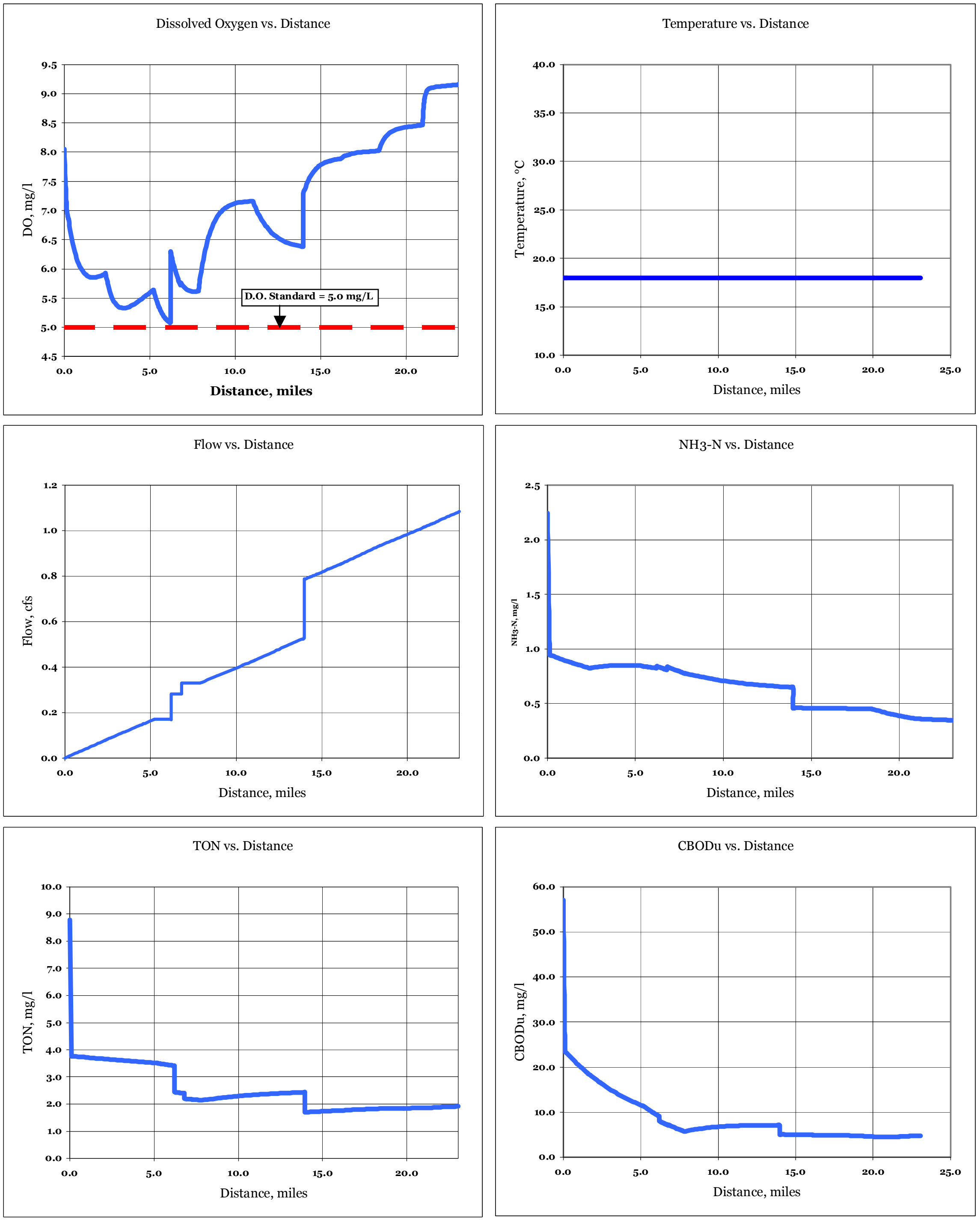


Figure 4-3. Winter Model Predictions.



4.4 Loading Reduction Analysis

4.4.1. Required Reductions

Scarham Creek has a $7Q_{10}$ of zero; therefore, the summer stream flow comes from the point source discharges. As a result, the point sources were targeted for reduction in order to maintain water quality standards for Scarham Creek.

A summary of the required reductions for point source loads is presented in Tables 4-1 and 4-2.

Table 4-1. Required Organic Load Reductions for Point Sources in Summer TMDL

Existing Point Source Load[1]	Existing Non-Point Source Load[1]	Total Existing Load [1]	Reduced Load[1]	% Reduction	% Reduction
(lbs./day)	(lbs./day)	(lbs./day)	(lbs./day)	Point Sources	Non-Point Sources
10.9	0.0	10.9	2.6	76.1	0.0

Notes: 1 = $CBOD_u$ + NBOD

Table 4-2. Required Ammonia as Nitrogen Load Reductions for Point Sources in Summer TMDL

Existing Point Source Load[1]	Existing Non-Point Source Load	Total Existing Load	Reduced Load[1]	% Reduction	% Reduction
(lbs./day)	(lbs./day)	(lbs./day)	(lbs./day)	Point Sources	Non-Point Sources
0.8	0.0	0.8	0.2	75.0	0.0

Notes: 1 = $CBOD_u$ + NBOD

The required reductions will be sought through the NPDES permit program with follow up monitoring as part of TMDL implementation to determine the effectiveness of implementation. Follow up monitoring as discussed further in this document will be conducted according to basin rotation.

4.4.2. Point Source Sensitivity Analysis

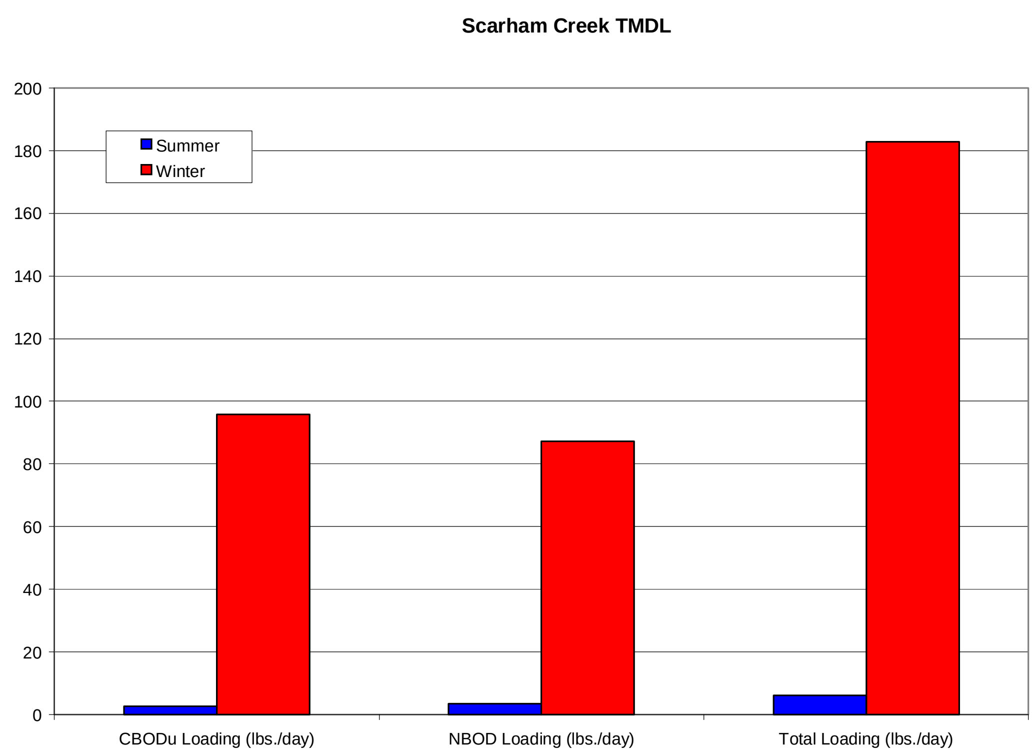
Scarham Creek has a $7Q_{10}$ of zero; therefore, the stream flow during the summer period is a result of the point source discharges. As a result, a point source sensitivity analysis for Scarham Creek was not done at this time.

4.5 *Seasonal Variation*

The regulations require that a TMDL be established with consideration of seasonal variations. Since impairments occurred only during the summer months and not during other times of the year, a seasonal variation in the TMDL was not necessary. However, since there were point source loads identified, both summer and winter TMDLs were calculated for the purposes of determination of applicable point source permit limitations year round.

As discussed previously, TMDLs have been estimated for the summer and winter. Figure 4-4, below, illustrates the effect that seasonal temperatures and stream flows have on CBODu, NBOD and total organic loading.

Figure 4-4. Seasonal Temperature and Stream Effects on the TMDLs



5.0 Conclusions

A summary of the TMDL for both summer and winter is presented in Table 5-1.

Table 5-1. Summer and Winter TMDLs Summary

	TMDL	
	Summer	**Winter**
$CBOD_u$ Loading (lbs./day)	2.5	95.7
NBOD Loading (lbs./day)	3.5	87.1
Total Loading (lbs./day)	6.0	182.8
NH_3-N (lbs./day)	0.2	4.4

Within the impaired segment, the point source allocations used in development of the summer and winter TMDL will be addressed by the NPDES permit program during permit renewals and modifications. Based on the summer and winter TMDL analysis the revised NPDES permit limitations presented in Table 5-2 are necessary.

Table 5-2. Suggested Revised NPDES Permit Limits for Significant Contributing Point Sources.

NPDES Permit	Facility Name	Permit Limitations - Summer					Permit Limitations - Winter					
		$CBOD_u$ (mg/L)	$CBOD_5$ (mg/L)	NH_3-N (MG/L)		DO (MG/L)	$CBOD_u$ (mg/L)	$CBOD_5$ (mg/L)	NH_3-N (MG/L)		DO (MG/L)	Flow (MGD)
		Max	Avg	Max	Avg	Min	Max	Avg	Max	Avg	Min	
AL 0048402	Crossville Health Care	6.0	4.0	0.75	0.5	6.5	37.5	25	7.5	5.0	6.0	0.014
AL 0050989	Geraldine High School	15.0	10	1.8	1.2	6.5	19.8	13.2	1.8	1.2	6.0	0.03
AL 0051012	Crossville High School	6.0	4.0	0.75	0.5	6.5	7.9	5.3	1.5	1.0	6.0	0.03

Notes: n/a = not applicable

6.0 TMDL Implementation

6.1 Non-Point Source Approach

Scarham Creek is impaired solely by point sources during the critical period (summer) and soley by non-point sources during the winter. The collection of additional data for Scarham Creek will be a major part of the implementation plan. ADEM will be sampling in the Tennessee River basin in 2003. Scarham Creek will be a part of this sampling event. Once adequate data is obtained, the TMDL will be revised to calculate the required reductions, if applicable

For 303(d) listed waters impaired solely or primarily by nonpoint source (NPS) pollutants, necessary reductions will be sought during TMDL implementation using a phased approach. Voluntary, incentive-based mechanisms will be used to implement NPS management measures in order to assure that measurable reductions in pollutant loadings can be achieved for the targeted impaired water. Cooperation and active participation by the general public and various industry, business, and environmental groups is critical to successful implementation of TMDLs. Local citizen-led and implemented management measures offer the most efficient and comprehensive avenue for reduction of loading rates from nonpoint sources. Therefore, TMDL implementation activities will be coordinated through interaction with local entities in conjunction with Clean Water Partnership efforts.

The primary TMDL implementation mechanism used will employ concurrent education and outreach, training, technology transfer, and technical assistance with incentive-based pollutant management measures. The ADEM Office of Education and Outreach (OEO) will assist in the implementation of TMDLs in cooperation with public and private stakeholders. Planning and oversight will be provided by or coordinated with the Alabama Department of Environmental Management’s (ADEM) Section 319 nonpoint source grant program in conjunction with other local, state, and federal resource management and protection programs and authorities. The CWA Section 319 grant program may provide limited funding to specifically ascertain NPS pollution sources and causes, identify and coordinate management programs and resources, present education and outreach opportunities, promote pollution prevention, and implement needed management measures to restore impaired waters.

Depending on the pollutant of concern, resources for corrective actions may be provided, as applicable, by the Alabama Cooperative Extension System (education and outreach); the USDA-Natural Resources Conservation Service (NRCS) (technical assistance) and Farm Services Agency (FSA) (federal cost-share funding); and the Alabama Soil and Water Conservation Committee (state agricultural cost share funding and management measure implementation assistance) through local Soil and Water Conservation Districts, or Resource Conservation and Development Councils (funding, project implementation, and coordination). Additional assistance from such agencies as the Alabama Department of Public Health (septic systems), Alabama Department of Agriculture and Industries (pesticides), and the Alabama Department of Industrial Relations and Dept of Interior - Office of Surface Mining (abandoned minelands), Natural Heritage Program and US Fish and Wildlife Service (threatened and endangered species), may also provide practical TMDL implementation delivery systems, programs, and information. Land use and urban sprawl issues will be addressed through the Nonpoint Source for Municipal Officials (NEMO) education and outreach program. Memorandums of Agreements (MOAs) may be used as a tool to formally define roles and responsibilities.

Additional public/private assistance is available through the Alabama Clean Water Partnership (CWP) Program. The CWP program uses a local citizen-based environmental protection approach to coordinate efforts to restore and protect the state's resources in accordance with the goals of the Clean Water Act. Interaction with the state or river basin specific CWP will facilitate TMDL implementation by providing improved and timely communication and information exchange between community-based groups, units of government, industry, special interest groups, and individuals. The CWP can assist local entities to plan, develop, and coordinate restoration strategies that holistically meet multiple needs, eliminate duplication of efforts, and allow for effective and efficient use of available resources to restore the impaired waterbody or watershed.

Other mechanisms that are available and may be used during implementation of this TMDL include local regulations or ordinances related to zoning, land use, or storm water runoff controls. Local governments can provide funding assistance through general revenues, bond issuance, special taxes, utility fees, and impact fees. If applicable, reductions from point sources will be addressed by the NPDES permit program. The Alabama Water Pollution Control Act empowers ADEM to monitor water quality, issue permits, conduct inspections, and pursue enforcement of discharge activities and conditions that threaten water quality. In addition to traditional "end-of-pipe" discharges, the ADEM NPDES permit program addresses animal feeding operations and land application of animal wastes. For certain water quality improvement projects, the State Clean Water Revolving Fund (SRF) can provide low interest loans to local governments.

Long-term physical, chemical, and biological improvements in water quality will be used to measure TMDL implementation success. As may be indicated by further evaluation of stream water quality, the effectiveness of implemented management measures may necessitate revisions of this TMDL. The ADEM will continue to monitor water quality according to the rotational river basin monitoring schedule as allowed by resources. In addition, assessments may include local citizen-volunteer monitoring through the Alabama Water Watch Program and/or data collected by agencies, universities, or other entities using standardized monitoring and assessment methodologies. Core management measures will include, but not be limited to water quality improvements and designated use support, preserving and enhancing public health, enhancing ecosystems, pollution prevention and load reductions, implementation of NPS controls, and public awareness and attitude/behavior changes.

6.2 Point Source Approach

Point source reductions will be addressed by the NPDES permit program.

7.0 Follow Up Monitoring

ADEM has adopted a basin approach to water quality management; an approach that divides Alabama's fourteen major river basins into five groups. Each year, the ADEM water quality resources are concentrated in one of the basin groups. One goal is to continue to monitor §303(d) listed waters. This monitoring will occur in each basin according to the following schedule:

River Basin Group	Schedule
Cahaba / Black Warrior	2002
Tennessee	2003
Choctawhatchee / Chipola / Perdido-Escambia / Chattahoochee	2004
Tallapoosa / Alabama / Coosa	2005
Escatawpa / Upper Tombigbee / Lower Tombigbee / Mobile	2006

Scarham Creek will be a part of the Tennessee River basin-sampling effort 2003, once sufficient data is obtained the TMDL will be revised to calculate the required reductions, if applicable. Monitoring will help further characterize the water quality conditions resulting from the implementation of best management practices in the watershed.

8.0 Public Participation

A thirty-day public notice will be provided for this TMDL. During this time, the availability of the TMDL will be public noticed, a copy of the TMDL will be provided as requested, and the public will be invited to provide comments on the TMDL.

Appendix 9.1
References

References

Adkins, J.B., Pearman, J.L.. 1994. Low-Flow and Flow-Duration Characteristics of Alabama Streams. Water-Resources Investigations Report 93-4186.

Bingham, R.H.. 1982. Low-Flow Characteristics of Alabama Streams. Geological Survey Water-Supply Paper 2083

United States Environmental Protection Agency. 1991. Guidance for Water Quality-Based Decisions: The TMDL Process, Office of Water, EPA 440/4-91-00

United States Environmental Protection Agency Region IV. Sediment Oxygen Demand Database

Appendix 9.2
Water Quality Data

Physical / chemical data collected monthly from April 1988 to March 1998 as part of the Sand Mountain Nonpoint Source Monitoring Project in the Lake Guntersville Cataloging Unit (0603-0001) (ADEM 1998b).

Station	Date	Time	Air Temp.	Water Temp.	Dissolved Oxygen	pH	Conductivity	Turbidity	Stream Flow	Tape Down	Fecal Coliform	BOD-5	TDS	TSS	NH3	NO2/ NO3	TKN	T-PO4	TON
#	yymmdd	24hr	C	C	mg/l	s.u.	umhos @25c	NTU	cfs	Ft.	col/100ml	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/l	mg/l
SC-3	880413			11	9.1	6.3	100	9			3500	3.3		2	1.500	2.360	3.000	0.090	1.500
SC-3	880510			3	8.0	5.7	71	4	36		1900	1.4		6	0.100	1.980	0.700	0.060	0.700
SC-3	880622		33	24	4.1	6.3	58	2	0		21	2.1		2	0.070	0.020	1.100	0.080	1.030
SC-3	880823		28	26	5.8	7.5	51	2	0.34		54	1.0		1	0.040	0.040	1.900	0.020	1.900
SC-3	880920		28	23	8.1	5.8	100	31	76.98		400	1.0		7	0.300	3.300	2.200	0.050	1.900
SC-3	881018		21	15	9.4	5.3	94	1	7.06		52	1.0		0.5	0.200	1.980	1.100	0.020	1.100
SC-3	881129		14	10	10.7	6.4	89	37	271		540	1.0		5	<0.2	2.400	1.600	0.030	1.600
SC-3	881227		11	10	11.7	6.5	85	2	51		140	<1		<1	<0.2	2.020	0.800	0.090	0.800
SC-3	890124		20	8	11.2	5.6	75				54	<1		2	<0.2	3.300	<.2	<.02	<0.2
SC-3	890221		17	12		6.3	65	120				5.3		294	<0.2	3.480	3.600	0.460	3.600
SC-3	890322		10	11	10.4	6.4	69	10			1540	<1		16	0.200	2.020	<.4	<.02	
SC-3	890418		20	16	9.5	6.5	72	4	99		77	1.2		9	<0.2	1.720	1.000	<.02	1.000
SC-3	890523		29	21	8.5	6.7	66	2	19		84	<1		1.5	0.200	1.000	2.800	0.040	2.600
SC-3	890628		34	24	8.3	6.7	65	5	79.03			1.4		3.5	0.780	1.870	1.250	0.110	0.470
SC-3	890712		29	24	8.6	6.2	76	10	180.27		>1750	<1		11	<0.2	1.670	0.610	0.080	0.410
SC-3	890824		29	25	6.7	6.8	82	1	4.64		45	1.2		<1	<0.2	0.290	1.280	0.050	1.080
SC-3	891004		17	20	8.7	6.5	73	6	174		360	<1		13	<0.3	1.720	0.450	0.020	0.420
SC-3	891115		21	16	9.2	7.2	78	5	78		>4500	2.2		3	<0.3	1.400	0.360	0.041	0.330
SC-3	900110		13	9	11.3	6.3	74	9			53	<1		15	<0.03	2.320	0.340	<.02	0.310
SC-3	900214		12	8	10.1	6.4	69	4	38		80	<1		6	<0.03	2.550	0.210	<.02	0.180
SC-3	900314		26	17	9.9	7.1	63	3	36		29	<1		1	<0.03	2.030	0.240	<.02	0.210
SC-3	900403		7	13	11.0	7.3	47	2	34		67	<1		1	<0.03	1.720	0.280	0.130	0.250
SC-3	900516		26	21	8.3	6.7	60	14			>600	<1		8	0.090	1.460	0.440	0.090	0.340
SC-3	920226		4	11		7.3	74	38				<1		54	0.280	3.330	0.730	0.100	0.450
SC-3	920324		27	12		5.9	83	7			120	1.0		2	<.1	4.000	0.300	<.05	0.300
SC-3	920428		15	16	12.2	7.8	76	4	38.8			1.0		<1	0.100	1.810	0.470	<.05	0.370
SC-3	920506		18	16	9.2	6.5	73	1	13		70	<1		5	<.1	1.360	0.520	0.230	0.520
SC-3	920617		27	21	8.3	7.1	75	4	26		216	2.0		<1	<.1	1.670	0.200	0.180	0.200
SC-3	920804		24	24	7.4	7.2	96	3	14.02		2700	1.0		<1	0.140	1.150	0.260	0.550	0.120
SC-3	921020		20	13	10.2	7.0	103	1	*23		53	<1		<1					
SC-3	921112		17	14	9.5	6.7	85	13			80	1.0		24	0.210	2.320	0.400	<.04	0.190
SC-3	921208		5	7	11.4	6.2	77	5			124	<1		3	0.160		0.270	0.500	0.110
SC-3	930120		5	8	11.3	6.1	73	5	157		128	1.0		<1	0.24	2.680	0.240	<.05	<.04
SC-3	930223		9	8	11.7	5.9	76	2	97		148	<1		<1	0.140	2.150	0.170	<.04	0.030
SC-3	930323		18	12	9.8	6.6	69	35			>600	2.0		34	0.310	1.960	0.770	<.04	0.460
SC-3	930413		27	16	9.3	7.4	74	2	102.06		20	1.0		<1	0.630	1.720	0.360	0.190	
SC-3	930512		23	17	8.3	6.8	82	3	56		60	<1		<1	<.1	1.700	0.140	<.04	0.140
SC-3	930602		26	17	8.2	7.0	84	2	16		1180	<1		<1	0.110	1.190	0.230	0.320	0.120
SC-3	930721		35	28	6.0	6.2	108	2			5600	0.5		<1	0.110	0.030	0.370	0.180	0.260
SC-3	930831		35	28	5.5	6.0	84	1	*0		2600	1.1		<1	0.28	<.05	0.390	0.330	0.110
SC-3	930921		26	21	4.8	6.6	76	1			32	0.8		<1	0.230	<.04	0.420	0.830	0.190
SC-3	931013		21	13	8.4	6.5	99	1			1	3.1		<1	<.05	<.03	0.290	0.180	0.290
SC-3	931109		14	10	3.4	6.1	123	4	*8		21	6.0		<1	<.05	<.04	0.580	0.210	0.580
SC-3	931208		12	9	10.5	6.0	125	1	*28		30	1.6		<1	<.05	0.040	0.210	0.570	0.210

Physical / chemical data collected monthly from April 1988 to March 1998 as part of the Sand Mountain Nonpoint Source Monitoring Project in the Lake Guntersville Cataloging Unit (0603-0001) (ADEM 1998b).

Station	Date	Time	Air Temp.	Water Temp.	Dissolved Oxygen	pH	Conductivity	Turbidity	Stream Flow	Tape Down	Fecal Coliform	BOD-5	TDS	TSS	NH3	NO2/NO3	TKN	T-PO4	TON
SC-3	940105		4	6	12.5	7.1	148	4	47.88		86	0.5		<1	<.05	4.620	0.200	0.160	0.200
SC-3	940223		21	15	9.1	6.0	81	157				4.6		183	0.140	2.500	0.720	1.100	0.580
SC-3	940322		19	15	10.5	6.1	90	2	83		40	1.0		<1	<.05	3.140	0.240	0.040	0.240
SC-3	940419		23	16	9.7	6.5	78	5	144		246	0.6		2	<.05	2.130	0.170	0.040	0.170
SC-3	940524		28	19	8.8	6.7	89	3	*10		132				0.009	1.200	0.410	0.029	0.410
SC-3	940621		34	26	6.5	7.1	99	4	*0		160	2.0		<1	<.05	0.590	0.440	0.820	0.440
SC-3	940719		28	23	8.4	7.1	119	5	15.3		140	0.3		<1	<.05	1.200	0.230	<.04	0.230
SC-3	940809		29	25	7.7	6.7	127	21	*70			1.6		7	<.05	1.240	0.360	0.740	0.360
SC-3	940913		30	22	7.6	6.8	88	1	*28		650	0.5		<1	<.05	0.210	0.230	<.05	0.230
SC-3	941018		21	17	9.8	6.8	83	3	41.68		90	1.2		<1	<.05	1.660	0.210	0.290	0.210
SC-3	941115		22	14	9.9	6.8	84	3	35.01			0.8		<1	<.05	1.260	0.400	<.04	0.400
SC-3	941206		17	14	9.5	6.5	77	8	*160			0.9		13	<.05	2.180	0.330	0.110	0.330
SC-3	950111		11	8	11.8	6.4	80	3	71		296	0.6		2	<.05	3.090	0.300	0.140	0.300
SC-3	950215		9	7	11.0	6.9	87	2	*68		260	0.6		<1	0.060	2.770	0.290	0.500	0.230
SC-3	950308		2	10	9.8	6.7	76	71			10500	2.2		156	0.130	1.340	<.5	0.250	
SC-3	950411		21	18	8.5	6.9	82	1	17.15		31	2.0		<1	<.05	1.680	0.270	0.330	0.270
SC-3	950510		22	20	8.0	6.9	80	2	*55		116	0.8		<1	<.05	1.230	0.230	0.140	0.230
SC-3	950613		21	20	7.9	6.7	79	4	*12		2600	1.2		<1	0.280	0.500	0.290	0.240	0.010
SC-3	950719		31	25	4.6	6.9	105	2	*0		140	0.7		6	0.320	0.100	0.390	0.140	0.070
SC-3	950816		34	27	6.2	6.5	91	2	*0		1320	0.9		<1	0.224	0.474	0.446	0.046	0.222
SC-3	950906		27	21	5.4	6.4	96	2	*0		300	1.4		<1	0.229	0.051	0.356	0.791	0.127
SC-3	951017		20	17	9.4	6.2	101	1	*40		92	<.1		<1	0.094	2.200	0.205	0.100	0.111
SC-3	951114		5	9	11.4	6.2	84	3			210	0.7		3	0.099	2.691	0.287	0.043	0.166
SC-3	951212		9	6	13.2	7.6	80	2	*75		132	0.1		1	<.005	2.464	0.286	0.031	0.286
SC-3	960117	1100	9	9	11.0	6.1	78	3	85	31.15	216	1.2	44	1	0.115	2.359	0.338	0.060	0.223
SC-3	960214	1030	12	7	12.4	6.4	73	3		30.07	140	0.9	58	1	0.069	1.669	0.368	0.222	0.299
SC-3	960313	1140	20	10	11.6	6.5	74	4	149	31.05	70	1.6	46	2	<.05	2.333	0.235	0.212	0.235
SC-3	960424	1030	15	15	10.0	6.2	66	5	102	30.95	310	1.2	48	3	<.05	1.533	0.155	0.950	0.155
SC-3	960521	1100	38	24	6.9	7.0	81	1	10	32.55	230	0.9	59	<1	<.05	1.283	0.266	0.804	0.266
SC-3	960611	1020	20	20	7.3	7.0	79	2	55	31.53	660	<.1	66	1	0.069	0.903	<.1	0.065	<.1
SC-3	960716	1030	28	21	5.1	6.9	89	1		37.95	300	1.1	58	1	0.110	0.085	0.385	<.04	0.275
SC-3	960813	1045	27	24	7.3	6.8	114	2	13	32.55	88	0.4	61	1	0.054	0.722	0.300	0.058	0.246
SC-3	960903	1045	28	18	6.9	7.0	119	2	15	32.45	168	1.1	60	<1	0.088	0.866	0.345	<.04	0.257
SC-3	961022	1100	22	11	9.1	6.8	62	1	3	32.8	65	1.3	71	1	<.10	1.510		<.05	
SC-3	961119	1025	19	13	10.4	7.1	68	4	90	31.04	410	0.6	71	<1	<.05	1.440	0.387	0.150	
SC-3	961217	1030	3	9	10.4	6.4	55	27		30.15	4200	2.6	56	35	<.01	2.140	1.228	0.211	1.228
SC-3	970122	1015	10	8	10.7	6.2	53	3	65	31.43	110	0.8	43	1	0.029	2.594	0.142	0.037	0.113
SC-3	970219	1040	15	10	11.0	6.3	54	2	46	31.72	32	0.8	37	4	<.05	2.518	<.1	0.022	<.10
SC-3	970318	1030	21	12	9.9	6.4	48	5	115	30.8	196	0.9	53	4	<.05	1.959	0.236	<.005	0.236
SC-3	970409	1100	15	13	9.9	6.5	49	3	111	31.45	60	0.7	47	4	0.111	1.434	0.467	0.080	0.356
SC-3	970513	1030	19	16	9.0	6.3	47	3	88	31.6	56	1.3	52	<1	0.083	1.503	0.167	0.042	0.084
SC-3	970624	1000	32	23	8.9	6.9	56	4	67	31.39	168	2.0	63	3	<.005	1.596	0.464	0.181	0.464
SC-3	970722	1017	23	24	5.7	6.7	65	2	12	32.52	210	1.3	60	<1	0.010	1.115	0.695	0.081	0.685
SC-3	970827	1030	28	22	6.8	6.7	59	1	0	33.19	80	3.0	57	<1	<.005	0.109	0.418	0.044	0.418
SC-3	970923	1015	22	20	4.5	6.1	94	1	*28	32.11		1.0	57	<1	<.05	0.038	0.566	0.046	0.566
SC-3	971014	1020	12	18	7.3	6.1	86	1	13	32.5	340	0.1	59	<1	0.046	0.622	0.612	0.225	0.566
SC-3	971119	1115	11	7	11.5	7.0	51	1	71	31.78	42	1.2	50	<1	<.05	1.811	0.196	<.050	0.196
SC-3	971202	1045	12	9	10.7	4.7	52	2	69	31.77	72	1.1	58	<1	0.077	1.631	0.249	0.110	0.172
SC-3	980127	1020	9	8	10.7	5.7	58	8	125	30.77	240	4.7	56	2	<.05	2.823	0.235	<.05	0.235
SC-3	980217	1025	15	9	10.4	7.2	46	136		27.06	12,700	4.7	60	223	<.05	1.504	2.099	0.532	2.099
SC-3	980311	1000	1	6	11.6	6.1	48	8		30.06	180	1.4	61	8	<.05	1.921	0.056	0.093	0.056

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Station	Date	Time	Air Temp.	Water Temp.	Dissolved Oxygen	pH	Conductivity	Turbidity	Stream Flow	Fecal Coliform	BOD-5	TDS	TSS	NH3-N	NO2/ NO3-N	TKN	T-PO4	TON
#	yymmdd	24hr	C	C	mg/l	s.u.	umhos @25c	NTU	cfs	col/100ml	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/l	mg/l
SC-4	880412	1210		12	9.2	6.0	83	33		10000	6.3		100	0.600	1.950	3.600	0.290	3.000
SC-4	880510	1200		20	8.9	6.0	70	2		40	1.3		1	0.100	1.440	0.800	0.050	0.800
SC-4	880622	0845	30	23	5.4	6.9	50	1		430	1.6		1	0.040	0.020	1.300	0.050	1.260
SC-4	880823	1105	30	28	7.0	6.8	73	6		3	1.0		36	0.040	0.040	0.600	0.020	0.600
SC-4	880920	1030	26	22	8.1	6.9	102	3		225	1.0		7	0.200	3.040	0.800	0.050	0.600
SC-4	881018	0950	20	15	9.9	6.8	91	1		30	1.0		1	0.200	1.580	1.100	0.020	1.100
SC-4	881129	1100	14	10	11.5	5.5	90	4		340	<1		4	<.2	2.120	1.400	0.030	1.400
SC-4	881227	1035	15	8	11.5	6.3	81	2		60	<1		<1	<.2	1.920	0.800	0.040	0.800
SC-4	890124	1040	17	9	10.9	7.1	75			21	<1		1.5	<.2	2.700	0.400	<.02	0.400
SC-4	890221	1120	16	12		6.4	61	1			4.9		238	<.2	2.080	3.200	0.320	3.200
SC-4	890322	1110	13	12	11.3	6.4	73	15		>2230	<1		23	<.2	1.720	<.4	<.02	<.4
SC-4	890418	1030	22	16	10.7	8.1	75	3		45	<1		<1	<.2	1.600	1.000	<.02	1.000
SC-4	890523	1145	24	21	9.2	6.2	74	3		117	1.3		1	0.400	1.000	1.200	0.030	0.800
SC-4	890628	1330	30	23	8.7	6.4	55	6		410	1.2		6	<.2	1.730	1.110	0.070	0.910
SC-4	890712	1040	38	27	8.2	6.6	78	11		>1950	1.0		14	<.2	2.570	0.610	0.080	0.410
SC-4	890824	1045	32	25	7.0	6.2	81	1		38	1.4		<1	<.2	0.700	1.910	0.050	1.710
SC-4	891004	1015	22	20	9.2	6.7	78	7		490	<1		13	<.03	1.620	0.370	<.02	0.340
SC-4	891115	1015	20	15	9.8	6.8	82	3		270	<1		2	<.03	1.310	0.320	0.022	0.290
SC-4	900110	1150	15	10	11.8	6.4	89	7		26	<1		13	0.050	2.170	0.390	<.02	0.340
SC-4	900214	1050	18	13	10.7	6.5	68	5		143	<1		6	<.03	2.360	0.240	<.02	0.210
SC-4	900314	1330	28	17	9.9	6.9	61	3		68	<1		1	<.03	1.860	0.210	<.02	0.180
SC-4	900403	1110	7	12	11.0	7.1	49	2		24	<1		2	0.060	1.630	0.230	0.130	0.170
SC-4	900516	1215	31	24	9.2	6.7	54	3		145	<1		3	<.03	1.210	0.430	0.050	0.400
SC-4	920226	1200	4	11		7.2	75	46			1.0	65	61	0.260	3.310	0.790	0.100	0.530
SC-4	920324	1225	25	14		6.1	84	7		152	2.0	54	4	0.150	2.970	0.250	<.05	0.100
SC-4	920428	1500	17	15	11.2	7.3	75	2			1.0	48	2	0.280	1.570	0.320	0.550	0.040
SC-4	920506	0845	12	15	8.7	6.4	71	1		128	<1	48	<1	<.1	1.180	0.590	<.05	0.590
SC-4	920617	0748	23	21	8.4	7.0	65	4		80	3.0	65	<1	<.1	1.570	0.180	<.05	0.180
SC-4	920804	1305	22	23	8.8	7.6	80	4		60	1.0	207	<1	0.170	0.980	0.310	<.04	0.140
SC-4	921020	1246	22	14	11.0	6.0	79	1		4	<1	42	<1	0.170	1.380	0.360	0.660	0.190
SC-4	921112	1330		4	9.6	7.0	86	16		98	1.0	55	18	0.150	2.210	0.300	<.04	0.150
SC-4	921208	1115	5	7	11.7	6.1	78	3		252	<1	45	2	0.170		0.250	0.370	0.080
SC-4	930120	1145	4	8	11.6	6.6	69	3		100	2.0	57	2	0.200	2.610		<.05	
SC-4	930223	1050	6	8	11.5	9.1	72	3		68	<1	55	4	0.160	1.980	0.160	<.04	<.01
SC-4	930323	1130	19	12	9.9	6.3	65	90		>620	1.0	49	93	0.240	1.760	0.600	<.04	0.360
SC-4	930413	1100	22	17	10.0	7.0	69	3		0	2.0	51	<1	0.450	1.600	0.510	0.500	
SC-4	930512	1215	19	19	9.1	7.4	78	3		20	<1	25	<1	<.1	1.610	0.180	0.660	0.180
SC-4	930602	1130	27	18	10.2	8.2	85	2		25	0.1	55	<1	0.080	1.040	0.250	<.04	0.170
SC-4	930721	1200	34	29	7.0	6.7	244	3		484	0.2	144	<1	0.240	0.040	0.350	0.040	0.110
SC-4	930831	1145	35	29	6.3	6.6	81	2		2260	1.2	51	2	0.200	<.05	0.270	0.330	0.070
SC-4	930921	1200	30	21	6.0	6.7	60	2		340	1.0	50	<1	0.160	<.04	0.390	1.080	0.230
SC-4	931013	1201	24	15	9.1	6.7	65	1		112	1.2	42	<1	0.050	<.03	0.290	<.04	0.240
SC-4	931109	1230	19	9	10.2	6.5	65	2		18	1.2	33	1	<.05	<.04	0.270	<.04	0.270
SC-4	931208	1205	18	9	10.8	6.0	116	1		16	1.3	84	<1	0.060	<.03	0.210	0.210	0.150

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Station	Date	Time	Air Temp.	Water Temp.	Dissolved Oxygen	pH	Conductivity	Turbidity	Stream Flow	Fecal Coliform	BOD-5	TDS	TSS	NH3-N	NO2/ NO3-N	TKN	T-PO4	TON
SC-4	940105	1201	6	6	12.0	6.2	144	2		36	0.1	76	<1	<.05	4.480	0.310	0.270	0.310
SC-4	940223	1255	21	15	10.4	6.0	79	152			4.0	69	204	0.080	2.090	0.660	0.700	0.580
SC-4	940322	1201	23	15	10.6	6.7	87	1		10	0.7	33	<1	<.05	2.980	0.180	0.040	0.180
SC-4	940419	1201	29	27	9.8	6.6	74	5		164	0.9	46	<1	<.05	1.970	0.160	<.04	0.160
SC-4	940524	1035	26	20	9.4	6.8	86	4		16				<.01	1.120	0.280	0.025	0.280
SC-4	940621	1210	34	27	7.7	7.0	100	3		31	1.3	63	<1	<.05	0.620	0.280	0.040	0.280
SC-4	940719	1130	30	23	8.6	6.8	100	6		78	0.8	60	<1	<.05	1.050	0.210	<.04	0.210
SC-4	940809	1201	29	25	8.3	6.8	121	36			1.7	79	12	<.05	1.260	0.270	0.350	0.270
SC-4	940913	1105	28	24	9.1	7.1	92	1		36	0.2	62	<1	<.05	0.170	0.200	<.05	0.200
SC-4	941018	1216	23	16	10.0	6.9	95	2		44	0.7	54	<1	<.05	1.510	0.200	<.05	0.200
SC-4	941115	1240	24	15	10.4	7.1	77	4		26	0.9	54	<1	<.05	1.080	0.270	<.05	0.270
SC-4	941206	1230	18	14	9.0	6.7	78	9		5	0.8	65	0.17	<.05	2.150	0.290	0.110	0.290
SC-4	950111	1230	13	8	11.8	6.5	78	2		236	0.6	67	3	<.05	2.960	0.260	<.04	0.260
SC-4	950215	1045	10	7	12.5	7.0	82	2		62	0.7	51	<1	<.05	2.630	0.300	<.03	0.300
SC-4	950308	1105	2	13	10.9	6.9	65	75		>1200	3.4	43	187	0.140	1.340	<.5	0.240	
SC-4	950411	1150	19	19	8.8	7.0	77	2		12	2.4	55	2	<.05	1.530	0.100	0.560	0.100
SC-4	950510	1135	26	22	8.3	7.0	76	2		40	1.3	55	1	<.05	1.010	0.200	<.03	0.200
SC-4	950613	1115	20	21	8.7	6.8	68	28		680	1.2	50	<1	0.190	0.430	0.230	0.250	0.040
SC-4	950719	1135	33	29	6.0	6.9	79	1		60	0.4	47	3	0.190	0.030	0.300	0.710	0.110
SC-4	950816	1135	37	29	7.5	6.6	83	2		42	1.0	54	2	0.219	0.646	0.377	0.291	0.158
SC-4	950906	1135	31	22	6.7	6.4	82	2		6	1.7	53	1	0.271	0.041	0.374	0.731	0.101
SC-4	951017	1235	21	18	9.9	6.9	100	1		48	<.1	80	<1	0.074	2.050	0.169	0.051	0.095
SC-4	951114	1230	3	10	10.2	6.5	83	4		132	0.3	55	2	0.138	2.574	0.236	0.058	0.108
SC-4	951212	1220	8	6	12.3	6.9	78	2		98	<.1	62	<1	<.005	2.348	0.235	0.063	0.235
SC-4	960117	1235	11	9	10.8	6.4	77	3		160	1.2	43	<1	0.147	2.427	0.263	0.036	0.116
SC-4	960214	1105	12	7	11.9	6.3	73	2		60	1.2	63	2	0.044	1.644	0.404	0.400	0.360
SC-4	960313	1235	22	9	11.6	6.8	72	4		44	1.4	40	2	<.05	2.183	0.354	0.217	0.354
SC-4	960424	1130	17	16	10.2	6.4	67	5		200	1.3	45	3	<.05	1.427	0.176	0.341	0.176
SC-4	960521	1300	34	24	8.5	7.5	75	1		20	1.5	54	<1	0.133	0.971	0.415	0.834	0.282
SC-4	960611	1100	20	20	8.8	7.2	93	5		148	<.1	68	2	0.370	1.316	0.300	0.547	
SC-4	960716	1120	28	22	7.3	7.5	86	2		96	1.5	56	<1	0.158	0.038	0.340	<.04	0.182
SC-4	960813	1200	29	25	8.5	7.2	197	3		52	<.1	74	<1	<.05	1.082	0.362	0.059	0.362
SC-4	960903	1205	28	19	8.3	7.2	114	2		68	1.0	62	<1	0.085	0.663	0.399	<.04	0.314
SC-4	961022	1145	28	11	10.0	6.8	61	1		94	1.2	71	1	<.10	1.750		<.05	
SC-4	961119	1125	20	14	10.5	6.9	77	3		340	0.9	69	<1	0.060	1.540	0.432	0.140	0.428
SC-4	961217	1120	3	10	10.7	6.6	54	30		4120	2.5	55	37	0.055	2.300	1.133	0.217	1.078
SC-4	970122	1110	10	8	11.1	6.2	52	3		94	0.7	41	2	0.031	2.507	0.072	0.060	0.041
SC-4	970219	1200	16	10	11.0	6.4	53	3		17	0.6	53	2	<.05	2.407	0.161	0.022	0.161
SC-4	970318	1115	27	13	10.2	6.5	46	5		77	1.2	52	4	<.05	1.880	0.319	<.05	0.319
SC-4	970409	1200	15	14	9.5	6.8	48	3		45	0.6	46	<1	0.106	1.341	0.467	0.079	0.361
SC-4	970513	1210	19	16	9.2	6.7	44	3		38	1.3	51	1	0.179	1.390	0.153	0.040	<.05
SC-4	970624	1110	30	22	8.8	7.1	53	3		110	2.2	60	1	0.061	1.455	0.430	0.019	0.369
SC-4	970722	1115	23	25	6.8	7.0	67	3		630	1.6	64	1	0.006	1.269	1.023	0.099	0.917
SC-4	970827	1140	34	23	7.5	7.4	54	1		32	3.1	50	<1	<.004	0.070	0.455	0.045	0.455
SC-4	970923	1130	23	21	5.9	6.1	69	2			1.0	40	1	<.05	0.053	0.524	0.048	0.524
SC-4	971014	1100	15	18	7.8	5.8	84	1		1340	0.5	57	<1	0.095	0.625	0.670	0.110	0.575
SC-4	971119	1230	14	8	11.8	6.6	51	1		10	1.9	53	<1	<.05	1.692	0.301	<.050	0.301
SC-4	971202	1205	14	10	10.5	6.0	50	1		20	1.1	56	<1	<.05	1.560	<.1	<.005	<.1
SC-4	980127	1100	12	8	11.0	5.8	54	5		200	4.3	54	<1	<.05	2.720	0.191	<.05	0.191
SC-4	980217	1140	13	10	10.7	6.5	46	136		10800	4.3	59	209	0.051	1.554	2.078	0.498	2.027
SC-4	980311	1005	1	7	11.8	6.8	54	12		118	1.8	64	13	<.05	1.678	0.488	0.095	0.488

ADEM 1992 Clean Water Strategy Sampling Event

Station	Date	Time	Water Temp (°C)	pH (S.U.)	D.O. (mg/L)	Conductivity (uhmos)	CBOD5 (mg/L)	NH3-N (mg/L)	TKN (mg/L)	NO2+NO3-N (mg/L)	T-PO4 (mg/L)	Bacteria (org/100 ml)
SC-1	06/25/1992	1210	21.5	6	6.2	349	2	<0.05	0.24	0.48	<0.01	64
SC-1	07/30/1992	1130	32	5.3	5.3	767	2.8	<0.05	0.34	0.69	<0.05	
SC-1	09/24/1992	1240	19.6	6.4	6.3	87	6	0.31	1.46	0.77	0.28	>240
SC-1	10/22/1992	1325	16.1	6.6		112	2	<0.08	0.59	0.5	<0.02	12
SC-2	06/25/1992	1107	21	6.6	7.8	251	2	<0.05	0.38	1.26	<0.01	105
SC-2	07/30/1992	1200	28	5.4	5.5	897	2	<0.05	0.48	0.5	<0.05	
SC-2	08/20/1992	1115	20.9	6.4	5	135	5	<0.05	0.92	0.28	<0.05	680
SC-2	09/24/1992	1135	19.8	6.5	5.7	160	4	0.06	0.78	0.14	0.18	>600
SC-2	10/22/1992	1245	16.3	7		206	2	<0.05	0.63	<0.02	0.34	50

Appendix 9.3
Water Quality Model
Input and Output Files

SUMMER TMDL MODEL

WINTER TMDL MODEL

9.4
Spreadsheet Water Quality Model (SWQM) User Guide