

FINAL

PETIT CAILLOU WATERSHED TMDL FOR BIOCHEMICAL OXYGEN-DEMANDING SUBSTANCES AND NUTRIENTS

SUBSEGMENTS 120504

SURVEYED JUNE 7 – 9, 2005

TMDL REPORT

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MARCH 31, 2008

EXECUTIVE SUMMARY

This report presents the results of a watershed based, calibrated modeling analysis of Petit Caillou, subsegment 120504. The modeling was conducted to establish a TMDL for biochemical oxygen-demanding pollutants for the Petit Caillou watershed. The model extends from the Klondyke Bridge to its confluence with Boudreaux Canal. Petit Caillou is located in south Louisiana and this subsegment has no tributaries. Petit Caillou is in the Terrebonne Basin and this study includes Water Quality Subsegment 120504. The area is sparsely populated and land use is dominated by agriculture and wetlands.

There were six permitted dischargers located in this subsegment. Four of the permitted dischargers are located on the Petit Caillou waterbody. The other two permitted dischargers actually discharge to other streams located in the 120504 subsegment but never reach the Petit Caillou 120504 mainstem. The two dischargers located in this subsegment but never reach Petit Caillou are Indian Ridge STP and the Piggly Wiggly Store. In these situations, limits for these facilities are generally set by state policy. Therefore, the limits for Indian Ridge and the Piggly Wiggly store will remain the same.

The other four permitted dischargers are Sarah Bridge STP, Indian Ridge Shrimp Company, Price Seafood, and Triple T Seafood. All four of these dischargers were included in the projection modeling. They were shown to have little impact on Petit Caillou and as such will also remain at their same limits.

Input data for the calibration model was developed from data collected during the June 2005 intensive survey; data collected by LDEQ monitoring stations in the watershed; USGS drainage area and low flow publications. The nonpoint source loads included nonpoint loading not associated with flow. A satisfactory calibration was achieved for the main stem. For the projection models, data was taken from ambient temperature and dissolved oxygen records. The Louisiana Total Maximum Daily Load Technical Procedures, Revision 9 have been followed in this study.

The various spreadsheets that were used in conjunction with the modeling program may be found in the appendices. Projections were adjusted to meet the dissolved oxygen criteria by reducing total nonpoint source loads.

Modeling was limited to low flow scenarios for both the calibration and the projections since the constituent of concern was dissolved oxygen and the available data was limited to low flow conditions. The model used was LAQUAL, a modified version of QUAL-TX, which has been adapted to address specific needs of Louisiana waters.

Petit Caillou, Subsegment 120504 is listed on the 2002 Consent Decree (CD) 303(d) list . Subsegment 120504 was found to be "not supporting" any of its designated uses of Primary and Secondary Contact Recreation, Fish and Wildlife Propagation, and Shellfish Propagation. Petit Caillou was subsequently scheduled for TMDL development with other listed waters in the Terrebonne Basin. The suspected causes of impairment are dissolved oxygen, taste and odor, total fecal coliform, and nutrients. The suspected sources are unknown sources, on site treatment systems, package plants, other permitted small flows discharges, and total retention domestic sewage lagoons. This TMDL addresses the organic enrichment/low DO impairment.

This TMDL establishes load limitations for oxygen-demanding substances and goals for reduction of those pollutants. LDEQ's position, as supported by the declaratory ruling issued by Secretary Givens in response to the lawsuit regarding water quality criteria for nutrients (*Sierra Club v. Givens*, 710 So.2d 249 (La. App. 1st Cir. 1997), writ denied, 705 So.2d 1106 (La. 1998), is that when oxygen-demanding substances are controlled and limited in order to ensure that the dissolved oxygen criterion is supported, nutrients are also controlled and limited. The implementation of this TMDL through wastewater discharge permits and implementation of best management practices to control and reduce runoff of soil and oxygen-demanding pollutants from nonpoint sources in the watershed will also control and reduce the nutrient loading from those sources.

A calibrated water quality model for the watershed was developed and projections were modeled to quantify the non-point source load reductions which would be necessary in order for Petit Caillou, subsegment 120504 to comply with its established water quality standards and criteria. This report presents the results of that analysis.

The results of the projection modeling for subsegment 120504 show that the water quality standard of 4.0 mg/l for dissolved oxygen can be maintained during the summer critical season with a 70% reduction of total nonpoint pollution. The minimum DO is 4.14 mg/l. There were no appropriate reference streams to calculate background conditions.

Table 1. Total Maximum Daily Load (Sum of UCBOD¹, UNBOD, and SOD)

ALLOCATION	Summer	Summer	Winter	Winter
	% Reduction Required	May – Oct (lbs/day)	% Reduction Required	Nov - Apr (lbs/day)
Point Source WLA	0%	1206	0%	1206
Point Source Reserve MOS (20%)		302		302
Total Nonpoint Source LA	70%	8,141	70%	7,753
Total Nonpoint Source Reserve MOS (20%)		2,035		1,938
TMDL		11,684		11,199

***Note1: UCBOD as stated in this allocation is Ultimate CBOD.
 UCBOD to CBOD₅ ratio = 2.3 for all treatment levels
 Permit allocations are generally based on CBOD₅***

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Revised: March 31, 2008

The results of the projection modeling for subsegment 120504 show that the water quality standard of 4.0 mg/l for dissolved oxygen can be maintained during the winter critical season with the same 70% reduction of total nonpoint pollution. The minimum DO is 4.38 mg/l in subsegment 120504. The TMDL is presented in Table 1. A summary of the point sources is presented in Table 2.

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 is continuing to implement a watershed approach to the surface water quality monitoring. In 2004 a four year sampling cycle replaced the previous five year cycle. Approximately one quarter of the states watersheds will be sampled in each year so that all of the states watersheds will be sampled within the four 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.

Table 2. 120504 Discharger Inventory

FACILITY	FILE No.	Out-fall No.	OUTFALL DESCRIPTION	FACILITY TYPE	RECEIVING WATER	EXPECTED FLOW GPD	MONTHLY AVERAGE CONCENTRATION LIMITS		MONTHLY AVERAGE MASS LIMITS		MODELING COMMENTS
							BOD5/ CBOD5, mg/L	NH ₃ -N, mg/L	BOD, lbs./day	NH ₃ -N, lbs./day	
Price Seafood	19047	LA0077461	Discharge to process wastewater, and washdown wastewater.	Shrimp Processor	Petite Caillou	9,500	Report		Report		Modeled
Indian Ridge Shrimp Co.	41891	LA0004073	Discharge to process wastewater, washdown water, and hand sink wastewater	Shrimp Processor	Petite Caillou	144,000			500		Modeled
Indian Ridge STP	43511	LAG560177	Discharge treated sanitary wastewater	STP	Bayou La Cache	30,000	20		5.01		This discharger is located in this subsegment but does not discharge to Petite Caillou.
Triple T Enterprises	43639	LA0091278	Discharge treated process wastewater, wash down water, and previously monitored sanitary wastewater.	Shrimp Processor	Petite Caillou	192,000	Report		Report		Modeled
Sarah Bridge	18955	LAG530311	Discharge Sanitary Wastewater	Traffic Bridge	Petite Caillou	20	30		0.005		Modeled
Piggly Wiggly	81084	LAG531035	Discharge treated wastewater	Supermarket	Unnamed ditch to Unnamed bayou to Boudreaux Canal	1200	30		0.30		This discharger is located in this subsegment but does not discharge to Petite Caillou.

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Introduction

Petit Caillou, Subsegment 120504, was on the 303(d) list starting with the 1999 list. Subsegment 120504 was found to be "not supporting" any of its designated uses of Primary and Secondary Contact Recreation, Fish and Wildlife Propagation, and Shellfish Propagation. Petit Caillou was subsequently scheduled for TMDL development with other listed waters in the Terrebonne Basin. The suspected causes of impairment are dissolved oxygen, taste and odor, total fecal coliform, and total phosphorus. The suspected sources are unknown sources, on site treatment systems, package plants, other permitted small flows discharges, and total retention domestic sewage lagoons. This report presents the model development and results.

2. Study Area Description
2.1 General Information

Terrebonne Basin

“The Terrebonne Basin covers an area extending approximately 120 miles from the Mississippi River on the north to the Gulf of Mexico on the south. It varies in width from 18 miles to 70 miles. This basin is bounded on the west by the Atchafalaya River Basin and on the east by the Mississippi River and Bayou LaFourche. The topography of the entire basin is lowland, and all the land is subject to flooding except the natural levees along major waterways. The coastal portion of the basin is prone to tidal flooding and consists of marshes ranging from fresh to saline.” (LA DEQ, 1996)

Subsegment 120504 includes Petit Caillou from the Klondyke Road Bridge to its confluence with Boudreaux Canal. This subsegment is tidally influenced. Water flows in either direction depending upon tides and wind conditions. This area is typical of the basin and is primarily comprised of agriculture and wetlands as documented in Table 3 (LADEQ, 1999). A detailed land cover map of Subsegment 120504 is also included in Appendix H2. Average annual precipitation in the segment, based on the nearest Louisiana Climatic Station, is 64 inches based on a 30-year period of record (LSU, 1999). There is a Louisiana average annual precipitation map located in Appendix H3.

Table 3. Land Uses in Segment 120504

Land Type	Acres	Percent Land
Agriculture/Cropland/Grassland	3389.96	35.93
Wetland Forest Deciduous	2325.36	24.65
Vegetated Urban	1494.94	15.85
Water	1050.59	11.14
Fresh Marsh	471.70	5.00
Brackish Marsh	412.10	4.37
Wetland S/S Deciduous	213.28	2.26
Upland Forest Deciduous	39.14	0.41
Upland Forest Mixed	30.69	0.33
Upland S/S Mixed	6.89	0.07

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Figure 1. Model Layout

Petit Caillou Model Layout Subsegment 120504

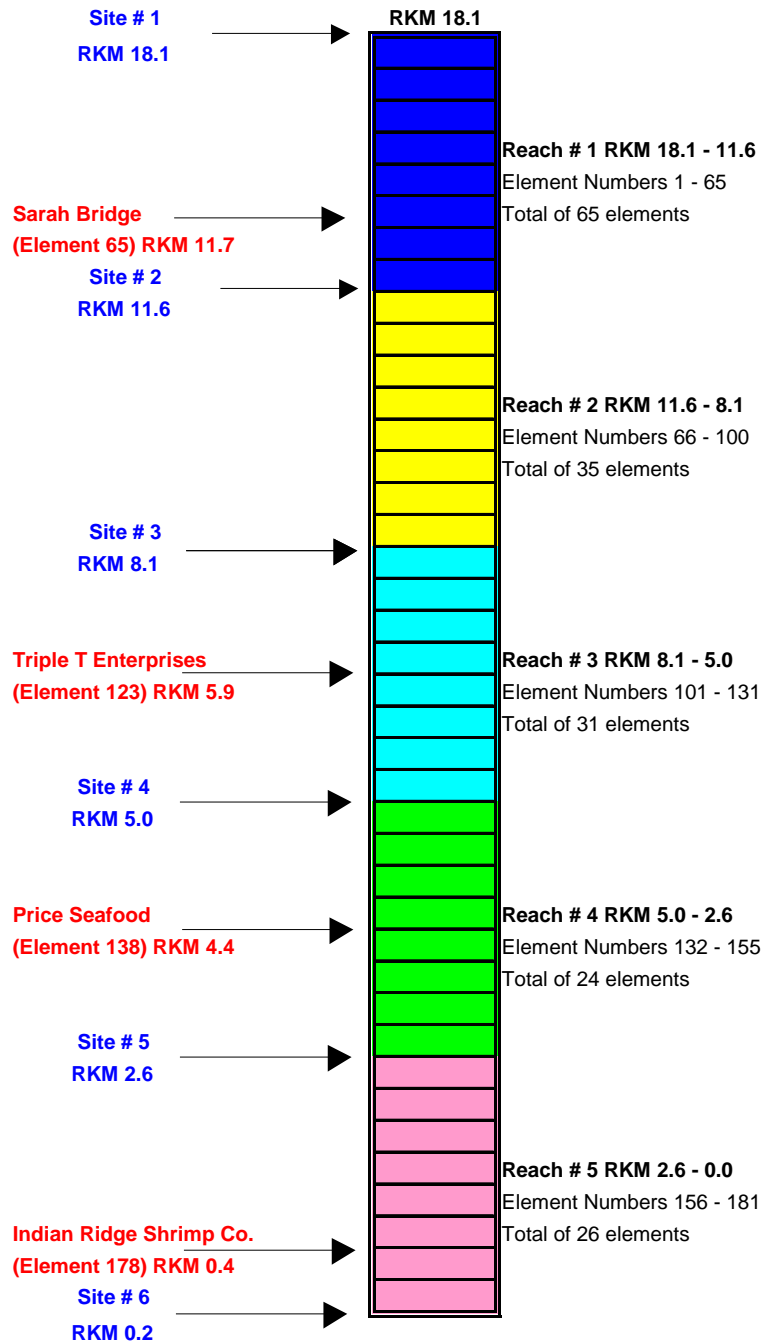
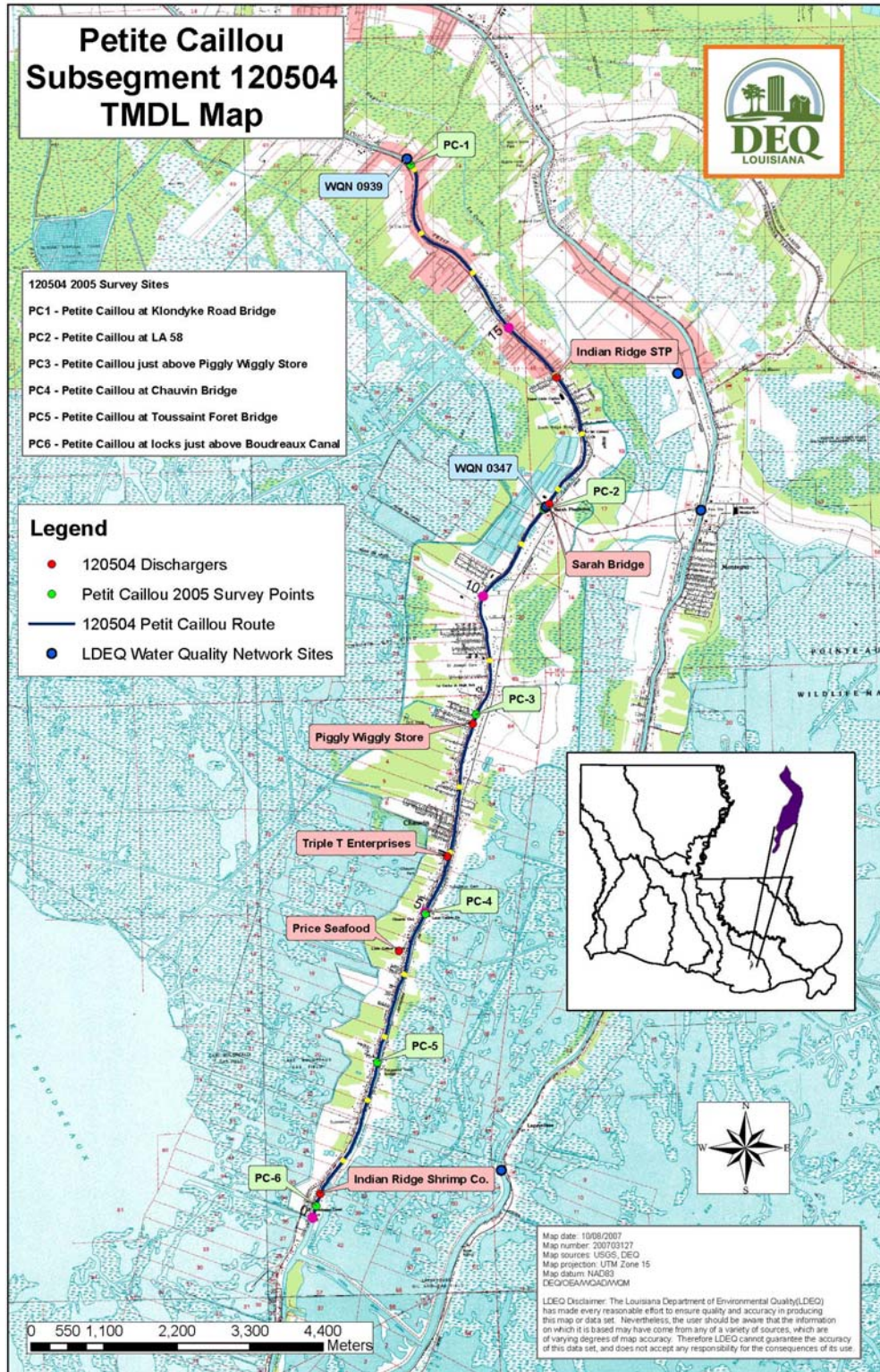


Figure 2. Map of Study Area



2.2 Water Quality Standards

The Water Quality criteria and designated uses for Petit Caillou Watershed are shown in Table 4. As noted in the table, Petit Caillou, Subsegment 120504 has a year round dissolved oxygen standard of 4.0 mg/L.

Table 4. Water Quality Numerical Criteria and Designated Uses

Parameter	Value
Designated Uses	A B C E
DO, mg/L	4.0
Cl, mg/L	N/A
SO ₄ , mg/L	N/A
pH	6.0 – 9.0
BAC	4
Temperature, deg Celsius	32
TDS, mg/L	N/A

USES: A – primary contact recreation; B - secondary contact recreation; C – propagation of fish and wildlife; D – drinking water supply; E – oyster propagation; F – agriculture; G – outstanding natural resource water; L – limited aquatic life and wildlife use.

*Note 1 – 200 colonies/100mL maximum log mean and no more than 25% of samples exceeding 400 colonies/100mL for the period May through October; 1,000 colonies/100mL maximum log mean and no more than 25% of samples exceeding 2,000 colonies/100mL for the period November through April.

2.3 Wastewater Discharges

There were six permitted dischargers located in this subsegment. Facilities that do not have permitted discharge limits for BOD were not addressed in this TMDL. Below is a table listing the BOD permitted dischargers for subsegment 120504. A discharger listing with an inventory is located in Table 5. The limits for these facilities will remain the same and will continue to be permitted using state policy.

Table 5. Discharger Inventory for Petit Caillou Subsegment 120504

FACILITY	FILE No.	Out-fall No.	OUTFALL DESCRIPTION	FACILITY TYPE	RECEIVING WATER	EXPECTED FLOW GPD	MONTHLY AVERAGE CONCENTRATION LIMITS		MONTHLY AVERAGE MASS LIMITS		MODELING COMMENTS
							BOD5/ CBOD5, mg/L	NH ₃ -N, mg/L	BOD, lbs./day	NH ₃ -N, lbs./day	
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Indian Ridge STP	43511	LAG560177	Discharge treated sanitary wastewater	STP	Bayou La Cache	30,000	20		5.01		This discharger is in this subsegment but not discharging to Petite Caillou.
Triple T Enterprises	43639	LA0091278	Discharge treated process wastewater, wash down water, and previously monitored sanitary wastewater.	Shrimp Processor	Petite Caillou	192,000	Report		Report		Modeled
Sarah Bridge	18955	LAG530311	Discharge Sanitary Wastewater	Traffic Bridge	Petite Caillou	20	30		0.005		Modeled

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Piggly Wiggly	81084	LAG531035	Discharge treated wastewater	Supermarket	Unnamed ditch to Unnamed bayou to Boudreaux Canal	1200	30		0.30	This discharger is located in this subsegment but does not discharge to Petite Caillou.
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2.4 Water Quality Conditions/Assessment

Petit Caillou, subsegment 120504, of the Terrebonne Basin was listed on the court-ordered 303(d) list. This subsegment is listed as not supporting Primary and Secondary Contact Recreation, Fish and Wildlife Propagation and Shellfish propagation. The suspected causes of impairments are low DO, nutrients, fecal coliform, and taste and odor. The suspected sources are unknown sources, on-site treatment systems, package plant, other permitted small flow discharges, and total retention domestic sewage lagoons. Because of the impairment, this subsegment requires the development of a total maximum daily load (TMDL) for oxygen demanding substances.

2.5 Prior Studies

LDEQ had a monthly water quality sampling station on Petit Caillou. LDEQ Water Quality Site 347 has a period of record from January 1991 to December 2000. Data collected during the Eularian survey conducted in June 2005, included discharge data, cross-section data, field in-situ data, continuous monitor data, and lab water quality data. This data was used to establish the input for the model calibration and is presented in Appendix F.

3. Documentation Calibration Model

3.1 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 near shore 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.” (EPA841-b-97-006, pp. 1-30)

The model used for this TMDL was LA-QUAL, a steady-state one-dimensional water quality model. LA-QUAL history dates back to the QUAL-I model developed by the Texas Water Development Board with Frank D. Masch & Associates in 1970 and 1971. William A. White wrote a original code.

In June, 1972, the United States Environmental Protection Agency awarded Water Resources Engineers, Inc. (now Camp Dresser & McKee) a contract to modify QUAL-I for application to the Chattahoochee-Flint River, the Upper Mississippi River, the Iowa-Cedar River, and the Santee River. The modified version of QUAL-I was known as QUAL-II.

Over the next three years, several versions of the model evolved in response to specific client needs. In March, 1976, the Southeast Michigan Council of Governments (SEMCOG) contracted with Water Resources Engineers, Inc. to make further modifications and to combine the best features of the

existing versions of QUAL-II into a single model. That became known as the QUAL-II/ SEMCOG version.

Between 1978 and 1984, Bruce L. Wiland with the Texas Department of Water Resources modified QUAL-II for application to the Houston Ship Channel estuarine system. Numerous modifications were made to enable modeling this very large and complex system including the addition of tidal dispersion, lower boundary conditions, nitrification inhibition, sensitivity analysis capability, branching tributaries, and various input/output changes. This model became known as QUAL-TX and was subsequently applied to streams throughout the State of Texas.

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 total maximum daily loads in the State of Louisiana.

The development of a TMDL for dissolved oxygen generally occurs in 3 stages. 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 and 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 in to 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 water body, 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 judgment 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 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. If a second set of measurements is available for slightly different conditions, the calibrated model is run with these conditions to see if the calibration holds for both sets of data. When this happens, the model is said to be verified.

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.

3.2 Input Data Documentation

Data collected during an intensive survey conducted from June 7 – 9, 2005, was used to establish the input for the model calibration. The data is presented in Appendix F. The headwater flow was based on the UNET data average of harmonic mean values for Site PC-6 and PC-2 from midnight 6/7/2005 to midnight 6/8/2005.

Field and laboratory water quality data were entered in a spreadsheet for ease of analysis. Upon review of the measured CBOD daily values it became apparent that there were two distinct CBOD components, which had varying ultimate values as well as decay rates and lag times. The first component started its decay almost immediately while the second component had substantial lag times. The total CBOD curve presented in Appendix F5 is the sum of the two first order equations, which were derived using the Microsoft Excel Solver and were based on the measured daily CBOD values. These two CBOD components were modeled separately as CBOD1 and CBOD2 in the LAQUAL model. NBOD simulated organic nitrogen, ammonia nitrogen, and nitrate/nitrite nitrogen. The Louisiana BOD program was applied to the BOD data in a separate spreadsheet and values were computed for each sample taken of ultimate CBOD1, CBOD1 decay rate, CBOD1 lag time, ultimate CBOD2, CBOD2 decay rate, and CBOD2 lag time as well as the NBOD, NBOD decay rate, and NBOD lag time. The survey data was the primary source of the model input data for initial conditions, decay rates, mainstem water temperature, dissolved oxygen loading, headwater temperature, and DO data.

3.2.1 Model Schematics and Maps

A vector diagram of the modeled area is presented in Figure 1 and Appendix C1. The vector diagram shows the locations of survey stations, the reach/element design, and the dischargers included in the model. An ARCVIEW map of the stream and subsegment showing river kilometers, survey stations, dischargers, and other points of interest are also included in Figure 2 and Appendix H1.

3.2.2 Model Options, Data Type 2

Six constituents were modeled during the calibration process. These were dissolved oxygen, carbonaceous biochemical oxygen demand components 1 and 2, nitrogenous biochemical oxygen

demand, chloride, and conductivity. The continuous monitors did show diurnal swings indicative of algal activity. The algae cycle was not modeled; however, the measured chlorophyll A values were included in the initial conditions. This allowed the model to simulate the oxygen production associated with algae without modeling the entire algal cycle.

3.2.3 Program Constants, Data Type 3

A minimum K_L value of 0.7 m/day was used. This value is a conversion from 2.3 ft/day which is a Louisiana standard minimum. The K_2 maximum was set to 25 1/day at 20° C which is the EPA Policy in the absence of a measured value.

The tide height was calculated from PC-6. The tide height was set equal to the max depth minus the min depth.

The inhibition control value was set to option 3 which is all rates but sediment oxygen demand. The water column dissolved oxygen demand is assumed to come primarily from facultative bacteria under anoxic conditions and SOD is not influenced by modeled dissolved oxygen levels in the upper water column.

The hydraulic calculation method was set to option 2 or “widths and depths.” This was done because the low slopes in these waterbodies cause a substantial amount of water to be present in some reaches during critical flow. Using a modified Leopold relationship allows the model to predict a more accurate depth and width during low flow.

The settling rate units were set to option 2 which is 1/day. By making the settling rate a velocity, the rate becomes dependent upon the depth.

The algae oxygen production was set to zero in order to model to a wide variation in dissolved oxygen.

Dispersion equation 3 was used to take into account all modes of transport.

3.2.3 Temperature Correction of Kinetics, Data Type 4

The temperature values computed are used to correct the rate coefficients in the source/sink terms for the other water quality variables. These coefficients are input at 20 °C and are then corrected to temperature using the following equation:

$$X_T = X_{20} * \text{Theta}^{(T-20)}$$

Where:

X_T = the value of the coefficient at the local temperature T in degrees Celsius

X_{20} = the value of the coefficient at the standard temperature at 20 degrees Celsius

Theta = an empirical constant for each reaction coefficient

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In the absence of specified values for data type 4, the model uses default values. A complete listing of these values can be found in the LA-QUAL for Windows User's Manual (LDEQ, 2004). For this model all values used were LAQUAL default values.

3.2.4 Reach Identification Data, Data Type 8

A diagram of the modeled area is presented in Appendix C1. The vector diagram shows the reach/element design. The modeled area is characterized by 6 sample sites. The model starts at the Klondyke Road Bridge and extends to Boudreaux Canal. This calibrated model includes 5 reaches, 181 elements, and one headwater. A digitized map of the stream showing river kilometers, and the June 2005 survey sampling sites are included in Figure 2 and Appendix H1.

3.2.5 Advective Hydraulic Coefficients, Data Type 9

The Leopold equations are used to scale the velocity (U), width (W), and depth (H) of a free flowing stream from a lower value of flow to a higher value or from a higher value of flow to a lower value. Note that the exponents add to one and the coefficients multiply to 1. This is known as the rule of ones. This method is not appropriate for streams which are not dependent entirely on flow such as waterbodies where flow approaches zero, but contain some depth.

$$U = aQ^b \quad H = cQ^d \quad W = eQ^f$$

$$b + d + f = 1 \quad (a)(c)(e) = 1$$

The Leopold equations presume that the water surface width and average depth of a stream are zero at zero flow. Most Louisiana streams, such as Petit Caillou, retain a significant width and depth at zero flow. The equations have therefore been modified to allow for a zero flow width and depth. The rule of ones does not apply to the modified equations. The modified Leopold equations are:

$$W = aQ^b + c \quad H = dQ^e + f \quad U = gQ^h$$

The width and depths were assumed to be independent of flow. Consequently, the modified Leopold coefficients and exponents were not calculated for this model.

3.2.6 Dispersive Hydraulic Coefficients, Data Type 10

The dispersion was estimated based on the dye study. Fixed site dye runs as well as boat runs were conducted during the survey. The boat runs were used because the calculations were more reasonable values for this type of waterbody. There were three dye runs conducted during this study. Based on the data retrieved the final dye run was determined to be most representative of the stream. This was because the final dye run had the longest run time. The longer time frame gave the dye a longer time to become more uniformly dispersed in the river. The Kd value was determined to be 2.679. All documentation can be found in Appendix F6.

To take into consideration all modes of transport, equation 3, ($D_L = aH^bQ^cV_M^d$) in Laqual was used. Using $b=5/6$, $c=0$, and $d=1$ will take into account all modes of transport in the manner of the Tracor and QUAL2E equations. The value for coefficient "a" was calibrated to within the boundaries of the final dye run by setting all other parameters to the previously mentioned values. All documentation can be found in Appendix F6.

3.2.7 Initial Conditions, Data Type 11

The initial conditions are used to reduce the number of iterations required by the model. The values required for this model were temperature and DO by reach. The input values came from the survey station(s) located closest to the reach.

When the continuous monitoring dissolved oxygen (DO) data for at least one diurnal cycle is available, it is standard practice to calibrate to the mean DO. In this case, a diurnal variation of greater than 2mg/L was encountered. The standard DEQ practice for this is as follows:

1. Calibrate without simulating algal production as follows:

<u>Range of DO cycle</u>	<u>Calibrate</u>
0 – 2 mg/l	Mean DO for one or more full cycles
2 – 9 mg/l	One mg/l over minimum DO
>9 mg/l	0.11*DO cycle over minimum DO

These practices were followed for this model.

Chlorophyll a values were also used since the mild effects of algae on the dissolved oxygen concentrations were also simulated with this model. The initial conditions are only a starting point for the model, therefore, all values were set to the measured values. The input data and sources are shown in Appendix B.

3.2.8 Reaeration Rates, Data Type 12

The applicability of the various reaeration equations was examined. The Texas Equation was the most applicable to Petit Caillou. The input data and sources are shown in Appendix B2.

3.2.9 Sediment Oxygen Demand, Data Type 12

The SOD values were achieved through calibration. The SOD value for each reach is shown in Appendix B2. The values were considered to be reasonable for this type of stream. The conversion ratio of settled CBOD and settled NBOD to SOD was considered to be zero for all reaches.

3.2.10 Carbonaceous BOD Decay and Settling Rates, Data Type 12

The decay rates used were based on the bottle rates from the survey. Review of the measured CBOD daily values revealed two distinct CBOD components, which had varying decay rates and lag times. The first component started its decay almost immediately with decay rates ranging from 0.0978 to 0.3350 per day. The second component had substantial lag times and decay rates from 0.0294 to 0.0392 per day. The decay rates for PC1 are not consistent with the rest of the survey sites. The total CBOD curves presented in Appendix F5 are the sum of the two first order equations, which were derived using the Microsoft Excel Solver and were based on the measured daily CBOD values. These two components were modeled separately as CBOD1 and CBOD2 in the LAQUAL model. The decay and settling rates used for each reach are shown in Appendix F5.

3.2.11 Nitrogenous BOD Decay and Settling Rates, Data Type 15

These rates are labeled NBOD Decay and Settling in the model. The decay rates used were based on the bottle rates from the survey. NBOD decay rates were fairly consistent with main stem rates ranging from 0.0451 to 0.1287. The decay rate for PC1 is not consistent with the rest of the survey sites. The decay and settling rates used for each reach are shown in Appendix F5.

3.2.12 Incremental Conditions, Data Types 16, 17, and 18

Incremental conditions were not used in the model.

3.2.13 Nonpoint Sources, Data Type 19

Nonpoint source loads which are not associated with a flow are input into this part of the model. These can be most easily understood as resuspended load from the bottom sediments and are modeled as SOD, CBOD1, CBOD2, and NBOD loads. These values are achieved through calibration.

3.2.14 Headwaters, Data Types 20, 21, and 22

There were no headwater flow measurements taken. Thus, the headwater flow was based on UNET data average of harmonic mean values for Site PC-6 and PC-2 from midnight 6/7/2005 to midnight 6/8/2005. This value was determined to be 2.65 cms. The data and sources are presented in Appendix B2.

3.2.15 Wasteloads, Data Types 23, 24, and 25

A facility review was performed on the subsegment and six permitted dischargers were found to be located in subsegment 120504. The six dischargers are Indian Ridge STP, Sarah Bridge, Piggly Wiggly Store, Triple T Enterprises, Price Seafood, and Indian Ridge Shrimp Company. Indian Ridge STP and Piggly Wiggly Store never reach Petit Caillou. In these situations, limits for these facilities are generally set by state policy. Due to the fact that these facilities have no impact on the named 303(d) listed waterbody, Petit Caillou, they were not modeled and will remain at their current permit limits and will continue to be permitted by state policy. Of the other four dischargers, only Price Seafood was discharging at the time of the survey and was therefore, included in the calibration. The discharger was included at expected flow. The CBOD and NBOD values used were calculated based on expected flow using standard practices for seafood processing. The statement of basis for modeled permitted dischargers is located in Appendix G4.

3.2.16 Boundary Conditions, Data Type 27

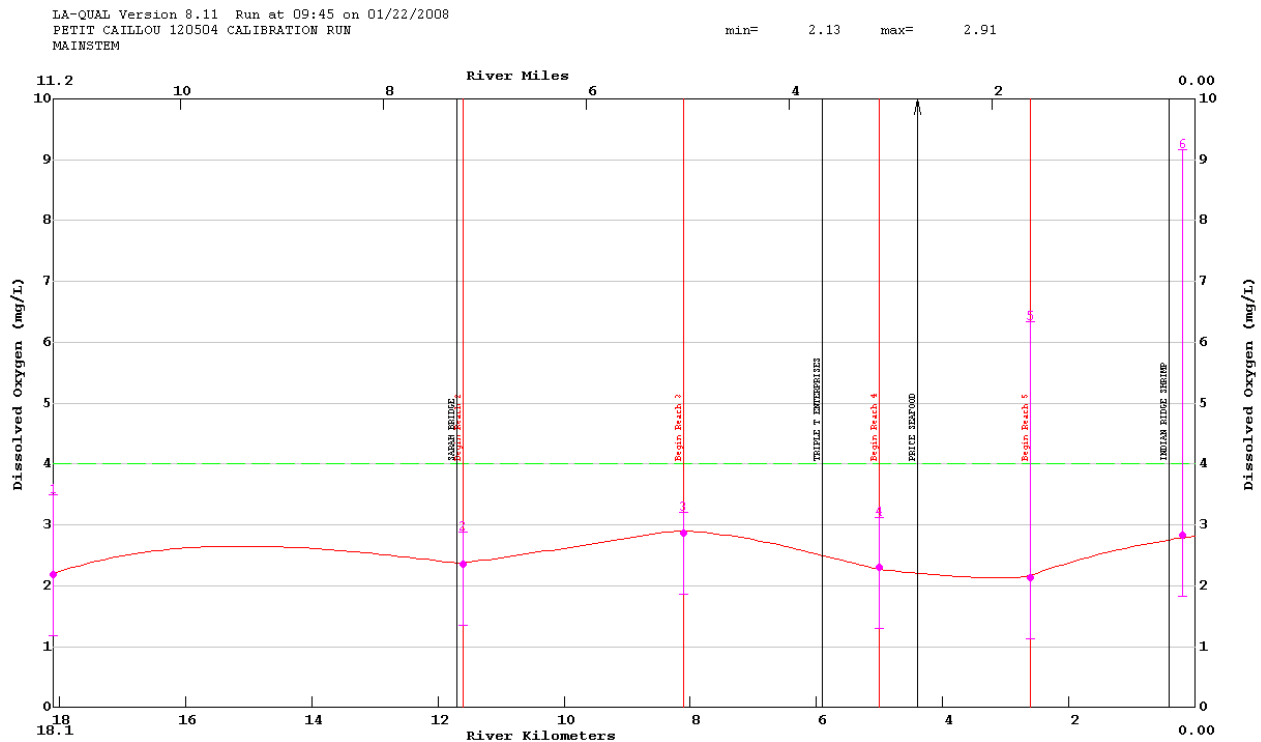
The lower boundary conditions were assumed to be equivalent to the measurements taken at survey station PC-6. PC-6 was used because PC-7 was still within the mixing zone for Boudreaux Canal.

3.3 Model Discussion and Results

The calibration model input and output is presented in Appendix B. The overlay plotting option was used to determine if calibration had been achieved. A plot of the dissolved oxygen concentration versus river kilometer is presented in Figure 3. The calibration points for temperature and salinity were calculated based on the average continuous monitor readings. The calibration points for dissolved oxygen were based on the minimum DO + 1. The calibration points for CBOD1, CBOD2, and NBOD were the measured values from the water quality samples. The calibration points for conductivity were the insitu readings. The calibration points for the chlorides and chlorophyll A were the measured values from the water quality samples.

An adequate calibration was achieved for DO, UCBOD1, UCBOD2, NBOD, chlorides, and conductivity on the main stem. The calibration model shows that during June 2005 survey period, the DO standard of 4 mg/l was not being met in subsegment 120504 in any of the modeled reaches. The calibration model minimum DO on the main stem was 2.13 mg/l.

Figure 3. Calibration Model Dissolved Oxygen versus River Kilometer



- numbered points indicate survey stations
- vertical lines indicate beginning of reach
- the horizontal line indicates the DO Criterion
- upper plotted line indicates DO saturation
- lower plotted line indicates calibration model output

4. Water Quality Projections

The traditional summer critical projection loading scenario was performed at the current annual DO standard. This scenario was based on reduced total nonpoint loads at summer season critical conditions (ie. 90th percentile seasonal temperatures and summer default flows) in accordance with the LTP. A winter projection was run based on the percent reduction of total nonpoint loads used for summer critical projections. Additionally, a summer no-load projection was performed to emulate background conditions.

4.1 Critical Conditions, 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 Petit Caillou, subsegment 120504 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 Petit Caillou using water quality data from water quality site number 0347 on the LDEQ Ambient Monitoring Network. The 90th percentile temperature for each season and the corresponding 90% of saturation DO was determined. Ambient temperature data, critical temperature and DO saturation determinations are shown in Appendix G1.

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 Petit Caillou, subsegment 120504 dissolved oxygen TMDL projection modeling by using the flow of 1/3 average tidal flow as per regulations, and the 90th percentile temperature.

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 Input Data Documentation

The LTP states that the flow for critical conditions for a tidal waterbody should be 1/3 average tidal flow. Bayou Petit Caillou is a tidal waterbody. This is consistent with the regulations, LAC 33:IX.1115.

Critical conditions include dissolved oxygen, temperature, and flow. Pollutant loading is adjusted in the projection models to meet the dissolved oxygen criteria.

The calibration values were retained for the remaining parameters and used as input values in the summer and winter projections. The model adjusts the input values for SOD, CBODU decay, and NBODU decay based upon the input temperature.

4.2.1 Model Options, Data Type 2

Four constituents were modeled during the projection process. These were dissolved oxygen, the two components of carbonaceous biochemical oxygen demand, and nitrogenous biochemical oxygen demand.

4.2.2 Temperature Correction of Kinetics, Data Type 4

The temperature correction factors specified in the LTP are entered in the model.

4.2.3 Reach Identification Data, Data Type 8

The reach-element design from the calibration was used in the projection modeling.

4.2.4 Advective Hydraulic Coefficients, Data Type 9

The hydraulic coefficients, exponents, and constants determined for the calibration were used in the projection model.

4.2.5 Initial Conditions, Data Type 11

The initial conditions were set to the 90th percentile critical season temperature in accordance with the LTP. The dissolved oxygen values for the initial conditions were set at the stream criteria.

4.2.6 Reaeration Rates, Carbonaceous BOD Decay and Settling Rates, Nitrogenous BOD Decay and Settling Rates, Data Type 12 and 15

The reaeration rate equations, CBOD1 and CBOD2 decay and settling rates, NBOD decay and settling rates, and the fractions converting settled CBOD and settled NBOD to SOD were not changed from the calibration.

4.2.8 Sediment Oxygen Demand, Nonpoint Sources, Headwaters, Wasteloads, Data Type 12, 19, 20, 21, 22, 24, 25, and 26

The NPS values were calculated for each projection scenario using a load equivalent spreadsheet. An analysis was made of the calibration NPS and SOD loads in terms of total loading in units of gm-O₂/m²/day. The same spreadsheet also calculated load reductions for the headwaters and wasteloads. The values and sources of the input data and the load analyses are presented in Appendix D for each of the projection runs.

LDEQ has collected and measured the CBOD and NBOD oxygen demand loading components for a number of years. These loads have been found in all streams including the non-impacted reference streams. It is LDEQ's opinion that much of this loading is attributable to run-off loads which are flushed into the stream during run-off events, and subsequently settle to the bottom in our slow moving streams. These benthic loads decay and breakdown during the year, becoming easily resuspended into the water column during the low flow/high temperature season. This season has historically been identified as the critical dissolved oxygen season.

LDEQ simulates part of the non-point source oxygen demand loading as resuspended benthic load and SOD. The calibrated non-point loads, UCBOD, UNBOD and SOD, are summed to produce the total calibrated benthic load. The total calibrated benthic load is then reduced by the total background benthic load (determined from LDEQ's reference stream research) to determine the total manmade benthic loading. The manmade portion is then reduced incrementally on a percentage basis to determine the necessary percentage reduction of manmade loading required to meet the water body's dissolved oxygen criteria. These reductions are applied uniformly to all reaches sharing similar hydrology and land uses.

Following the same protocol as the point source discharges, the total reduced manmade benthic load is adjusted for the margin of safety by dividing the value by one minus the margin of safety. This adjusted load is added back to the total background benthic value to obtain the total projection model

benthic load. This total projection benthic load is then broken out into its components of SOD, resuspended CBOD and resuspended NBOD by multiplying the total projection benthic load by the ratio of each calibrated component to the total calibrated benthic load.

LDEQ has found variations in the breakdown of the individual CBOD and NBOD components. While the total BOD is reliable, the carbonaceous and nitrogenous component allocation is subject to the type of test method. In the past, LDEQ used a method which suppressed the nitrogenous component to obtain the carbonaceous component value, which was then subtracted from the total measured BOD to determine the nitrogenous value. The suppressant in this method was only reliable for twenty days thus leading to the assumption that the majority of the carbonaceous loading was depleted within that period of time. The test results supported this assumption. Recently the suppressant started failing around day seven and the manufacturer of the suppressant will only guarantee its potency for a five day period. LDEQ felt a five day test would not adequately depict the water quality of streams and began a search for a new test method. The research found a new proposed method for testing long term BODs in Standard Methods.

This proposed method is a sixty day test which measures the incremental total BOD of the sample while at the same time measuring the increase in nitrite/nitrate in the sample. This increase in nitrite/nitrate allows LDEQ to calculate the incremental nitrogenous portion by multiplying the increase by 4.57 to determine the NBOD daily readings. These NBOD daily readings are then subtracted from the daily reading for total BOD to determine the CBOD daily values. A curve fit algorithm is then applied to the daily component readings to obtain the estimated ultimate values of each component as well as the decay rate and lag times of the first order equations.

LDEQ implemented the new test method during the 2000 survey season. The results obtained using the new method showed that a portion of the CBOD first order equation does begin to level off prior to the twentieth day, however a secondary CBOD component begins to use dissolved oxygen sometime between day ten and day twenty-five. This secondary CBOD component was not being assessed as CBOD using the previous method but was being included in the NBOD load. Thus the CBOD and NBOD component loading used in the reference stream studies is not consistent with the results using the new proposed 60 day method and the individual values should not be used to determine background values for samples processed using the new test methods. However, the sum of CBOD and NBOD should be about the same for both new and old test methods. For this reason LDEQ decided to use the sum of reference stream benthic loads as background values. Again, background values can not be quantified for PETIT CAILLOU.

The resuspended total nonpoint CBOD1, CBOD2, and NBOD loading was reduced by 70% for all reaches in the summer critical projection scenario to meet the summer water quality criterion for dissolved oxygen. Since LDEQ assumes these benthic loads are long-term loads brought to the stream by various sources throughout the year, the same percentage reductions were made in the winter projection model as were in the summer critical projection model. These reductions met the summer dissolved oxygen criteria and well surpassed requirements in the non-critical winter projection.

The reductions were determined using the calibrated values for nonpoint CBOD1, CBOD2, and NBOD. These values were summed by reach, as justified above and adjusted for the margin of safety. Each reach's total benthic nonpoint load was then reduced to meet the dissolved oxygen criteria in

each reach. Using the ratios determined in calibration, this reduced total nonpoint load was then broken into its components of CBOD1, CBOD2, NBOD, and SOD. The percentage reduction within the mainstem was calculated based on the comparison of the reduced total nonpoint benthic load to the calibration total nonpoint benthic load. These calculations are shown in Appendix E. The value and sources of CBOD1, CBOD2, and NBOD for each projection run are presented in Appendix F5.

4.2.12 Boundary Conditions, Data Type 27

The lower boundary conditions were set at the 90th percentile critical season temperature, the dissolved oxygen criteria, and the measured stream UCBOD and UNBOD loads for all projections and scenarios.

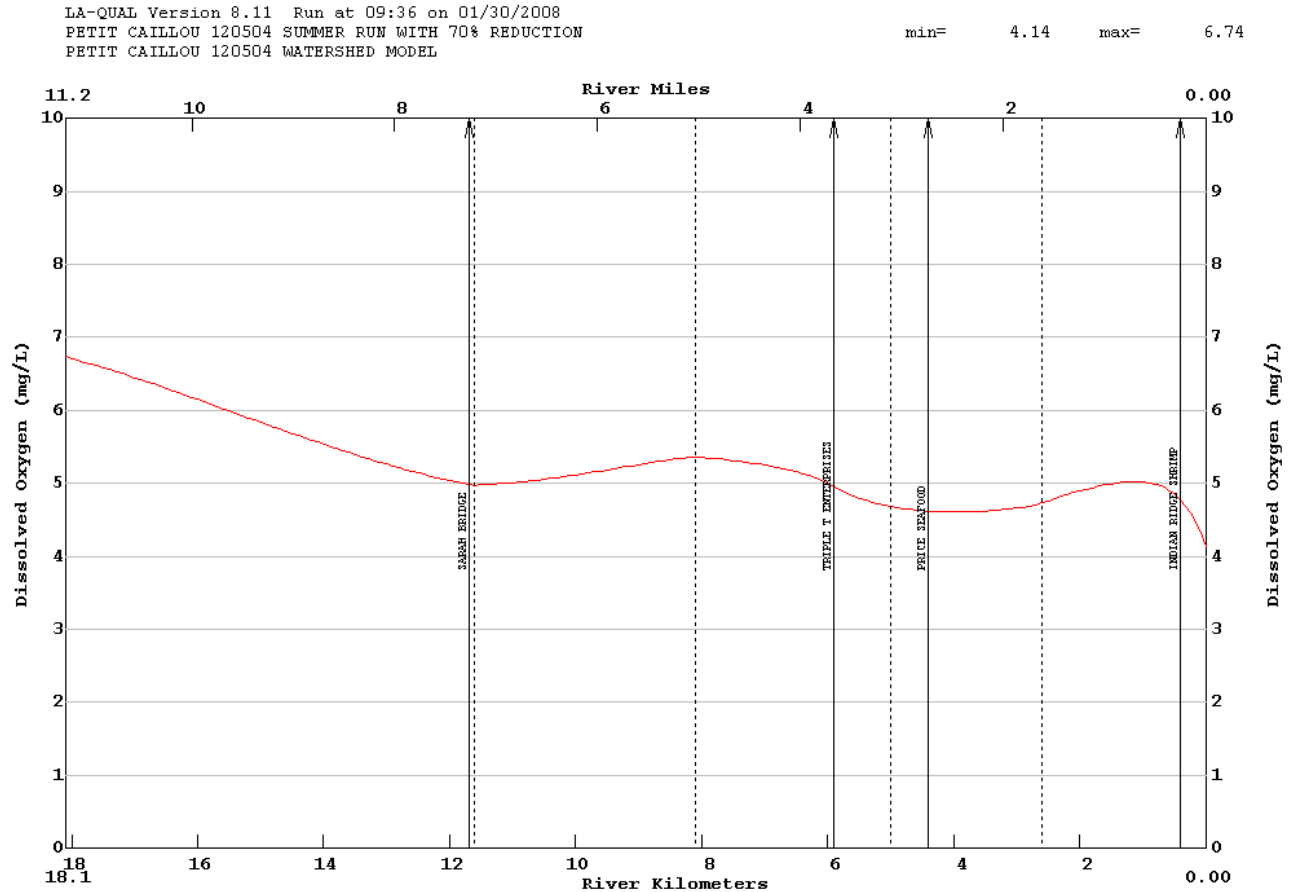
4.3 Model Discussion and Results

The projection model input and output data sets are presented in Appendix D.

4.3.1 Summer Projection

Summer critical season projections were run for the current standard of 4.0 mg/L May – November. In order to meet the standard, a 70% reduction of total nonpoint sources is necessary. With these percentage reductions in the benthic oxygen loads, Petit Caillou meets the dissolved oxygen criterion. The minimum DO on the main stem is 4.14 mg/L. A graph of the dissolved oxygen concentration versus river kilometer for the summer projection is presented in Figure 4.

Figure 4. Summer Projection at 70% Removal of NPS Loads

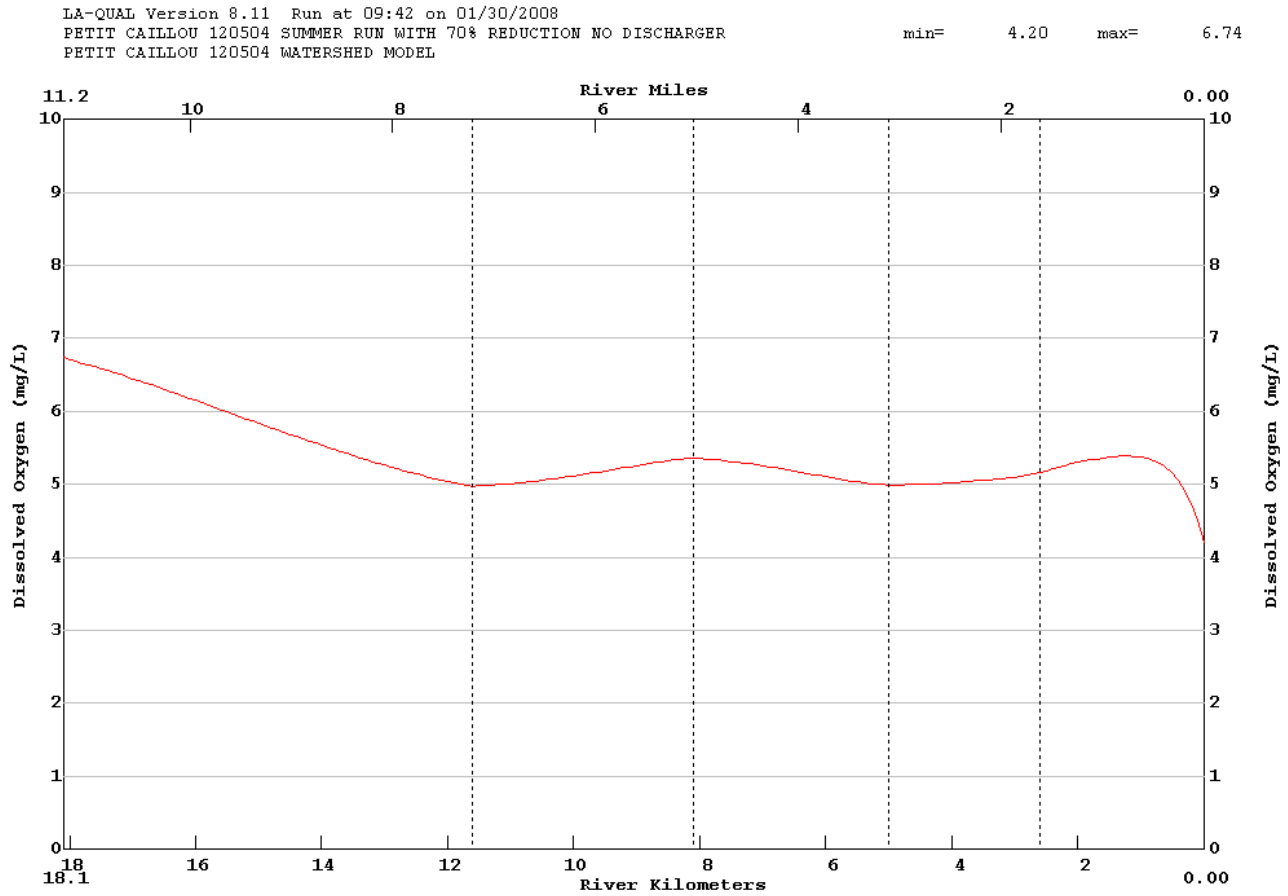


4.3.2 Summer Projection without dischargers

Summer critical season projections were run for the current standard of 4.0 mg/L May – November without the four dischargers to see what impact they were having on Petit Caillou. In order to meet the standard, a 70% reduction of total nonpoint sources is still necessary. With these percentage reductions in the benthic oxygen loads, Petit Caillou meets the dissolved oxygen criterion. The minimum DO on the main stem is 4.20 mg/L. This indicates that the dischargers are having only a slight impact on Bayou Petit Caillou and changing their limits will not make a significant impact. A graph of the dissolved oxygen concentration versus river kilometer for the summer projection is presented in Figure 5.

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Figure 5. Summer Projection at 70% Removal of NPS Loads Without Dischargers

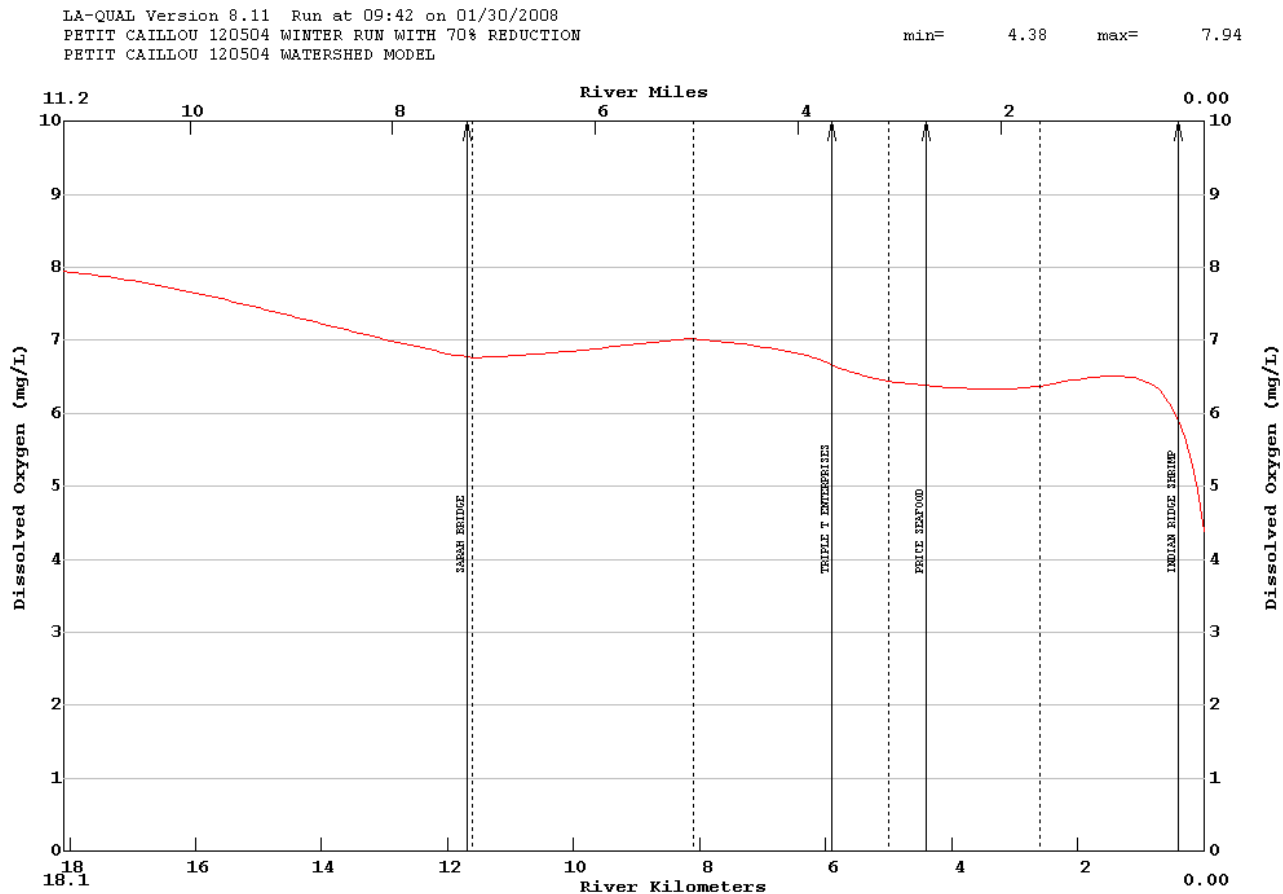


4.3.3 Winter Projection

The results of the model show that the water quality criterion for dissolved oxygen of Petit Caillou of 4.0 mg/l can be maintained during the winter critical season. The minimum dissolved oxygen is 4.38 mg/l. This is acceptable. To achieve the criterion, the model assumed a 70% reduction from all manmade nonpoint sources. A graph of the dissolved oxygen concentration versus river kilometer for the winter projection is presented in Figure 6.

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Figure 6. Winter Projection at 70% Removal of NPS Loads



4.4 Calculated TMDL, 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.

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

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 $\text{gm O}_2/\text{m}^2\text{-day}$ 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. Where headwaters and tributaries exhibit man-made pollutant loads in excess of reference stream values, the loadings are reduced by the same uniform percent reduction as the benthic loads.

- The projection benthic loading at 20 °C is calculated as the sum of the projection resuspension and SOD components expressed as gm O₂/m²-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 also computed in units of lb/d and kg/d for each kind.

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 and kg/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 and kg/d.
- Point source CBOD and NBOD loading in lb/d and kg/d.
- The margin of safety in lb/d and kg/d.

4.4.2 Petit Caillou Subsegment 120504 TMDL

The TMDL for the biochemical oxygen demanding constituents (CBOD1, CBOD2, NBOD, and SOD), have been calculated for the summer and winter critical seasons. The Summer TMDL for the Petit Caillou, Subsegment 120504 watershed was set equal to the total stream loading capacity. They are presented in Appendix A by reach. A summary of the loads is presented in Table 6.

Table 6. Total Maximum Daily Load (Sum of UCBOD¹, UNBOD, and SOD)

ALLOCATION	Summer	Summer	Winter	Winter
	% Reduction Required	May – Oct (lbs/day)	% Reduction Required	Nov - Apr (lbs/day)
Point Source WLA	0%	1206	0%	1206
Point Source Reserve MOS (20%)		302		302
Total Nonpoint Source LA	70%	8,141	70%	7,753
Total Nonpoint Source Reserve MOS (20%)		2,035		1,938
TMDL		11,684		11,199

***Note1: UCBOD as stated in this allocation is Ultimate CBOD.
 UCBOD to CBOD₅ ratio = 2.3 for all treatment levels
 Permit allocations are generally based on CBOD₅***

5. 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. The LAQUAL model 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. The rest of the parameters listed in the sensitivity section are held at their original projection value. Thus the sensitivity of each parameter is reviewed separately. A sensitivity analysis was performed on the calibration. The sensitivity of the model's minimum DO projections to these parameters is presented in Appendix I2. Parameters were varied by +/- 30%, except temperature, which was adjusted +/- 2 degrees Centigrade.

Values reported in Appendix I2 are percentage variation of minimum DO in the main stem Petit Caillou. As shown in Table 7, stream baseflow, stream velocity, initial temperature, CBOD decay rate, CBOD settling rate, benthic demand, stream reaeration, headwater flow, headwater DO and stream depth are the parameters to which DO is most sensitive. The model is slightly sensitive to insensitive to the remaining parameters.

Table 7. Summary of Calibration Model Sensitivity Analysis

SENSITIVITY ANALYSIS SUMMARY

MAINSTEM

PETIT CAILLOU 120504 SENSITIVITY RUN

Plot 1 Base Model Minimum DO = 2.13

Parameter	%Param Chg	Min D.O.	%D.O. Chg	%Param Chg	Min D.O.	%D.O. Chg
Stream Baseflow	30.	2.18	2.2	-30.	1.72	-19.2
Initial Chlorophyll a	30.	2.13	0.0	-30.	2.13	0.0
Stream Velocity	30.	1.85	-13.2	-30.	2.18	2.2
Initial Temperature	2.	1.85	-13.4	-2.	2.18	2.2
CBOD Aerobic Decay Rate	30.	1.85	-13.4	-30.	2.18	2.2
CBOD2 Aerobic Decay Rate	30.	2.03	-4.9	-30.	2.18	2.2
CBOD Settling Rate	30.	2.18	2.2	-30.	1.90	-11.0
CBOD2 Settling Rate	30.	2.13	0.0	-30.	2.13	0.0
NBOD Decay Rate	30.	2.00	-6.4	-30.	2.18	2.2
NBOD Settling Rate	30.	2.18	2.2	-30.	2.08	-2.5
Benthic Demand	30.	1.85	-13.3	-30.	2.18	2.2
Stream Dispersion	30.	2.14	0.3	-30.	2.13	-0.3
Stream Reaeration	30.	2.18	2.2	-30.	1.41	-33.9
Headwater Flow	30.	2.18	2.2	-30.	1.72	-19.2
Headwater DO	30.	2.17	1.8	-30.	1.61	-24.7
Headwater CBOD	30.	2.10	-1.5	-30.	2.17	1.5
Headwater CBOD2	30.	2.10	-1.3	-30.	2.16	1.3
Headwater NBOD	30.	2.11	-1.2	-30.	2.16	1.3
Stream Depth	30.	1.83	-14.4	-30.	2.18	2.2
Wasteload Flow	30.	2.13	-0.3	-30.	2.14	0.3
Wasteload Temperature	2.	2.13	0.0	-2.	2.13	0.0
Wasteload DO	30.	2.13	0.0	-30.	2.13	0.0
Wasteload CBOD	30.	2.13	-0.1	-30.	2.14	0.1
Wasteload CBOD2	30.	2.13	0.0	-30.	2.13	0.0
Wasteload NBOD	30.	2.13	-0.2	-30.	2.14	0.2
Lower Boundary Temperature	2.	2.13	0.0	-2.	2.13	0.0
Lower Boundary DO	30.	2.13	0.0	-30.	2.13	0.0
Lower Boundary CBOD	30.	2.13	0.0	-30.	2.13	0.0
Lower Boundary CBOD2	30.	2.13	0.0	-30.	2.13	0.0
Lower Boundary NBOD	30.	2.13	0.0	-30.	2.13	0.0

6. Conclusions

This TMDL establishes load limitations for oxygen-demanding substances and goals for reduction of those pollutants. LDEQ's position, as supported by the declaratory ruling issued by Secretary Givens in response to the lawsuit regarding water quality criteria for nutrients (*Sierra Club v. Givens*, 710 So.2d 249 (La. App. 1st Cir. 1997), writ denied, 705 So.2d 1106 (La. 1998), is that when oxygen-demanding substances are controlled and limited in order to ensure that the dissolved oxygen criterion is supported, nutrients are also controlled and limited. The implementation of this TMDL through wastewater discharge permits and implementation of best management practices to control and reduce runoff of soil and oxygen-demanding pollutants from nonpoint sources in the watershed will also control and reduce the nutrient loading from those sources.

A calibrated water quality model for the watershed was developed and projections were modeled to quantify the non-point source load reductions which would be necessary in order for Petit Caillou, subsegment 120504 to comply with its established water quality standards and criteria. This report presents the results of that analysis.

There were six permitted dischargers located in this subsegment. Four of the permitted dischargers are located on the Petit Caillou waterbody. The other two permitted dischargers actually discharge to other streams located in the 120504 subsegment but never reach the Petit Caillou 120504 mainstem. The two dischargers located in this subsegment but never reach Petit Caillou are Indian Ridge STP and the Piggly Wiggly Store. In these situations, limits for these facilities are generally set by state policy. Therefore, the limits for Indian Ridge and the Piggly Wiggly store will remain the same.

The other four permitted dischargers are Sarah Bridge STP, Indian Ridge Shrimp Company, Price Seafood, and Triple T Seafood. All four of these dischargers were included in the projection modeling. They were shown to have little impact on Petit Caillou and as such will also remain at their same limits.

The modeling, which has been conducted for this TMDL, is conservative and based on limited information. The TMDL requires a 70% decrease in manmade nonpoint source loads in order to meet the DO criterion of 4.0 mg/L in the summer critical season.

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 database 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 is continuing to implement a watershed approach to surface water quality monitoring. In 2004 a four year sampling cycle replaces the previous five year cycle. Approximately one quarter of the states watersheds will be sampled each year so that all of the state's watersheds will be sampled within the four year cycle. This will allow 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.

7. References

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8. Appendices