BLACK RIVER TMDLS FOR DISSOLVED OXYGEN AND NUTRIENTS

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BLACK RIVER TMDLS
FOR DISSOLVED OXYGEN AND NUTRIENTS

SUBSEGMENT 080302

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EXECUTIVE SUMMARY

Section 303(d) of the Federal Clean Water Act requires states to identify waterbodies that are not meeting water quality standards and to develop total maximum daily pollutant loads for those waterbodies. A total maximum daily load (TMDL) is the amount of pollutant that a waterbody can assimilate without exceeding the established water quality standard for that pollutant. Through a TMDL, pollutant loads can be distributed or allocated to point sources and nonpoint sources (NPS) discharging to the waterbody. This report presents TMDLs that have been developed for dissolved oxygen (DO) and nutrients for Black River (subsegment 080302), in the Ouachita River basin in central Louisiana.

Subsegment 080302 is located approximately midway between Alexandria, LA and Natchez, MS and includes 25 miles of the Black River between Jonesville Lock and Dam and the Red River. The Black River is formed at Jonesville, LA by the confluence of the Ouachita, Tensas, and Little Rivers. The drainage area of the Black River at the upstream end of this subsegment is approximately 24,335 mi^2. The hydraulics along the Black River are affected by locks and dams that are operated for navigation by the Vicksburg District Corps of Engineers.

Subsegment 080302 was listed on the Modified Court Ordered 303(d) List for Louisiana as not fully supporting the designated use of propagation of fish and wildlife and was ranked as priority #2 for TMDL development. The causes for impairment cited in the 303(d) List included nutrients. Although organic enrichment/low DO was not included as a suspected cause of impairment for this subsegment, a DO TMDL was developed because maintaining and protecting DO is considered to be, in effect, limiting and controlling nutrient concentrations and impacts. The water quality standard for DO in this subsegment is 5 mg/L year round.

A water quality model (LA-QUAL) was set up to simulate DO, carbonaceous biochemical oxygen demand (CBOD), ammonia nitrogen, and organic nitrogen in the subsegment. The model was set up and calibrated using LDEQ assessment data collected during January through December 1999 and other various information obtained from LDEQ and U.S. Geological Survey (USGS). The projection simulation was run at critical flows and temperatures to address seasonality as required by the Clean Water Act. Reductions of existing NPS loads were required for the projection simulation to show the DO standard of 5 mg/L being maintained. In general, the modeling in this study was consistent with guidance in the Louisiana TMDL Technical Procedures Manual.

A TMDL for oxygen demanding substances (CBOD, ammonia nitrogen, organic nitrogen, and sediment oxygen demand) was calculated using the results of the projection simulation. Both implicit and explicit margins of safety were included in the TMDL calculations. The nutrient TMDL was developed based on Louisiana's water quality standard for nutrients, which states that "the naturally occurring range of nitrogen to phosphorus ratios shall be maintained". The nutrient TMDL was calculated using allowable nitrogen loading from the projection simulation and applying a naturally occurring nitrogen to phosphorus ratio to determine the allowable phosphorus loading.

The results of the modeling and TMDL calculations showed that NPS loads will need to be reduced by approximately 42% to meet the DO standard of 5 mg/L in subsegment 080302.

TABLE OF CONTENTS

1.0 INTRODUCTION 1-1

2.0 STUDY AREA DESCRIPTION 2-1

2.1 General Information 2-1

2.2 Water Quality Standards 2-2

2.3 Identification of Sources 2-3

2.3.1 Point Sources 2-3

2.3.2 Nonpoint Sources 2-3

2.4 Previous Data and Studies 2-3

3.0 CALIBRATION OF WATER QUALITY MODEL 3-1

3.1 Model Setup 3-1

3.2 Calibration Period and Calibration Targets 3-1

3.3 Temperature Correction of Kinetics (Data Type 4) 3-2

3.4 Hydraulics (Data Type 9) 3-2

3.5 Initial Conditions (Data Type 11) 3-3

3.6 Water Quality Kinetics (Data Types 12 and 13) 3-3

3.7 Nonpoint Source Loads (Data Type 19) 3-4

3.8 Headwater Flow Rates (Data Type 20) 3-5

3.9 Headwater Water Quality (Data Types 20 and 21) 3-5

3.10 Point Source Inputs (Data Types 24 and 25) 3-5

3.11 Model Results for Calibration 3-7

4.0 WATER QUALITY MODEL PROJECTION 4-1

4.1 Identification of Critical Conditions 4-1

4.2 Temperature Inputs 4-2

4.3 Headwater Inputs 4-3

4.4 Point Source Inputs 4-3

4.5 Nonpoint Source Loads 4-3

4.6 Wind Aided Reaeration 4-4

TABLE OF CONTENTS (CONTINUED)

4.7 Other Inputs 4-4
4.8 Model Results for Projection 4-4
5.0 TMDL CALCULATIONS 5-1
5.1 DO TMDL 5-1
5.2 Nutrient TMDL 5-2
5.3 Ammonia Toxicity Calculations 5-2
5.4 Summary of NPS Reductions 5-3
5.5 Seasonal Variation 5-3
5.6 Margin of Safety 5-3
6.0 SENSITIVITY ANALYSES 6-1
7.0 OTHER RELEVANT INFORMATION 7-1
8.0 PUBLIC PARTICIPATION 8-1
9.0 REFERENCES 9-1

TABLE OF CONTENTS (CONTINUED)

LIST OF APPENDICES

APPENDIX A:	Maps of the Study Area
APPENDIX B:	LDEQ Routine Monitoring Data
APPENDIX C:	Analysis of LDEQ Long Term BOD Data
APPENDIX D:	HEC-2 Model Output and Plots
APPENDIX E:	Model Input Data and Sources Calibration
APPENDIX F:	Wind Aided Reaeration Calculation
APPENDIX G:	CBOD Decay Rate Calculations
APPENDIX H:	Literature Values for Mineralization Rates
APPENDIX I:	USGS Flow Data and Drainage Area Information
APPENDIX J:	Plots of Predicted and Observed Water Quality
APPENDIX K:	Printout of Model Output for Calibration
APPENDIX L:	Model Input Data and Sources for Projection
APPENDIX M:	90^{th} Percentile Temperature Calculations
APPENDIX N:	Published 7Q10 Information
APPENDIX O:	Plot of Predicted DO for Projection
APPENDIX P:	Printout of Model Output for Projection
APPENDIX Q:	Input File for TMDL Calculation Program
APPENDIX R:	Output from TMDL Calculation Program
APPENDIX S:	Source Code for TMDL Calculation Program
APPENDIX T:	Ammonia Toxicity Calculations
APPENDIX U:	Responses to Comments

LIST OF TABLES

Table 1.1 Summary of 303(d) Listing of subsegment 080302 1-1

Table 2.1 Land uses in subsegment 080302 based on GAP data 2-1

Table 2.2 Water quality standards and designated uses 2-2

Table 5.1 DO TMDL for Subsegment 080302 5-1

Table 5.2 Nutrient TMDL for Subsegment 080302 5-2

Table 6.1 Summary of results of sensitivity analyses 6-2

1.0 INTRODUCTION

This report presents total maximum daily loads (TMDLs) for dissolved oxygen (DO) and nutrients for subsegment 080302 which is the Black River from Jonesville Lock and Dam to the Red River. This subsegment was listed on the February 29, 2000 Modified Court Ordered 303(d) List for Louisiana (EPA 2000) as not fully supporting the designated use of propagation of fish and wildlife. The suspected sources and suspected causes for impairment in the 303(d) List are included in Table 1.1. Although organic enrichment/low DO was not included as a suspected cause of impairment for this subsegment, a DO TMDL was developed because maintaining and protecting DO is considered to be, in effect, limiting and controlling nutrient concentrations and impacts. Subsegment 080302 was ranked as priority #2 for TMDL development. The TMDLs in this report were developed in accordance with Section 303(d) of the Federal Clean Water Act and EPA's regulations at 40 CFR 130.7. The 303(d) Listings for other pollutants in this subsegment are being addressed by EPA and the Louisiana Department of Environmental Quality (LDEQ) in other documents.

The purpose of a TMDL is to determine the pollutant loading that a waterbody can assimilate without exceeding the water quality standard for that pollutant, and to establish the load reduction that is necessary to meet the standard in a waterbody. The TMDL is the sum of the wasteload allocation (WLA), the load allocation (LA), and a margin of safety (MOS). The WLA is the load allocated to point sources of the pollutant of concern, and the LA is the load allocated to nonpoint sources (NPS). The MOS is a percentage of the TMDL that accounts for the uncertainty associated with the model assumptions, data inadequacies, and future growth.

Table 1.1. Summary of 303(d) Listing of subsegment 080302 (EPA 2000).

Subsegment Number	**Waterbody Description**	**Suspected Sources**	**Suspected Causes**	**Priority Ranking (1 = highest)**
080302	Black River	Agriculture	Pesticides Nutrients Siltation	2

2.0 STUDY AREA DESCRIPTION

2.1 General Information

Subsegment 080302 is located approximately midway between Alexandria, LA and Natchez, MS and includes 25 miles of the Black River between Jonesville Lock and Dam and the Red River (see Figures A.1 and A.2 in Appendix A). The drainage area of the Black River at Jonesville Lock and Dam (the upstream end of this subsegment) is approximately 24,335 mi^2 (USGS 1971). The Black River is formed at Jonesville, LA by the confluence of the Ouachita, Tensas, and Little Rivers. Another inflow to the Black River is the Catahoula Lake Diversion Channel, which enters in the middle of this subsegment. The hydraulics along the Black River are affected by locks and dams that are operated for navigation by the Vicksburg District Corps of Engineers.

Nearly all of the flow in the Black River originates from other subsegments, partly due to levees constructed along both sides of the river. These levees limit the local drainage area (which coincides with the subsegment area) to approximately 10 mi^2. The land uses within the subsegment are shown in Table 2.1.

Table 2.1. Land uses in subsegment 080302 based on GAP data (USGS 1998).

Land Use Type	% of Total Area
Fresh Marsh	0.3%
Saline Marsh	0.0%
Wetland Forest	27.3%
Upland Forest	0.0%
Wetland Scrub/Shrub	1.0%
Upland Scrub/Shrub	0.0%
Agricultural	42.7%
Urban	0.0%
Water	28.7%
Barren Land	0.0%
TOTAL	100.0%

2.2 Water Quality Standards

The numeric water quality standards and designated uses for this subsegment are shown in Table 2.2. The primary numeric standard for the TMDLs presented in this report is the DO standard of 5 mg/L year round.

Table 2.2. Water quality standards and designated uses (LDEQ 2000).

Subsegment Number	080302
Waterbody Description	Black River – Jonesville L & D to Red River
Designated Uses	ABC
Criteria:	
Chloride	95 mg/L
Sulfate	20 mg/L
DO	5 mg/L (year round)
pH	6.0-8.5
Temperature	32 °C
TDS	265 mg/L

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.

For nutrients, there are no specific numeric criteria, but there is a narrative standard that states "The naturally occurring range of nitrogen-phosphorus ratios shall be maintained.... Nutrient concentrations that produce aquatic growth to the extent that it creates a public nuisance or interferes with designated water uses shall not be added to any surface waters." (LDEQ 2000).

In addition, LDEQ issued a declaratory ruling on April 29, 1996, concerning this language and stated, "That DO directly correlates with overall nutrient impact is a well-established biological and ecological principle. Thus, when the LDEQ maintains and protects DO, the LDEQ is in effect also limiting and controlling nutrient concentrations and impacts." DO serves as the indicator for the water quality criteria and for assessment of use support. For the TMDLs in this report, the nutrient loading required to maintain the DO standard is the nutrient TMDL.

2.3 Identification of Sources

2.3.1 Point Sources

A listing of all NPDES permits in the Ouachita and Calcasieu River basins was searched to identify any permits within the Black River subsegment (080302). This listing was prepared by EPA Region 6 using databases and permit files from LDEQ. Based on this listing, no NPDES permits were identified within subsegment 080302. Therefore, no point sources were included in the model or TMDL calculations for this subsegment.

2.3.2 Nonpoint Sources

Agriculture was the only nonpoint source that was cited as a suspected source of impairment in the 303(d) List (Table 1.1).

2.4 Previous Data and Studies

Listed below are previous water quality data and studies in or near the Black River subsegment. The locations of the LDEQ ambient monitoring stations are shown on Figure A.2 (in Appendix A).

1. Monthly data collected by LDEQ for "Black River south of Jonesville, Louisiana" (Station 0775) for January to August 1999.
2. Monthly data collected by LDEQ for "Black River south of Book, Louisiana" (Station 0776) for January to August 1999.
3. Intensive survey data collected by Louisiana Department of Natural Resource (LDNR) for the Ouachita and Black Rivers from the Arkansas State Line to the Red River. These surveys were conducted on September 6, 1978 and October 31, 1978 and included 5 stations in subsegment 080302. These surveys include data for temperature, DO, BOD, ammonia nitrogen, and total Kjeldahl nitrogen (TKN).
4. Data collected by USGS for "Black River @ Acme, LA" (Station 07373270) on two dates (September 17, 1979 and October 1, 1979).
5. Data collected by USGS for "Black River at mouth" (Station 311618091494200) on a single date in August 1975.

3.0 CALIBRATION OF WATER QUALITY MODEL

3.1 Model Setup

In order to evaluate the linkage between pollutant sources and water quality, a computer simulation model was used. The model used for these TMDLs was LA-QUAL (version 4.13), which was selected because it includes the relevant physical, chemical, and biological processes and it has been used successfully in the past for other TMDLs in Louisiana. The LA-QUAL model was set up to simulate organic nitrogen, ammonia nitrogen, ultimate carbonaceous biochemical oxygen demand (CBODu), and DO. This model was set up as one reach with one element because there were not data to provide evidence of spatial variation in water quality.

3.2 Calibration Period and Calibration Targets

An intensive field survey was not performed for the study area due to schedule and budget limitations. A synoptic survey of the study area was performed by FTN in August 2001, but only limited data were collected during that survey. Routine ambient monitoring data for this subsegment were collected by LDEQ at station 0776 during 1999.

The water quality data for this period were retrieved from the LDEQ website. These data are shown in Appendix B. The two conditions that usually characterize critical periods for DO are high temperatures and low flows. High temperatures decrease DO saturation values and increase rates for oxygen demanding processes (BOD decay, nitrification, and sediment oxygen demand (SOD)). In most systems, low flows cause reaeration rates to be lower. The purpose of selecting a critical period for calibration is so that the model will be calibrated as accurately as possible for making projection simulations for critical conditions.

Based on the LDEQ data in Appendix B, the calibration period was selected as May 25 to July 27, 1999. This period represented the most critical period for DO. The calibration target (i.e., the concentration to which the model was calibrated) for each parameter was set to the average of the concentrations measured during the calibration period.

The LDEQ routine monitoring data did not include CBODu, but there were measurements of total organic carbon (TOC). Therefore, the calibration target for CBODu was estimated from the TOC data based on statistics from LDEQ's long term BOD analyses. The LDEQ's long term BOD analyses consisted of 140 samples from intensive surveys in the Ouachita River basin during 2001. These samples were analyzed for numerous parameters including CBODu and TOC. The ratio of CBODu to TOC was calculated for each sample and the median of these 140 ratios was determined to be 1.10. Using this result, the CBODu calibration target was estimated as 1.10 times the average TOC during the calibration period. Data from the LDEQ long term BOD analyses are shown in Appendix C.

3.3 Temperature Correction of Kinetics (Data Type 4)

The temperature correction factors used in the model were consistent with the Louisiana Technical Procedures Manual (the "LTP"; LDEQ 2001). These correction factors were:

- Correction for BOD decay: 1.047 (value in LTP is same as model default)
- Correction for SOD: 1.065 (value in LTP is same as model default)
- Correction for ammonia N decay: 1.070 (specified in Data Group 4)
- Correction for organic N decay: 1.020 (not specified in LTP; model default used)
- Correction for reaeration: automatically calculated by the model

3.4 Hydraulics (Data Type 9)

The hydraulics were specified in the input for the LA-QUAL model using the power functions (width = a * Q^b + c and depth = d * Q^e + f). Widths and depths were estimated from an existing HEC-2 model of the Ouachita and Black Rivers that was obtained from the Vicksburg District Corps of Engineers. HEC-2 is a hydraulic model that calculates depths, widths, velocities, and other parameters. The HEC-2 model was run with the average flow rate during calibration period and the downstream boundary set to the average water surface elevation during the calibration period for the Black River at Acme, LA. The Acme gage is located near the mouth of the Black River and is representative of the water surface elevation at the downstream end of the model (confluence with the Red River). The output from this HEC-2 model includes calculated depths and widths at each of 125 cross sections between Jonesville Lock and Dam and the Red River. A printout of the model output is included in Appendix D.

Because the water levels during low flow are controlled by the locks and dams, the widths and depths were assumed to be independent of flow. Therefore, the width and depth exponents and coefficients (a, b, d, and e) for each reach were set to zero. The width and depth of the widths and depths form the HEC-2 model are shown in Appendix D. Input values used in the LA-QUAL model are shown in Appendix E.

3.5 Initial Conditions (Data Type 11)

Because temperature is not being simulated in the model, the temperature was specified in the initial conditions for LA-QUAL. The temperature was set to 28.3°C, which was the average temperature measured at station 0776 during the calibration period. The input data and sources are shown in Appendix E.

One other parameter that was specified in the initial conditions was chlorophyll. Chlorophyll was not simulated in the model (i.e., it was not “turned on” in Data Group 2), but a chlorophyll value was entered as an initial condition and used as a calibration parameter to calibrate the model for DO. The calibration methodology is discussed in Section 3.11.

For other constituents not being simulated, the initial concentrations were set to zero; otherwise, the model would have assumed a fixed concentration of those constituents and the model would have included the effects of the unmodeled constituents on the modeled constituents.

3.6 Water Quality Kinetics (Data Types 12 and 13)

Kinetic rates used in LA-QUAL include reaeration rates, CBOD decay rates, nitrification rates, and mineralization rates (organic nitrogen decay). The values used in the model input are shown in Appendix E.

The O’Connor-Dobbins equation (option 3) was specified for reaeration in the model because it was developed for deep streams like the Black River. However, a minimum surface transfer coefficient (K_L) was also specified in Data Type 3. A minimum K_L was specified because under certain low flow conditions, the velocities in the Black River may be so low that the O'Connor-Dobbins equation would yield a reaeration coefficient less than the minimum value in the LTP (0.7 m/day divided by depth). The minimum K_L was computed based on wind speed because the Black River was considered wide enough that wind-aided reaeration may be significant. Daily wind speeds measured at the Alexandria, LA station were averaged over the calibration period, corrected to a height of 0.1 m, and then used to calculate a wind-aided surface transfer coefficient of 0.78 m/day. The data and calculations for the wind-aided surface transfer coefficient are shown in Appendix F.

The CBOD decay rate was set to 0.07/day. This decay rate was the average of decay rates measured during an LDEQ 2001 intensive survey of the Ouachita River from the Arkansas state line to Columbia Lock and Dam (unpublished data). These calculations are included as Appendix G.

The mineralization rates (organic nitrogen decay) in the model were set to 0.02/day for all reaches. This value was similar to the values shown in Table 5.3 of the "Rates, Constants, and Kinetics" publication (EPA 1985) for dissolved organic nitrogen being transformed to ammonia nitrogen. The literature values for mineralization rates are shown in Appendix H.

One other input value was specified for characterizing the nitrification process. In the program constants section of the model input file (Data Type 3), the nitrification inhibition option was set to 1 instead of the default of option number 2. With the default option, the nitrification rate drops rapidly when the DO drops below 2 mg/L, which results in an unrealistic build up of ammonia nitrogen at low DO. Option number 1 provides nitrification inhibition that is similar to what is used in other water quality models such as QUAL2E and WASP (see Figure 3.5 in FTN 2000).

3.7 Nonpoint Source Loads (Data Type 19)

The NPS loads that are specified in the model can be most easily understood as resuspended load from the bottom sediments and are modeled as SOD, benthic ammonia source rates, CBOD loads, and organic nitrogen loads. The SOD (specified in data type 12), the benthic ammonia source rates (specified in data type 13), and the mass loads of organic nitrogen and

CBODu (specified in data type 19) were all treated as calibration parameters; their values were adjusted until the model output was similar to the calibration target values. The procedures used for calibrating the model are discussed in Section 3.11.The values used as model input are shown in Appendix E.

3.8 Headwater Flow Rates (Data Type 20)

Inflow rates for the Black River were based on the average flows measured by the USGS during the calibration period for Tensas River at Tendal, LA (07369500), Ouachita River at Monroe, LA (07367000), and Little River near Rochelle, LA (07372200). The drainage area of the Boeuf River is included with the Ouachita River and the drainage area of the Catahoula Lake Diversion Channel was added to the Little River. Because each of these flow gages is located upstream of the Black River, the flow per square mile of drainage area was calculated at each gage location and applied to the confluence of that stream and the Black River. The sum of these computed tributary flows was used as the headwater flow for the Black River. The data and calculations for developing the headwater flow rate are included in Appendix I.

3.9 Headwater Water Quality (Data Types 20 and 21)

Concentrations of DO, CBODu, organic nitrogen, and ammonia nitrogen were specified in the model for the headwater inflow were based on the average concentrations that were measured at LDEQ station 0775 during the calibration period. LDEQ station 0775 is located at the Jonesville Lock and Dam, which is the upstream end of subsegment 080302.

CBODu was estimated from TOC using the relationship between these parameters that was developed from the LDEQ long term BOD analyses (described in Section 3.2). Organic nitrogen was estimated as TKN minus ammonia nitrogen. The values used as model input are shown in Appendix E.

3.10 Point Source Inputs (Data Types 24 and 25)

As discussed in Section 2.3.1, no NPDES permits were identified within subsegment 080302. Therefore, no point source discharges were included in the model.

3.11 Calibration Methodology

The model was calibrated by adjusting 5 input parameters: organic nitrogen loads, benthic ammonia source rates, CBODu mass loads, SOD, and the chlorophyll concentration. First, the organic nitrogen loads were adjusted until the predicted organic nitrogen concentrations were similar to the observed concentrations. Organic nitrogen was calibrated first because none of the other state variables (DO, CBODu, ammonia nitrogen) will affect the organic nitrogen concentrations. Next, the benthic ammonia source rates were adjusted until the predicted ammonia nitrogen concentrations were similar to the observed concentrations. Then the CBODu loads were adjusted until the predicted CBODu concentrations were similar to the observed concentrations.

After the organic nitrogen, ammonia nitrogen, and CBODu were calibrated, an attempt was made to calibrate the DO by adjusting the SOD. However, the predicted DO was lower than the calibration target even after reducing the SOD to zero. Therefore, a chlorophyll concentration was specified in the initial conditions to account for the effects of algae on DO. This was considered reasonable because most large streams in Louisiana have significant algal productivity.

Because no chlorophyll data were available for the Black River, the chlorophyll concentration was used as a calibration parameter. The SOD was set to 0.5 g/m^2/day, which was considered to be a reasonable value for the Black River. Then the chlorophyll concentration was adjusted until the predicted DO concentration was similar to the calibration target for DO. Because adding the chlorophyll increased the “effective CBODu” concentration in the model, the CBODu mass load was then reduced until the predicted “effective CBODu” concentration was similar to the calibration target for CBODu. Then the DO calibration was refined again by adjusting the chlorophyll slightly. This iteration of fine tuning the CBODu mass load the chlorophyll concentration was repeated several times until a close match between predicted and observed values was achieved for both the CBODu and DO.

The reason that the chlorophyll affects the predicted “effective CBODu” concentration in the model is that the model assumes that a measured CBODu concentration will include oxygen demand from algal respiration and death in addition to oxygen demand from decay of dissolved substances in the water. The model provides a coefficient in Data Type 3 to account for this effect. This coefficient was set to 0.175 mg/L of BOD per μg/L of chlorophyll, which was the midpoint of the range recommended in the LA-QUAL User's Manual.

3.12 Model Results for Calibration

Plots of predicted and observed water quality for the calibration are presented in Appendix J and a printout of the LA-QUAL output file is included as Appendix K. The calibration was considered to be acceptable based on the amount of data that were available.

4.0 WATER QUALITY MODEL PROJECTION

EPA's regulations at 40 CFR 130.7 require the determination of TMDLs to take into account critical conditions for stream flow, loading, and water quality parameters. Therefore, the calibrated model was used to project water quality for critical conditions. The identification of critical conditions and the model input data used for critical conditions are discussed below.

4.1 Identification of Critical Conditions

Section 303(d) of the Federal Clean Water Act and EPA's regulations at 40 CFR 130.7 both require the consideration of seasonal variation of conditions affecting the constituent of concern and the inclusion of a MOS in the development of a TMDL. For the TMDLs in this report, analyses of LDEQ long-term ambient data were used to determine critical seasonal conditions. A combination of implicit and explicit MOS was used in developing the projection model.

Critical conditions for DO have been determined for Louisiana waterbodies in previous TMDL studies. The analyses concluded that the critical conditions for stream DO concentrations occur during periods with negligible nonpoint runoff, low stream flow, and high stream temperature.

When the rainfall runoff (and nonpoint loading) and stream flow are high, turbulence is higher due to the higher flow and the stream temperature is lowered by the cooler precipitation and runoff. In addition, runoff 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. DO saturation values 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 DO but not necessarily periods of high BOD decay.

LDEQ interprets this phenomenon in its TMDL modeling by assuming that the annual nonpoint loading, rather than loading for any particular day, is responsible for the accumulated benthic blanket of the stream, which is, in turn, expressed as SOD and/or resuspended BOD in the model. This accumulated loading has its greatest impact on the stream during periods of higher temperature and lower flow.

According to the LTP, critical summer conditions in DO TMDL projection modeling are simulated by using the annual 7Q10 flow or 0.1 cfs, whichever is higher, for all headwaters, and 90th percentile temperature for the summer season. Model loading is from perennial tributaries, SOD, and resuspension of sediments.

In reality, the highest temperatures occur in July-August and the lowest stream flows occur in October-November. The combination of these conditions plus the impact of other conservative assumptions regarding rates and loadings yields an implicit MOS that is not quantified. Over and above this implicit MOS, an explicit MOS of 10% for NPS was incorporated into the TMDLs in this report to account for model uncertainty.

4.2 Temperature Inputs

The LTP (LDEQ 2001) specifies that the critical temperature should be determined by calculating the 90th percentile seasonal temperature for the waterbody being modeled. Because both of the LDEQ stations for the Black River have only 12 months of data, LDEQ data from another river were used for this analysis. Long term temperature data from the Ouachita River at Harrisonburg (LDEQ station 0085) were used to calculate a 90th percentile summer temperature of 30.5EC. However, the water temperatures for the Black River during May through October 1999 were slightly cooler than the temperatures in the Ouachita River during that time. Therefore, the critical temperature for the Black River was estimated as the 90th percentile summer temperature for the Ouachita River at Harrisonburg (30.5EC) minus the average temperature difference (0.5EC) during May through October 1999 between the Ouachita River and the Black River. This yielded a critical temperature of 30.0EC for the Black River. This value was specified in data type 11 in the model input and is shown in Appendix L along with other model inputs for the projection. The data for the 90th percentile temperature calculations are shown in Appendix M.

Because the Black River has a year round standard for DO, a winter projection simulation was not performed. As discussed above, the most critical time of year for meeting a constant DO standard is the period of high temperatures and low flows (i.e., summer).

4.3 Headwater Inputs

The inputs for the headwaters for the projection simulation were based on guidance in the LTP. As specified in the LTP, the DO concentration for the headwater inflow was set to 90% saturation at the critical temperature. Headwater concentrations for other parameters were set to calibration values.

There are no USGS flow gages and no published 7Q10 flows for the Black River. Of the three primary tributaries to the Black River (Ouachita, Tensas, and Little Rivers), critical stream flows for two rivers were estimated from draft TMDL reports being currently developed. For the Ouachita River, the flow at the confluence with the Black River in the projection simulation was 8.21 m^3/sec (FTN 2002a). For the Tensas River, the flow at the confluence with the Black River in the projection simulation was 7.14 m^3/sec (FTN 2002b). For the Little River, the published 7Q10 for the Little River near Rochelle (15.8 cfs; Lee 2000) was divided by the drainage area at the gage (1899 mi^2) and multiplied by the drainage area at the confluence with the Black River (3096 mi^2 including the Catahoula Lake Diversion Channel) to obtain an estimated 7Q10 inflow to the Black River of 0.73 m^3/sec. The headwater flow for the Black River projection simulation was set to the sum of these three flows (8.21 + 7.14 + 0.73 = 16.07 m^3/sec). The published 7Q10 information is shown in Appendix N.

4.4 Point Source Inputs

As discussed in Section 2.3.1, no NPDES permits were identified within subsegment 080302. Therefore, no point source discharges were included in the model.

4.5 Nonpoint Source Loads

Because the initial projection simulation was showing a low DO, the NPS loadings were reduced until the predicted DO value was equal to or greater than the water quality standard of 5.0 mg/L. The same percent reduction was applied to both the CBODu and organic nitrogen mass loads. The SOD value was set to 0.5 $g/m^2/day$ during the calibration, which is assumed to be a minimum value, and therefore was not reduced in the projection simulation. The values used as model input in the projection simulation are shown in Appendix L.

4.6 Wind Aided Reaeration

Reaeration for the projection simulation was calculated using weather stations with long-term average wind speed data. The nearest stations to the Black River with long-term average wind data were Baton Rouge, LA and Shreveport, LA. Because the Baton Rouge and Shreveport data show the wind speeds during the calibration period to be less than the long term average (i.e. normal) wind speeds for this period of the year, it was more conservative to set the K_L for the projection to the same value as used in the calibration, rather than adjusting it using long term average wind speeds. The value used in the projection model is included in Appendix L and the supporting wind speed data is included in Appendix F.

4.7 Other Inputs

The only model inputs that were changed from the calibration to the projection simulation were the inputs discussed above in Sections 4.2 – 4.6. Other model inputs (e.g., hydraulic coefficients, decay rates, reaeration rates, etc.) were unchanged from the calibration simulation.

4.8 Model Results for Projection

Plots of predicted water quality for the projection are presented in Appendix O and a printout of the LA-QUAL output file is included as Appendix P.

An NPS load reduction of approximately 42% was required to bring the predicted DO value to at least 5.0 mg/L. This percentage reduction for NPS loads represents a percentage of the entire NPS loading, not a percentage of the manmade NPS loading. The NPS loads in this report were not divided between natural and manmade because it would be difficult to estimate natural NPS loads for the study area.

5.0 TMDL CALCULATIONS

5.1 DO TMDL

A total maximum daily load (TMDL) for DO was calculated for the Black River subsegment based on the results of the projection simulation. The DO TMDL is presented as oxygen demand from CBODu, organic nitrogen, ammonia nitrogen, and SOD. A summary of the loads for the Black River is presented in Table 5.1.

The TMDL calculations were performed using a FORTRAN program that was written by FTN personnel. This program reads two files; one is the LA-QUAL output file from the projection simulation and the other is a small file with miscellaneous information needed for the TMDL calculations (shown in Appendix Q). The output from the program is shown in Appendix R and the source code for the program is shown in Appendix S.

Table 5.1. DO TMDL for Subsegment 080302.
(Black River from Jonesville Lock and Dam to the Red River).

	Oxygen Demand (kg/day) from:				**Total Oxygen Demand (kg/day)**
	CBODu	**Organic N**	**Ammonia N**	**SOD**	
WLA for point sources	0	0	0	0	0
MOS for point sources	0	0	0	0	0
LA for NPS	29920.43	2046.20	102.19	294.81	32363.63
MOS for NPS	3324.49	227.36	11.35	32.76	3595.96
Total maximum daily load	33244.92	2273.56	113.54	327.57	35959.59

The oxygen demand from organic nitrogen and ammonia nitrogen was calculated as 4.33 times the nitrogen loads (assuming that all organic nitrogen is eventually converted to ammonia). The value of 4.33 is the same ratio of oxygen demand to nitrogen that is used by the LA-QUAL model. For the SOD loads, a temperature correction factor was included in the calculations (in order to be consistent with LDEQ procedures).

5.2 Nutrient TMDL

As discussed in Section 2.2, Louisiana has no numeric standards for nutrients, but has a narrative standard that states that “the naturally occurring range of nitrogen-phosphorus ratios shall be maintained” (LDEQ 2000). For these TMDLs, nutrients were defined as total nitrogen (organic nitrogen plus ammonia nitrogen plus nitrate/nitrite nitrogen) and total phosphorus. The value used for the naturally occurring nitrogen to phosphorus ratio was 10.1. This ratio was based on LDEQ reference stream data for the Upper Mississippi Alluvial Plain and South Central Plain ecoregions (Smythe 1999). These data are shown in Appendix T.

The first step in calculating the nutrient TMDL was to determine the loads of total nitrogen (TN) that were simulated in the projection model. The loads in the projection model represent the maximum allowable loads that will maintain DO standards. Then the allowable loads of total phosphorus (TP) were calculated by dividing the nitrogen loads by the naturally occurring ratio of TN to TP. The resulting loads of TN and TP for the Black River subsegment are presented in Table 5.2.

Table 5.2. Nutrient TMDL for Subsegment 080302.
(Black River from Jonesville Lock and Dam to the Red River).

	Organic Nitrogen	**Ammonia Nitrogen**	**NO_2+NO_3 Nitrogen**	**Total N**	**Total P**
WLA for point sources	0	0	0	0	0
MOS for point sources	0	0	0	0	0
LA for NPS (90%)	472.56	23.60	132.16	628.32	62.21
MOS for NPS (10%)	52.51	2.62	14.68	69.81	6.91
Total Maximum Daily Load	525.07	26.22	146.84	698.13	69.12

5.3 Ammonia Toxicity Calculations

Although subsegment 080302 is not on a 303(d) List for ammonia, the ammonia concentrations predicted by the projection model were checked to make sure that they did not exceed EPA criteria for ammonia toxicity (EPA 1999). The EPA criteria are dependent on temperature and pH. The water temperature used to calculate the ammonia toxicity criterion for Black River was the same as the critical temperature used in the projection simulation (30.0°C).

For pH, an average of the values measured at LDEQ station 0776 during the calibration period was used. The resulting criterion was 2.3 mg/L of ammonia nitrogen. The instream ammonia nitrogen concentration predicted by the LA-QUAL model (0.07 mg/L) was well below the criterion. This indicates that the ammonia nitrogen loadings that will maintain the DO standard are low enough that the EPA ammonia toxicity criteria will not be exceeded under critical conditions. The ammonia toxicity calculations are shown in Appendix U.

5.4 Summary of NPS Reductions

In summary, the projection modeling used to develop the TMDLs above showed that NPS loads need to be reduced by 42% to maintain the DO standard in the lower Black River.

5.5 Seasonal Variation

As discussed in Section 4.1, critical conditions for DO in Louisiana waterbodies have been determined to be when there is negligible nonpoint runoff and low stream flow combined with high water temperatures. In addition, the model accounts for loadings that occur at higher flows by modeling sediment oxygen demand. Oxygen demanding pollutants that enter the waterbodies during higher flows settle to the bottom and then exert the greatest oxygen demand during the high temperature seasons.

5.6 Margin of Safety

The MOS accounts for any lack of knowledge or uncertainty concerning the relationship between load allocations and water quality. As discussed in Section 4.1, the highest temperatures occur in July through August, the lowest stream flows occur in October through November. The combination of these conditions, in addition to other conservative assumptions regarding rates and loadings, yields an implicit MOS which is not quantified. In addition to the implicit MOS, the TMDLs in this report also include an explicit MOS of 10% for NPS loads.

6.0 SENSITIVITY ANALYSES

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 sensitivity analyses were performed by allowing the LA-QUAL model to vary one input parameter at a time while holding all other parameters to their original value. The calibration simulation was used as the baseline for the sensitivity analysis. The percent change of the model's minimum DO projections for each parameter varied is presented in Table 6.1. Each parameter was varied by "30%, except for temperature, which was varied "2ºC.

Values reported in Table 6.1 are sorted by percentage variation of minimum DO from smallest percentage variation to largest. BOD decay rate, reaeration, and depth were the parameters to which DO was most sensitive.

Table 6.1. Summary of results of sensitivity analyses.

Input Parameter	**Parameter Change**	**Predicted minimum DO (mg/L)**	**Percent Change in Predicted DO (%)**
Baseline	-	4.36	N/A
NH3 decay rate	+30%	4.34	<1
NH3 decay rate	-30%	4.38	<1
Organic N decay rate	+30%	4.35	<1
Organic N decay rate	-30%	4.37	<1
Wasteload BOD	+30%	4.36	<1
Wasteload BOD	-30%	4.36	<1
Wasteload DO	+30%	4.36	<1
Wasteload DO	-30%	4.36	<1
Wasteload flow	+30%	4.36	<1
Wasteload flow	-30%	4.36	<1
Wasteload NH3	+30%	4.36	<1
Wasteload NH3	-30%	4.36	<1
Wasteload Organic N	+30%	4.36	<1
Wasteload Organic N	-30%	4.36	<1
SOD	-30%	4.41	1
SOD	+30%	4.31	1
Headwater flow	+30%	4.45	2
Initial temperature	-2EC	4.47	3
Initial temperature	+2EC	4.25	3
Headwater flow	-30%	4.20	4
Depth	+30%	4.19	4
Reaeration	+30%	4.54	4
Reaeration	-30%	4.15	5
BOD decay rate	+30%	4.03	8
BOD decay rate	-30%	4.72	8
Depth	-30%	4.71	8

7.0 OTHER RELEVANT INFORMATION

This TMDL has been developed to be consistent with the antidegradation policy in the LDEQ water quality standards (LAC 33:IX.1109.A).

Although not required by this TMDL, LDEQ utilizes funds under Section 106 of the Federal Clean Water Act and under the authority of the Louisiana Environmental Quality Act to operate an established 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 NPS 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 establishment 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. The Ouachita River Basin will be sampled again in 2004.

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.)

In addition to ambient water quality sampling in the priority basins, the LDEQ has increased compliance monitoring in those basins, following the same schedule. Approximately 1,000 to 1,100 permitted facilities in the priority basins were targeted for inspections. The goal set by LDEQ was to inspect all of those facilities on the list and to sample 1/3 of the minors and 1/3 of the majors.

8.0 PUBLIC PARTICIPATION

When EPA establishes a TMDL, 40 CFR §130.7(d)(2) requires EPA to publicly notice and seek comment concerning the TMDL. Pursuant to an October 1, 1999 Court Order, this TMDL was prepared under contract to EPA. After development of the draft of this TMDL, EPA commenced preparation of a notice seeking comments, information, and data from the general and affected public. Comments and additional information were submitted during the public comment period and this TMDL was revised accordingly. Responses to these comments and additional information are included in Appendix V. EPA has transmitted this revised TMDL to LDEQ for incorporation into LDEQ's current water quality management plan.

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APPENDIX A THROUGH U AVAILABLE THROUGH EPA UPON REQUEST

APPENDIX V

Responses to Comments

COMMENTS AND RESPONSES
BLACK RIVER TMDLs FOR DO AND NUTRIENTS
May 28, 2002

EPA appreciates all comments concerning these TMDLs. Comments that were received are shown below with EPA responses or notes inserted in a different font.

GENERAL COMMENTS FROM LOUISIANA DEPARTMENT OF ENVIRONMENTAL QUALITY (LDEQ):

Note: LDEQ submitted one document containing comments on 98 TMDLs for various pollutants and subsegments throughout the Ouachita and Calcasieu basins. Only the portions of that comment document that apply to the DO and nutrient TMDLs in the Ouachita basin (10 subsegments) are shown below. Some of the general comments may not apply to this report.

The Louisiana Department of Environmental Quality hereby submits comments on the 98 TMDLs and the calculations for these TMDLs prepared by EPA Region 6 for waters listed in the Calcasieu and Ouachita river basins, under section 303(d) of the Clean Water Act. Listed below are general comments.

1. Many of these TMDLs are based on models using historical water quality data gathered at a single or small number of locations rather than survey data gathered at sites spaced throughout the waterbody. The hydraulic information used was generally an average value or estimated value, not taken at the same time as the water quality data. The calibrations are inadequate due to the lack of appropriate hydrologic data and the paucity of water quality data. The resulting TMDLs are invalid. LDEQ does not accept these TMDLs.

Response: The TMDLs were based on existing data plus information that could be obtained with available resources. Each model was developed using the most appropriate hydraulic information and water quality data that were available. A rationale was provided for data use and assumptions and limitations were given. Although LDEQ typically collects more data for model calibration than what was available for calibration of most of these models, EPA considers these model calibrations and the resulting TMDLs to be valid.

2. LDEQ does not consider any of these waters to be impaired due to low dissolved oxygen, nutrients, or ammonia. Many of these waters simply have inappropriate standards and criteria. The resources spent on developing these TMDLs could have been far more effectively and wisely spent on reviewing, approving, and assisting in the development of appropriate standards and criteria for these waters through the UAA process.

Response: TMDLs were developed for these subsegments based on the requirements of Section 303(d) of the Clean Water Act and regulations at 40 CFR 130.7 and the suspected causes of impairment (organic enrichment/low DO and/or nutrients) for each subsegment in the EPA Modified Court Ordered 303(d) List. TMDLs must be established to meet existing water quality standards. If it is determined that a standards changes is appropriate, the TMDL can be revised to reflect that change.

3. CBODu and NH3-N were estimated from surrogate parameters rather than actual measured data for most of the TMDLs. The TMDL report uses the LDEQ's multi-basin loading database's median ratio values between the ultimate loads and the proposed surrogates. This data was based on the measured data from the last two years of LDEQ water quality surveys. LDEQ objects to the correlation of TOC to CBOD and NH3-N to TKN unless these correlations are taken from water quality data on the modeled waterbody. Our studies have shown only a moderate correlation between these parameters within the same waterbody, however when this correlation was attempted across waterbodies, extreme variability was seen and the correlations were not judged valid. It is possible that a combination of surrogates will obtain a better correlation, such as TOC along with color, turbidity, pH, etc. LDEQ is currently researching these options.

Response: EPA agrees that it would be ideal to have data collected from each modeled waterbody for relating TOC to CBOD and NH3-N to TKN. However, none of these subsegments had sufficient data from which these relationships could be developed. Relationships with surrogate parameters were used only when data for the desired parameter was not available.

4. BOD decay rates were estimated from surrogate parameters rather than actual measured data for most of the TMDLs. The TMDL report uses the LDEQ's multi-basin loading database's median values. This data was based on the measured data from the last two years of LDEQ water quality surveys. It has been LDEQ's experience that these rates vary significantly from waterbody to waterbody and frequently vary significantly within the same waterbody. LDEQ objects to using surrogate data without regard for specific waterbody conditions for these parameters.

Response: Due to the schedule and level of resources available for this project, it was not feasible to perform long term BOD time series analyses on samples from these waterbodies. Given this situation, using LDEQ’s database was considered the best approach for estimating decay rates.

5. A winter projection model was not developed for most of the TMDLs. Winter projection models must be developed to address seasonality requirements of the Clean Water Act. Where point sources have seasonally variable effluent limitations or such seasonal variations are proposed, a winter projection model is required to show that standards are met year-round.

Response: As discussed in Section 4.2 of each report, summer is the most critical season for meeting the year round standard for DO for these subsegments. Therefore, the summer simulation satisfies the seasonality requirements of the Clean Water Act. The available information for point source discharges indicated that the facilities discharging to these waterbodies do not have seasonal permit limits. If any of these facilities wishes to pursue seasonal permit limits, then LDEQ or the permittee can re-run the model to develop seasonal wasteload allocations.

6. LDEQ takes exception to the calculation of a TMDL based on TN/TP ratios derived from waterbodies other than the modeled waterbody. It is LDEQ's experience that the natural allowable TN/TP ratio is waterbody-specific and can vary dramatically between streams.

Response: These nutrient TMDLs were developed using naturally occurring ratios of nitrogen to phosphorus based on Louisiana's narrative water quality standard for nutrients. These ratios were calculated using reference stream data rather than long term monitoring data for each subsegment because the reference stream data were considered to be more appropriate for naturally occurring conditions.

7. LDEQ has not adopted the EPA recommended ammonia criteria (1999) and takes exception to its use in these TMDLs. In general, LDEQ does not accept EPA's use of national guidance for TMDL endpoints. The nationally recommended criteria do not consider regional or site- specific conditions or species and may be inappropriately over protective or under protective. No ammonia nitrogen toxicity has been demonstrated or documented in any of the waterbodies in these TMDLs. The general criteria (in particular, LAC 33:IX.1113.B.5) require state waters be free from the effects of toxic substances.

Response: Ammonia toxicity calculations were performed to ensure that the ammonia loadings that will maintain DO standards will not cause any exceedences of the ammonia toxicity criteria. National guidance for ammonia toxicity was used in the absence of any numerical state water quality standards for ammonia. EPA believes that this evaluation offers assurances that waters will continue to be free from the effects of toxic substances.

8. Algae were not simulated. Was there evidence that algae did not have an impact on the waterbody? Did the contractor have any Chlorophyll a measurements on which to base this determination?

Response: For most of these subsegments, the effects of algae were not simulated in the models because there were no data to clearly demonstrate a need for including algae and the models calibrated well without including algae (i.e., the models were calibrated without having to use unreasonable coefficients to compensate for algal effects).

SPECIFIC COMMENTS FROM LDEQ FOR BLACK RIVER:

No specific comments were received from LDEQ for the Black River.