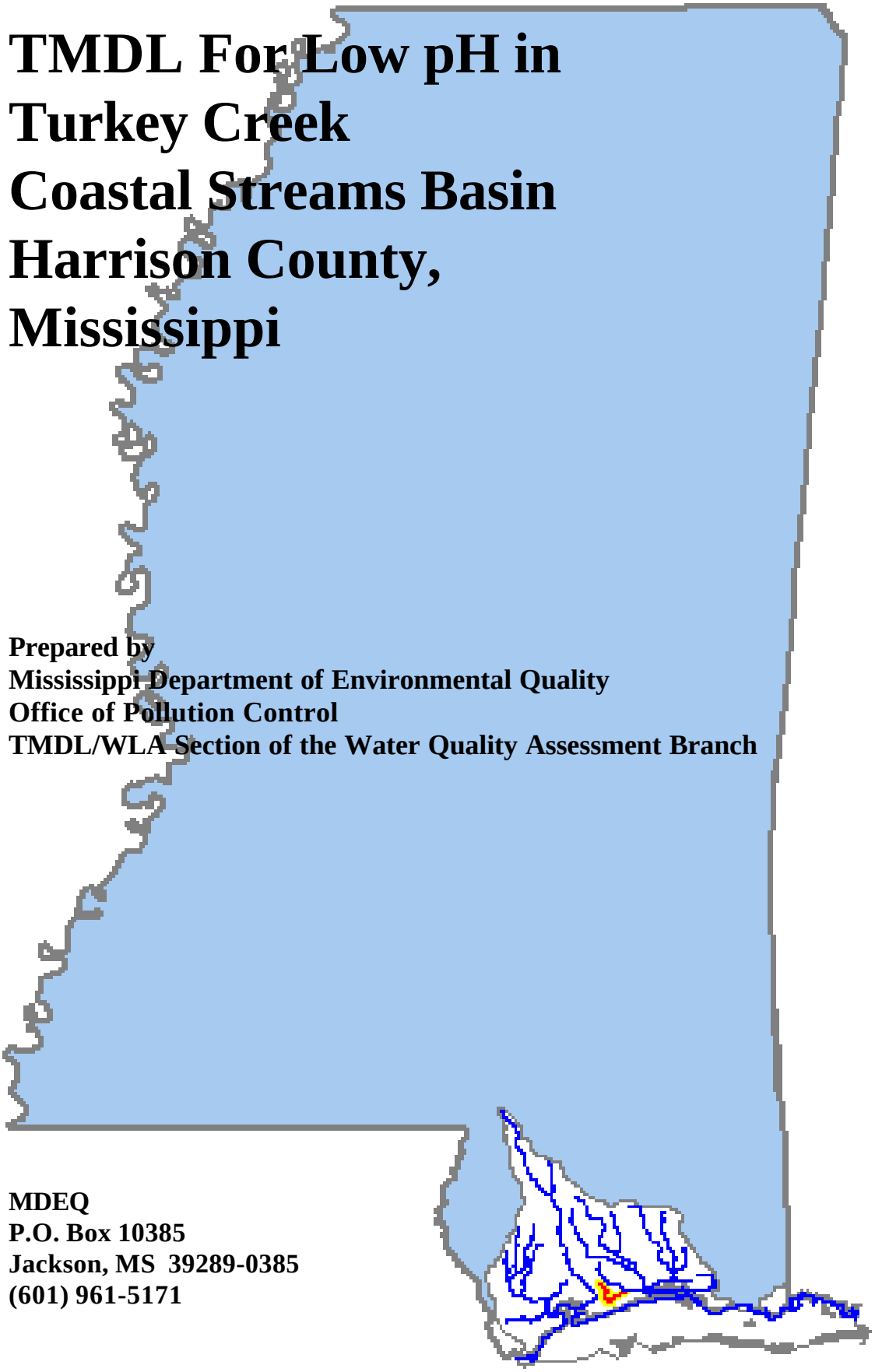
Final TMDL
December 15, 2000

TMDL For Low pH in Turkey Creek Coastal Streams Basin Harrison County, Mississippi



Prepared by
Mississippi Department of Environmental Quality
Office of Pollution Control
TMDL/WLA Section of the Water Quality Assessment Branch

MDEQ
P.O. Box 10385
Jackson, MS 39289-0385
(601) 961-5171

FOREWORD

This report has been prepared in accordance with the schedule contained within the federal consent decree dated December 22, 1998. *(Sierra Club v. Hankinson, No. 97-CV-3683 (N.D> Ga.)*) The report contains one or more Total Maximum Daily Loads (TMDLs) for waterbody segments found on Mississippi's 1996 Section 303(d) List 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 segments addressed are comprised of monitored segments that have data indicating impairment. The implementation of the TMDLs contained herein will be prioritized within Mississippi's rotating basin approach.

The amount and quality of the 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 landuse within the watershed. In some cases, additional water quality data may indicate that no impairment exists.

Prefixes for fractions and multiples of SI units

Fraction	Prefix	Symbol	Multiple	Prefix	Symbol
10^{-1}	deci	d	10	deka	da
10^{-2}	centi	c	10^{2}	hecto	h
10^{-3}	milli	m	10^{3}	kilo	k
10^{-6}	micro	µ	10^{6}	mega	M
10^{-9}	nano	n	10^{9}	giga	G
10^{-12}	pico	p	10^{12}	tera	T
10^{-15}	femto	f	10^{15}	peta	P
10^{-18}	atto	a	10^{18}	exa	E

Conversion Factors

To convert from	To	Multiply by	To Convert from	To	Multiply by
Acres	Sq. miles	0.0015625	Days	Seconds	86400
Cubic feet	Cu. Meter	0.028316847	Feet	Meters	0.3048
Cubic feet	Gallons	7.4805195	Gallons	Cu feet	0.133680555
Cubic feet	Liters	28.316847	Hectares	Acres	2.4710538
cfs	Gal/min	448.83117	Miles	Meters	1609.344
cfs	MGD	.6463168	Mg/l	ppm	1
Cubic meters	Gallons	264.17205	µg/l * cfs	Gm/day	2.45

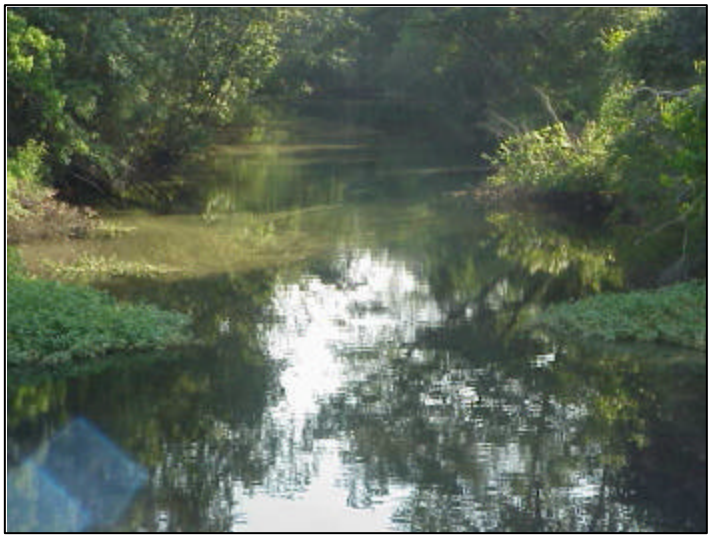
CONTENTS

MONITORED SEGMENT IDENTIFICATION

Name:	Turkey Creek
Waterbody ID:	MS118BBM1
Location:	Near Gulfport: From confluence with Canal #2 to Hwy 49
County:	Harrison County, Mississippi
USGS HUC Code:	03170009
NRCS Watershed:	160
Length:	12.9 miles
Use Impairment:	Aquatic Life Support
Cause Noted:	Low pH
Priority Rank:	71
NPDES Permits:	There are three (one is active) NPDES Permits issued for facilities that discharge in the watershed (Table 3).
Standards Variance:	None
Pollutant Standard:	The normal pH of the waters shall be 6.5 to 9.0 and shall not be caused to vary more than 1.0 unit; however, should the natural background pH be outside the 6.5 to 9.0 limits, it shall not be changed more than 1.0 unit unless after the change the pH will fall within the 6.5 to 9.0 limits, and the Commission on Environmental Quality determines that there will be no detrimental effect on stream usage as a result of the greater pH change.

EXECUTIVE SUMMARY

A segment of Turkey Creek has been placed on the Mississippi 1998 Section 303(d) List of Waterbodies as an impaired waterbody segment due to pH. pH is defined as a measure of acidity and alkalinity of a solution that is a number on a scale on which a value of 7 represents neutrality and lower numbers indicate increasing acidity and higher number increasing alkalinity and on which each unit of change represents a tenfold change in acidity or alkalinity and that is the negative logarithm of the effective hydrogen-ion concentration or hydrogen-ion activity in gram equivalents per liter of the solution. The applicable state standard specifies the normal pH of the waters shall be 6.5 to 9.0 and shall not be caused to vary more than 1.0 unit. However, should the natural background pH be outside the 6.5 to 9.0 limits, it shall not be changed more than 1.0 unit unless after the change the pH will fall within the 6.5 to 9.0 limits. And, the Commission determines that there will be no detrimental effect on stream usage as a result of the greater pH change. A review of the available monitoring data for the watershed indicates that the levels of pH are sometimes below the normal limits.



Turkey Creek

Turkey Creek flows approximately 12.9 miles in a southeastern direction from its headwaters until its confluence with Bernard Bayou. This TMDL, however, has been developed for the section of Turkey Creek found on the 303(d) List. The 5-mile long section of the creek is located in Harrison County near Gulfport from Canal #2 to Highway 49. Daily flow values from the USGS Gage 02480500 on the Tchoutacabouffa River near Biloxi were used to calibrate the hydrologic flow for the watershed. The weather data used for this study were collected at Saucier Experimental Forest Station.

The pH loading from nonpoint sources in the watershed were based upon estimates of the watershed runoff, the soil acidity, and the acidic contribution from pine needles. There is one active NPDES Permitted discharge located in the watershed and included as point sources in the study.

The purpose of this TMDL is to report on the study to determine if the pH levels found in the stream are indeed caused by a controllable source or by natural background. The study of low pH in this watershed appears to indicate that the variance to the standard is cyclic and is due to natural, uncontrollable sources.

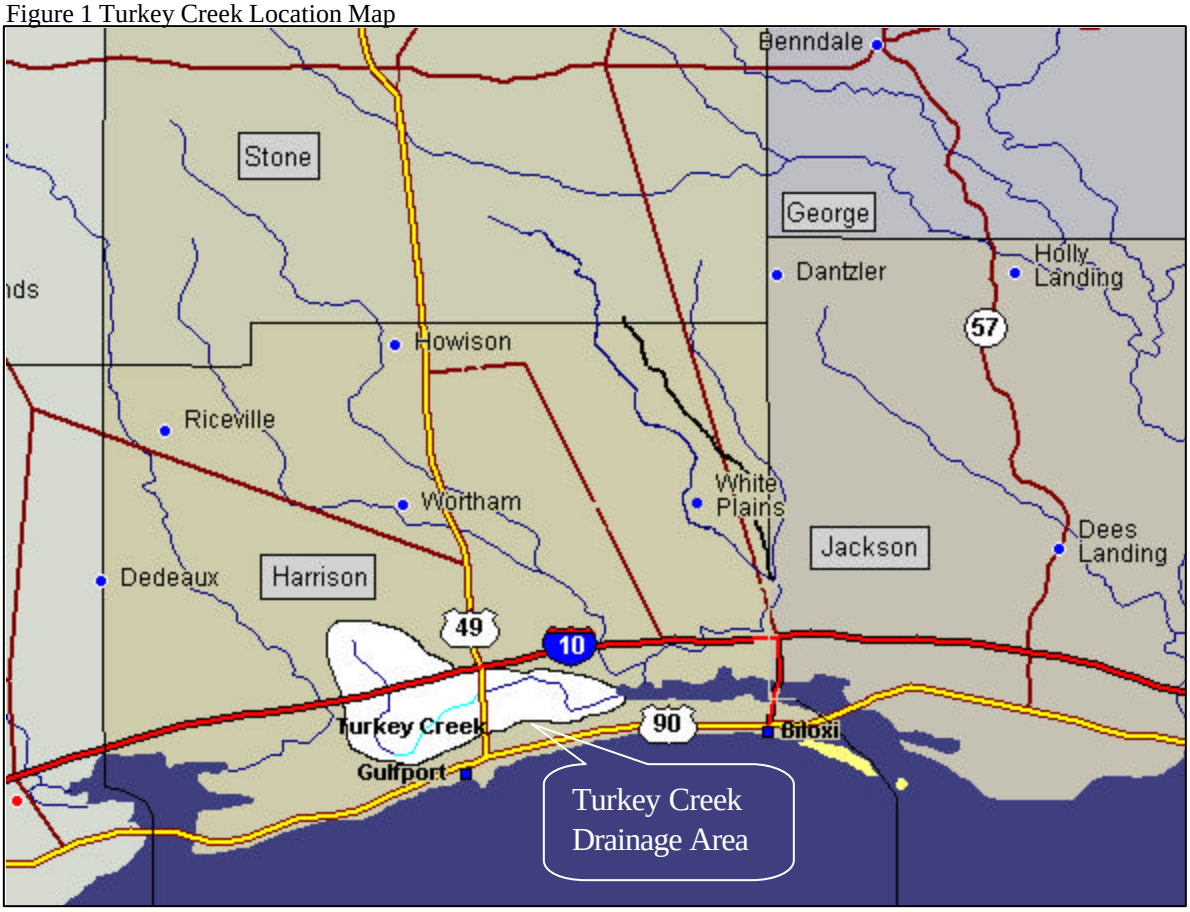
INTRODUCTION

1.1 Background

The identification of waterbodies not meeting their designated use and the development of total maximum daily loads (TMDLs) for those waterbodies are required by Section 303(d) of the Clean Water Act and the Environmental Protection Agency's (EPA) Water Quality Planning and Management Regulations (40 CFR part 130). The TMDL process is designed to restore and maintain the quality of those impaired waterbodies through the establishment of pollutant specific allowable loads. The pollutant of concern for this TMDL is slightly acidic water as indicated by measurements of low pH.

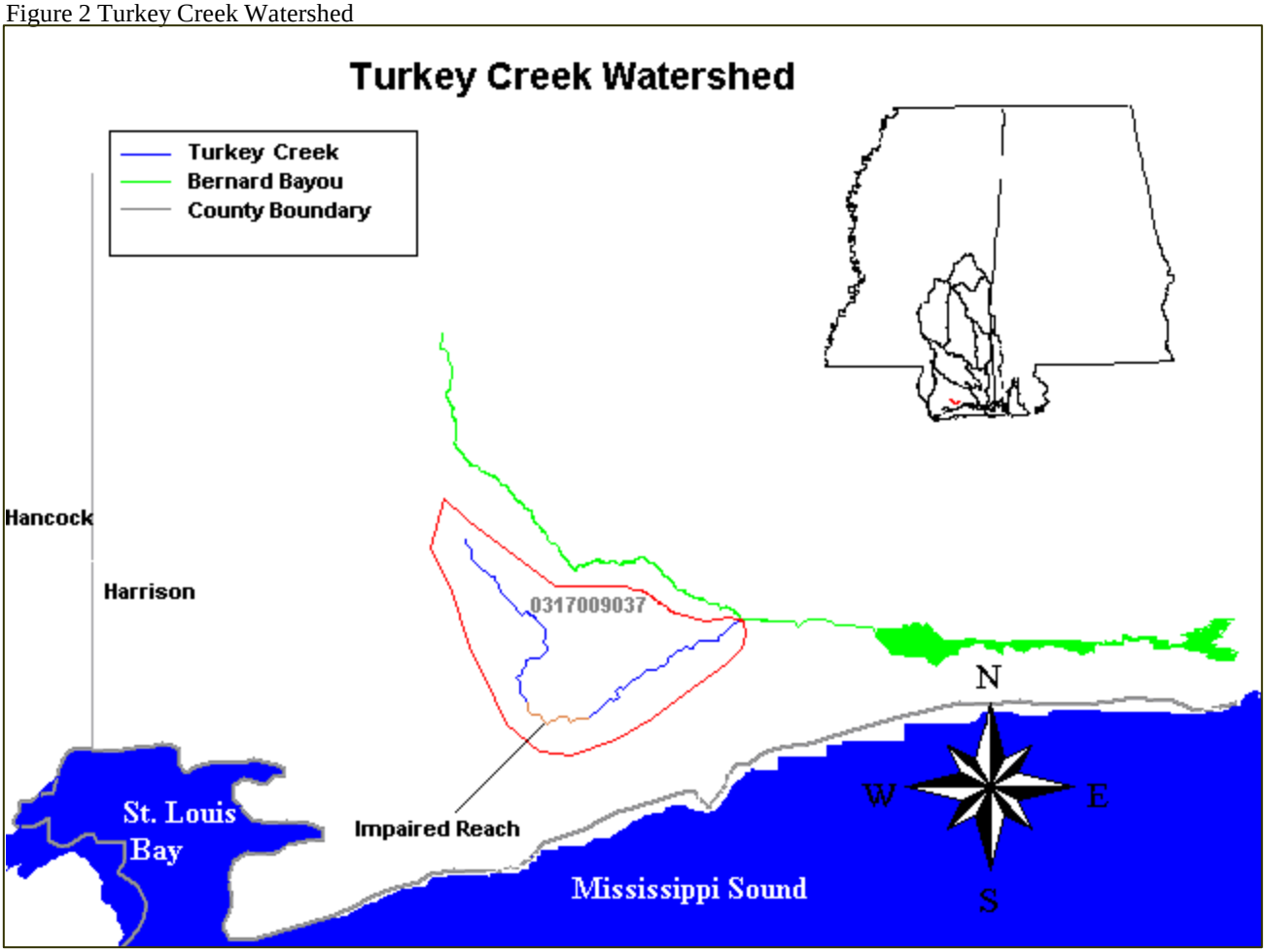
The Mississippi Department of Environmental Quality (MDEQ) has listed a segment of Turkey Creek as being impaired due to low pH for a length of 5 miles as reported in the Mississippi 1998 Section 303(d) List of Waterbodies. This segment is listed because monitoring data are available to show that the pH level is not within the water quality standards' approved range. However, for this indicator, natural background contributions do not necessarily indicate impairment. The purpose of this TMDL is to report on the study to determine if the pH levels found in the stream are indeed caused by a controllable source or by natural background. The section of Turkey Creek is in Harrison County near Gulfport from confluence with Canal # 2 to Hwy 49. Turkey Creek is highlighted in Figure 1.

Figure 1 Turkey Creek Location Map



The sources of runoff and low pH in the Turkey Creek Watershed were analyzed by treating the area as a single watershed. The monitored segment is contained entirely within the watershed, 03170009037. Figure 2 shows a map of the drainage area of Turkey Creek. The map also shows the 11-digit identification number for the delineated watershed.

Figure 2 Turkey Creek Watershed



This segment of Turkey Creek is in the Coastal River Basin Hydrologic Unit Code (HUC) 03170009 in southeast Mississippi. This segment is located within NRCS Watershed 160. The drainage area of the monitored segment from the headwaters to the end of the monitored section is approximately 11,100 acres; and lies within Harrison County. The watershed is very rural in nature however; it does contain portions of the city of Gulfport. Forest is the dominant landuse within this watershed. Figure 3 shows the landuse distribution within the monitored drainage area.

1.2 Applicable Waterbody Segment Use

Designated beneficial uses and water quality standards are established by the *State of Mississippi Water Quality Criteria for Intrastate, Interstate, and Coastal Waters* regulations. The designated use for Turkey Creek as defined by the regulations is Fish and Wildlife.

1.3 Applicable Waterbody Segment Standard

The water quality standard applicable to the use of the waterbody and the pollutant of concern is defined in the *State of Mississippi Water Quality Criteria for Intrastate, Interstate, and Coastal Waters*. The standard states that the normal pH of the waters shall be 6.5 to 9.0 and shall not be caused to vary more than 1.0 unit. However, should the natural background pH be outside the 6.5 to 9.0 limits, it shall not be changed more than 1.0 unit unless after the change the pH will fall within the 6.5 to 9.0 limits. And the Commission determines that there will be no detrimental effect on stream usage as a result of the greater pH change.

Turkey Creek near Bernard Bayou

TMDL ENDPOINT AND WATER QUALITY ASSESSMENT

2.1 Selection of a TMDL Endpoint and Critical Condition

One of the major components of a TMDL is the establishment of instream numeric endpoints, which are used to evaluate the attainment of acceptable water quality. Instream numeric endpoints, therefore, represent the water quality goals that are to be achieved by implementing the load and wasteload reductions specified in the TMDL. The endpoints allow for a comparison between observed instream conditions and conditions that are expected to restore designated uses. The instream target for low pH is that the normal pH of the waters shall be 6.5 to 9.0 and shall not be caused to vary more than 1.0 unit. However, should the natural background pH be outside the 6.5 to 9.0 limits, it shall not be changed more than 1.0 unit unless after the change the pH will fall within the 6.5 to 9.0 limits.

Because pH variance may be attributed to both nonpoint and point sources, the critical condition used for studying the stream response was represented by a multi-year period. Critical conditions for waters impaired by nonpoint sources generally occur during periods of wet-weather and high surface runoff. But, critical conditions for point source dominated systems generally occur during low-flow, low-dilution conditions.

2.2 Discussion of Instream Water Quality

Water quality data available for the monitored segment of Turkey Creek show that low levels of pH have been found in the stream. There is one ambient station operated by MDEQ that has pH monitoring data available. Station 02481240 located on Turkey Creek near Long Beach has measurements of flow and pH between May 1993 and April 1995. Two additional data points are available from 1998 monitoring.

2.2.1 Inventory of Available Water Quality Monitoring Data

The State's 1998 Section 305(b) Water Quality Assessment Report was reviewed to assess water quality conditions and data available for the watershed. According to the report, Turkey Creek is not supporting the use of Aquatic Life Support for pH. These conclusions were based on instantaneous data collected at station 02481240. Data collected at this station are listed below in Table 1.

2.2.2 Analysis of Instream Water Quality Monitoring Data

A statistical summary of the water quality data discussed above is presented in Table 2. The percent exceedance was calculated by dividing the number of exceedances by the total number of samples and does not represent the amount of time that the water quality was in violation. These data are charted in Chart 1 on page 6. The line drawn on the chart at pH = 6.5 represents the lowest pH levels allowed by Mississippi's water quality standards.

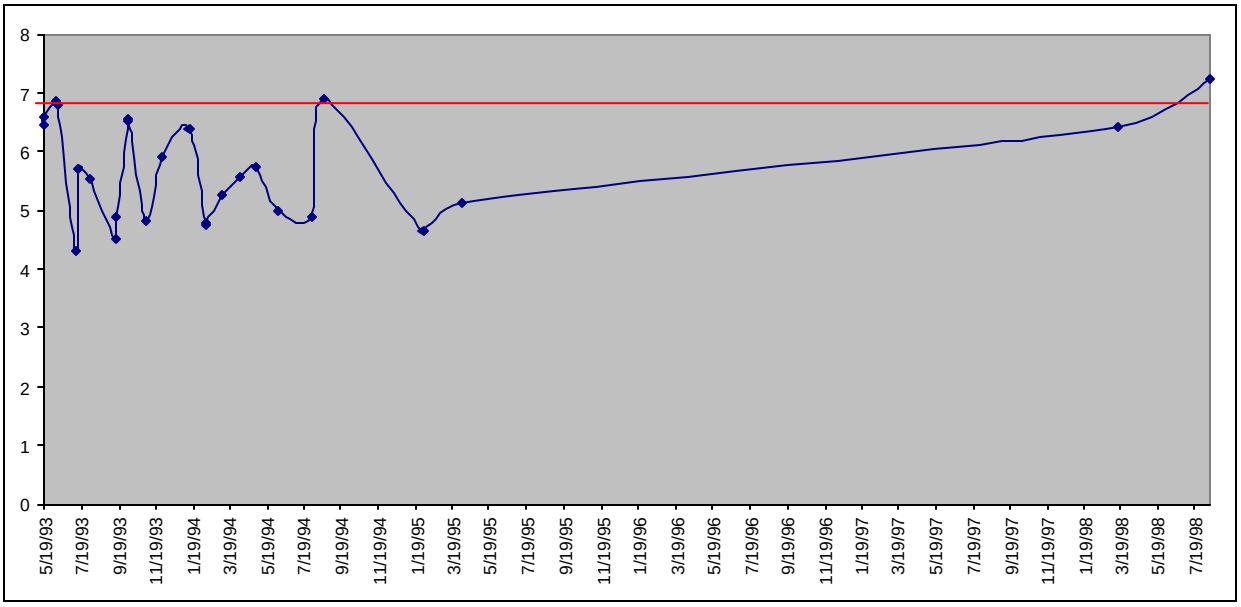
Table 1 pH Data Reported in Turkey Creek, Station #02481240

Date	pH
05/19/93	6.44
05/20/93	6.60
06/08/93	6.88
06/09/93	6.80
07/12/93	4.30
07/13/93	5.71
08/03/93	5.55
09/13/93	4.52
09/14/93	4.89
10/04/93	6.54
10/05/93	6.55
11/02/93	4.81
11/30/93	5.91
01/11/94	6.40
02/07/94	4.75
02/08/94	4.80
03/08/94	5.26
04/05/94	5.56
05/02/94	5.73
06/07/94	4.99
08/01/94	4.89
08/23/94	6.91
01/31/95	4.65
04/04/95	5.14
03/16/98	6.41
08/12/98	7.21

Table 2 pH Data Statistical Summary

Station Number	Number of Samples	Minimum Value	Maximum Value	Average Value
02480500	26	4.30	7.21	5.7

Chart 1 pH Data for Turkey Creek



6.5 min.

SOURCE ASSESSMENT

It is recognized that many of the sources for low pH in the stream are natural. These sources are considered uncontrollable, and this TMDL does not attempt to address any type of controlling strategy for these sources.

The TMDL evaluation summarized in this report examined all known controllable and uncontrollable pH-altering sources in the Turkey Creek Watershed. The source assessment was used as the basis of development for the study and the ultimate analysis of the TMDL allocation options. In evaluation of the sources, loads were characterized by the best available information, monitoring data, literature values, and local management activities. This section documents the available information and interpretation for the analysis.

Turkey Creek was studied as a single reach from its headwaters to Bernard Bayou. The watershed delineations were based primarily on an analysis of the Reach File 3 (RF3) stream network in the basin as well as a topographic analysis of the watershed.

3.1 Assessment of Point Sources

Point sources have their greatest potential impact on water quality during periods of low-flow. Thus, a careful evaluation of point sources was necessary in order to quantify the degree of impairment present during the low-flow, critical-condition period. There were three wastewater treatment plants in the Turkey Creek Watershed that served residential areas. Table 3 lists the dischargers in this watershed, along with the NPDES Permit number. Two facilities are now offline.

Once the permitted dischargers were located, the effluent from the sources were characterized based on all available monitoring data including permit limits, discharge monitoring reports, and information on treatment types. The permitted discharges for the Turkey Creek Watershed were characterized by the limits of the NPDES Permit. The permitted average pH allowed from each facility is given in Table 3.

Table 3 Identified NPDES Permitted Dischargers

Facility Name	Watershed	NPDES Permit	pH	Receiving Waterbody
Dolan's Trailer Park	03170009037	MS0042897	6.0 – 8.5	Turkey Creek
Ridgecrest Estates	03170009037	MS0052248	6.0 – 8.5	Facility offline
William Ladner Homes	03170009037	MS0023175	6.0 – 8.5	Facility offline

3.2 Assessment of Nonpoint Sources

Turkey Creek Forested Area

There are potential nonpoint sources from storm water runoff that could contribute to an alteration of pH in Turkey Creek, including:

- Failing Septic Systems
- Land Application of Chicken Litter
- Acidic Soil
- Pine Needle Decay
- Urban Development

The 11,124 -acre drainage area of the monitored segment of Turkey Creek contains many different landuse types, including urban, forests, cropland, pasture, barren, and wetlands. The landuse information is based on data collected by the State of Mississippi's Automated Information System (MARIS, 1997). This data set is based on Landsat Thematic Mapper digital images taken between 1992 and 1993. Table 4 and Figure 3 show the landuse distribution within the watershed in acres. The watershed is very rural in nature however; it does contain portions of the city of Gulfport. Forest is the dominant landuse within this watershed.

Table 4 Landuse Distribution in Number of Acres

Watershed	Forest*	Croplands	Pasture	Urban**	Total
03170009037	5,134	3,270	1,328	1,392	**11,124**
	46.2%	29.4%	11.9%	12.5%	

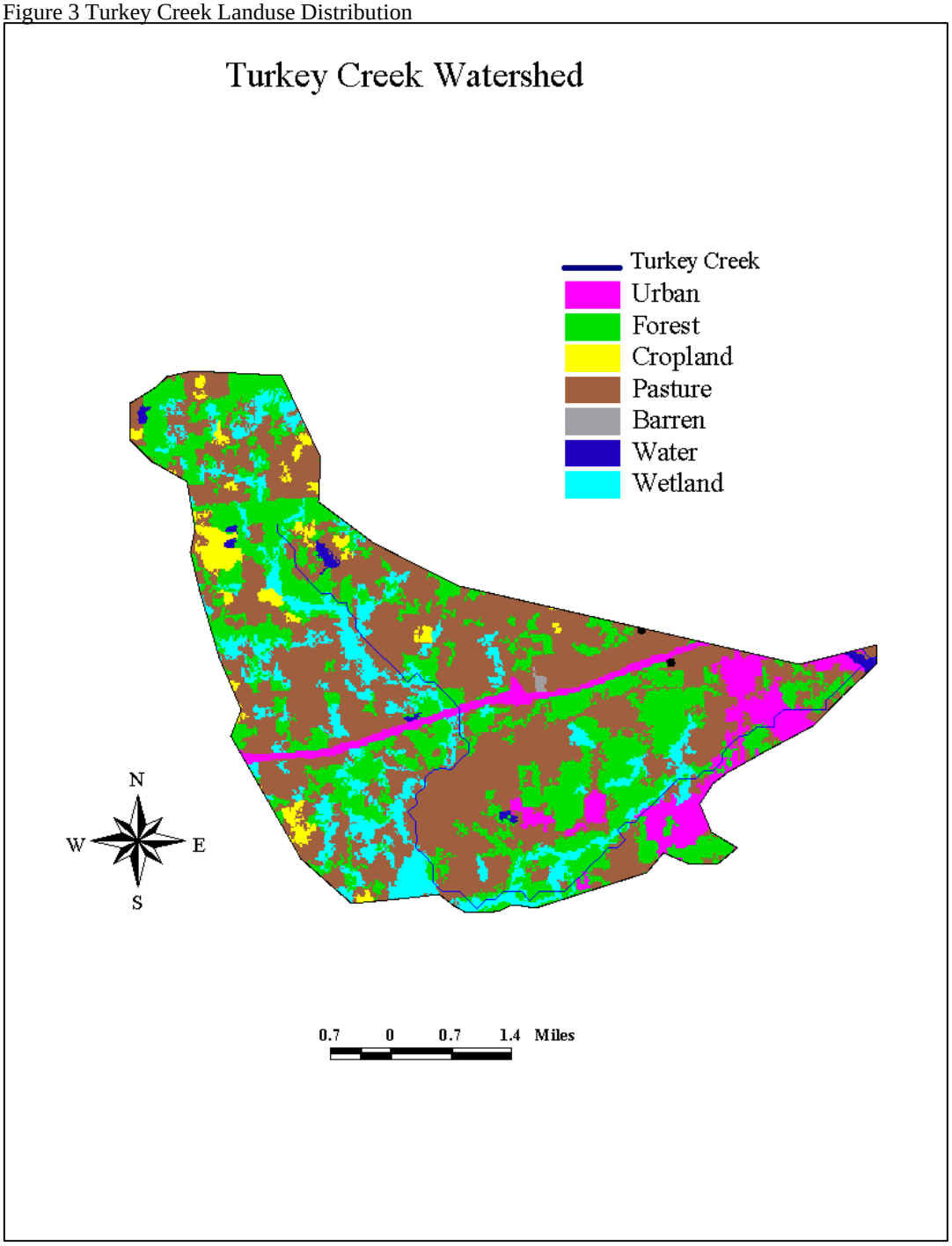
* Includes Wetlands ** Includes Barren Land

3.2.1 Failing Septic Systems

Septic systems have a potential to deliver pH-altering loads (either higher pH or lower pH) to surface waters due to malfunctions, failures, and direct pipe discharges. Household chemicals and waste products could be introduced into the environment by a failing septic system. Properly operating septic systems treat wastewater and dispose of the water through a series of underground field lines. The water is applied through these lines into a rock substrate, thence into underground absorption. The systems can fail when the field lines are broken, or when the underground substrate is clogged or flooded. A failing septic system's discharge can reach the surface, where it becomes available for wash-off into the stream. Another potential problem is a direct bypass from the system to a stream. In an effort to keep the water off the land, pipes are occasionally placed from the septic tank or the field lines directly to the creek, which can be represented as a point source.

Another consideration is the use of individual onsite wastewater treatment plants. These treatment systems are widely used in Mississippi. They can adequately treat wastewater when properly maintained. However, these systems do not typically receive the maintenance needed for proper, long-term operation.

Figure 3 Turkey Creek Landuse Distribution



3.2.2 Land Application of Chicken Litter

In the Coastal Basin processed manure from chicken houses could be a source of pH alteration in the stream. However, no known chicken houses are in the watershed. Also, no known litter application currently takes place in the watershed. Therefore, this activity has been omitted from consideration.

3.2.3 Acidic Soil

Soil acidity has long been reported as a major fertility problem in the southeastern United States. To combat this problem, farmers typically apply appropriate amounts of lime to counteract the acidity, in order to increase crop production. In 1957, 216,012 tons of lime were used in Mississippi; however, by 1979 800,000 tons of lime were used on agricultural fields in Mississippi (Vanderford, 1975). Still, this was only 40% of the amount of lime necessary to adequately combat the historically acid soils for increased crop production.

Turkey Creek Forest Area

A great deal of water infiltrates through the soils of humid regions such as the coastal areas of Mississippi. As water moves through the soils, hydrogen ions combine with carbon dioxide and other compounds to form weak acids, such as carbonic acid. When rainfall events occur, these weak acids will leach the lime from the soils. As this leaching from rain water occurs, calcium and other bases are gradually removed, leaving soils more acidic than before.[1]

3.2.4 Pine Needle Decay

Vast numbers of coniferous trees within the basin also contribute to the acidity of surrounding waterbodies due to the decay of the pine needles. Duffy *et al*. (1989) examined the nutrient flux in a pine forest following simulated rainfall. The pH of their simulated rainfall ranged from 3.94 – 5.18 on four different plots; however, the pH of the ensuing runoff water ranged from 4.34 – 5.0.

Assuming you have a rainfall, which itself is slightly acidic, encountering acidic pine needles, which then travels though acidic soils, one can safely deduce the surrounding receiving water will likewise be acidic in nature.[2]

1 National Sedimentation Laboratory, Water Quality and Ecological Processes Research Unit, Report on the Causes of acid pH in the Yazoo Basin, Dr. Charles Cooper, 2000.
2 Ibid.

3.2.5 Urban Development

Urban areas include land classified as urban and barren. Even though only a small percentage of the watershed is classified as urban, the contribution of the urban areas to pH alteration in Turkey Creek was considered. Stormwater runoff contributions from urban areas may come from construction sites, residential subdivisions, and runoff contribution from improper disposal of materials such as household toxic materials. Due to the low percentage of urban area in the watershed, 12.5%, this source of lower pH is considered to be very minor.

MODELING PROCEDURE: LINKING THE SOURCES TO THE ENDPOINT

Establishing the relationship between the instream water quality target and the source loading is a critical component of TMDL development. It allows for the evaluation of management options that will achieve the desired source load reductions. The link can be established though a range of techniques, from qualitative assumptions based on sound scientific principles to sophisticated modeling techniques. Ideally, the linkage will be supported by monitoring data that allow the TMDL developer to associate certain waterbody responses to flow and loading conditions. In this section, the selection of the modeling tools, setup, and model application are discussed.

4.1 Modeling Framework Selection

The BASINS model platform and the NPSM model were used to predict the hydrology in the Turkey Creek Watershed. BASINS is a multipurpose environmental analysis system for use in performing watershed and water quality-based studies. A geographic information system (GIS) provides the integrating framework for BASINS and allows for the display and analysis of a wide variety of landscape information such as landuses, monitoring stations, point source discharges, and stream descriptions. The NPSM model simulates nonpoint source runoff from selected watersheds, as well as the transport and flow of the pollutants through stream reaches. While this approach does not simulate pH in the watershed, the BASINS as the modeling framework integrates both point and nonpoint sources in the simulation.

4.2 Model Setup

The Turkey Creek model includes the listed section of the creek as well as all of the drainage area that is upstream of the segment. Thus, all upstream contributors are accounted for in the model. A subwatershed delineation of the Turkey Creek Watershed was not necessary due to the small area of the watershed. The hydrology unit from the model was used in this study.

4.3 Source Representation

Both point and nonpoint sources were represented in this study. There were three NPDES Permitted facilities in the Turkey Creek Watershed, two of which are offline. Loading rates for point sources are input as flow in cubic feet per second and average pH.

4.3.1 Failing Septic Systems

The number of failing septic systems was derived from the watershed area normalized population of Harrison County. The percentage of the population on septic systems, which was determined from 1990 United States Census Data, is given in Table 5. Based on the best available information, a failure rate of 40% was assumed. This information was used to calculate the estimated number of failing septic tanks per watershed. The number of failing septic tanks also incorporates an estimate for the failing onsite wastewater

treatment systems in the area. Discharges from failing septic systems were quantified based on several factors including the estimated population served by the septic systems and an average daily discharge of 100 gallons per person per day.

Table 5 Percent of Population on Septic Systems, by County

County	Harrison
Percent on Septic Systems	19%

4.3.2 Land Application of Chicken Litter

The contribution due to land application of poultry litter was considered in the Turkey Creek Watershed nonpoint source assessment. Since there are no known chicken houses in the Turkey Creek Watershed, land application of poultry litter is not considered as a source for this watershed.

4.3.3 Acidic Soil

A great deal of water infiltrates through the soils of humid regions. As water moves through the soils, hydrogen ions combine with carbon dioxide and other compounds to form weak acids, such as carbonic acid. When rainfall events occur, these weak acids will leach the lime from the soils. As this leaching from rain water occurs, calcium and other bases are gradually removed, leaving soils more acidic than before. These sources are considered uncontrollable and are not accounted for in this TMDL.

4.3.4 Pine Needle Decay

Vast numbers of coniferous trees within the basin also contribute to the acidity of surrounding waterbodies due to the decay of the pine needles. Assuming you have a rainfall, which itself is slightly acidic, encountering acidic pine needles, which then travels though acidic soils, one can safely deduce the surrounding receiving water will likewise be acidic in nature. These sources are considered uncontrollable and are not accounted for in this TMDL.

4.3.5 Urban Development

Turkey Creek near Highway 49 Bridge

The Turkey Creek watershed is a suburban area of Gulfport, Mississippi. Within the last several years, development of this area has included the expansion of the regional wastewater collection system that has removed two NPDES discharges from this watershed. The area remains sparsely populated. The watershed can be considered rural and urban. These pH- lowering sources are controllable, however, there is only a very limited amount of urban area in the watershed.

4.4 Stream Characteristics

The stream characteristics given below describe the entire modeled section of Turkey Creek. This section begins at the headwaters and ends at the end of the monitored reach, where it joins Bernard Bayou. The channel geometry and lengths for Turkey Creek are based on data available within the BASINS modeling system. The 7Q10 flow was determined from USGS data. The characteristics of the modeled section of Turkey Creek are as follows.

- Length 12.9 miles
- Average Depth 0.77 ft
- Average Width 33.01 ft
- Mean Flow90.45 cubic ft per second
- Mean Velocity 0.93 ft per second
- 7Q10 Flow 0.08 cubic ft per second
- Slope 0.00030 ft per ft

4.5 Selection of Representative Modeling Period

The BASINS hydrological model was run for 12 years, from January 1, 1984, through December 31, 1995. The first year of data were used to stabilize the model. Results from the model were evaluated for the time period from January 1, 1985, until December 31, 1995. Because this 11-year time span is used, a margin of safety is implicitly applied. Seasonality and critical conditions are accounted for during the extended time-frame of the simulation.

The weather data used for this model were collected at Saucier Experimental Forest Station. The representative hydrologic period used for the TMDL was January 1, 1985, through December 31, 1995.

4.6 Model Calibration Process

The model was calibrated for hydrology on various gages in southeast Mississippi. A set of input values was established through the hydrologic calibration. The hydrological model had a continuous USGS gage (02480500) available on Tchoutacabouffa River near Biloxi for comparison with the modeled flow. A sample of these results is included in Appendix A. The modeled output and the most recent actual gage data are shown on the same graph.

ALLOCATION

The allocation for this TMDL involves a wasteload allocation for point sources and a load allocation for nonpoint sources necessary for attainment of water quality standards in segment MS118BBM1. Point source contributions enter the stream directly. Nonpoint sources contributions occur as a result of rainfall events. This TMDL will only consider allocations for controllable sources of low pH.

5.1 Wasteload Allocations

The contribution of point sources was considered on a watershed basis. Effluent pH levels from the point source that discharges into Turkey Creek shall be 6.5 to 9.0 standard units and shall not cause the pH in the receiving waters to vary more than 1.0 standard unit. Regarding implementation of these allocations to the NPDES permits, MDEQ will use its Reasonable Potential Procedures to determine appropriate monitoring requirements and/or limitations.

5.2 Load Allocations

For Turkey Creek, the pH of waters originating from nonpoint sources shall be 6.5 to 9.0 standard units and shall not cause the receiving waters to vary more than 1.0 standard unit. Nonpoint loading due to acidic soil, pine needle decay, and urban development are included in the load allocation. This TMDL has been completed for the acidic property of the water. pH is an indicator of the acidic or alkalinity properties of water. It is not a classic pollutant. Control of the pH range can be achieved by dilution or by source load manipulation.

One step that should be encouraged by this TMDL is the reduction of failing septic tanks in the watershed. This reduction in septic tank failures will lead to a reduction in the overall pollution reaching the Pearl River. This might be achieved by supporting BMP projects that promote education projects that encourage homeowners to properly maintain their septic tanks by routinely pumping them out, ensuring that improper chemicals are not disposed of in the septic tank, repairing broken field lines, and properly maintaining the effluent from individual onsite wastewater treatment plants.

5.3 Incorporation of a Margin of Safety

The margin of safety shall account for the lack of knowledge concerning the relationship between pollutant loads and the quality of the receiving waterbody. The wasteload allocation and load allocation suggested in sections 5.1 and 5.2 of this report establish that effluent from all point sources and waters originating from all nonpoint sources must individually meet the water quality standards for pH. As long as pH levels from point sources and nonpoint sources are consistent with the specified wasteload allocation and load allocation, the pH in Turkey Creek will be consistent with water quality standards. Therefore, a margin of safety for these pH TMDLs has been considered but was determined to be unnecessary, because there is no lack of knowledge concerning the relationship between the allocations to pollutant loads and the resulting quality of the receiving waters.

5.4 Seasonality

The chart of the data indicates a definite cyclic trend to pH in the stream. The theory is that the coniferous trees shed their needles, which decay and with springtime stormwater runoff alter the pH in the stream. This uncontrollable natural cyclic process will not be address by this TMDL. Seasonality is classically thought of as differing approaches to the pollutant based on variations in temperature or in rainfall. Seasonality for this within this TMDL is not based on changes between the seasons, temperature fluctuations, or rainfall events. By looking at several years worth of data, a cycle or trend is established that shows lower pH in the springtime. This corresponds to early rainfall events in the spring bringing the first acidic load from decaying coniferous trees. It is our contention that this is a natural event and is uncontrollable.

CONCLUSION

The reduction scenario used in this TMDL included requiring all NPDES Permitted dischargers to meet water quality standards for pH, along with reducing the pollution load from 85% of the failing septic tanks in the watershed. Table 3 lists the dischargers in this watershed, along with the NPDES Permit number. Two facilities are now offline.

The TMDL will not impact existing or future NPDES Permits as long as the effluent meets water quality standards for pH. MDEQ will not approve any NPDES Permit application that does not plan to meet water quality standards for pH. Education projects that teach best management practices should be used as a tool for reducing potential nonpoint source contributions from septic tanks. CWA Section 319 Nonpoint Source (NPS) Grants may fund these projects. MDEQ produced guidance for future Section 319 project funding will encourage NPS restoration projects that attempt to address TMDL related issues within Section 303(d)/TMDL watersheds in Mississippi.

This TMDL is for low pH. This is an indicator of water quality and is not in and of itself a pollutant. Manipulation of the pH value in the context of a TMDL calculation is meaningless. However, the effort to reduce controllable sources of lower pH producing pollution in the stream wherever possible is meaningful. That controllable source reduction is the goal for this TMDL.

6.1 Future Monitoring

MDEQ has adopted the Basin Approach to Water Quality Management, a plan that divides Mississippi's major drainage basins into five groups. During each year-long cycle, MDEQ resources for water quality monitoring will be focused on one of the basin groups. During the next monitoring phase in the Coastal Basin, Turkey Creek will receive additional monitoring to identify any change in water quality. Additionally, by completion of this TMDL, NPS projects proposed for this watershed that address pH will receive priority consideration for future Section 319 funding.

6.2 Public Participation

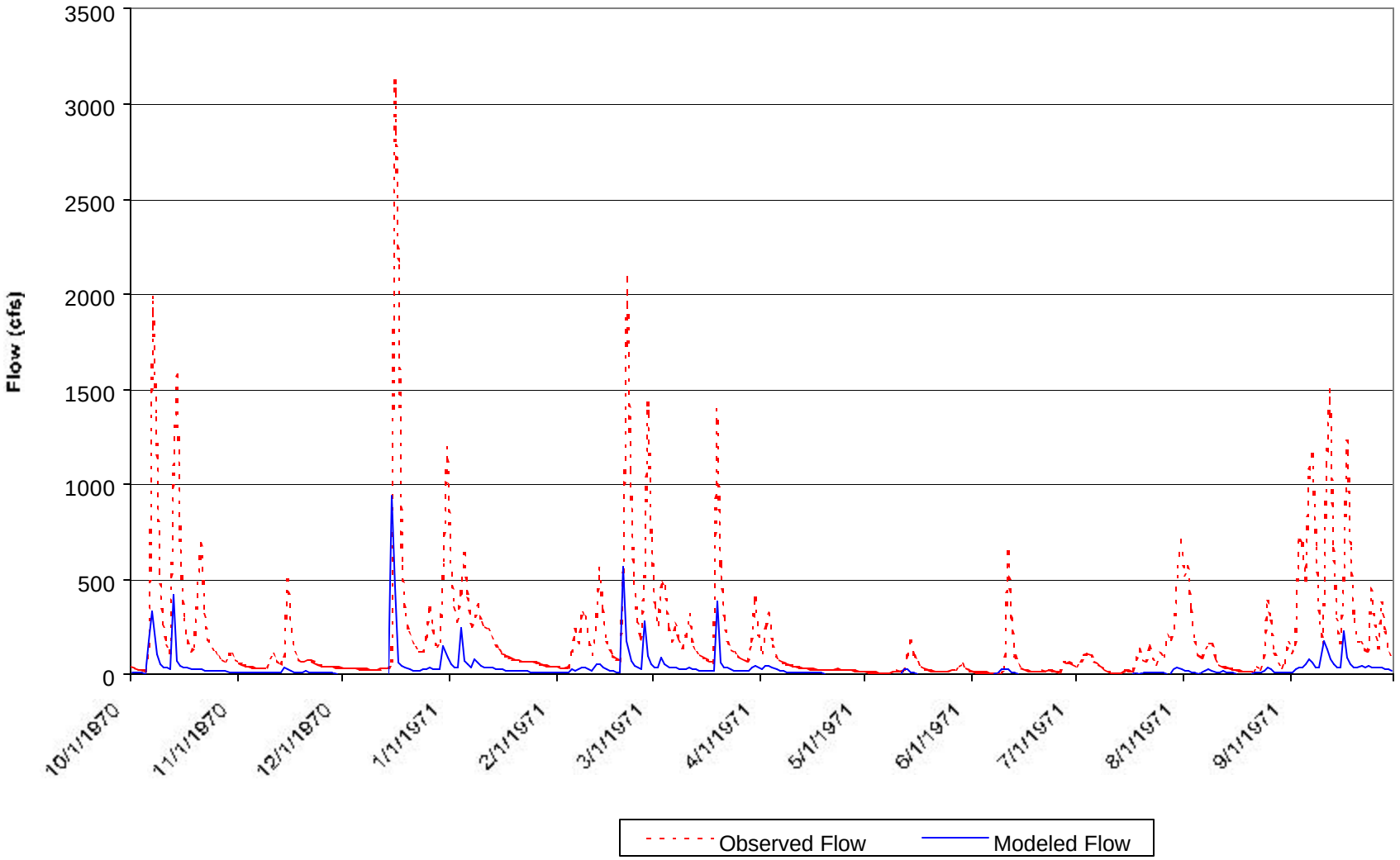
This TMDL will be published for a 30-day public notice. During this time, the public will be notified by publication in the statewide newspaper and a newspaper in Gulfport. The public will be given an opportunity to review the TMDL and submit comments. At the end of the 30-day period, MDEQ will determine the level of interest in the TMDL and make a decision on the necessity of holding a public hearing.

All comments received during the public notice period and at any public hearings become a part of the record of this TMDL. All comments will be considered in the ultimate approval of this TMDL and for submission of this TMDL to EPA Region IV for final approval.

APPENDIX A

This appendix contains printouts of the various model run results. Graph A-1 shows the modeled flow, in cubic feet per second, through Turkey Creek compared to the most recent actual USGS gage readings from Tchoutacabouffa River near Biloxi. Because a gage is not available for Turkey Creek, the graph shows a discrepancy between actual and modeled flow. This graph is shown to indicate that the trends in flow are commensurate. USGS Gage 02480500 was discontinued in 1971. The Tchoutacabouffa River gage is the closet gage available for this study.

Graph A-1 Daily Flow Comparison between USGS Gage 02480500 and Reach 03170009037 for 10/01/70 - 09/30/71



DEFINITIONS

Ambient stations: a network of fixed monitoring stations established for systematic water quality sampling at regular intervals, and for uniform parametric coverage over a long-term period.

Assimilative capacity: the capacity of a body of water or soil-plant system to receive wastewater effluents or sludge without violating the provisions of the State of Mississippi Water Quality Criteria for Intrastate, Interstate, and Coastal Waters and Water Quality regulations.

Background: the condition of waters in the absence of man-induced alterations based on the best scientific information available to MDEQ. The establishment of natural background for an altered waterbody may be based upon a similar, unaltered or least impaired, waterbody or on historical pre-alteration data.

Calibrated model: a model in which reaction rates and inputs are significantly based on actual measurements using data from surveys on the receiving waterbody.

Coniferous: an order (Coniferales) of mostly evergreen trees and shrubs including forms (as pines) with true cones and other (as yews) with an arillate fruit.

Controllable Sources: Sources of pollutants that can be modified or controlled with regulatory requirements and/or best management practices.

Critical Condition: hydrologic and atmospheric conditions in which the pollutants causing impairment of a waterbody have their greatest potential for adverse effects.

Daily discharge: the "discharge of a pollutant" measured during a calendar day or any 24-hour period that reasonably represents the calendar day for purposes of sampling. For pollutants with limitations expressed in units of mass, the "daily discharge" is calculated as the total mass of the pollutant discharged over the day. For pollutants with limitations expressed in other units of measurement, the "daily average" is calculated as the average.

Designated Use: use specified in water quality standards for each waterbody or segment regardless of actual attainment.

Discharge monitoring report: report of effluent characteristics submitted by a NPDES Permitted facility.

Effluent standards and limitations: all State or Federal effluent standards and limitations on quantities, rates, and concentrations of chemical, physical, biological, and other constituents to which a waste or wastewater discharge may be subject under the Federal Act or the State law. This includes, but is not limited to, effluent limitations, standards of performance, toxic effluent standards and prohibitions, pretreatment standards, and schedules of compliance.

Effluent: treated wastewater flowing out of the treatment facilities.

Geometric mean: the *n*th root of the product of *n* numbers. A 30-day geometric mean is the 30th root of the product of 30 numbers.

Impaired Waterbody: any waterbody that does not attain water quality standards due to an individual pollutant, multiple pollutants, pollution, or an unknown cause of impairment.

Land Surface Runoff: water that flows into the receiving stream after application by rainfall or irrigation. It is a transport method for nonpoint source pollution from the land surface to the receiving stream.

Load allocation (LA): the portion of a receiving water's loading capacity attributed to or assigned to nonpoint sources (NPS) or background sources of a pollutant.

Loading: the total amount of pollutants entering a stream from one or multiple sources.

Nonpoint Source: pollution that is in runoff from the land. Rainfall, snowmelt, and other water that does not evaporate become surface runoff and either drains into surface waters or soaks into the soil and finds its way into groundwater. This surface water may contain pollutants that come from land use activities such as agriculture; construction; silviculture; surface mining; disposal of wastewater; hydrologic modifications; and urban development.

NPDES permit: an individual or general permit issued by the Mississippi Environmental Quality Permit Board pursuant to regulations adopted by the Mississippi Commission on Environmental Quality under Mississippi Code Annotated (as amended) §§ 49-17-17 and 49-17-29 for discharges into State waters.

pH: a measure of acidity and alkalinity of a solution that is a number on a scale on which a value of 7 represents neutrality and lower numbers indicate increasing acidity and higher number increasing alkalinity and on which each unit of change represents a tenfold change in acidity or alkalinity and that is the negative logarithm of the effective hydrogen-ion concentration or hydrogen-ion activity in gram equivalents per liter of the solution.

Point Source: pollution loads discharged at a specific location from pipes, outfalls, and conveyance channels from either wastewater treatment plants or industrial waste treatment facilities. Point sources can also include pollutant loads contributed by tributaries to the main receiving stream.

Pollution: contamination, or other alteration of the physical, chemical, or biological properties, of any waters of the State, including change in temperature, taste, color, turbidity, or odor of the waters, or such discharge of any liquid, gaseous, solid, radioactive, or other substance, or leak into any waters of the State, unless in compliance with a valid permit issued by the Permit Board.

Publicly Owned Treatment Works (POTW): a waste treatment facility owned and/or operated by a

public body or a privately owned treatment works which accepts discharges which would otherwise be subject to Federal Pretreatment Requirements.

Scientific Notation (Exponential Notation): mathematical method in which very large numbers or very small numbers are expressed in a more concise form. The notation is based on powers of ten. Numbers in scientific notation are expressed as the following: *4.16 x 10^(+b)* and *4.16 x 10^(-b) [same as 4.16E4 or4.16E-4]*. In this case, *b* is always a positive, real number. The *10^(+b)* tells us that the decimal point is *b* places to the right of where it is shown. The *10^(-b)* tells us that the decimal point is *b* places to the left of where it is shown.
For example: $2.7X10^4 = 2.7E+4 = 27000$ and $2.7X10^{-4} = 2.7E-4 = 0.00027$.

Sigma (S): shorthand way to express taking the sum of a series of numbers. For example, the sum or total of three amounts 24, 123, 16, ($\mathbf{d}_1$, $\mathbf{d}_2$, $\mathbf{d}_3$) respectively could be shown as:

$$\sum_{i=1}^{3} d_i = d_1+d_2+d_3 = 24+123+16 = 163$$

Total Maximum Daily Load or TMDL: the calculated maximum permissible pollutant loading to a waterbody at which water quality standards can be maintained.

Regression Coefficient: an expression of the functional relationship between two correlated variables that is often empirically determined from data, and is used to predict values of one variable when given values of the other variable.

Waste: sewage, industrial wastes, oil field wastes, and all other liquid, gaseous, solid, radioactive, or other substances which may pollute or tend to pollute any waters of the State.

Wasteload allocation (WLA): the portion of a receiving water's loading capacity attributed to or assigned to point sources of a pollutant. It also contains a portion of the contribution from septic tanks

Water Quality Standards: the criteria and requirements set forth in *State of Mississippi Water Quality Criteria for Intrastate, Interstate, and Coastal Waters*. Water quality standards are standards composed of designated present and future most beneficial uses (classification of waters), the numerical and narrative criteria applied to the specific water uses or classification, and the Mississippi antidegradation policy.

Water quality criteria: elements of State water quality standards, expressed as constituent concentrations, levels, or narrative statements, representing a quality of water that supports the present and future most beneficial uses.

Waters of the State: all waters within the jurisdiction of this State, including all streams, lakes, ponds, wetlands, impounding reservoirs, marshes, watercourses, waterways, wells, springs, irrigation systems,

drainage systems, and all other bodies or accumulations of water, surface and underground, natural or artificial, situated wholly or partly within or bordering upon the State, and such coastal waters as are within the jurisdiction of the State, except lakes, ponds, or other surface waters which are wholly landlocked and privately owned, and which are not regulated under the Federal Clean Water Act (33 U.S.C.1251 et seq.).

Watershed: the area of land draining into a stream at a given location.

ABBREVIATIONS

7Q10.....Seven-Day Average Low Stream Flow with a Ten-Year Occurrence Period

BASINS..... Better Assessment Science Integrating Point and Nonpoint Sources

BMP .....Best Management Practice

CWA .....Clean Water Act

DMR.....Discharge Monitoring Report

EPA ..... Environmental Protection Agency

GIS .....Geographic Information System

HUC .....Hydrologic Unit Code

LA..... Load Allocation

MARIS ..... State of Mississippi Automated Information System

MDEQ ..... Mississippi Department of Environmental Quality

MOS..... Margin of Safety

NRCS ..... National Resource Conservation Service

NPDES .....National Pollution Discharge Elimination System

NPSM.....Nonpoint Source Model

RF3.....Reach File 3

USGS.....United States Geological Survey

WLA.....Waste Load Allocation

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