

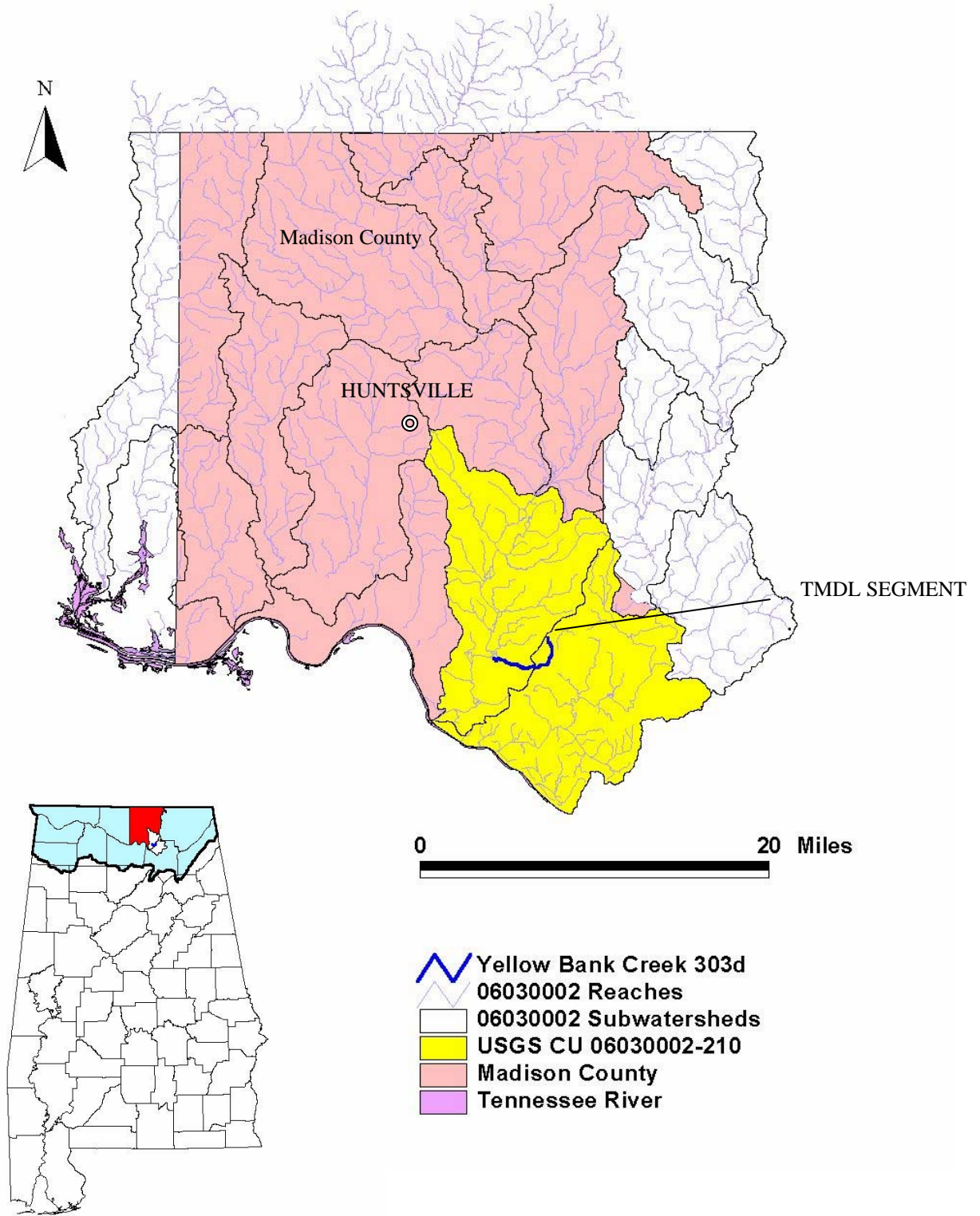


Final

Alabama Department of Environmental Management
TMDL Development for
Yellow Bank Creek, AL/06030002-210_02
Low Dissolved Oxygen/Organic Loading

Water Quality Branch
Water Division
October 2004

Yellow Bank Creek 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 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.

Yellow Bank Creek, a part of the Tennessee River basin, is located in Madison County near Huntsville, Alabama. It has been on the State of Alabama's §303(d) use impairment list since 1998 for organic enrichment/low dissolved oxygen (O.E./D.O.). Its use classification is Fish & Wildlife (F&W).

Biological data collected by TVA in 1994 and 1995 indicated impaired macroinvertebrate and fish communities. The impairment was attributed to siltation and organic enrichment/low dissolved oxygen but water column sampling was not available at the time to support this assumption. Since D.O. impairments generally occur during the summer months when stream flows are low and water temperatures are high, a steady state modeling approach, using the stream's 7Q₁₀ flow (the minimum 7-day flow that occurs on average, over a 10 year recurrence interval) was adopted as appropriate for the TMDL analysis.

The following report addresses the results of the TMDL analysis for O.E./D.O. 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. 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.

A summary of the TMDL for the watershed is provided in Table 1-1. The pollutants shown in the table include ultimate carbonaceous biochemical oxygen demand (CBOD_u) and nitrogenous biochemical oxygen demand (NBOD), 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 table lists allowable pollutant

loadings by source (point and non-point sources) for the critical period (May through November).

Table 1-1. Maximum Allowable Pollutant Loads by Source – Critical Period (May-November)

Pollutant	Point Source Loads (lbs./day)	Non-point Source Loads (lbs./day)
CBOD _u	0.0	1.7
NBOD	0.0	1.5
Total	0.0	3.2

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 Yellow Bank Creek as being impaired by organic loading (i.e., CBOD_u and NBOD) for a length of 5.6 miles, as reported on the 1998, 2000, 2002 and Draft 2004 §303(d) list(s) of impaired waters. Yellow Bank Creek is prioritized as “medium” on the list(s). Yellow Bank Creek is located in Madison County and lies within the Wheeler Lake watershed of the Tennessee River basin.

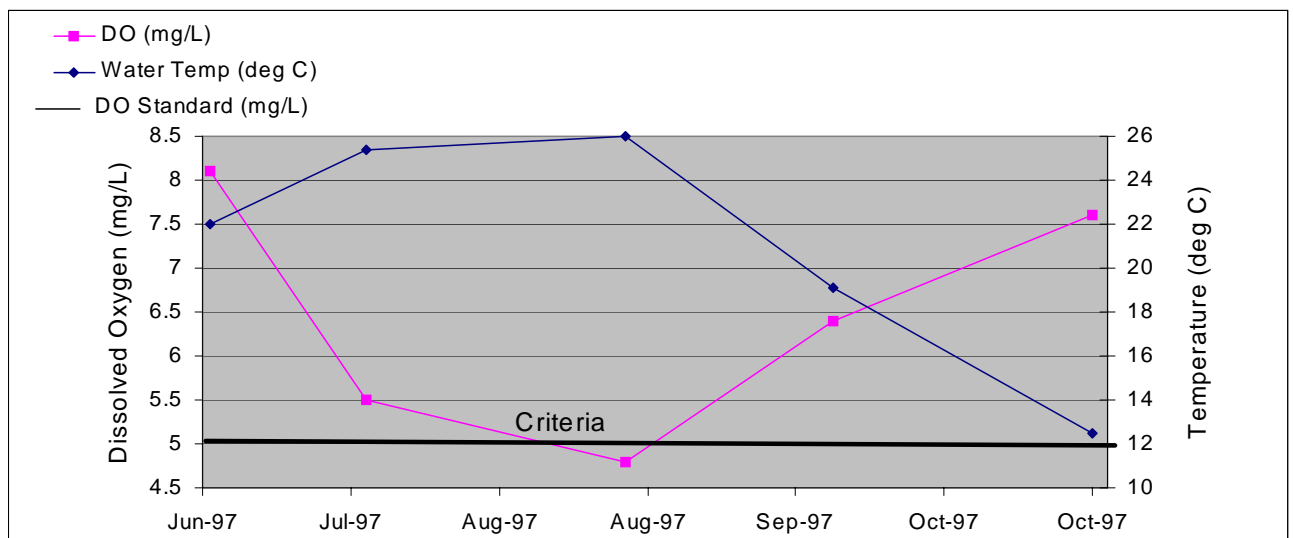
The TMDL developed for Yellow Bank Creek illustrates the steps that can be taken to address a waterbody impaired by low dissolved oxygen levels. The TMDL is consistent with a phased-approach: estimates are made of needed pollutant reductions, load reduction controls are implemented, and water quality 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

Yellow Bank Creek is a small, headwater stream with a relatively small drainage area of 9.27 square miles. Dry weather flows for the watershed are relatively low, or zero. Water quality data collected for the watershed during June 1997 through October 1997, indicates that dissolved oxygen impairments occurred primarily during stormwater events. The percentage of the dissolved oxygen data not meeting the minimum water quality standard is 20% during June 1997 through August 1999. 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 due to nonpoint source impacts during stormwater runoff events and are not the result of algal dynamics.

Figure 2.1, below, illustrates the dissolved oxygen versus temperature data available for Yellow Bank Creek at station #Yellow Bank Creek 1.2. This station is located on Hobbs Island Road Bridge.

Figure 2.1 Dissolved Oxygen vs. Temperature Data



Waterbody Impaired:

Yellow Bank Creek -from Flint River to its source.

Water Quality Standard Violation:

Dissolved Oxygen

Pollutant of Concern:

Organic Enrichment (CBOD_u/NBOD)

Water Use Classification:

Fish and Wildlife

The impaired stream segment, Yellow Bank 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.

3.0 Technical Basis for TMDL Development

3.1 Water Quality Target Identification

The minimum allowable 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.

3.2 Source Assessment

3.2.1. General Sources of CBOD_u and NBOD

Both point and non-point sources may contribute CBOD_u and NBOD (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 of 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 Yellow Bank 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, on the next page, 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. There were no point sources identified in the watershed as indicated in these tables.

3.2.3. Non-Point Sources in the Yellow Bank Creek Watershed

Shown in Table 3-3, below, is a detailed summary of land usage in the Yellow Bank Creek watershed. A land use map of the watershed is presented in Figure 3-1. Also shown below Figure 3-1 is a pie chart depicting principal land uses. The predominant land uses within the watershed are forest, pasture/hay, row crops and urban. Their respective percentages of the total watershed are 48%, 15%, 31%, and 6%. These percentages were calculated by combining the smaller insignificant land uses (i.e. emergent herbaceous wetlands, woody wetlands).

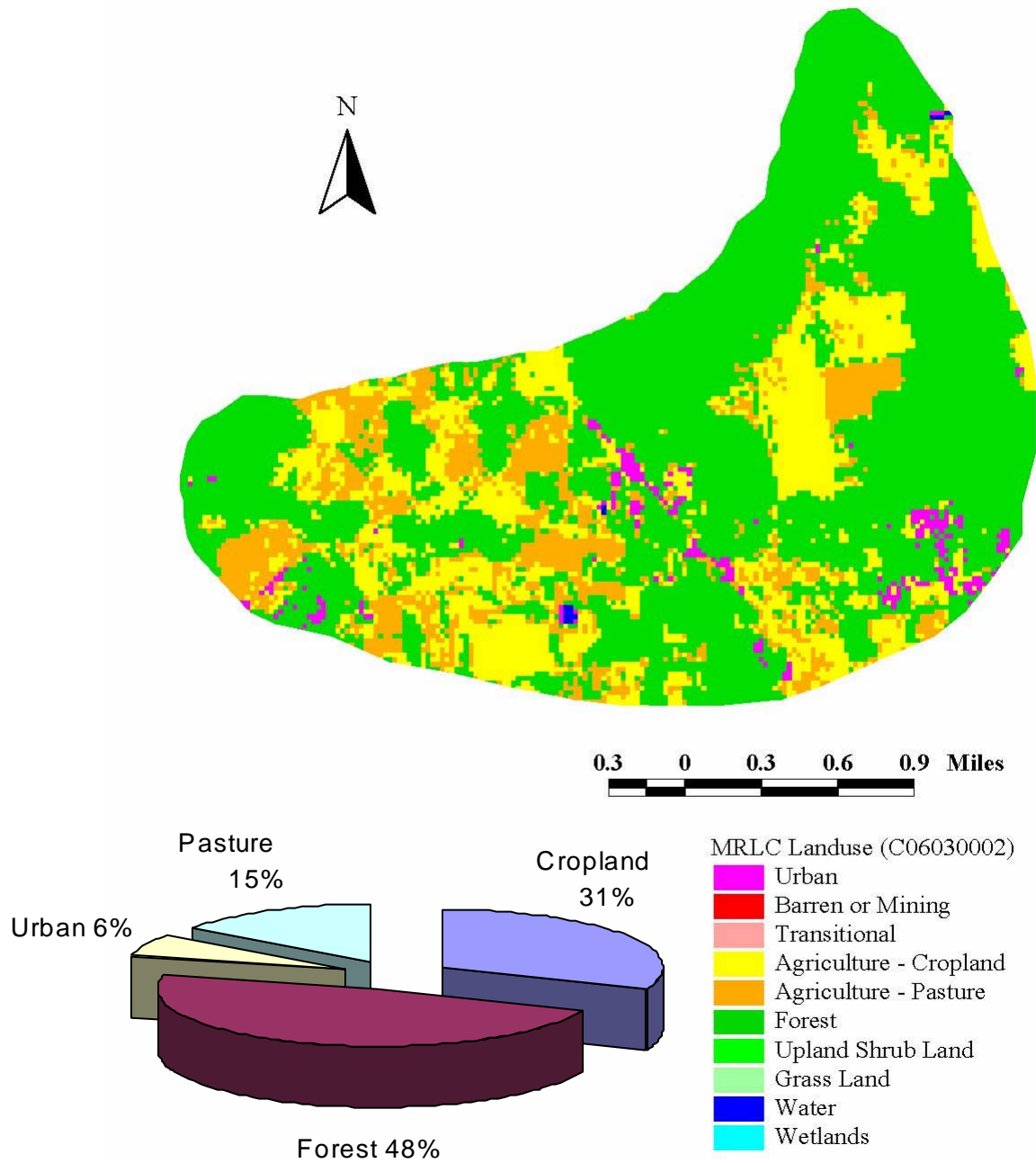
Table 3-3. Land Use in the Yellow Bank Creek Watershed.

LAND USE	PERCENTAGE
Open Water	1.40%
High Residential	1.19%
Low Residential	2.97%
High Commercial/Industrial/Transport	1.58%
Forest	47.71%
Transitional	0.33%
Pasture/Hay	14.83%
Row Crops	29.99%

For the purpose of this TMDL, the predominant land uses of Yellow Bank Creek are forest, pasture/hay, row crops and urban are assumed to make up 100% 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 Yellow Bank Creek watershed are forest, pasture/hay, row crops and urban 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 3-1. Land Use Map for the Yellow Bank 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.

Using the D.O. water quality criterion of 5.0 mg/l as the numerical target, 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). If 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 CBOD_u, 0.11 mg/l ammonia as nitrogen (NH₃N), and 0.22 mg/l total organic nitrogen (TON). 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. The model predictions for in-stream pollutant concentrations were then compared to actual field data. The model velocities and reaeration coefficients were adjusted in those cases where the field data indicated significant discrepancies from the model predictions.

3.4 Data Availability and Analysis

3.4.1. Watershed Characteristics

- A. **General Description:** Yellow Bank Creek, located in Madison County, is a tributary to the Flint River. The Yellow Bank Creek is a part of the Tennessee River basin. Yellow Bank Creek is a part of the USGS (United States Geological Survey) 06030002 cataloging unit and the NRCS (Natural Resources Conservation Service) 210 sub-watershed. Cataloging unit 06030002 represents the Tennessee River basin. NRCS sub-watershed number 210 represents the Lower Flint Creek watershed.

Yellow Bank Creek begins approximately 2 miles southeast of Huntsville, Alabama in SW1/4 Section 27, T5S, R2E. It has a total linear distance of 5.6 miles and a total drainage area of 9.27 square miles. Yellow Bank Creek has a use classification of Fish & Wildlife (F&W).

B. Geological Description:

The main rock type in the region is limestone. There is a Monteagle Limestone Formation.

Eco-region Description: The Yellow Bank Creek consists mainly of the Eastern Highland Rim (71g). The Eastern Highland Rim has more level terrain and weaker dissection than the Western Highland Rim (71f), with flat to gently rolling landforms. Mississippian-age limestone, chert, shale, and dolomite predominate, and springs, sinks, and caves have formed by solution of the limestone. Cave and spring-associated fish fauna also typify the region. In the southern part of the region, streams flow down from the Pottsville Escarpment of ecoregion 68, cutting north across the Moulton Valley and through narrow valleys of Little Mountain (71j) to the impounded Tennessee River. Natural vegetation for the region is transitional between the oak-hickory type to the west and the mixed mesophytic forests of the Appalachian ecoregions to the east. Much of the original bottomland hardwood forest has been inundated by impoundments. The flatter areas in the east and on both sides of the Tennessee River have deep, well-drained, reddish, productive soils that are intensively farmed.

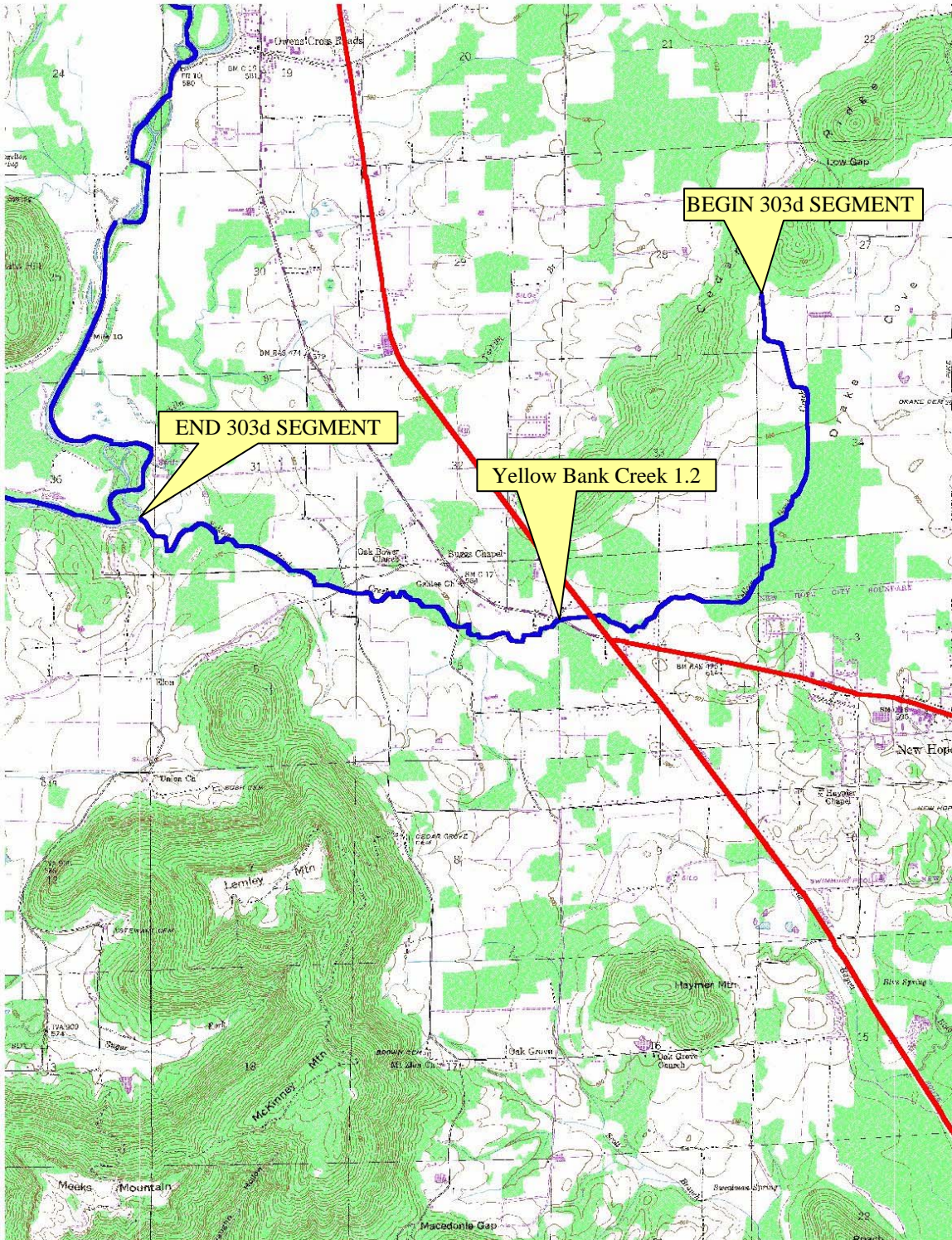
C. Other Notable Characteristics: N/A

3.4.2 Available Water Quality and Biological Data

Biological data for the Yellow Bank Creek is available during 1994 and 1995 and was collected by Tennessee Valley Authority (TVA). Water quality data is available for the period of June 1997 through October 1997. This data was collected by TVA. The data was collected from a single station 1.2 miles from the mouth of the stream. 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 3-2.

Figure 3-2. Map of Sampling Locations for the Yellow Bank Creek Watershed.



3.4.3. Flow data

For the purpose of this TMDL, annual 7Q10 stream flow for the summer season is employed. This flow represents worst-case scenarios for critical model evaluations. The use of worst-case conditions, in turn, creates a margin of safety in the final results.

The 7Q10 flow represents the minimum 7-day flow that occurs, on average, over a 10-year recurrence interval.

The 7Q10 can be calculated for the model using gage data from the United States Geological Survey (USGS) or by using the Bingham Equation. The Bingham Equation can be found on page 3 of a publication from the Geological Survey of Alabama entitled, **Low-Flow Characteristics of Alabama Streams, Bulletin 117**.

The 7Q10 flow was calculated for Yellow Bank Creek by using the Bingham equation. Low flow estimates employing this equation are based on the stream's recession index (G, no units), the stream's drainage area (A, mi²), and the mean annual precipitation (P, inches):

$$7Q_{10} \text{ (cfs)} = 0.15 \times 10^{-5} (G-30)^{1.35} (A)^{1.05} (P-30)^{1.64} \text{ (R.H. Bingham, 1982)}$$

YELLOW BANK CREEK AT HOBBS ISLAND ROAD BRIDGE:

Drainage = 8.12 mi²
Precipitation = 54 in./yr
Recession Index = 50
7Q10 = 0.14 cfs

YELLOW BANK CREEK AT MOUTH:

Drainage = 9.27 mi²
Precipitation = 54 in./yr
Recession Index = 50
7Q10 = 0.16 cfs

The calculated flows were distributed over Yellow Bank Creek in the form of 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 stream's 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..

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, specifying 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 7Q₁₀ stream flow employed for summer, reflects the lowest flows that would normally occur under critical conditions. Finally, 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. Water depths are shallow, generally less than one foot, which aggravates the effect of sediment oxygen demand (SOD). Water velocities are sluggish, generally 0.5 fps or less, which intensifies the effect of BOD decay.

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 $\text{CBOD}_u/\text{NH}_3\text{OD}_u$ and $\text{CBOD}_u/\text{TONOD}_u$ were calculated using water quality data for the waterbody or estimated during the calibration process. These ratios were assigned in the estimation of loading parameters for incremental flow and tributaries for all land uses, except forest and open water.
- $\text{CBOD}_u/\text{BOD}_5$ ratio used for nonpoint 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 .

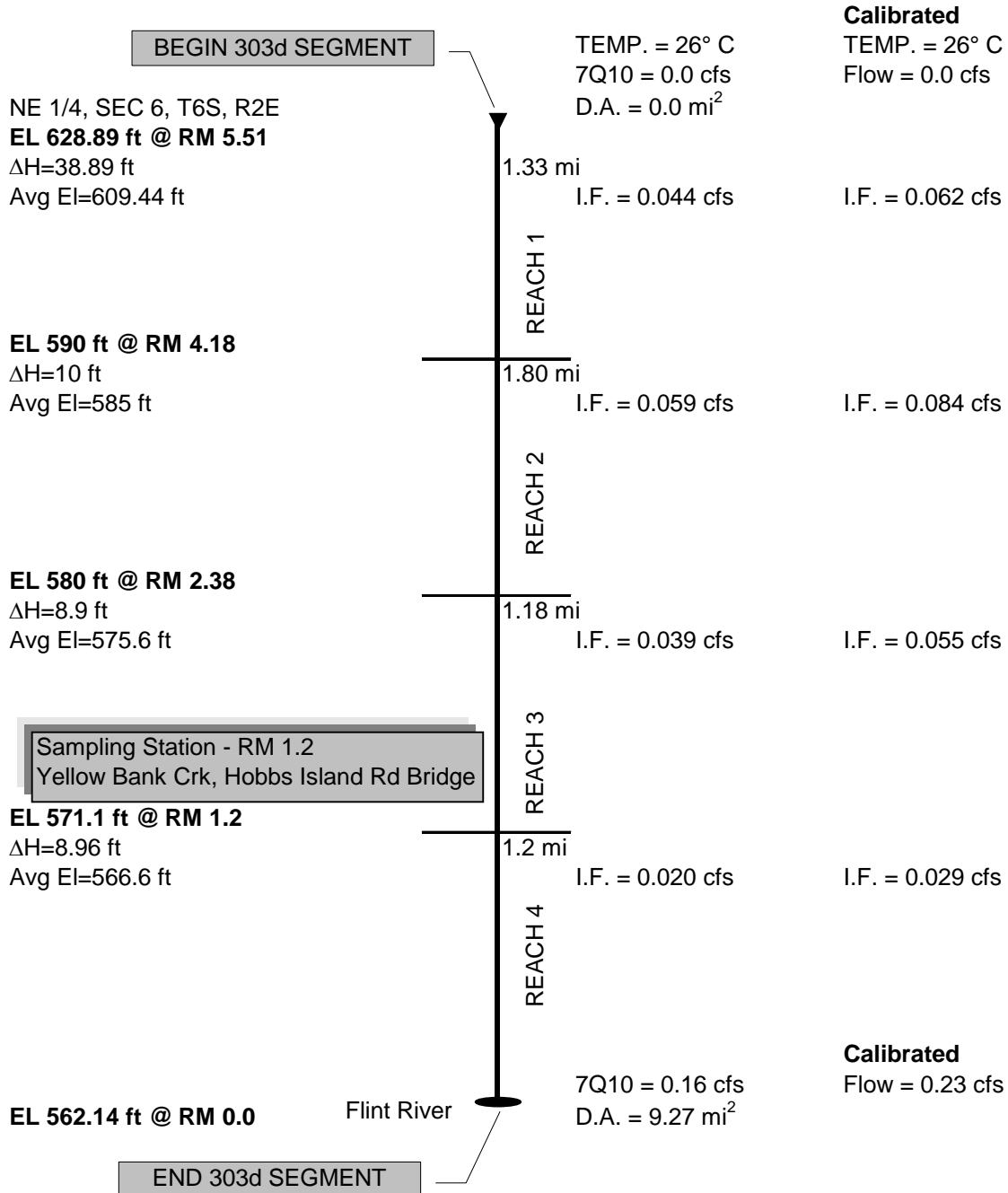
4.1.1. SOD Representation: Sediment oxygen demand (SOD) can be an important part of the oxygen demand budget in shallow streams. However, for shallow streams with steep slopes and rocky substrate, the SOD component is generally small. These hydrogeological conditions are representative of the Yellow Bank Creek. Therefore, it is believed, that the SOD for this stream is minimal. 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 of 0.05 gm-O₂/ft²/day was applied in the model for Yellow Bank Creek. The number was determined from the EPA SOD database for a stream with a sand and gravel bottom, which is similar to the characteristics in Yellow Bank Creek.

4.1.2. Calibration Data: The model calibration period was determined from an examination of the available field data (ref: Appendix) during the period of August 19, 1997. The combination of the lowest, steady flow period with the lowest dissolved oxygen defined the critical modeling period. The stream conditions (i.e., D.O., temperature) during this period were incorporated into the calibrated model TMDL spreadsheet.

4.2 Water Quality Model Summary

The model reach used for critical period was longer than the impaired reach in order to ensure that predicted model pollutant concentrations were at, or near, normal background concentrations at the end of the modeled reach. The critical model reach consisted of three segments. The impaired portion of the critical model reach consists of segment two. The length of the impaired portion is 5.51 miles. Total distance of the critical model reach is 5.51 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.



4.2.1. Critical (May – November) Model

Critical Stream Flow Parameter

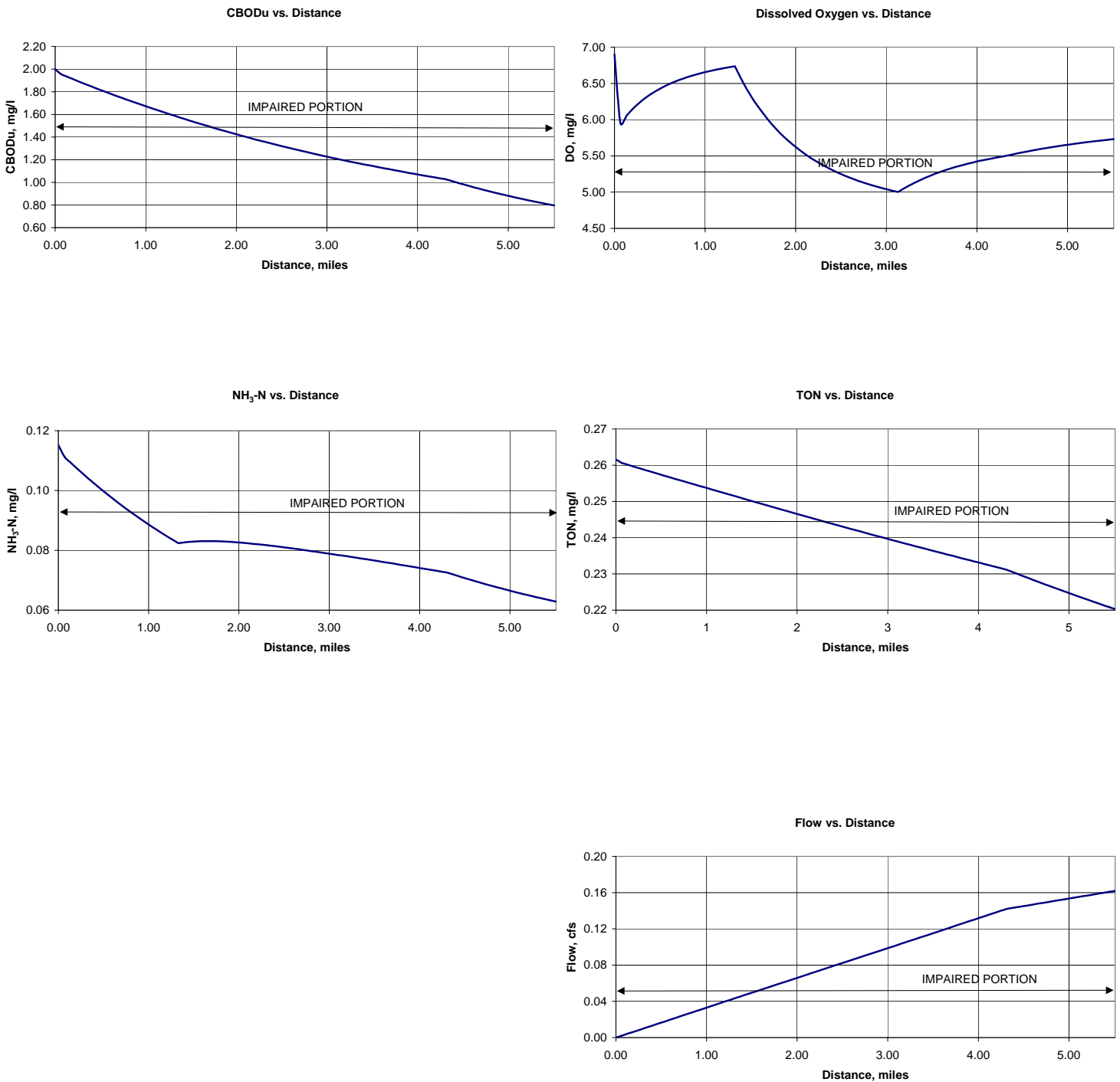
Description	Flow (cfs)	DO (mg/l)	CBOD _U (mg/l)	NH ₃ N (mg/l)	TON (mg/l)	Temp (°C)
Headwaters	0.0	6.9	2.0000	0.1152	0.2616	26.0
Conditions @ Lowest D.O.	0.1030	5.0025	1.2042	0.0783	0.2388	26.0
Flow @ End of Model	0.1620	5.7325	0.7957	0.0629	0.2203	26.0

Critical Incremental Flow Parameters

Sections	CBOD _U (mg/l)	NH ₃ N (mg/l)	TON (mg/l)	DO (mg/l)	Total Flow (cfs)	Temp. (°C)
1	2.0000	0.1152	0.2616	5.6800	0.04	26.0
2	2.0000	0.1152	0.2616	5.6800	0.06	26.0
3	2.0000	0.1152	0.2616	5.6800	0.04	26.0
4	2.0000	0.1152	0.2616	5.6800	0.02	26.0

4.3 Critical Model Predictions and Graphics

Figure 4-2. Critical Model Predictions.



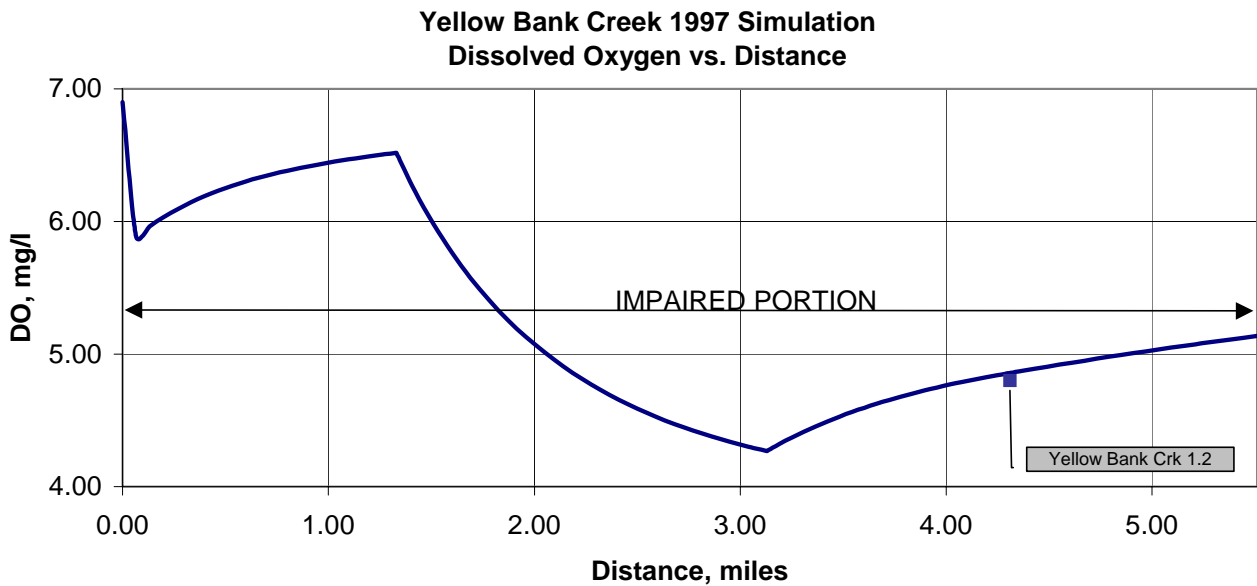
4.4 Loading Reduction Analysis

4.4.1. Calibrated Model

The only D.O. violation from available field data occurred at Yellow Bank Creek 1.2. The lowest observed D.O. value occurred during the August 19, 1997, sampling event. The measured concentration was 4.8 mg/l. Field data from the sampling event were used as input into the critical TMDL model to perform a second simulation referred to as the calibrated model (the first simulation is the critical model). The model predictions simulated the measured D.O. value as closely as possible at Yellow Bank Creek 1.2, while still providing a reasonable representation of water quality in the stream at the time of the sampling event.

Shown in Figure 4-3, below, is a plot of D.O. calibrated model predictions vs. actual D.O. field data.

Figure 4-3. Calibrated Model D.O. Predictions vs. Actual D.O. Field Data.



Calibrated Model Flow Parameters

Description	Flow (cfs)	DO (mg/l)	CBOD_U (mg/l)	NH₃N (mg/l)	TON (mg/l)	Temp (°C)
Headwaters	0	6.9	6.1600	0.0100	0.6256	26.0
Conditions @ Calibrated Point	0.2010	4.8574	3.1661	0.0499	0.5529	26.0
Flow @ End of Model	0.2300	5.1357	2.4583	0.0571	0.5271	26.0

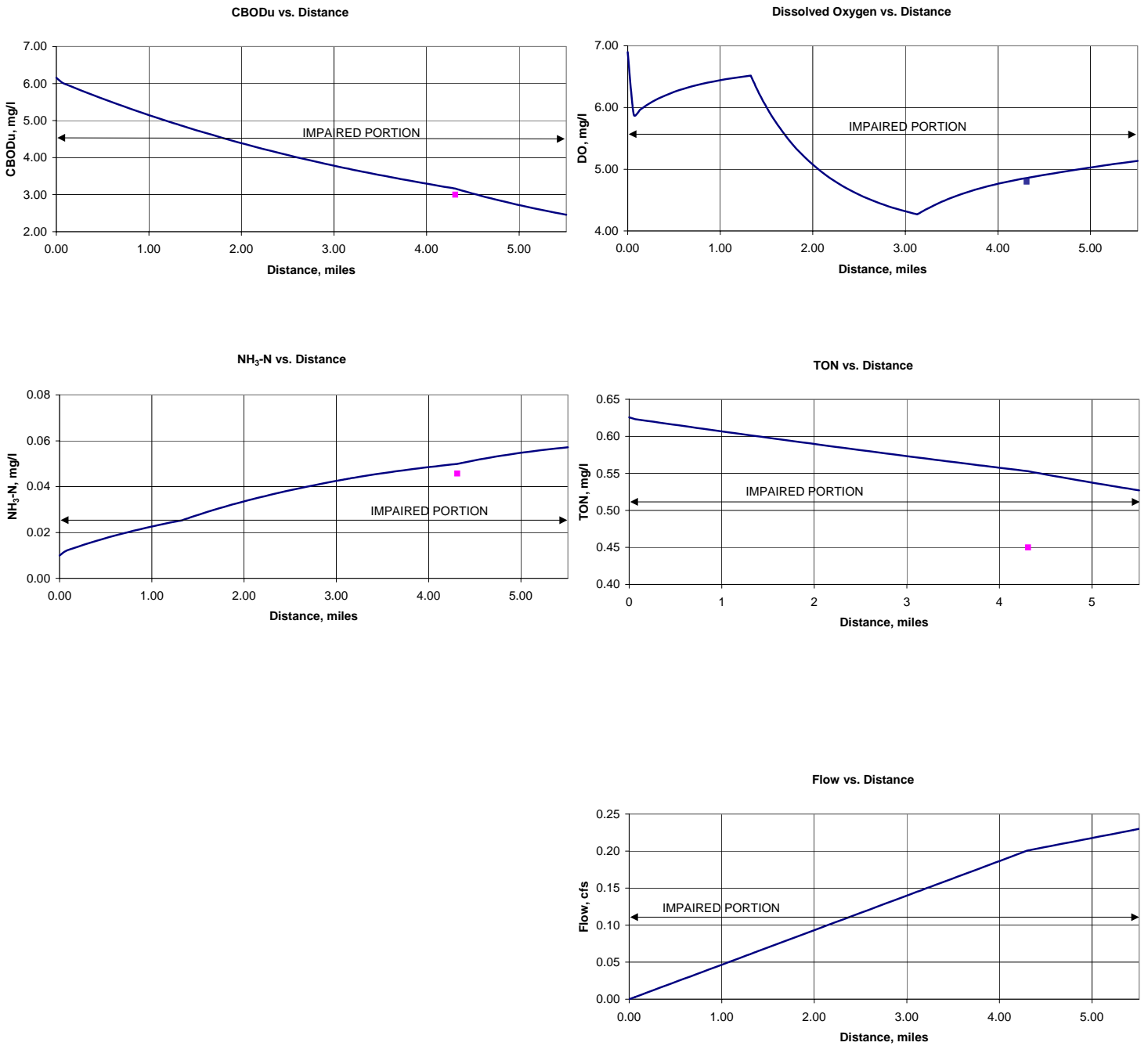
Calibrated Model Incremental Flow Parameters

Sections	CBOD_U (mg/l)	NH₃N (mg/l)	TON (mg/l)	DO (mg/l)	Total Flow (cfs)	Temp. (°C)
1	6.1600	0.0100	0.6256	5.6800	0.06	26.0
2	6.1600	0.0100	0.6256	5.6800	0.08	26.0
3	6.1600	0.0100	0.6256	5.6800	0.06	26.0
4	6.1600	0.0100	0.6256	5.6800	0.03	26.0

Comparison of Calibrated Model Flow Parameters to Actual Data

Description	Flow (cfs)	DO (mg/l)	CBOD_U (mg/l)	NH₃N (mg/l)	TON (mg/l)	Temp (°C)
Actual Conditions @ Low D.O.	0.2	4.8	3	0.0457	-	26.0
Cal. Conditions @ Low D.O.	0.2010	4.8574	3.1661	0.0499	0.5529	26.0

Figure 4-4. Calibrated Model Predictions and Graphics.



4.4.2. Load Reduction Model

The third simulation is referred to as the load reduction model. In this simulation, non-point and point source loadings in the calibrated model were adjusted to bring the waterbody into compliance with the 5 mg/l D.O. Fish & Wildlife water quality standard.

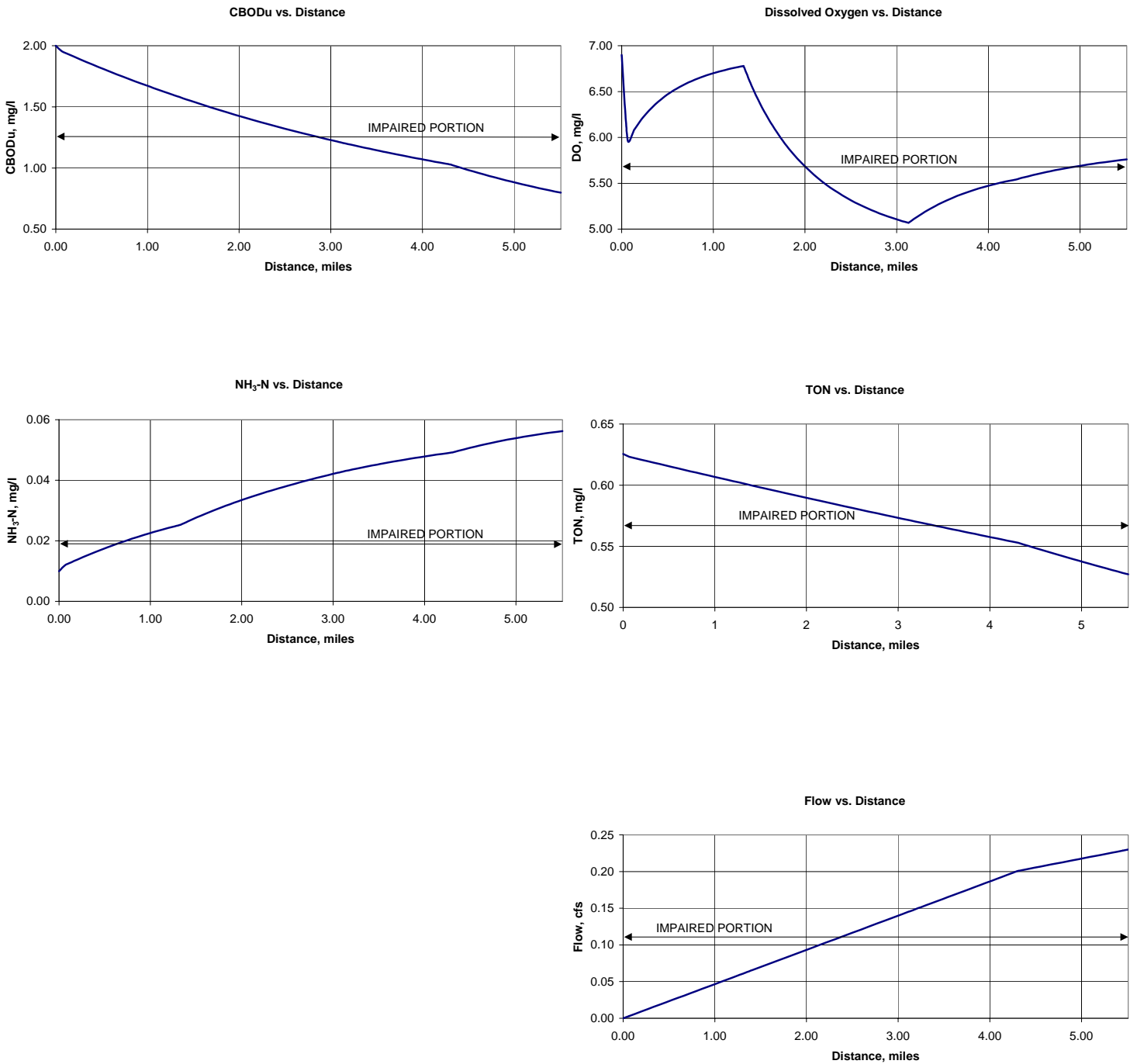
Load Reduction Model Flow Parameters

Description	Flow (cfs)	DO (mg/l)	CBOD _U (mg/l)	NH ₃ N (mg/l)	TON (mg/l)	Temp (°C)
Headwaters	0	6.9	4.6000	0.1634	2.6511	26.0
Conditions @ Calibrated Point	0.2010	5.5435	1.0279	0.0492	0.5529	26.0
Flow @ End of Model	0.2300	5.7605	0.7982	0.0562	0.5271	26.0

Load Reduction Model Incremental Flow Parameters

Sections	CBOD _U (mg/l)	NH ₃ N (mg/l)	TON (mg/l)	DO (mg/l)	Total Flow (cfs)	Temp. (°C)
1	2.0000	0.0100	0.6256	5.6800	0.06	26.0
2	2.0000	0.0100	0.6256	5.6800	0.08	26.0
3	2.0000	0.0100	0.6256	5.6800	0.06	26.0
4	2.0000	0.0100	0.6256	5.6800	0.03	26.0

Figure 4-5. Load Reduction Model Predictions and Graphics.



4.4.3. Required Reductions

Total organic loading (i.e., CBOD_u and NBOD) was calculated at Yellow Bank Creek-1.2 for both the calibrated model and the load reduction model. The total organic loading for the calibrated model was 11.2 lbs./day. For the load reduction model, the total organic loading for non-forest, non-point sources was 6.1 lbs./day. This would require a theoretical total organic loading reduction of 0% for point source loads and 61.6% reduction for non-forest, non-point source loads to bring Yellow Bank Creek into compliance with the Fish & Wildlife D.O. water quality standard of 5.0 mg/l. Since there are no point sources in the watershed, the necessary reductions are being sought from existing non-point sources.

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

Table 4-1. Required Load Reductions for Point and Non-Point Sources.

Existing Point Source Load ¹ (lbs./day)	Existing Non-Point Source Load ¹ (lbs./day)	Total Existing Load ¹ (lbs./day)	Reduced Load ¹ (lbs./day)	Reduced Load ¹ Non- Forest (lbs./day)	% Reduction Point Sources	% Reduction Non-Point Sources	% Reduction Non-Forest Non-Point Sources
0	11.2	11.2	6.1	4.3	0%	45.5%	61.6%

Notes: 1 = CBOD_u + NBOD

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

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.

5.0 Conclusions

A summary of the TMDL for the critical model is presented in Table 5-1.

Table 5-1. Critical Period TMDL Summary

	SIMULATION
	Critical Period
CBOD _u Loading (lbs\day)	1.7
NBOD Loading (lbs\day)	1.5
Total Loading (lbs\day)	3.2

Within the impaired segment, the point source allocations used in development of the critical 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.

The parameters in the calibrated model were all at or below background conditions, except dissolved oxygen. The stream's low to no flow conditions likely contributed to low dissolved oxygen concentrations. For these reasons, no estimated reductions were calculated in the TMDL. Follow up monitoring to be conducted in accordance with the State of Alabama's basin rotation monitoring will be used to revise the TMDL, if so indicated by the data.

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

NPDES Permit	Facility Name	Permit Limitations - Summer					Permit Limitations - Winter					
		CBOD ₅ (MG/L)		NH ₃ -N (MG/L)		DO (MG/L)	CBOD ₅ (MG/L)		NH ₃ -N (MG/L)		DO (MG/L)	
		Max	Avg	Max	Avg	Min	Max	Avg	Max	Avg	Min	
None												

Notes: n/a = not applicable

6.0 TMDL Implementation

6.1 Non-Point Source Approach

Yellow Bank Creek is impaired solely by nonpoint sources. 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

There are no point sources located within the Yellow Bank Creek watershed.

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

Monitoring will help further characterize water quality conditions resulting from the implementation of best management practices in the watershed.

8.0 Public Participation

As part of the public participation process, this TMDL was placed on public notice and made available for review and comment. The public notice was prepared and published in the four major daily newspapers in Montgomery, Huntsville, Birmingham, and Mobile, as well as submitted to persons who have requested to be on ADEM's postal and electronic mailing distributions. In addition, the public notice and subject TMDL was made available on ADEM's Website: www.adem.state.al.us. The public can also request paper or electronic copies of the TMDL by contacting Mr. Chris Johnson at 334-271-7827 or clj@adem.state.al.us. The public was given an opportunity to review the TMDL and submit comments to the Department in writing. At the end of the public review period, all written comments received during the public notice period became part of the administrative record. ADEM considered all comments received by the public prior to finalization of this TMDL and subsequent submission to EPA Region 4 for final review and approval.

9.0 Appendices

9.1 References

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 440/4-91-001.

ADEM admin. Code R. 335 – 6 – 10 -.xx

ADEM, June 1996, "Water Quality Report to Congress", for Calendar Years 1994 and 1995.

9.2.1 Water Quality Data

Station I.D. 1245702 - HOBBS ISLAND ROAD BRIDGE
 State-Alabama Latitude 34°32'56"
 County-Madison Longitude 86°27'09"
 Agency - TVA NE1/4, Sec. 6, T6S, R2E RM 1.2

Station Name	Date	Time	WATER TEMP. °C	AIR TEMP. °C	Flow cfs	Stream Depth (feet)	D.O. mg/l	BOD5 mg/l	NH3N mg/l	pH S.U.	TKN mg/l	NO3&NO2 Total mg/l	Total P mg/l	Conductivity (µmhos/cm)
YELLOW BANK CRK 1.2	06/24/1997	10:25	22	33.2	2.5	1.5	8.1	2K	0.05	7.36	0.92	0.15	0.20	253
YELLOW BANK CRK 1.2	07/15/1997	8:30	25.4	24.1	0.2	1.38	5.5	2K	0.02	7.94	0.22	0.06	0.19	342
YELLOW BANK CRK 1.2	08/19/1997	9:30	26	24.7	0.2	1.3	4.8	2	0.01	7.5	0.46	0.01K	0.09	249
YELLOW BANK CRK 1.2	09/16/1997	9:30	19.1	21.8	0***	1.04	6.4	2K	0.01K	7.68	0.62	0.01K	0.04	180
YELLOW BANK CRK 1.2	10/21/1997	9:00	12.5	10.5	0***	1	7.6	2K	0.01K	7.65	0.18	0.09	0.02	316

K=less than

*** =No Measurable Flow

9.2.2 Water Quality Data

Locations of Fish Collection Sites by TVA's Wheeler/Elk River Action Team, 1994-95

Station No.	Stream Name	R.M.	Latitude	Longitude	Quad Map	Location
Resource Area 07: Flint R						
0701	Yellow Bank Cr	1.2	34° 32.937'	86° 27.141'	82SW	Hobbs Island Rd Br

TVA Macroinvertebrate/EPT and Fish/IBI Biological Data for 1994-95

CU	Waterbody	Bug Health	EPT*	Fish Health	IBI*	Causes	Sources
Partially Supporting							
0701	Yellow Bank Cr	Fair	7	Poor	28	silt, org enrich	Ag NPS

9.3 Water Quality Model Input and Output Files

9.4 Spreadsheet Water Quality Model (SWQM) User Guide