Total Maximum Daily Load

Evaluation

for

Buffalo Creek

in the

Oconee River Basin

(Zinc)

Submitted to:

The U.S. Environmental Protection Agency
Region 4
Atlanta, Georgia

Submitted by:
The Georgia Department of Natural Resources
Environmental Protection Division
Atlanta, Georgia

January 2002

Table of Contents

1.0 INTRODUCTION

1.1 Background

The State of Georgia assesses its water bodies for compliance with water quality standards criteria established for their designated uses as required by the Federal Clean Water Act (CWA). Assessed water bodies are placed into three categories; supporting, partially supporting, or not supporting their designated uses depending on water quality assessment results. These water bodies are found on Georgia's 305(b) list as required by that section of the CWA that defines the assessment process, and are published in *Water Quality in Georgia* every two years.

Some of the 305(b) partially and not supporting water bodies are also assigned to Georgia's 303(d) list, also named after that section of the CWA. Water bodies on the 303(d) list are required to have a Total Maximum Daily Load (TMDL) established for the water quality constituent(s) in violation of the water quality standard. The TMDL process establishes the allowable loading of pollutants or other quantifiable parameters for a water body based on the relationship between pollution sources and in-stream water quality conditions. This allows water quality based controls to be developed to reduce pollution and restore and maintain water quality.

The State of Georgia has identified 10 miles of Buffalo Creek, from Keg Creek to its confluence with the Oconee River, in the Oconee River basin as not supporting its designated uses for the parameter zinc. In addition, this same segment of Buffalo Creek is listed as not supporting its designated uses for pH. The water use classification for Buffalo Creek is Fishing.

1.2 Watershed Description

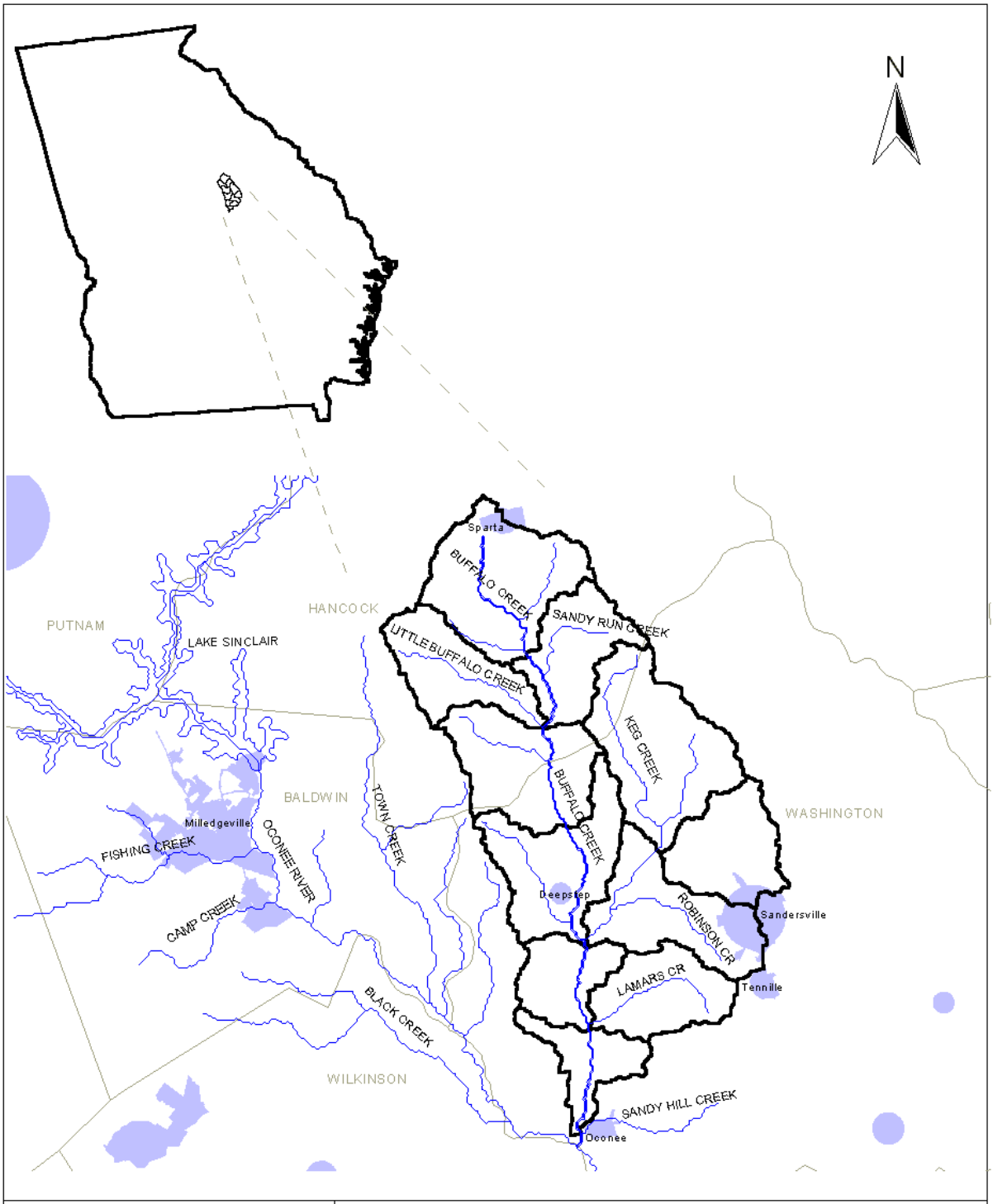
The Buffalo Creek watershed is located in the Oconee River basin in central Georgia in Washington County (see Figure 1). The watershed is part of the Coastal Plain Red Uplands Ecoregion. It is in the Southern Coastal Plain Soil Province. Buffalo Creek originates in Hancock County and flows south into Washington County.

Upstream of the confluence of Buffalo Creek and the Oconee River, the stream flows through areas that are predominantly forest with many abandoned and active kaolin mines. There is also a significant urban area around the City of Sandersville and some agricultural land. The stream flows through wetland areas and becomes very slow and wide with a swampy streambed for most of the listed segment. The size of the watershed is estimated to be 290 square miles.

The 1-day, 10-year minimum (1Q10) statistical flow value at the Highway 272 Bridge near Oconee, Georgia, is approximately 23 cubic feet per second (cfs). In addition, the 7-day, 10-year minimum (7Q10) statistical flow value is approximately 26 cfs.

1.3 Water Quality Standard

The water use classification for Buffalo Creek is fishing. The fishing classification, as stated in Georgia's Rules and Regulations for Water Quality Control Chapter 391-3-6-.03(6)(c), is established to protect the "Propagation of Fish, Shellfish, Game and Other Aquatic Life; secondary contact recreation in and on the water; or for any other use requiring water of a lower quality."



TMDL Evaluation - Zinc **Oconee River Basin**	**Figure 1. Buffalo Creek Watershed**

Chapter 391-3-6-.03(5)(e)(ii) of Georgia's Rules and Regulations establishes criteria for metals which applies to all waters in the State. The established chronic criterion and acute criterion for dissolved zinc are as follows:

$$\text{acute criteria for dissolved zinc} = (e^{(0.8473[\ln(\text{hardness})] + 0.8604)})(0.978)\ \mu g/L$$
$$\text{chronic criteria for dissolved zinc} = (e^{(0.8473[\ln(\text{hardness})] + 0.7614)})(0.986)\ \mu g/L$$

The hardness used in the above equations is expressed as mg/L as $CaCO_3$. The minimum hardness allowed for use in these equations shall not be less than 25 mg/L as $CaCO_3$, and the maximum shall not be greater than 400 mg/L as $CaCO_3$.

This regulation requires that instream concentrations of dissolved zinc shall not exceed the acute criteria indicated above under 1Q10 or higher stream flow conditions and shall not exceed the chronic criteria indicated above under 7Q10 or higher stream flow conditions.

In accordance with Georgia Rules and Regulations for Water Quality Control 391-3-6-.03(5)(e)(ii), guidance found in EPA's "Guidance Document of Dynamic Modeling and Translators August 1993" may be used to determine the relationship between the total recoverable concentration of a metal and the dissolved form of a metal. The metals translator is determined using default linear partition coefficient values found in an EPA document entitled, "Technical Guidance Manual for Performing Waste Load Allocations – Book II: Streams and Rivers."

In addition, Georgia Regulation 391-3-6-.06(4)(d)5.(ii)(b)(2) allows methods from this EPA guidance document to be used to translate dissolved criteria concentrations into total recoverable permit limits. Metals effluent permit limitations are required to be expressed as total recoverable metal per 40 CFR §122.45(c). Therefore, the TMDL will be expressed as both the total maximum daily load of total recoverable zinc that will be protective of the dissolved zinc chronic criterion and the total maximum daily load of total recoverable zinc that will be protective of the dissolved zinc acute criterion.

2.0 WATER QUALITY ASSESSMENT

The listing of Buffalo Creek for zinc resulted from the assessment of water quality data that were collected at State Road 272 near Oconee, Georgia. Two water quality samples were collected, one in 1999 and one in 2000. The data is provided in Table 1.

The translator formulas are presented in Section 4.2 of this TMDL. The calculated translator is a function of the instream TSS. The average TSS from this trend monitoring station in 1999 was 16 mg/L.

Table 1. Zinc Data Collected From Buffalo Creek

Date	Measured Total Recoverable Zinc Concentration (μg/L)	Calculated Translator (Total Recoverable to Dissolved)	Assumed Dissolved Zinc Concentration (μg/L)	Calculated Total Hardness (mg/L as $CaCO_3$)	Acute Criterion (μg/L)	Chronic Criterion (μg/L)
11/16/99	61	3.8	16	49	62	57
9/14/00	400	3.8	104	74	88	81

3.0 SOURCE ASSESSMENT

A source assessment characterizes the known and suspected sources of zinc in the watershed for use in a water quality model and the development of the TMDL. The sources of zinc in this watershed are both point sources and nonpoint sources. Both will be addressed in this TMDL.

There are several point source discharges in this watershed. The point sources that discharge to Buffalo Creek are authorized to discharge through the Georgia National Pollutant Discharge Elimination System (NPDES) program. In accordance with the NPDES program, these facilities have periodically taken samples of their discharges and some have analyzed for the parameter zinc. Others have not tested for zinc because of the type of discharge.

The area has many kaolin mines and several associated industries. The Sandersville WWTP is the only major municipal point source discharger in the watershed. It treats both municipal and industrial wastewater using an activated sludge system with a design capacity of 1.7 million gallons per day (MGD). The City of Sanderville and Thiele Kaolin Company are the only two facilities with permits that currently have zinc limitations. The permit limits are provided in Table 2.

Table 2. Zinc Data Collected From NPDES dischargers to Buffalo Creek

NPDES Discharger	Permit Design Flow MGD	Permitted Total Recoverable Zinc Concentration (μg/L)	Calculated Translator (Total Recoverable To Dissolved)	Assumed Dissolved Zinc Concentration (μg/L)
Sandersville WWTP GA0032051	1.7	62.3	3.8	16
Thiele Kaolin GA0002453	4.0	111.4	3.8	29

In addition to permitted discharges to the watershed, there are also permitted sludge application sites in the watershed. Atmospheric deposition of zinc in the watershed could add a quantifiable load of zinc, but it is not well understood at this time.

It is unknown whether any nonpoint sources potentially cause or contribute to excursions of the water quality standard for zinc. There is no data available which indicates any specific nonpoint source of zinc.

4.0 TMDL DEVELOPMENT APPROACH

An important component of TMDL development is to establish relationships between source loadings and in-stream water quality. In this section, the numerical modeling techniques used to develop the TMDL are discussed.

4.1 Steady-State Approach

Steady-state models are applied for "critical" environmental conditions that represent extremely low assimilative capacity. For effluent-dominated riverine systems critical environmental conditions correspond to low flows. The assumption behind steady-state modeling is that effluent concentrations that protect water quality during critical conditions will be protective for the large majority of environmental conditions that occur. A mass balance equation is used in section 5.3 to model the critical conditions. and calculate zinc allocations. The allowable zinc concentration in Buffalo Creek will be used to calculate the allocations in order to protect the stream.

4.2 Critical Conditions

The critical flow conditions for this TMDL occurs when the ratio of effluent to stream flow is the greatest. For protection of the chronic criteria, this flow condition occurs when the Sandersville WWTP and Thiele Kaolin are discharging at their design capacity and the stream is flowing at 7Q10 conditions. For protection of the acute criteria, this flow condition occurs when the Sandersville WWTP and Thiele Kaolin are discharging at their design capacity and the stream is flowing at 1Q10 conditions. It is assumed that these will be the critical periods for aquatic life. Table 3 provides the critical flow data.

Table 3. Critical Flow Conditions for Buffalo Creek

Source of Flow	Flow value (MGD/ cfs)
Thiele Kaolin WTF	4.0/6.2
Sandersville WWTP	1.7/2.6
Buffalo Creek (during 7Q10 conditions)	17/26
Buffalo Creek (during 1Q10 conditions)	15/23

The hardness of the receiving waters is also a critical condition in calculating the dissolved fraction of zinc in the Creek. A lower hardness results in a higher proportion being in the dissolved form resulting in more conservative criterion. Based on the available data for Buffalo Creek (i.e., 49 mg/L and 74 mg/L as $CaCO_3$), the hardness value used for critical conditions is 49 mg/L. This hardness value corresponds to a dissolved zinc chronic criterion of 57 µg/L and a dissolved zinc acute criterion of 62 µg/L.

Consistent with the suggestions in the EPA guidance document referenced in Georgia's water quality standards for metals, the translator for converting total recoverable zinc concentrations to dissolved zinc concentrations will be expressed as follows:

A translator may be established using the methods documented in EPA's "Technical Guidance Manual for Performing Waste Load Allocations – Book II: Streams and Rivers".

The partition coefficient for zinc found in the EPA's Technical Guidance Manual is expressed as:

$$K_d = K_{po} \times TSS^a$$

where K_d = partition coefficient for zinc in L/kg
K_{po} = 1.25×10^6
TSS = total suspended solids concentration in mg/L
a = -0.7038

It is important to note that the authors of EPA's Technical Guidance Manual derived the above values for the 'K_{po}' coefficient and the 'a' exponent based on the statistical analysis of 2253 data records collected from rivers and streams distributed throughout the United States.

The partitioning of zinc between solid and dissolved phases can be determined as a function of the partition coefficient for zinc and the concentration of solids in the water column. This function is expressed as:

$$C_t/C_d = 1 + K_d \times TSS \times (10^{-6}\ kg/mg)$$

where C_t = total zinc concentration in µg/L
C_d = dissolved zinc concentration in µg/L

Instream TSS data is available for Buffalo Creek. The average total suspended solids (TSS) for 1999, from this trend monitoring station is 16 mg/L. Applying this value to the above relationship, the expected ratio of total zinc to dissolved zinc (i.e. the translation factor) is 3.8.

5.0 ALLOCATION

5.1 Total Maximum Daily Load

A TMDL is the sum of the individual WLAs for point sources and load allocations (LA) for nonpoint sources and natural background (40 CFR 130.2). The sum of these components may not result in an exceedence of water quality standards for that water body. To protect against exceedences, the TMDL must also include a margin of safety (MOS), either implicitly or explicitly, that accounts for the uncertainty in the relationship between pollutant loads and the water quality response of the receiving water body. Conceptually, a TMDL can be expressed as follows:

$$TMDL = \Sigma WLAs + \Sigma LAs + MOS$$

The TMDL is the total amount of pollutant that can be assimilated by the receiving water body while maintaining water quality standards. For pollutants such as metals, TMDLs are expressed on a mass loading basis (e.g., pounds per day). In accordance with 40 CFR Part 130.2(i), "TMDLs can be expressed in terms of ... mass per time, toxicity, or other appropriate measure."

5.2 Waste Load Allocations

As is stated in Section 4.1 of this report, the dissolved zinc chronic criterion is equal to 57 μg/l and the dissolved zinc acute criterion is equal to 62 μg/L for the established critical conditions. Using a translation factor equal to 3.8, the allowable instream total recoverable concentrations are 217 μg/L and 236 μg/L, to protect against chronic and acute effects of zinc, respectively.

The WLAs for this TMDL, are for the loading to Buffalo Creek. Each facility's waste load allocation is calculated using the effluent design flow and the critical low flow. These facilities do not discharge into Buffalo Creek, but discharge to tributaries upstream in this watershed that are effluent dominated. The wasteload allocations require the effluent concentration from each point source not exceed the allowable instream total dissolved and total recoverable chronic and acute concentrations at the end of pipe with no dilution. The waste load allocation is the sum of the allowable loadings from the individual point sources. The allowable point source loadings are calculated by multiplying the allowable effluent concentrations by the effluent design flow (see Table 4).

These total recoverable concentrations are higher than the current zinc limits for the permitted facilities. The current permit limits were based on limits without a translator. Any permits in this watershed will need to meet this wasteload allocation, as well as any more stringent limitations required for the specific receiving waters.

Table 4. Wasteload Allocation

Facility	Permitted Limit	Total Dissolved Zinc		Total Recoverable Zinc	
		Chronic	Acute	Chronic	Acute
Sandersville WWTP	0.40 kg/day	0.37 kg/day	0.40 kg/day	1.40 kg/day	1.45 kg/day
Thiele Kaolin Company	1.68 kg/day	0.86 kg/day	0.94 kg/day	3.29 kg/day	3.42 kg/day

5.3 Load Allocations

There are currently no known zinc contributions to Buffalo Creek from nonpoint sources. The allowable zinc concentration in Buffalo Creek (217 μg/L and 236 μg/L, to protect against chronic and acute effects of zinc, respectively) will be used with the wasteload allocation data to calculate the load allocations (see Table 5).

In the event that nonpoint source contributions of zinc were present, it is extremely unlikely that the WLA would need to be different than what has been established in Section 5.2 of this report, because the WLA requires that the effluent from each facility must itself be protective of the water quality criteria. Considering this information, the load allocation is established so that is protective of the standard.

5.4 TMDL Results

This TMDL can be summarized as follows:

Table 5. TMDL

Parameter	Criteria	WLA	LA	MOS	TMDL
Total Dissolved Zinc	Chronic	1.23 kg/day	3.67 kg/day	Implicit	4.90 kg/day
Total Dissolved Zinc	Acute	1.34 kg/day	2.34 kg/day	Implicit	3.68 kg/day
Total Recoverable Zinc	Chronic	4.69 kg/day	9.31 kg/day	Implicit	14.0 kg/day
Total Recoverable Zinc	Acute	5.09 kg/day	8.30 kg/day	Implicit	13.39 kg/day

5.5 Seasonal Variation

The low flow critical conditions incorporated in this TMDL are assumed to represent the most critical design conditions and to provide year-round protection of water quality.

5.6 Margin of Safety

The MOS is a required component of TMDL development. As specified by section 303(d) of the CWA, the margin of safety must account for any lack of knowledge concerning the relationship between effluent limitations and water quality. There are two basic methods for incorporating the MOS: 1) implicitly incorporate the MOS using conservative model assumptions to develop allocations; or 2) explicitly specify a portion of the TMDL as the MOS and use the remainder for allocations.

The MOS was implicitly incorporated into the TMDL for Buffalo Creek through the use of critical conditions established in section 4.1 of this report. Through the use of low flow conditions, the lowest

of available hardness values, and the methods used to develop the translators, the margin of safety for this TMDL adequately accounts for the lack of knowledge concerning the relationship between effluent limitations and water quality.

6.0 POINT AND NONPOINT SOURCE APPROACHES

An allocation to an individual point source discharger does not automatically result in a permit limit or a monitoring requirement. Through its NPDES permitting process, Georgia will determine whether each of the permitted dischargers to the Buffalo Creek watershed has a reasonable potential of discharging zinc levels equal to or greater than the allocated load. The results of this reasonable potential analysis will determine the specific type of requirements in an individual facility's NPDES permit. As part of its analysis, the EPD will use its EPA-approved 1995 NPDES Reasonable Potential Procedures to determine whether monitoring requirements or effluent limitations are necessary.

If effluent limitations are determined to be necessary for any or all of these facilities, they should be established in accordance with Georgia Rules and Regulations for Water Quality Control, Section 391-3-6-.06(4)(d)5.(ii)(b)(2). This regulation establishes that to protect against chronic effects, an effluent limitation should be imposed as a monthly average limit. To protect against acute effects, an effluent limitation should be imposed as a daily maximum limit. Additionally, if effluent limitations or monitoring requirements are determined through a reasonable potential analysis to be necessary for any or all of these facilities, it is recommended that concentration limits or concentration monitoring requirements should be imposed in addition to any loading limits or monitoring requirements.

7.0 PUBLIC PARTICIPATION

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

8.0 INITIAL TMDL IMPLEMENTATION PLAN

EPD has coordinated with EPA to prepare this Initial TMDL Implementation Plan for this TMDL. EPD has also established a plan and schedule for development of a more comprehensive implementation plan after this TMDL is established. EPD and EPA have executed a Memorandum of Understanding that documents the schedule for developing the more comprehensive plans. This Initial TMDL Implementation Plan includes a list of best management practices and provides for an initial implementation demonstration project to address one of the major sources of pollutants identified in this TMDL while State and/or local agencies work with local stakeholders to develop a revised TMDL implementation plan. It also includes a process whereby EPD and/or Regional Development Centers (RDCs) or other EPD contractors (hereinafter, "EPD Contractors") will develop expanded plans (hereinafter, "Revised TMDL Implementation Plans").

This Initial TMDL Implementation Plan, written by EPD and for which EPD and/or the EPD Contractor are responsible, contains the following elements.

1. EPA has identified a number of management strategies for the control of nonpoint sources of pollutants, representing some best management practices. The "Management Measure Selector Table shown below identifies these management strategies by source category and pollutant. Nonpoint sources are the primary cause of excessive pollutant loading in most cases. Any wasteload allocations in this TMDL will be implemented in the form of water-quality based effluent limitations in NPDES permits issued under CWA Section 402. See 40 C.F.R. § 122.44(d)(1)(vii)(B). NPDES permit discharges are a secondary source of excessive pollutant loading, where they are a factor, in most cases.

2. EPD and the EPD Contractor will select and implement one or more best management practice (BMP) demonstration projects for each River Basin. The purpose of the demonstration projects will be to evaluate by River Basin and pollutant parameter the site-specific effectiveness of one or more of the BMPs chosen. EPD intends that the BMP demonstration project be completed before the Revised TMDL Implementation Plan is issued. The BMP demonstration project will address the major category of contribution of the pollutant(s) of concern for the respective River Basin as identified in the TMDLs of the watersheds in the River Basin. The demonstration project need not be of a large scale, and may consist of one or more measures from the Table or equivalent BMP measures proposed by the EPD Contractor and approved by EPD. Other such measures may include those found in EPA's "Best Management Practices Handbook", the "NRCS National Handbook of Conservation Practices, or any similar reference, or measures that the volunteers, etc., devise that EPD approves. If for any reason the EPD Contractor does not complete the BMP demonstration project, EPD will take responsibility for doing so.

3. As part of the Initial TMDL Implementation Plan the EPD brochure entitled "Watershed Wisdom -- Georgia's TMDL Program" will be distributed by EPD to the EPD Contractor for use with appropriate stakeholders for this TMDL, and a copy of the video of that same title will be provided to the EPD Contractor for its use in making presentations to appropriate stakeholders, on TMDL Implementation plan development.

4. If for any reason an EPD Contractor does not complete one or more elements of a Revised TMDL Implementation Plan, EPD will be responsible for getting that (those) element(s) completed, either directly or through another contractor.

5. The deadline for development of a Revised TMDL Implementation Plan, is the end of August, 2003.

6. The EPD Contractor helping to develop the Revised TMDL Implementation Plan, in coordination with EPD, will work on the following tasks involved in converting the Initial TMDL Implementation Plan to a Revised TMDL Implementation Plan:
   A. Generally characterize the watershed;
   B. Identify stakeholders;
   C. Verify the present problem to the extent feasible and appropriate, (e.g., local monitoring);
   D. Identify probable sources of pollutant(s);
   E. For the purpose of assisting in the implementation of the load allocations of this TMDL, identify potential regulatory or voluntary actions to control pollutant(s) from the relevant nonpoint sources;
   F. Determine measurable milestones of progress;
   G. Develop monitoring plan, taking into account available resources, to measure effectiveness; and
   H. Complete and submit to EPD the Revised TMDL Implementation Plan.

7. The public will be provided an opportunity to participate in the development of the Revised TMDL Implementation Plan and to comment on it before it is finalized.

8. The Revised TMDL Implementation Plan will supersede this Initial TMDL Implementation Plan when the Revised TMDL Implementation Plan is approved by EPD.

Management Measure Selector Table

Land Use	Management Measures	Fecal Coliform	Dissolved Oxygen	pH	Sediment	Temperature	*Toxicity*	*Mercury*	Metals (copper, lead, zinc, cadmium)	PCBs, toxaphene
Agriculture	1. Sediment & Erosion Control	_	_		_	_				
	2. Confined Animal Facilities	_	_							
	3. Nutrient Management	_	_							
	4. Pesticide Management		_							
	5. Livestock Grazing	_	_		_	_				
	6. Irrigation		_		_	_				
Forestry	1. Preharvest Planning				_	_				
	2. Streamside Management Areas	_	_		_	_				
	3. Road Construction &Reconstruction		_		_	_				
	4. Road Management		_		_	_				
	5. Timber Harvesting		_		_	_				
	6. Site Preparation & Forest Regeneration		_		_	_				
	7. Fire Management	_	_	_	_	_				
	8. Revegetation of Disturbed Areas	_	_	_	_	_				
	9. Forest Chemical Management		_			_				

Land Use	Management Measures	Fecal Coliform	Dissolved Oxygen	pH	Sediment	Temperature	*Toxicity*	*Mercury*	Metals (copper, lead, zinc, cadmium)	PCBs, toxaphene
	10. Wetlands Forest Management	_	_	_		_		_		
Urban	1. New Development	_	_		_	_			_	
	2. Watershed Protection & Site Development	_	_		_	_		_	_	
	3. Construction Site Erosion and Sediment Control		_		_	_				
	4. Construction Site Chemical Control		_							
	5. Existing Developments	_	_		_	_			_	
	6. Residential and Commercial Pollution Prevention	_	_							
Onsite Wastewater	1. New Onsite Wastewater Disposal Systems	_	_							
	2. Operating Existing Onsite Wastewater Disposal Systems	_	_							
Roads, Highways and Bridges	1. Siting New Roads, Highways & Bridges	_	_		_	_			_	
	2. Construction Projects for Roads, Highways and Bridges		_		_	_				
	3. Construction Site Chemical Control for Roads, Highways and Bridges		_							

Land Use	Management Measures	Fecal Coliform	Dissolved Oxygen	pH	Sediment	Temperature	*Toxicity*	*Mercury*	Metals (copper, lead, zinc, cadmium)	PCBs, toxaphene
	4. Operation and Maintenance- Roads, Highways and Bridges	–	–			–			–	

REFERENCES

GAEPD, NPDES Reasonable Potential Procedures. Atlanta, GA. January 1995.

GAEPD, *Rules and Regulations For Water Quality Control, Chapter 391-3-6, June 2001*, Georgia Department of Natural Resources, Environmental Protection Division.

USEPA. Technical Guidance Manual for Performing Waste Load Allocations: Book II Streams and Rivers - Chapter 3 Toxic Substances. U.S. Environmental Protection Agency, Office of Water, Regulations and Standards, Monitoring and Data Support Division, Washington, D.C. June 1984.

USEPA. 1991a. *Technical Support Document for Water Quality – based Toxics Control.* U.S. Environmental Protection Agency, Office of Water, Washington, DC. EPA-505/2-90-001, April 1991.

USEPA. 1991b. *Guidance for Water Quality –based Decisions: The TMDL Process.* U.S. Environmental Protection Agency, Office of Water, Washington, DC. EPA-440/4-91-001, April 1991.

USEPA. Appendix J of Water Quality Standards Handbook: Second Edition (i.e., "Guidance Document on Dynamic Modeling and Translators August 1993"). U.S. Environmental Protection Agency, Office of Water, Washington, D.C. EPA/823/B-94-005a. August 1994.

USEPA, 1998. Better Assessment Science Integrating Point and Nonpoint Sources (BASINS), Version 2.0 User's Manual, U.S. Environmental Protection Agency, Office of Water, Washington D.C.