BEAR HEAD CREEK PARTIAL TMDL FOR OXYGEN DEMAND

GREEN ISLAND ROAD TO THE CONFLUENCE WITH THE HOUSTON RIVER

SUBSEGMENT 030807

SURVEYED SEPTEMBER 19-21, 2000

Louisiana Department of Environmental Quality
Office of Environmental Assessment
Environmental Technology Division
Engineering Services Group 2

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EXECUTIVE SUMMARY

This report presents the results of a watershed based, calibrated modeling analysis of Bear Head Creek. The modeling was conducted to establish a total maximum daily load (TMDL) for oxygen-demanding pollutants for the Bear Head Creek watershed. Due to intermittent conditions during the water quality survey, the model only includes the portion of Bear Head Creek that exhibited a contiguous water surface. The model extends from Green Island Road north of Starks, Louisiana to the confluence with the Houston River at Creek Road. Bear Head Creek is in subsegment 030807 located in the Calcasieu River Basin. There were no point sources included in the modeling effort. Hyatt High School (LAG530067) discharges 4,480 gallons per day of treated sanitary sewage into a tributary of Bear Head Creek. This tributary and Hyatt High School were not located in the modeled portion of Bear Head Creek. Hyatt High School will continue to be permitted according to state policy.

Bear Head Creek was not listed on any 303(d) list; however, Bear Head Creek was part of the 1999 ambient sampling program and was found to not be meeting its designated use of Fish and Wildlife Propagation due to organic enrichment/low dissolved oxygen. It is, however, meeting its designated uses of Primary and Secondary Contact Recreation. Natural and unknown sources are the suspected sources of impairment.

Input data for the calibration model for dissolved oxygen was developed from the survey conducted in September 2000. A satisfactory calibration was achieved.

LA-QUAL was the water quality model used in this analysis. In 1999, the Louisiana Department of Environmental Quality and Wiland Consulting, Inc. developed LA-QUAL based on QUAL-TX Version 3.4. The program was converted from a DOS-based program to a Windows-based program with a graphical interface and enhanced graphic output. Other program modifications specific to the needs of Louisiana and the Louisiana DEQ were also made. LA-QUAL is a user-oriented model and is intended to provide the basis for evaluating TMDLs in the State of Louisiana.

The current state standard requires a dissolved oxygen (DO) of 5.0 mg/L throughout the year. The DO standard could possibly change to correspond to the Houston River criteria of 5.0 mg/L December-February and 3.0 mg/L March-November. Therefore, model projections were performed for the current and alternate criteria using the seasons of March-November and December-February. The alternate criteria will not be applicable until a standards change is promulgated and approved by EPA.

One of the projection scenarios resulted in a required reduction of more than 100% when the required reduction was differentiated between man-made and natural nonpoint pollution. Therefore, the percentage reductions necessary to meet the DO standards were presented as total nonpoint pollution since a reduction of more than 100% is not possible. In order to meet the current DO criterion of 5.0 mg/L in the summer, a 69% reduction of total nonpoint loading is necessary. This result indicates that the current criterion is inappropriate for Bear Head Creek and that a UAA should be conducted. The possible

revised criterion of 3.0 mg/L in the summer can be attained with a 46% reduction of total nonpoint loading. For the winter season, a 21% reduction of total nonpoint loading is necessary. The resulting TMDLs are shown below.

	3 mg/L DO, Mar-Nov (alternate)	5 mg/L DO, Mar-Nov (current)	5 mg/L DO, Dec-Feb (current & alternate)
Point Source WLA, lb/day of oxygen demand	5.0	5.0	5.0
Point Source MOS, lb/day of oxygen demand	1.2	1.2	1.2
Nonpoint LA, lb/day of oxygen demand	1455	832	1463
Nonpoint MOS, lb/day of oxygen demand	17	0	106
TMDL, lb/day of oxygen demand	1479	838	1575

In accordance with Section 106 of the federal Clean Water Act and under the authority of the Louisiana Environmental Quality Act, the LDEQ has established a comprehensive program for monitoring the quality of the state's surface waters. The LDEQ Surveillance Section collects surface water samples at various locations, utilizing appropriate sampling methods and procedures for ensuring the quality of the data collected. The objectives of the surface water monitoring program are to determine the quality of the state's surface waters, to develop a long-term data base for water quality trend analysis, and to monitor the effectiveness of pollution controls. The data obtained through the surface water monitoring program is used to develop the state's biennial 305(b) report (*Water Quality Inventory*) and the 303(d) list of impaired waters. This information is also utilized in establishing priorities for the LDEQ nonpoint source program.

The LDEQ has implemented a watershed approach to surface water quality monitoring. Through this approach, the entire state is sampled over a five-year cycle with two targeted basins sampled each year. Long-term trend monitoring sites at various locations on the larger rivers and Lake Pontchartrain are sampled throughout the five-year cycle. Sampling is conducted on a monthly basis or more frequently if necessary to yield at least 12 samples per site each year. Sampling sites are located where they are considered to be representative of the waterbody. Under the current monitoring schedule, targeted basins follow the TMDL priorities. In this manner, the first TMDLs will have been implemented by the time the first priority basins will be monitored again in the second five-year cycle. This will allow the LDEQ to determine whether there has been any improvement in water quality following implementation of the TMDLs. As the monitoring results are evaluated at the end of each year, waterbodies may be added to or removed from the 303(d) list. The sampling schedule for the first five-year cycle is shown below.

1998 - Mermentau and Vermilion-Teche River Basins
1999 - Calcasieu and Ouachita River Basins
2000 - Barataria and Terrebonne Basins
2001 - Lake Pontchartrain Basin and Pearl River Basin
2002 - Red and Sabine River Basins

(Atchafalaya and Mississippi Rivers will be sampled continuously.)
The Calcasieu River Basin will be sampled again in 2004.

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1.0 Introduction

Bear Head Creek is in the Calcasieu River Basin. Waterbodies located in the Basin currently have priority for TMDL development. Bear Head Creek was not listed on any 303(d) list; however, Bear Head Creek was part of the 1999 ambient sampling program and was found to not be meeting its designated use of Fish and Wildlife Propagation due to organic enrichment/low dissolved oxygen. It is, however, meeting its designated uses of Primary and Secondary Contact Recreation. Natural and unknown sources are the suspected sources of impairment.

A survey of Bear Head Creek was conducted September 19-21, 2000. A calibrated water quality model for a portion of the watershed was developed and projections were modeled to quantify the reductions which would be necessary for Bear Head Creek to comply with its water quality criteria for DO. This report presents a total maximum daily load (TMDL) for oxygen-demanding pollutants for a portion of Bear Head Creek.

2.0 Study Area Description

2.1 General Information

Bear Head Creek is in subsegment 030807 located in the Calcasieu River Basin. The Calcasieu River Basin is located in southwestern Louisiana and is positioned in a north-south direction. The basin is bordered by the Mermentau River to the east and the Sabine River to the west. The drainage area of the basin comprises approximately 3,910 square miles. The landscape in this basin varies from pine forested hills in the upper end to brackish and salt marshes in the lower reach around the Calcasieu River (LDEQ, 1999). The land use for the Bear Head Creek watershed is summarized below in Table 1, and a land use map is in Appendix I.

Table 1. Land Uses in the Bear Head Creek Watershed, Subsegment 030807

LAND USE TYPE	**NUMBER OF ACRES**	**% OF TOTAL AREA**
Agricultural land	7288	6
Forest land	72113	59
Rangeland	20288	17
Urban or built-up	14	0
Water	2343	2
Wetland	19837	16
TOTAL	121883	100

The model extends from Green Island Road north of Starks, Louisiana to the confluence with the Houston River at Creek Road. There were no point sources included in the modeling effort. Hyatt High School (LAG530067) discharges 4,480 gallons per day of treated sanitary sewage into a tributary of Bear Head Creek. This tributary and Hyatt High School were not located in the modeled portion of Bear Head Creek.

2.2 Water Quality Standards

The Water Quality criteria and designated uses for the Bear Head Creek watershed are shown in Table 2.

Table 2. Water Quality Numerical Criteria and Designated Uses (LDEQ, 03/20/2001)

Subsegment	030807
Stream Description	Bear Head Creek - Headwaters to junction with Houston River at Parish Road
Designated Uses	A B C
Criteria:	
Cl	250 mg/L
SO_4	75 mg/L
DO	5.0 mg/L
pH	6.0 - 8.5
BAC	1 (Primary Contact Recreation)
Temperature	32°C
TDS	500 mg/L

USES: A – primary contact recreation; B – secondary contact recreation; C – propagation of fish and wildlife

The current state standard requires a DO of 5.0 mg/L throughout the year. The DO standard could possibly change to correspond to the Houston River criteria of 5.0 mg/L December-February and 3.0 mg/L March-November. Therefore, model projections were performed for the current and alternate criteria using the seasons of March-November and December-February. The alternate criteria will not be applicable until a standards change is promulgated and approved by EPA.

2.3 Wastewater Discharges

There were no point sources included in the modeling effort. The discharger inventory for Bear Head Creek was reviewed, and only one facility was found The discharger inventory review is shown in Appendix A. Hyatt High School (LAG530067) discharges 4,480 gallons per day of treated sanitary sewage into a tributary of Bear Head Creek. This tributary and Hyatt High School were not located in the modeled portion of Bear Head Creek. Hyatt High School is currently permitted at a BOD_5 weekly average of 45 mg/L with no limits for NH_3-N. Hyatt High School will continue to be permitted according to state policy and will receive monthly average limits of 30 mg/L $CBOD_5$ and 15 mg/L NH_3-N. The NH_3-N limit corresponds to the respective $CBOD_5$ level of treatment as indicated in the Louisiana Total Maximum Daily Load Technical Procedures (LTP) (LDEQ, 9/8/2000).

2.4 Water Quality Conditions/Assessment

Bear Head Creek was not listed on any 303(d) list; however, Bear Head Creek was part of the 1999 ambient sampling program and was found to not be meeting its designated use of Fish and Wildlife Propagation due to organic enrichment/low dissolved oxygen. It is, however, meeting its designated uses of Primary and Secondary Contact Recreation. Natural and unknown sources are the suspected sources of impairment.

2.5 Prior Studies

No previous modeling work has been done on Bear Head Creek.

3.0 Documentation of Calibration Model

3.1 Model Description

3.1.1 Program Description

"Simulation models are used extensively in water quality planning and pollution control. Models are applied to answer a variety of questions, support watershed planning and analysis and develop total maximum daily loads (TMDLs). . . . Receiving water models simulate the movement and transformation of pollutants through lakes, streams, rivers, estuaries, or nearshore ocean areas. . . . Receiving water models are used to examine the interactions between loadings and response, evaluate loading capacities (LCs), and test various loading scenarios. . . . A fundamental concept for the analysis of receiving waterbody response to point and nonpoint source inputs is the principle of mass balance (or continuity). Receiving water models typically develop a mass balance for one or more constituents, taking into account three factors: transport through the system, reactions within the system, and inputs into the system." (Shoemaker, May 1997)

LA-QUAL was the water quality model used in this analysis. In 1999, the Louisiana Department of Environmental Quality and Wiland Consulting, Inc. developed LA-QUAL based on QUAL-TX Version 3.4. The program was converted from a DOS-based program to a Windows-based program with a graphical interface and enhanced graphic output. Other program modifications specific to the needs of Louisiana and the Louisiana DEQ were also made. LA-QUAL is a user-oriented model and is intended to provide the basis for evaluating TMDLs in the State of Louisiana.

The development of a TMDL for oxygen-demanding pollutants generally occurs in 3 stages. 1) Data Collection Activities, 2) Calibration Model Development, 3) Projection Modeling and TMDL.

Stage 1 encompasses the data collection activities. These activities may include gathering such information as stream cross-sections, stream flow, stream water chemistry, stream temperature and dissolved oxygen at various locations on the stream, location of the stream centerline and the boundaries of the watershed which drains into the stream, and other physical and chemical factors which are associated with the stream. Additional data gathering activities include gathering all available information on each facility which discharges pollutants into the stream, gathering all available stream water quality chemistry and flow data from other agencies and groups, gathering population statistics for the watershed to assist in developing projections of future loadings to the waterbody, land use and crop rotation data where available, and any other information which may have some bearing on the quality of the waters within the watershed. During Stage 1, any data available from reference or least impacted streams which can be used to gauge the relative health of the watershed is also collected.

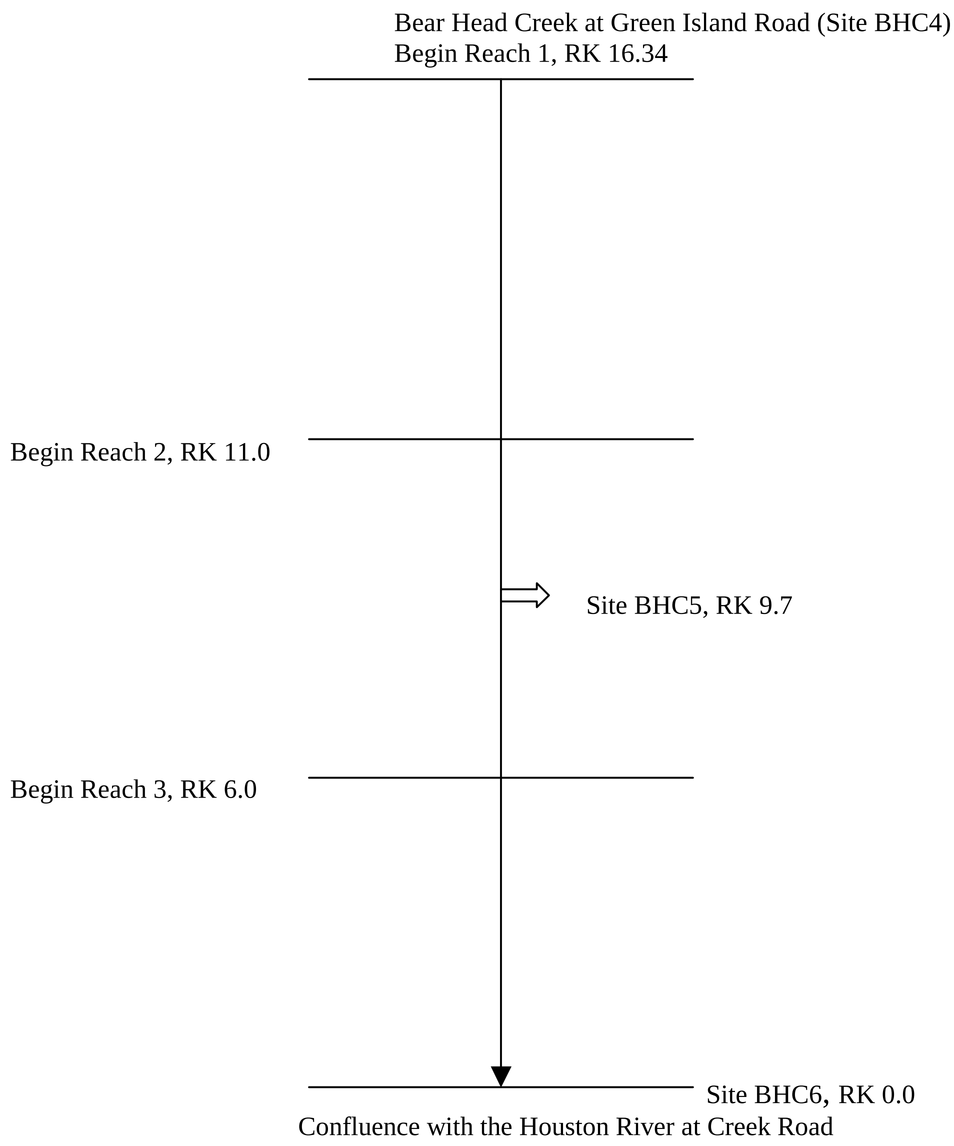
Stage 2 involves organizing all of this data into one or more useable forms from which the input data required by the model can be obtained or derived. Water quality samples, field measurements, and historical data must be analyzed and statistically evaluated in order to determine a set of conditions which have actually been measured in the watershed. The findings are then input to the model . Best professional judgement is used to determine initial estimates for parameters which were not or could not be measured in the field. These estimated variables are adjusted in sequential runs of the model until the model reproduces the field conditions which were measured. In other words, the model produces a value of the dissolved oxygen, temperature, or other parameter which matches the measured value within an acceptable margin of error at the locations along the stream where the measurements were actually made. When this happens, the model is said to be calibrated to the actual stream conditions. At this point, the model should confirm that there is an impairment and give some indications of the causes of the impairment.

Stage 3 covers the projection modeling which results in the TMDL. The critical conditions of flow and temperature are determined for the waterbody and the maximum pollutant discharge conditions from the point sources are determined. These conditions are then substituted into the model along with any related condition changes which are required to perform worst case scenario predictions. At this point, the loadings from the point and nonpoint sources (increased by an acceptable margin of safety) are run at various levels and distributions until the model output shows that dissolved oxygen criteria are achieved. It is critical that a balanced distribution of the point and nonpoint source loads be made in order to predict any success in future achievement of water quality standards. At the end of Stage 3, a TMDL is produced which shows the point source permit limits and the amount of reduction in man-made nonpoint source pollution which must be achieved to attain water quality standards. The man-made portion of the NPS pollution is estimated from the difference between the calibration loads and the loads observed on reference or least impacted streams.

3.1.2 Vector Diagram

A vector diagram of the modeled area is shown in Figure 1. Distances were measured in river kilometers (RK).

Figure 1. Vector Diagram of Bear Head Creek



3.2 Calibration Model Input Discussion

Appendix B contains survey notes, stream geometry calculations, continuous monitor data, water quality data, BOD calculations, and input justifications for the calibration model.

3.2.1 Natural Background Benthic Load

A natural background benthic load of 3.3 g O_2/m^2-day was used. This value is the average taken from three reference streams that have similar characteristics as Bear Head Creek. The reference streams and corresponding total benthic loads are Chemin-a-Haut Bayou=3.171, Middle Fork Bayou D'Arbonne=1.85, and Beaucoup Creek=4.867 all in g O_2/m^2-day.

3.3 Calibration Model Discussion and Results

During the September 2000 survey, Bear Head Creek was intermittent from its headwaters to Green Island Road. Therefore, the model extends from Green Island Road to the confluence with the Houston River at Creek Road. Bear Head Creek contained water in the reaches downstream of Green Island Road, but there was no flow. Additionally, there was no flow in any of the tributaries to Bear Head Creek. The portion of Bear Head Creek upstream of Green Island Road was not included in this TMDL modeling effort.

Very good calibration was achieved for CBOD, NBOD, and DO as shown in Figures 2-4 below. The vertical lines in the plots are Begin Reach 2 and Begin Reach 3. The calibration model input and output are presented in Appendix C.

Figure 2. CBOD Calibration Plot

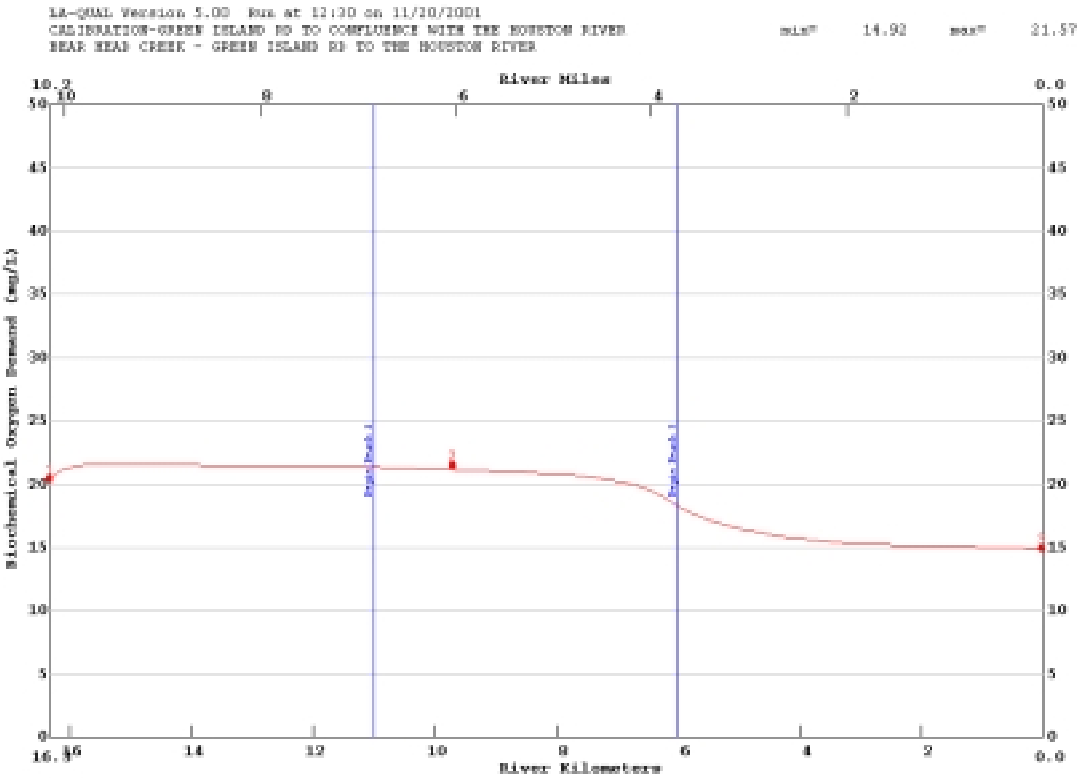


Figure 3. NBOD Calibration Plot

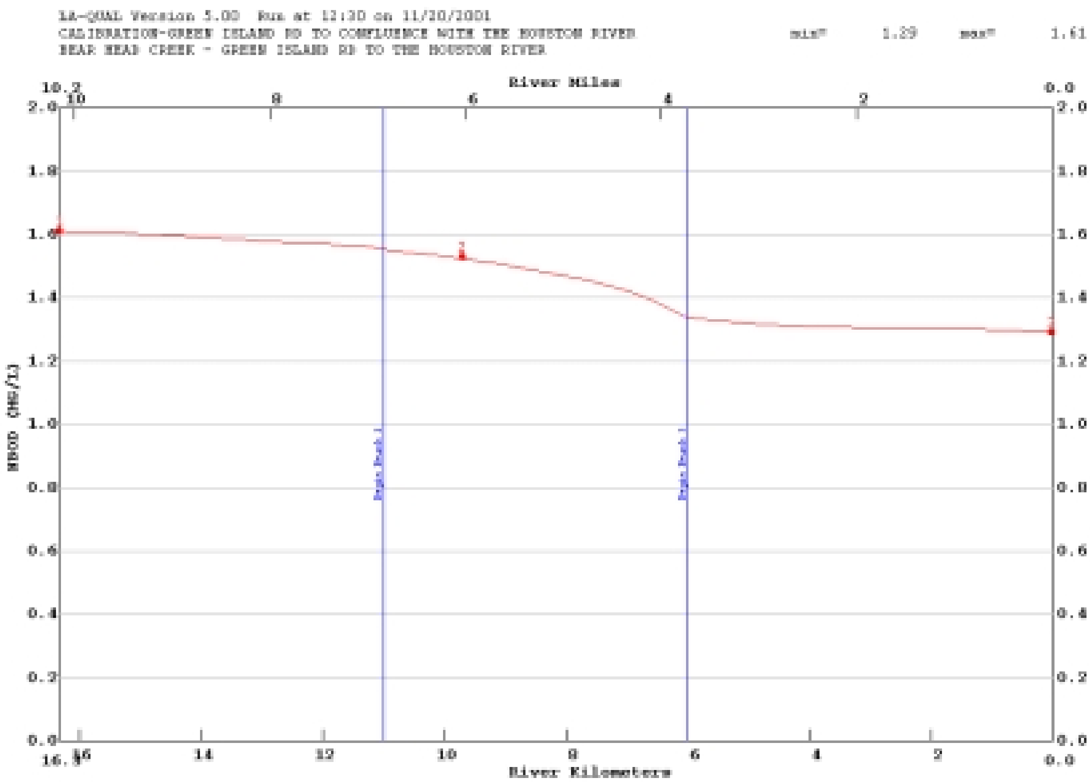
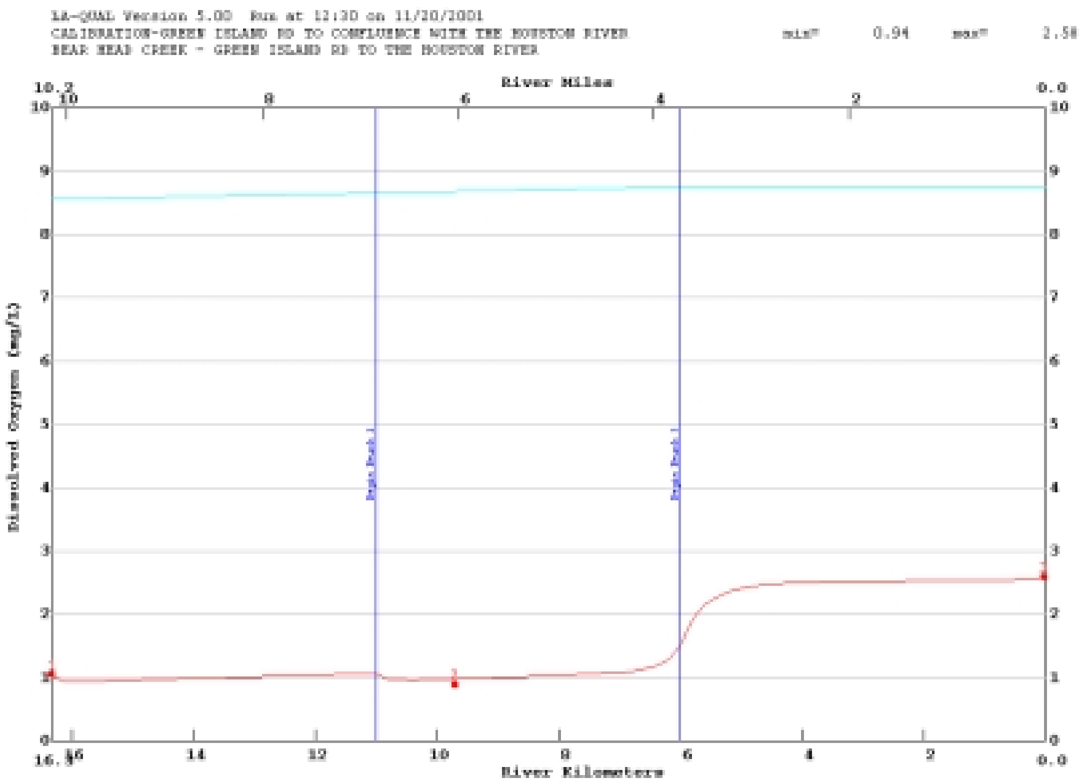


Figure 4. DO Calibration Plot



4.0 Water Quality Projections

Projections were performed for the following scenarios:

(1) March-November, 5.0 mg/L DO (current)
(2) March-November, 3.0 mg/L DO (alternate)
(3) December-February, 5.0 mg/L DO (current and alternate)

4.1 Critical Conditions

4.1.1 Seasonality and Margin of Safety

The Clean Water Act requires the consideration of seasonal variation of conditions affecting the constituent of concern, and the inclusion of a margin of safety (MOS) in the development of a TMDL. For the Bear Head Creek TMDL, an analysis of LDEQ ambient data has been employed to determine critical seasonal conditions and an appropriate margin of safety.

Critical conditions for dissolved oxygen were determined for Bear Head Creek using water quality data (January 1999-December 1999) from the station on the LDEQ Ambient Monitoring Network. The 90th percentile temperature for each season was determined. Graphical and regression analysis techniques have been used by LDEQ historically to evaluate the temperature and dissolved oxygen data from the Ambient Monitoring Network and run-off determinations from the Louisiana Office of Climatology water budget. Since nonpoint loading is conveyed by run-off, this was a reasonable correlation to use. Temperature is strongly inversely proportional to dissolved oxygen and moderately inversely proportional to run-off. Dissolved oxygen and run-off are also moderately directly proportional. The analysis concluded that the critical conditions for stream dissolved oxygen concentrations were those of negligible nonpoint run-off and low stream flow combined with high stream temperature.

When the rainfall run-off (and non-point loading) and stream flow are high, turbulence is higher due to the higher flow and the temperature is lowered by the run-off. In addition, run-off coefficients are higher in cooler weather due to reduced evaporation and evapotranspiration, so that the high flow periods of the year tend to be the cooler periods. Reaeration rates and DO saturation are, of course, much higher when water temperatures are cooler, but BOD decay rates are much lower. For these reasons, periods of high loading are periods of higher reaeration and dissolved oxygen but not necessarily periods of high BOD decay.

This phenomenon is interpreted in TMDL modeling by assuming that nonpoint loading associated with flows into the stream are responsible for the benthic blanket which accumulates on the stream bottom and that the accumulated benthic blanket of the stream, expressed as SOD and/or resuspended BOD in the calibration model, has reached steady state or normal conditions over the long term and that short term additions to the blanket are off set by short term losses. This accumulated loading has its greatest impact on the stream during periods of higher temperature and lower flow. The manmade portion of the NPS loading is the difference between the calibration load and the reference stream load where the calibration load is higher. The only mechanism for changing this normal benthic blanket condition is to implement best management practices and reduce the amount of nonpoint source loading entering the stream and feeding the benthic blanket.

Critical season conditions were simulated in the Bear Head Creek dissolved oxygen TMDL projection modeling by using the default flows from the LTP, and the 90th percentile temperature (LDEQ, 9/8/2000). Model loading was from sediment oxygen demand and resuspension of sediments.

In reality, the highest temperatures occur in July-August, the lowest stream flows occur in October-November, and the maximum point source discharge occurs following a significant rainfall, i.e., high-flow conditions. The summer projection model is established as if all these conditions happened at the same time. The winter projection model accounts for the seasonal differences in flows and BMP efficiencies. Other conservative assumptions regarding rates and loadings are also made during the modeling process. In addition to the conservative measures, an explicit MOS of 20% was used for all loads to account for future growth, safety, model uncertainty and data inadequacies.

4.2 Projection Model Input Discussion

Projections were run at the three scenarios as previously described. The parameters that changed for projections are summarized below.

4.2.1 Projections, Data Type 11 – Initial Conditions

The 90^{th} percentile temperature at water quality monitoring station 0847 was used (Appendix D). The DO values were set to the DO criteria.

4.2.2 Projections, Data Type 12 – Sediment Oxygen Demand

SOD values were reduced from the calibration values in order to meet the DO criteria.

4.2.3 Projections, Data Type 19 – Nonpoint Source Data

Nonpoint CBOD and NBOD were reduced from calibration values in order to meet the DO criteria.

4.2.4 Projections, Data Type 20 – Headwater Data for Flow and Temperature

The 7Q10 for March-November is 0.0 cfs. Therefore, a flow of 0.0028 cms (0.1 cfs) was used as stated in the LTP (LDEQ, 9/8/2000). The 7Q10 for December-February is 0.7 cfs; therefore, a flow of 0.028 cms (1.0 cfs) was used as stated in the LTP (LDEQ, 9/8/2000). The 90^{th} percentile temperature at water quality monitoring station 0847 was used.

4.2.5 Projections, Data Type 21 – Headwater Data for DO and BOD

DO values were set to the DO criteria. Values for BOD are shown in Appendix H on the Headwater/Tributary spreadsheet.

4.2.6 Projections, Data Type 22 – Headwater Data for Nonconservatives (NBOD)

NBOD values are shown in Appendix H on the Headwater/Tributary spreadsheet.

4.2.7 Projections, Data Type 27 – Lower Boundary Conditions

The ocean exchange ratio was set to zero so that the model would not be forced through any particular values at the most downstream point. However, even with the ocean exchange ratio at zero, the temperature is still forced to terminate at the lower boundary temperature. Therefore, the lower boundary temperatures were set at the 90th percentile critical season temperatures.

4.3 Projection Model Results

The results of the projection model scenarios are shown in Table 3 below. One of the projection scenarios resulted in a required reduction of more than 100% when the required reduction was differentiated between man-made and natural nonpoint pollution. Therefore, the percentage reductions necessary to meet the DO standards were presented as total nonpoint pollution since a reduction of more than 100% is not possible.

Table 3. Total Nonpoint Load Reductions Required

MONTHS	DO CRITERIA	TOTAL NONPOINT LOAD REDUCTIONS REQUIRED
March-November	3.0 mg/L (alternate)	46%
December-February	5.0 mg/L (alternate & current)	21%
March-November	5.0 mg/L (current)	69%

In order to meet the current DO criterion of 5.0 mg/L in the summer, a 69% reduction of total nonpoint loading is necessary. This result indicates that the current criterion is inappropriate for Bear Head Creek and that a UAA should be conducted.

DO plots are shown in Figures 5-7. Model input and output for the projection runs are presented in Appendices E-G.

Figure 5. DO Plot for Projection Run, Alternate 3.0 mg/L DO, March-November

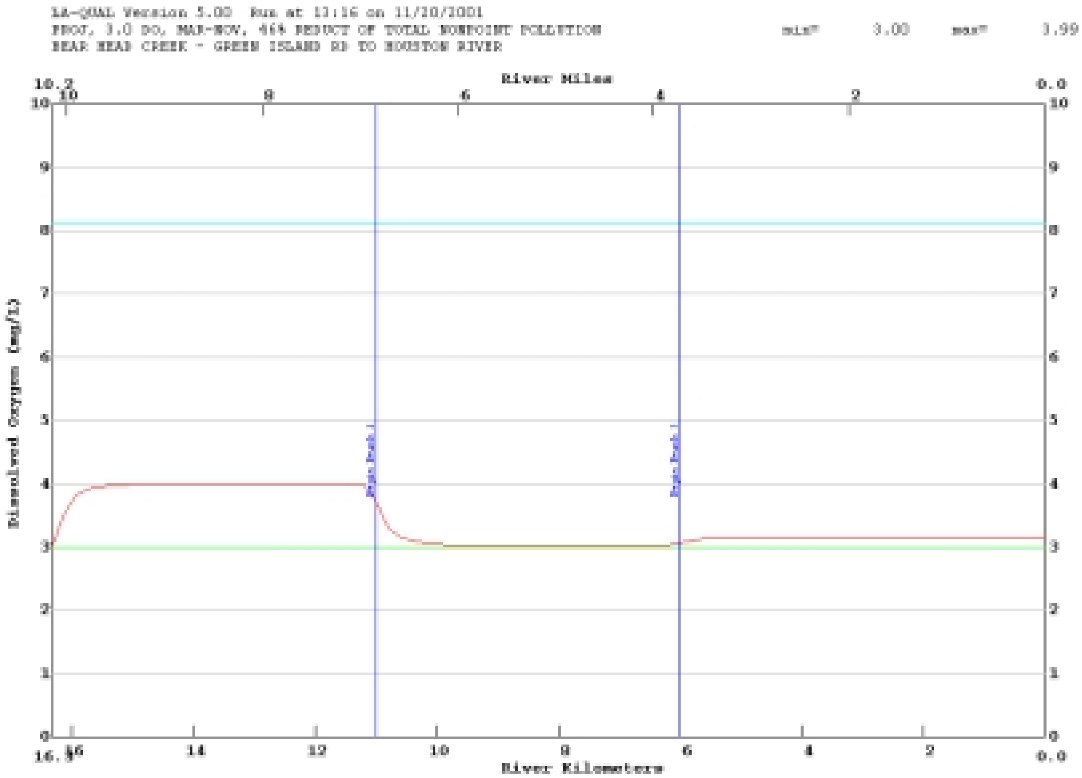


Figure 6. DO Plot for Projection Run, Current 5.0 mg/L DO, March-November

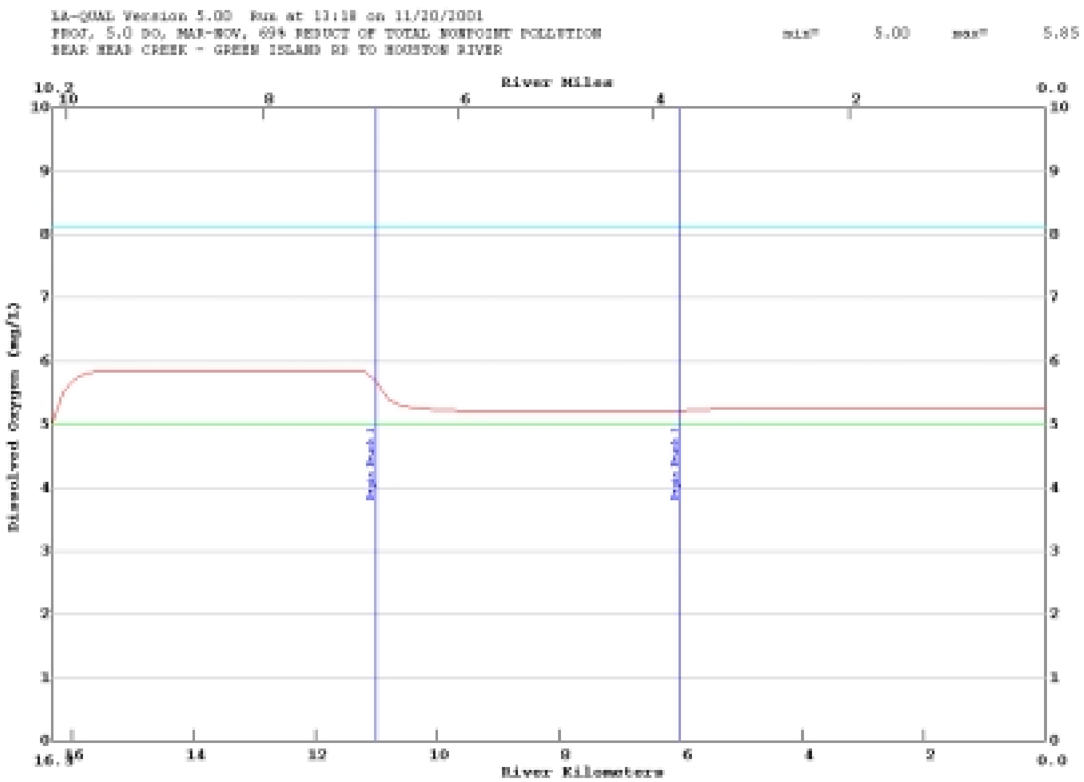
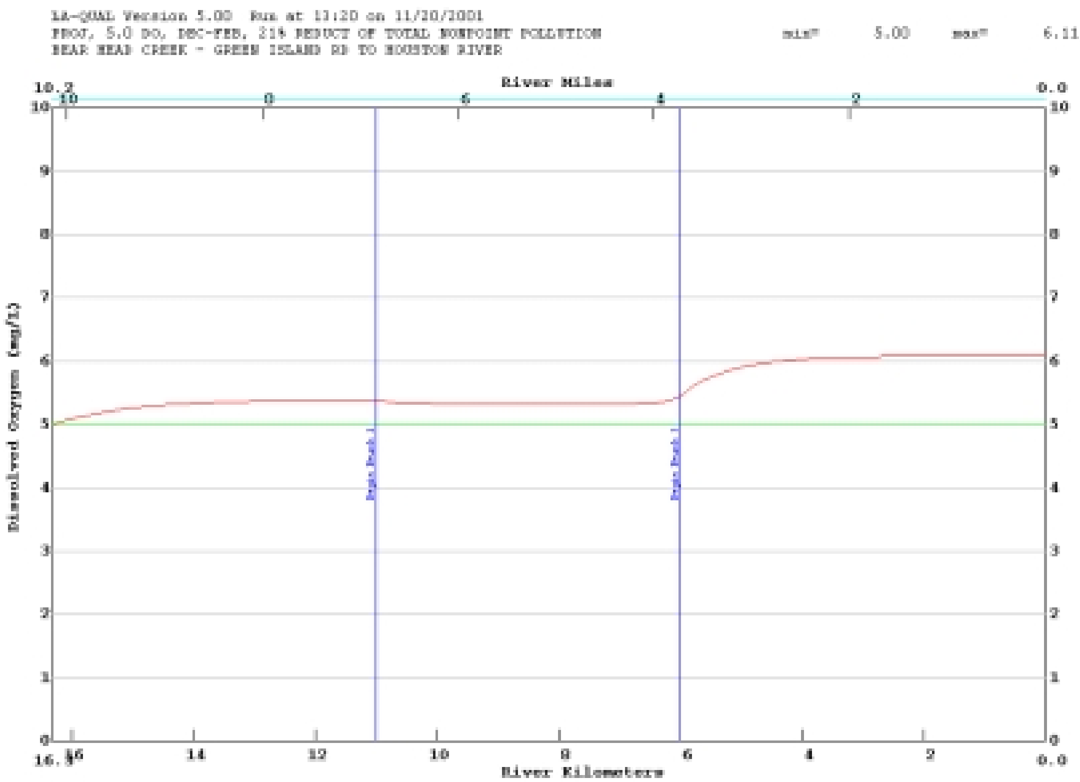


Figure 7. DO Plot for Projection Run, Current & Alternate 5.0 mg/L DO, December-February



4.4 Calculated TMDLs, WLAs and LAs

4.4.1 Outline of TMDL Calculations

An outline of the TMDL calculations is provided to assist in understanding the calculations in the Appendices. Slight variances may occur based on individual cases.

In some cases, percent reductions of more than 100% are calculated when the reductions are differentiated between man-made and natural nonpoint pollution. When this occurs, the percentage reduction is calculated as a reduction in total nonpoint pollution.

4.4.1.1 The natural background benthic loading was estimated from reference stream resuspension (nonpoint CBOD and NBOD), and SOD load data (Smythe, 1997).

4.4.1.2 The calibration man-made benthic loading was determined as follows:

- Calibration resuspension and SOD loads were summed for each reach as gm O_2/m^2-day to get the calibration benthic loading.

- The natural background benthic loading was subtracted from the calibration benthic loading to obtain the man-made calibration benthic loading.

4.4.1.3 Projection benthic loads are determined by trial and error during the modeling process using a uniform percent reduction for resuspension and SOD. Point sources are reduced as necessary to subsequently more stringent levels of treatment consistent with the size of the treatment facility as much as possible. Point source design flows are increased to obtain an explicit MOS of 20%. Headwater and tributary concentrations of CBOD, NBOD, and DO range from reference stream levels to calibration levels based on the character of the headwater.

- The projection benthic loading at 20^oC is calculated as the sum of the projection resuspension and SOD components expressed as gm O_2/m^2-day.

- The natural background benthic load is subtracted from the projection benthic load to obtain the man-made projection benthic load for each reach.

- The percent reduction of man-made loads for each reach is determined from the difference between the projected man-made non-point load and the man-made non-point load found during calibration.

- The projection loads are computed in units of lb/d for each reach.

4.4.1.4 The total stream loading capacity at critical water temperature is calculated as the sum of:

- Headwater and tributary CBOD and NBOD loading in lb/d.

- The natural and man-made projection benthic loading for all reaches of the stream is converted to the loading at critical temperature and summed in lb/d.

- Point source CBOD and NBOD loading in lb/d.

- The margin of safety in lb/d.

4.4.2 Bear Head Creek TMDL

The TMDLs for the oxygen demanding constituents (CBOD, NBOD and SOD) have been calculated for the current and alternate DO criteria. The alternate criteria will not be applicable until a standards change is promulgated and approved by EPA. A summary of the loads is shown in Table 4.

Table 4. Total Maximum Daily Loads (Sum of CBOD, NBOD, and SOD)

	3 mg/L DO, Mar-Nov (alternate)	5 mg/L DO, Mar-Nov (current)	5 mg/L DO, Dec-Feb (current & alternate)
Point Source WLA, lb/day of oxygen demand	5.0	5.0	5.0
Point Source MOS, lb/day of oxygen demand	1.2	1.2	1.2
Nonpoint LA, lb/day of oxygen demand	1455	832	1463
Nonpoint MOS, lb/day of oxygen demand	17	0	106
TMDL, lb/day of oxygen demand	1479	838	1575

Intermediate calculations for the TMDLs are shown in Appendix H.

5.0 Sensitivity Analysis

All modeling studies necessarily involve uncertainty and some degree of approximation. It is therefore of value to consider the sensitivity of the model output to changes in model coefficients and in the hypothesized relationships among the parameters of the model. LA-QUAL allows multiple parameters to be varied with a single run. The model adjusts each parameter up or down by the percentage given in the input set. Parameters were varied by +/- 30%, except temperature, which was adjusted +/- 2 degrees Celsius. The rest of the parameters listed in the sensitivity section are held at their original value. Thus the sensitivity of each parameter is reviewed separately.

A sensitivity analysis of the model’s minimum DO was performed on the calibration and showed that DO is most sensitive to reaeration, benthal demand, and initial temperature. The sensitivity analysis is shown below in Table 5.

Table 5. Sensitivity Analysis

SENSITIVITY ANALYSIS SUMMARY

Plot 1 Base Model Minimum DO = 0.94

Parameter	%Param Chg	Min D.O.	%D.O. Chg	%Param Chg	Min D.O.	%D.O. Chg
Stream Baseflow	30.	0.94	0.2	-30.	0.94	-0.3
Stream Velocity	30.	0.82	-12.9	-30.	1.05	11.5
Stream Depth	30.	0.90	-3.9	-30.	0.96	1.8
Stream Dispersion	30.	0.94	0.0	-30.	0.94	0.0
Stream Reaeration	30.	1.05	11.5	-30.	0.00	-100.0
BOD Decay Rate	30.	0.84	-10.8	-30.	1.05	11.5
BOD Settling Rate	30.	1.01	7.0	-30.	0.82	-13.1
Benthal Demand	30.	0.00	-100.0	-30.	1.05	11.5
Nonconservative Decay	30.	0.93	-1.1	-30.	0.95	1.3
Nonconservative Settling	30.	0.95	0.7	-30.	0.93	-0.9
Initial Temperature	2.	0.32	-65.8	-2.	1.05	11.5
Headwater Flow	30.	0.94	0.2	-30.	0.94	-0.3
Headwater Temperature	2.	0.94	0.0	-2.	0.94	0.0
Headwater DO	30.	0.94	0.2	-30.	0.93	-1.6
Headwater BOD	30.	0.91	-3.8	-30.	0.95	1.1
Headwater Nonconservative	30.	0.94	-0.4	-30.	0.95	0.4
Ocean Exchange Ratio	30.	0.94	0.0	-30.	0.94	0.0
Lower Boundary Temperature	2.	0.94	0.0	-2.	0.94	0.0
Lower Boundary DO	30.	0.94	0.0	-30.	0.94	0.0
Lower Boundary BOD	30.	0.94	0.0	-30.	0.94	0.0
Lower Boundary Nonconservative	30.	0.94	0.0	-30.	0.94	0.0

6.0 Conclusions

The current state standard for Bear Head Creek requires a DO of 5.0 mg/L throughout the year. Seasonal criteria of 3.0 mg/L during the summer and 5.0 mg/L during the winter could possibly be set for Bear Head Creek sometime in the future. Model projections were performed for the current and alternate criteria using the seasons of March-November and December-February. The alternate criteria will not be applicable until a standards change is promulgated and approved by EPA.

In order to meet the current DO criterion of 5.0 mg/L in the summer, a 69% reduction of total nonpoint loading is necessary. This result indicates that the current criterion is inappropriate for Bear Head Creek and that a UAA should be conducted. The alternate criterion of 3.0 mg/L in the summer can be attained with a 46% reduction of total nonpoint loading. For the winter season, a 21% reduction of total nonpoint loading is necessary.

Hyatt High School is currently permitted at a BOD_5 weekly average of 45 mg/L with no limits for NH_3-N. Hyatt High School will continue to be permitted according to state policy and will receive monthly average limits of 30 mg/L $CBOD_5$ and 15 mg/L NH_3-N.

The NH_3-N limit corresponds to the respective $CBOD_5$ level of treatment as indicated in the LTP (LDEQ, 9/8/2000).

LDEQ has developed this TMDL to be consistent with the State antidegradation policy (LAC 33:IX.1109.A).

LDEQ will work with other agencies such as local Soil Conservation Districts to implement agricultural best management practices in the watershed through the 319 programs. LDEQ will also continue to monitor the waters to determine whether standards are being attained.

In accordance with Section 106 of the federal Clean Water Act and under the authority of the Louisiana Environmental Quality Act, the LDEQ has established a comprehensive program for monitoring the quality of the state's surface waters. The LDEQ Surveillance Section collects surface water samples at various locations, utilizing appropriate sampling methods and procedures for ensuring the quality of the data collected. The objectives of the surface water monitoring program are to determine the quality of the state's surface waters, to develop a long-term data base for water quality trend analysis, and to monitor the effectiveness of pollution controls. The data obtained through the surface water monitoring program is used to develop the state's biennial 305(b) report (*Water Quality Inventory*) and the 303(d) list of impaired waters. This information is also utilized in establishing priorities for the LDEQ nonpoint source program.

The LDEQ has implemented a watershed approach to surface water quality monitoring. Through this approach, the entire state is sampled over a five-year cycle with two targeted basins sampled each year. Long-term trend monitoring sites at various locations on the larger rivers and Lake Pontchartrain are sampled throughout the five-year cycle. Sampling is conducted on a monthly basis or more frequently if necessary to yield at least 12 samples per site each year. Sampling sites are located where they are considered to be representative of the waterbody. Under the current monitoring schedule, targeted basins follow the TMDL priorities. In this manner, the first TMDLs will have been implemented by the time the first priority basins will be monitored again in the second five-year cycle. This will allow the LDEQ to determine whether there has been any improvement in water quality following implementation of the TMDLs. As the monitoring results are evaluated at the end of each year, waterbodies may be added to or removed from the 303(d) list. The sampling schedule for the first five-year cycle is shown below.

1998 - Mermentau and Vermilion-Teche River Basins
1999 - Calcasieu and Ouachita River Basins
2000 - Barataria and Terrebonne Basins
2001 - Lake Pontchartrain Basin and Pearl River Basin
2002 - Red and Sabine River Basins

(Atchafalaya and Mississippi Rivers will be sampled continuously.)
The Calcasieu River Basin will be sampled again in 2004.

As part of the monitoring program, compliance inspections are also being conducted in the targeted basins each year as part of the watershed approach to monitoring and to identify enforcement needs. Compliance inspections conducted during 1999 were as follows:

Calcasieu Basin - 33 major NPDES facilities, 260 minor facilities

Ouachita Basin - 348 facilities (total) inspected

7.0 References

Louisiana Department of Environmental Quality. 1999. Nonpoint Source Management Plan, Baton Rouge, Louisiana, http://nonpoint.deq.state.la.us/99manplan/99calcasieu.pdf

Louisiana Department of Environmental Quality. Louisiana Total Maximum Daily Load Technical Procedures (LTP), September 8, 2000. Office of Environmental Assessment, Environmental Technology Division, Engineering Group 2, Baton Rouge, Louisiana.

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Shoemaker, L., et. al. *Compendium of Tools for Watershed Assessment and TMDL Development.* Office of Wetland, Oceans, and Watersheds, USEPA, EPA841-B-97-006, pp. 1-30. Washington, DC: May, 1997.

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