BAYOU BOEUF, HALPIN CANAL AND THERIOT CANAL AND LAKE BOEUF IMPLEMENTATION PLAN

For
Dissolved Oxygen and Nutrients

Nonpoint Source Unit, 2005

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EXECUTIVE SUMMARY

Sub-segments 020102 (Bayou Boeuf, Halpin Canal, Theriot Canal) and 020103 (Lake Boeuf) are located in southern Louisiana in the Barataria Basin, west of New Orleans. These sub-segments were listed on the Modified Court Ordered 303(d) List for Louisiana as not meeting the water quality standard for the designated use of propagation of fish and wildlife as a result of organic enrichment/low dissolved oxygen (DO) and nutrients.

The two predominant land uses in sub-segment 020102 are wetland forest (62.1%) and agriculture (20.2%), while sub-segment 020103 is classified as mostly fresh marsh (67.6%) and water (26.8%). Most of the agricultural land in sub-segment 020102 is located near the ridge along Bayou Lafourche, with the primary crop being sugarcane. All these land uses are potential sources of water pollution.

To meet the estimated pollution loading reduction of 100% in summer and 92% in winter, from manmade sources, and of 37% in summer from natural background sources in order to meet the DO standard of 5 mg/L, a concerted effort by farmers, foresters, all residents and all levels of government is needed. Public education is the first critical element for accomplishing pollution reduction goals and objectives because education will help them understand and support the efforts to implement the best management practices (BMPs).

Pollution from minor industrial point sources (PS), pasture land, petroleum activities, spills, septic tanks, natural sources and non-irrigated crop production are suspected of contributing the substances that demand oxygen and therefore a high priority should be given to reducing nonpoint sources (NPS) and PS loading from these sources. Based on the TMDL data analysis, almost all pollution loading is contributed by the nonpoint sources. The largest contributing nonpoint oxygen demand sources in both sub-segments 020102 and 020103 are nonpoint biochemical oxygen demand (BOD) and sediment oxygen demand (SOD). It is therefore recommended that the sources of these substances (SOD and Carbon Biological Oxygen Demand and Nitrogenous Biological Oxygen Demand) within both sub-segments be accounted for so that the necessary best management practices (BMPs) can be applied. In addition, all the processes that deplete dissolved oxygen including algal respiration, due to high nutrient levels, should also be considered.

Based on the load by reach TMDL report data analysis, it is recommended that the areas near Bayou Onion, Pitre Lening Canal, and between Bayou Onion and La Peans Canal should be the focus points for reducing nonpoint source pollution in sub-segments 020102 and 020103. But most important, public education should be the first priority if NPS load reduction goals and objectives are to be accomplished. A consolidated list of recommended BMPs for crop agriculture and other land uses is found in volume 6 of the State of Louisiana Water Quality Management Plan.
(http://nonpoint.deq.louisiana.gov/wqa/default.htm)

1.0 INTRODUCTION

This report outlines a plan, which can be implemented using federal, state and local funds to reduce nonpoint source pollution (NPS) entering Bayou Boeuf, Halpin Canal, and Theriot Canal (sub-segment 020102) and Lake Boeuf (sub-segment 020103) in order to improve water quality to meet the designated uses. NPS pollution comes from a wide range of sources and it is caused by rainfall or snowmelt moving over and through the ground transporting natural and human-made contaminants into lakes, rivers, wetlands, coastal waters, and underground sources of drinking water. Common land uses that contribute to NPS pollution include urban, agricultural, forestry, construction, home sewage systems, saltwater intrusion, resource extraction and hydromodifications. In depth information on each of these land uses and their effect on NPS pollution can be found in Louisiana's Nonpoint Source Management Plan (LDEQ, 2000).

Section 319 of the Clean Water Act gives the Environmental Protection Agency (EPA) authority to issue grants to states to assist in implementing management programs to control NPS water pollution (EPA, 2004). Water bodies included in the Modified Court Ordered 303(d) List of Impaired Waters are given the highest priority. A water body is entered into the 303(d) list of impaired waters when it surpasses the water quality standard 10% of the time during an assessment period. Sub-segments 020102 and 020103 were listed as impaired on both the EPA 1999 Court Ordered 303(d) list for Louisiana and the Louisiana Department of Environmental Quality (LDEQ) 2002 Final 303(d) list. These sub-segments were found to not be fully supporting their designated use of propagation of fish and wildlife.

1.1. Eco-Region Description

Sub-segments 020102 and 020103 lie in the Lower Mississippi River Alluvial Plain, which is one of the two different eco-regions that comprise the Barataria Basin. The other eco-region is the Coastal Deltaic Plain eco-region, which is on the southern part of the Barataria Basin (Figure 1.1). An eco-region is a region with similar ecological characteristics, delineated based on characteristics such as climate, land surface form, soils, vegetation, land use and hydrographic modifications (levee systems) to form a management unit with similar biological, chemical and physical features (Omernik, 1987).

The Mississippi Alluvial Plain eco-region contains natural levees of moderate elevation and slope; and vegetation includes both cypress forest and bottomland hardwoods. Many of the streams in this eco-region have been hydrologically modified. The southern section of the Mississippi Alluvial Plain eco-region is bisected by the Mississippi River. The western boundary is formed by the Atchafayala River levee system and the southern boundary is formed by the Intra-coastal Waterway. Part of the northern boundary of the southern component of the Lower Mississippi River Alluvial Plain eco-region is formed by the west bank of the Mississippi River. The northern boundary east of the Mississippi River is formed by the southern limit of the Southern Mississippi Silty Upland soil association and the southern boundary of the EPA designated Mississippi Valley Loess Plains, Southeastern Plains and Southern Coastal Plains eco-regions.

On the other hand, the Coastal Deltaic Plain eco-region is typified by low elevations and relief as well as both fresh and salt marsh vegetation. This eco-region is bounded on the west by the Vermilion Lock located on the western shoreline of Vermilion Bay and extends eastward around the Mississippi River levee system terminating at the Intra-coastal Waterway east of the Mississippi River. The Intra-coastal Waterway also forms the northern boundary of the Coastal Deltaic Plain west of the Mississippi River.

Figure 1.1. Map of Louisiana Eco-Regions

1.2. Description of Barataria Basin (02)

According to LDEQ (2000) the Barataria Basin lies in the eastern coastal region of the state and is bounded on the north and east by the Lower Mississippi River, on the west by Bayou Lafourche and on the south by the Gulf of Mexico. The major receiving water body in the basin is Barataria Bay. This basin consists largely of wooded lowlands and fresh to brackish marshes, with some saline marsh on the fringes of Barataria Bay. Elevations in this basin range from minus two to four feet above sea level.

1.3. Sub-segments 020102 and 020103

Sub-segments 020102 and 020103 (Figure 1.2) are located in southern Louisiana in the Barataria basin west of New Orleans. Sub-segment 020102 includes four main bayous and canals (Bayou Boeuf, Halpin Canal, Theriot Canal, and Grand Bayou) and numerous other smaller bayous and canals and other perennial streams, many of which are interconnected (Figure 1.3). Sub-segment 020103 is made up of only Lake Boeuf and is completely surrounded by sub-segment 020102.

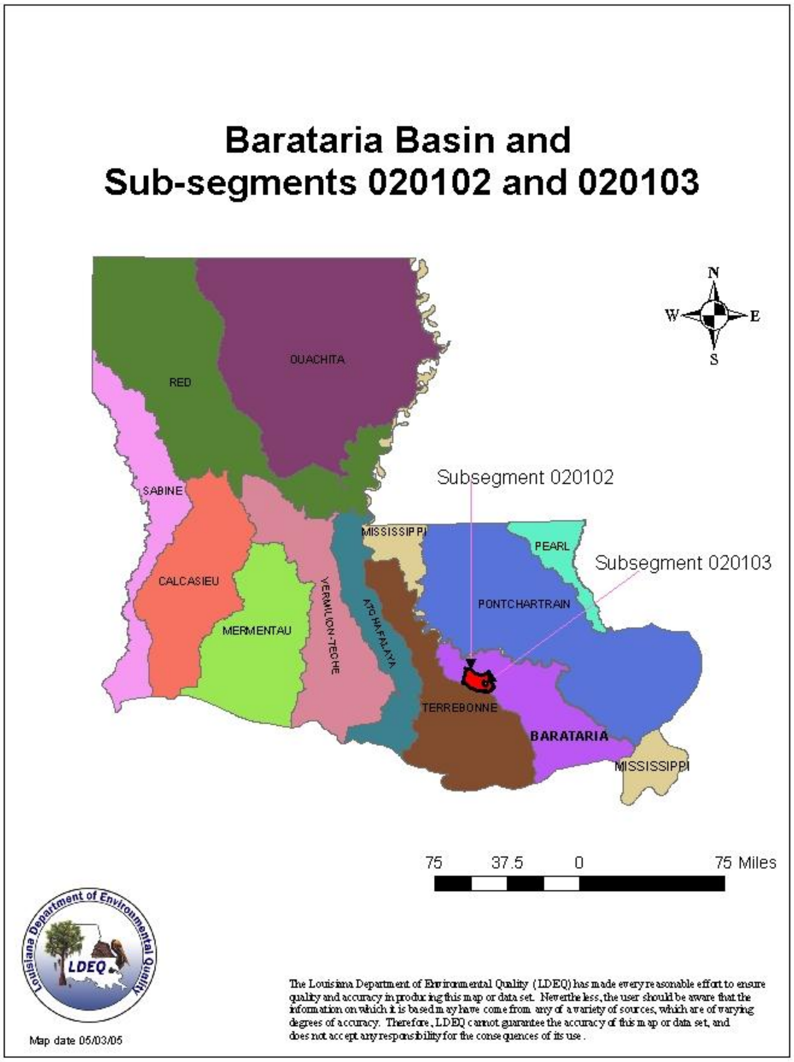


Figure 1.2. Barataria Basin and sub-segments 020102 and 020103

These sub-segments are bounded on the north by a slight natural ridge between Grand Bayou and Bayou Chevreuil and on the south by the natural ridge along Bayou Lafourche. The overall drainage pattern of these sub-segments is towards Lac des Allemands. Inflow from outside these sub-segments can occur at the western end of Grand Bayou (a distributary of Bayou Citamon) and at the southern end of Theriot Canal (which connects to Bayou Lafourche). The exchange of flow between Bayou Lafourche and Theriot Canal is limited by a gated structure near the south end of Theriot Canal. This structure, which is 8 feet wide and owned by the Bayou Lafourche freshwater diversion district, is normally closed during low flow periods except to allow boats to pass through its opening.

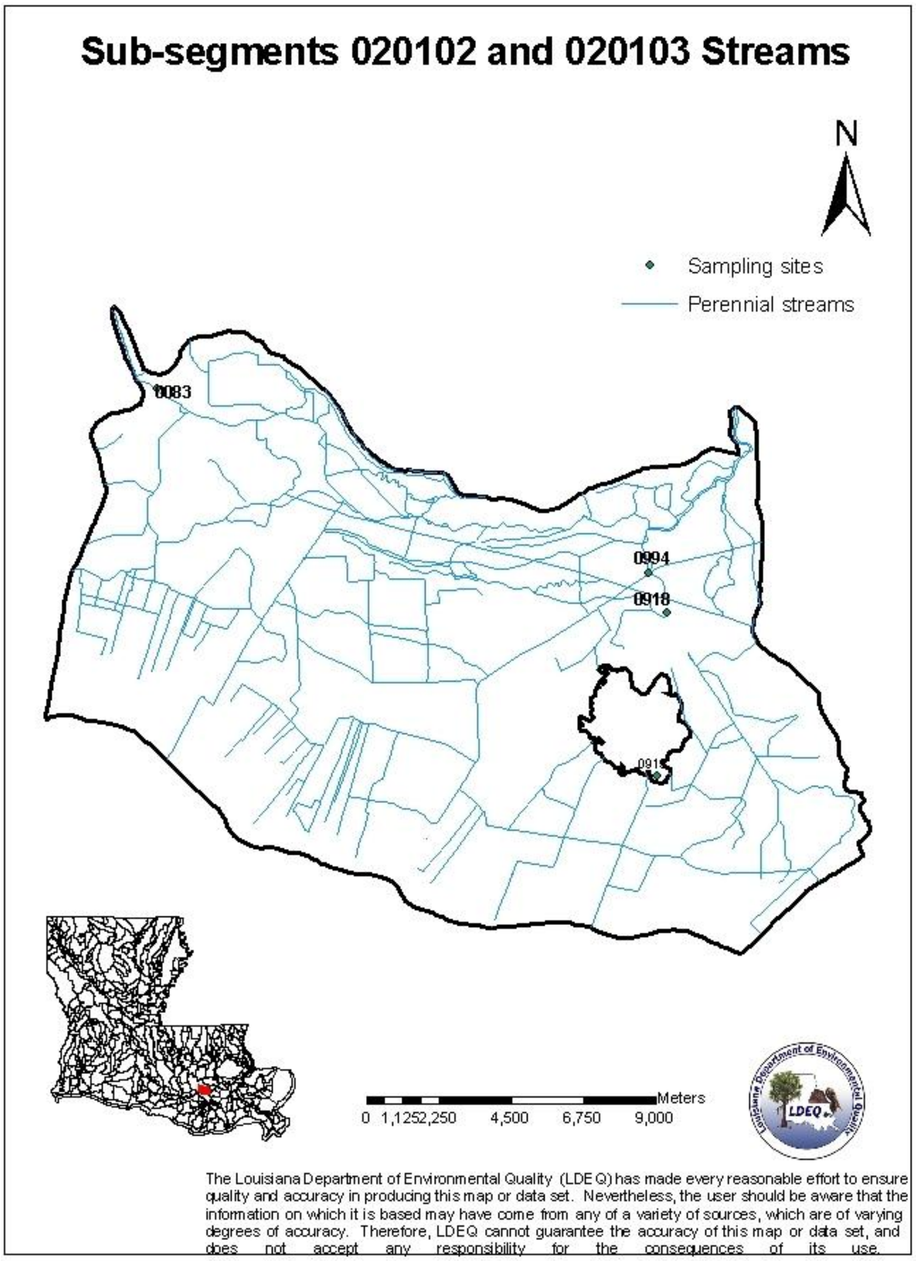


Figure 1.3. Perennial streams in sub-segments 020102 and 020103

Sub-segments 020102 and 020103 have a combined area of approximately 120 square miles (311 km^2). The two predominant land uses in sub-segment 020102 are wetland forest (57.1%) and agriculture (20.4%) as shown in Table 1.1. Most of the agricultural land in sub-segment 020102 is located near the ridge along Bayou Lafourche, with the primary crop being sugarcane.

Other land uses in sub-segment 020102 and 020103 include fresh marsh, water, developed (urban) and wetland shrub/scrub.

Table 1.1. Land uses for sub-segments 020102 and 020103 (LDEQ 2005 Barataria Basin Land Use Classification)

Land use	**Acres**	**% of Total Area**
Forest Wetland	44058.86	57.1
Deciduous Forest	4853.47	6.3
Agriculture - Sugarcane	7657.68	9.9
Agriculture - Bare Field	2796.98	3.6
Agriculture - Pasture	5324.20	6.9
Shrub / Scrub	1278.77	1. 7
Water	1699.42	2.2
Developed	1758.10	2.3
Marsh - Fresh	7660.67	9.9
Unclassified	7.66	0.1
Total	77037.81	100.0

1.4. Field Visit of Sub-segments 020102 and 020103

A site visit to sub-segments 020102 and 020103 was made on May 24, 2005 to assess the general condition of the watershed. Digital orthographical quarter quadrangle (DOQQ) satellite maps were used to identify different types of land uses and their locations in the watershed in order to identify potential sources of NPS loading in sub-segments 020102 and 020103.

Although the visit began at the intersection of Grand Bayou and Bayou Citamon in sub-segment 020102 going upstream towards Lake Boeuf (sub-segment 020103), this narrative begins with sub-segment 020103. As mentioned in section 1.3, sub-segment 020103 is made up of only Lake Boeuf and is completely surrounded by sub-segment 020102. During the site visit, it was not possible to access Theriot canal, which is part of sub-segment 020102 and flows into Lake Boeuf.

One notable observation in Lake Boeuf was the presence of a huge amount of invasive plants throughout the lake. Some of the common plants/vegetation included water hyacinth, lilies and anachris or elodea. Although these plants compete for dissolved oxygen at night, they do help provide oxygen during the daylight hours as a result of photosynthesis. However, when they die the decomposing bacteria use up a lot of oxygen. Also observed during the survey was a bird rookery which could be a source of fecal nutrients that could encourage the growth of water plants which directly compete for the dissolved oxygen when they die, as the decomposing bacteria use up the oxygen. Lake Boeuf flows into Bayou Boeuf (sub-segment 020102).

Bayou Boeuf is the main bayou within the watershed receiving water from Lake Boeuf, Halpin Canal, and Grand Bayou before it flows into Lake Lac des Allemands. At the flow entry point from Lake Boeuf into Bayou Boeuf, there were virtually no trees; vegetation comprised of fresh marsh grass and water was clear possibly because there was little or no surface runoff within the lake. Heading north on Bayou Boeuf through Bowie Canal and Halpin Canal, an increasing presence of wetland forest was noted on both sides of the bayou and the water began to get somewhat muddy, which signifies the presence of sediment loads maybe as a result of runoff from the wetland forests. One of the major bayous flowing into Bayou Boeuf is Grand Bayou.

The visit began at the intersection of Grand Bayou (sub-segment 020102) and Bayou Citamon (sub-segment 020101). At this location, just like on Bayou Boeuf, Grand Bayou was surrounded by wetland forest at the edges with some invasive plants near the stream bank and the water was somewhat muddy. Heading south, residential houses were noted in Chegby near LA 20 and at Kraemer north of LA 307 and house boats were noted at Kramer south of LA 307, all of which could be discharging into the stream. While traveling east on Grand Bayou on an unnamed tributary and further down near a gate, lots of duckweed and other invasive plants on north bank were noted signifying the presence of nutrients. On Grand Bayou near the intersection of St. James Canal and La Pecans Canal, a gas pipeline was noted but no sign of dredging was noted throughout this sub-segment. Finally, sugarcane fields were noted within the watershed within a close proximity to the waterbodies.

2.0 WATER QUALITY ANALYSIS

Analysis of water quality data is needed to determine if a given watershed meets the standards and its designated uses. The water quality standards and the designated uses for sub-segments 020102 and 020103 are shown in Table 2.1. The primary standard for the TMDLs presented by FTN Associates (2004) was the DO standard of 5 mg/L all year round.

Table 2.1. Water quality standard and designated uses for sub-segments 020102 and 020103 (LDEQ, 2005). Uses: A – primary contact recreation, B – secondary contact recreation, C – propagation of fish and wildlife, F – agriculture. Note 1 – 200 colonies/ 100 mL maximum log mean and no more than 25% of samples exceeding 400 colonies/ 100 mL for May through October; 1000 colonies/ 100 mL maximum log mean and no more than 25% samples exceeding 2000 colonies/ 100mL for November through April.

Water quality parameter	Sub-segment 020102 Numerical standard	Sub-segment 020103 Numerical standard
Chloride (CL)	500 mg/L	500 mg/L
Sulfate (SO_4)	150 mg/L	150 mg/L
Dissolved oxygen (DO)	5 mg/L	5 mg/L
PH	6.0 – 8.5	6.0 – 8.5
Bacterial criteria (BAC)	see not 1 above	see not 1 above
Temperature	32 ^oC	32 ^oC
Total dissolved solids (TDS)	1000 mg/L	1000 mg/L
Designated uses	A, B, C, F	A, B, C

Because there were only sixteen months of data for sub-segments 020102 and 020103 (Figure 2.1 and Figure 2.2 respectively), it was not possible to conclusively determine seasonal and long term trends for dissolved oxygen and nutrients.

2.1. Water Quality Test Results for Dissolved Oxygen (DO)

Dissolved oxygen is the volume of oxygen that is contained in water. DO is added to water by atmospheric diffusion at the surface and by photosynthesis during daylight hours. Photosynthesis accounts for most of the DO in water. Water can hold only a limited amount of DO. Oxygen concentrations in the water column fluctuate under natural conditions, but severe depletion usually results from human activities that introduce large quantities of biodegradable organic materials into surface waters. In polluted waters, bacterial degradation of organic materials can result in a net decline in oxygen concentrations in the water. Oxygen depletion can also result from chemical reactions that place a chemical oxygen demand on receiving waters. Other factors, such as atmospheric pressure, temperature, and salinity influence the amount of oxygen dissolved in water. DO increases as atmospheric pressure goes up and as temperature and salinity go down. Hot, cloudy, still weather is common in Louisiana during the summer months; warmer water holds less DO, cloud cover limits light and slows photosynthesis and no wind restricts surface diffusion.

Due to natural DO variation from one season to another, use attainability analyses (UAA) are often carried out. A UAA is a structured scientific assessment of the factors affecting the attainment of uses of water bodies such as swimming, fishing, and drinking. The UAA for the sub-segments 020102 and 020103 determined the DO standard as 5 mg/L throughout the year, although there are seasonal variations as shown in Figures 2.1 and

2.2. With a few exceptions, Figure 2.1 and Figure 2.2 show that the DO concentrations were lower than 5 mg/L during summer months, which are among the highest temperature months. Therefore, a possible cause for the low DO concentration would be the high temperature.

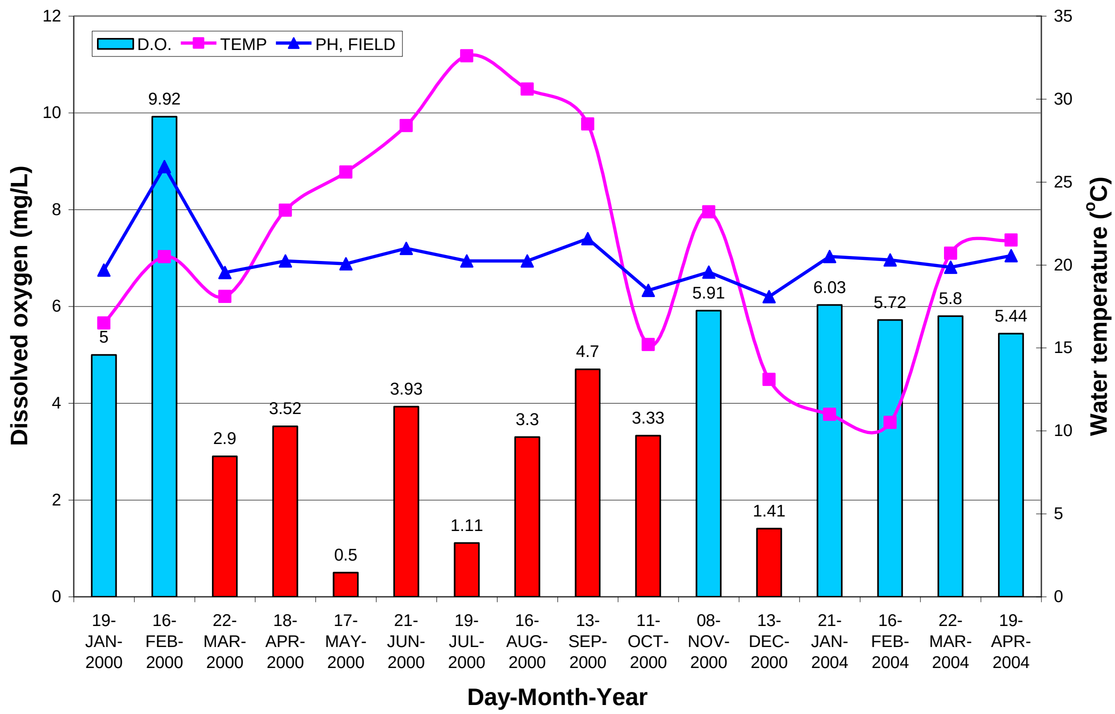


Figure 2.1. Seasonal variations of dissolved oxygen (DO) in sub-segment 020102 in 2000 and 2004. Red bars indicate the dates when DO was less than 5 mg/L

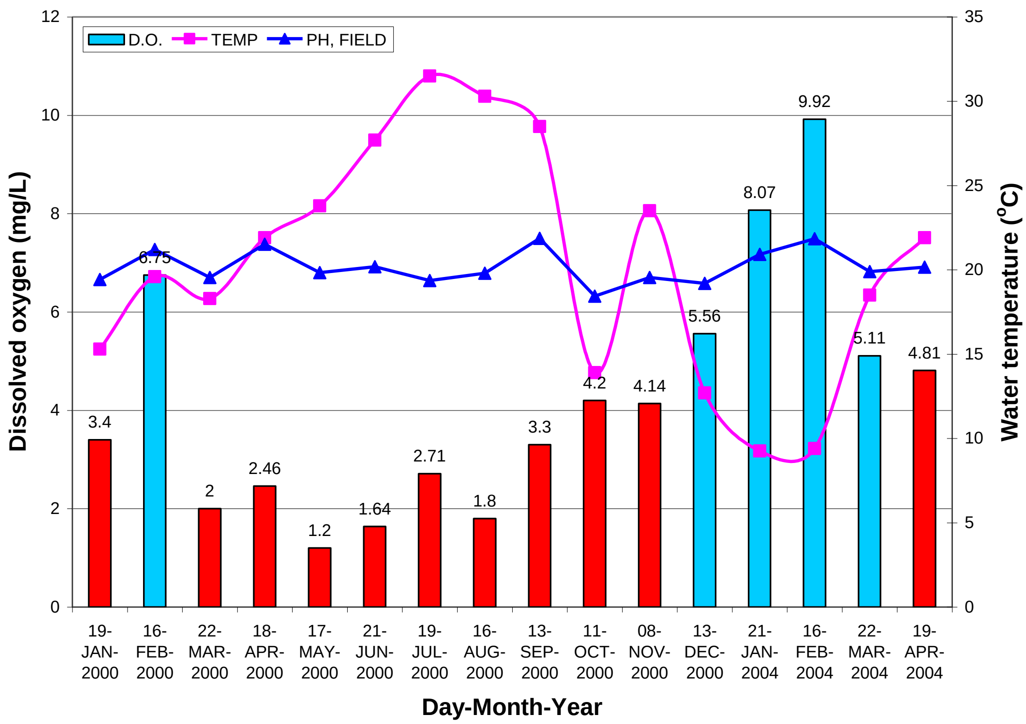


Figure 2.2. Seasonal variations of dissolved oxygen (DO) in sub-segment 020103 in 2000 and 2004. Red bars indicate the dates when DO was less than 5 mg/L

Data analysis for the two historical LDEQ ambient water quality monitoring sites near sub-segments 020102 and 020103 reveal generally an inverse relationship between water temperature and the amount of dissolved oxygen (Figures 2.2 and 2.3) as shown during summer and winter months. Therefore, low DO during summer months could have been due to high temperatures when data was collected. Consequently, more data is needed to determine if sub-segments 020102 and 020103 are DO impaired.

2.2. Water Quality Test Results for Nutrients

The high levels of eutrophication in some Louisiana lakes and streams can be attributed to the nutrients derived from agricultural land, mainly nitrogen and phosphorus. Generally, runoff from agricultural use has significantly higher nutrient concentrations than drainage waters from forested watersheds. Increased nutrient levels may result from fertilizer application and animal wastes. Nutrient concentrations are generally proportional to the percentage of land in agricultural use and inversely proportional to the percentage of the land in forested use (EPA, 1977).

These nutrients occur naturally but when applied in excess on agricultural farm fields, may reach waterbodies and become harmful to the waterbody organisms and this is called "nutrient pollution". Soluble nutrients may reach surface waters through runoff and ground waters through percolation, while others may be adsorbed onto soil particles and reach surface waters with eroding soil. Nutrients are essential to plant growth in a waterbody, but over-enrichment leads to excessive algae growth, an imbalance in natural nutrient cycles, changes in water quality and a decline in the number of desirable fish species (LDEQ, 2000). Factors that influence nutrient losses are precipitation, temperature, soil type, kind of crop, type of conservation practices used, nutrient mineralization, and denitrification.

Nitrogen is naturally present in soils within the organic matter but is usually added to increase crop production. Nitrogen is measured as Total Kjeldahl Nitrogen (T.K.N), which is the sum of organic nitrogen (Norg) and ammonia nitrogen (NH_3-N). Organic nitrogen is the nitrogen incorporated into organic compounds, mainly as unassimilated proteins. The action of bacteria on organic compounds degrades the material and releases ammonia (NH_3). Oxidation on ammonia by bacteria such as *nitrosomonas* results into nitrite (NO_2^-) formation, which when oxidized by *nitrobacter* bacteria becomes nitrate (NO_3^-). Other sources of nitrates present in water runoff from regions where agricultural fertilization is intense, municipal and industrial wastewater, septic tanks, feed lot discharges, animal wastes (including birds and fish) and discharges from car exhausts.

In addition to eutrophication, excessive nitrogen causes other water quality problems. Dissolved ammonia at concentrations above 0.2 mg/L may be toxic to fish, especially trout (LDEQ, 2000). Nitrates in drinking water are potentially dangerous to humans especially to newborn infants. Nitrate is converted to nitrite in the digestive tract reducing the oxygen-carrying capacity of the blood, a condition called methemoglobinaemia or blue baby syndrome (Bruninng-Fann and Kaneene, 1993), which results in brain damage or death in severe cases. The U.S. Environmental Protection Agency has set a limit of 10 mg/L nitrate-nitrogen in water used for human consumption (USEPA, 1989).

Phosphorus can also contribute to the eutrophication of both freshwater and estuarine systems. Although the phosphorus content of most soils in their natural condition is low, between 0.01 and 0.2 percent by weight (LDEQ, 2000), recent soil test results show that the phosphorus content of most cropped soils in the northeast U.S. have climbed to very high range (Sims, 1992) due to the application of manure and fertilizers in levels higher than plants need (Novais and Kamprath, 1978). Phosphorus can be found in the soil in dissolved, colloidal, or particulate forms. Runoff and erosion can carry the excess applied phosphorus to the nearby water bodies. Dissolved inorganic phosphorus (orthophosphate phosphorus) is most likely the only form directly available to algae. Particulate and organic phosphorus delivered to the waterbodies may later be released and made available to algae when bottom sediment of a stream becomes anaerobic, causing water quality problems.

Animal waste and crop residues are the major organic pollutants resulting from agricultural activities (LDEQ, 2000). The total carbon fraction of the organic matter is referred to as total organic carbon (TOC), which describes any organic (carbon-containing) compounds dissolved in natural waters. These organic materials place an oxygen demand on receiving waters upon decomposition. If dissolved oxygen decreases to low levels and remains low, fish and other aquatic species will die. Often this occurs on a seasonal basis in Louisiana, with the actual pollutant loading occurring during high rainfall (high flow events) times of the year and the water quality effect occurring during low flow and high temperature times of the year (LDEQ, 2000). This low flow, high temperature season is often defined as the “critical condition” for the waterbody and for the aquatic organisms that live in the waterbody.

Nutrient levels in the streams vary depending on the source. The major source of nutrient pollution for the sub-segment 020102 is wetland forest and agricultural production whereas for sub-segment 020103 is fresh marsh. Figure 2.3 and Figure 2.4 show the seasonal variations for the different nutrients for sub-segment 020102 and 020103 respectively. The nutrient loading required to maintain the DO standard is the nutrient TMDL used in this report.

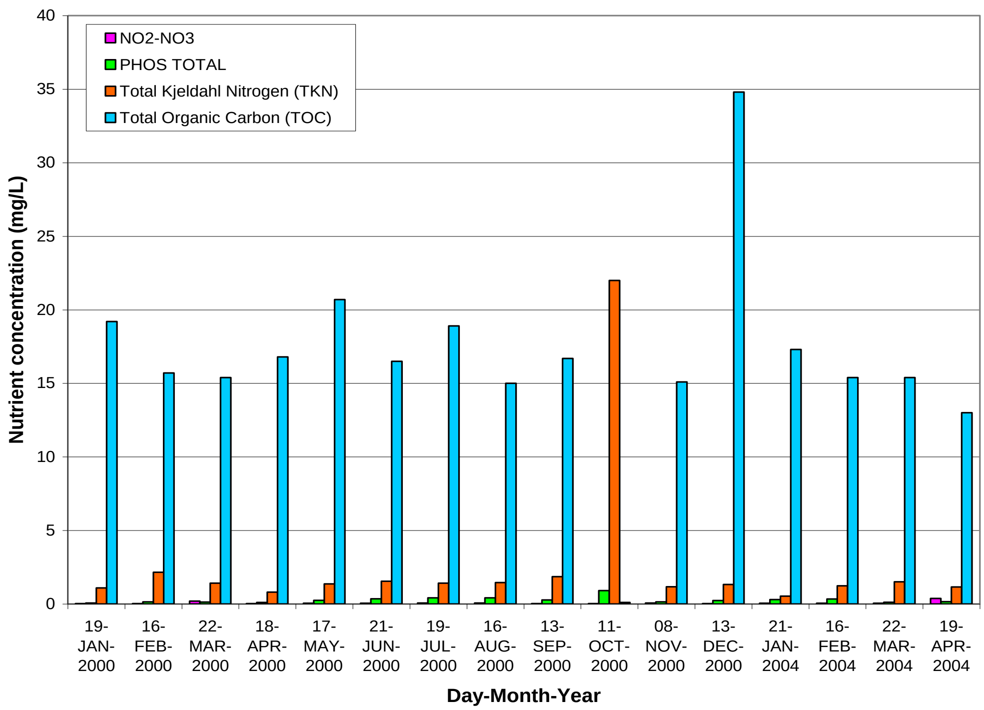


Figure 2.3. Seasonal nutrient variations in sub-segment 020102 in 2000 and 2004

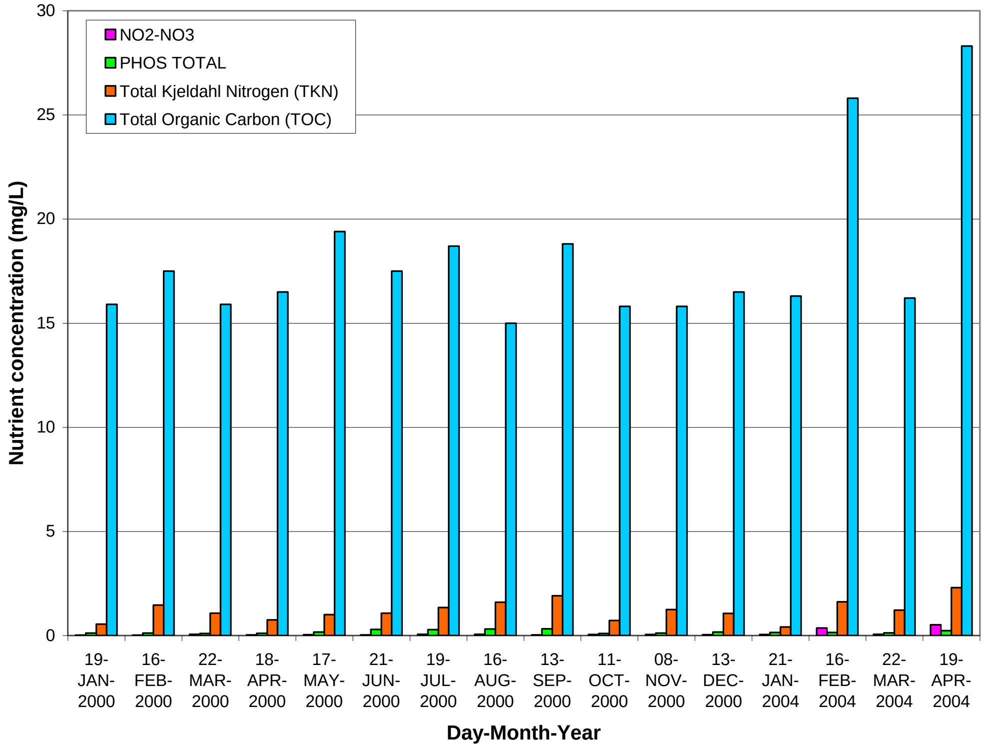


Figure 2.4. Seasonal nutrient variations in sub-segment 020103 in 2000 and 2004

2.3. Other Water Quality Test Results in Sub-segments 020102 and 020103

Although sub-segments 020102 and 020103 are listed as impaired for DO and nutrients only, there are other possible pollutants, which may not meet the water quality standards (LDEQ, 2005). Some of these may have an effect on the dissolved oxygen levels and could be directly related to the nutrient levels. These include total dissolved solids, total suspended solids and turbidity (Appendix A), fecal coliform (Appendix B) and heavy metals (Appendix C). TSS, turbidity and siltation are directly related to DO and therefore correcting the impairment due to DO may lead to the correction of impairment due to TSS, turbidity and siltation.

3.0 TMDL FINDINGS AND RECOMMENDATIONS

Total Maximum Daily Load (TMDL) is the maximum amount of a pollutant that a waterbody can receive without violating water quality standards and an allocation of that amount to the different pollutant's sources. A TMDL is the sum of the allowable loads of a single pollutant from all contributing point and nonpoint sources (allocations). 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. The critical conditions for stream DO concentrations occur during periods with negligible non-point runoff, low stream flow, and high stream temperature. The calculation of load reductions

(DO TMDL projection modeling) is based on the lowest stream flow for 7 consecutive days that occurs on average once every 10 years (7Q10) or 0.1 cfs, whichever is higher for all headwaters, and the 90^{th} percentile temperature for the summer season; this calculation is not based on the ambient flow and temperature. Both the 7Q10 flow and the 90^{th} percentile summer temperature are utilized together, but in reality it is extremely rare for both of these conditions to occur at the same time. In addition, DO TMDL projection modeling must include a margin of safety to account for model uncertainty and therefore ensure that the waterbody can be used for the purposes the State has designated. The calculation must also account for seasonal variation in water quality. Therefore, TMDL is computed using the following equation:

TMDL Allocation = WLA + LA + MOS

where WLA is the waste load allocations for the point sources, LA is the Load allocations for nonpoint sources, and MOS is the margin of safety.

Water quality standards are set by States, Territories, and Tribes based on the designated uses of each water body. The designated uses for sub-segment 020102 include primary contact recreation, secondary contact recreation, propagation of fish and wildlife and agriculture. For sub-segment 020103, the designated uses include primary contact recreation, secondary contact recreation, propagation of fish and wildlife (LDEQ, 2005). According to LDEQ (2005), primary contact recreation is any recreational or water use where there is a prolonged and intimate body contact with the water involving great risk of absorbing waterborne components through the skin or of ingesting components from water in quantities sufficient to cause a significant health hazard. In contrast, secondary contact recreation is any recreational or other water use in which body contact is either incidental or accidental, and in which the probability of swallowing appreciable quantities of water is minimal. Finally, fish and wildlife propagation includes the use of water for aquatic habitat, food, resting, reproduction, cover, and/or travel corridors for any indigenous wildlife and aquatic life associated with the aquatic environment (LDEQ, 2005).

To prepare a TMDL report for sub-segments 020102 and 020103, a water quality model (LA-QUAL) was utilized to simulate dissolved oxygen (DO), carbonaceous biochemical oxygen demand (CBOD), ammonia nitrogen, and organic nitrogen (FTN Associates, 2004). The model was set up and calibrated using LDEQ intensive survey data in June 2003 and information obtained from US Geological Survey (USGS). Based on the FTN Associates (2004) TMDL report, sub-segments 020102 and 020103 were listed on both the EPA Court Ordered 303(d) list for Louisiana and the LDEQ Final 2020 303(d) list as not fully supporting the designated use of propagation of fish and wildlife. Organic enrichment/low DO and nutrients were cited in the 303(d) as the causes of impairment; with the suspected causes being minor industrial point sources, pasture land, petroleum activities, spills, septic tanks, natural sources and non-irrigated crop production (FTN Associates, 2004). These TMDLs address the organic enrichment/ low DO impairment and the nutrient impairment.

3.1. TMDL for Dissolved Oxygen

The primary numeric standard for the TMDLs used in this report is the DO standard of 5 mg/L all year round. The TMDL for DO for Bayou Boeuf, Halpin Canal and Theriot Canal and Lake Boeuf sub-segments was calculated based on the results of the water model (LA-QUAL) projection simulation (FTN Associates, 2004). There were different sources of DO loads in both sub-segments. The dissolved oxygen demand from organic nitrogen and ammonia nitrogen was calculated as 4.33 (value of ratio of oxygen demand to nitrogen used by the LA-QUAL model) times the nitrogen loads. For the sediment oxygen demand (SOD) loads, a temperature correction was included in the calculations by FTN Associates (2004) in order to be consistent with LDEQ procedures. The TMDL oxygen demanding substances load distribution (Figure 3.1) reveals that almost all of the total load was attributed to nonpoint sources. The nonpoint load sources include SOD, incremental, nonpoint, headwaters and tributaries. Incremental load is the NPS load associated with groundwater inflows indicated by low DO, an increase in conductivity and a decrease in water temperature and it includes CBODu, Organic-N and Ammonia-N. Nonpoint load is the sum of the loads not associated with a flow and are used to simulate loads from the stream bed benthic load that have been re-suspended into the water column and it includes CBODu, Organic-N. Headwater and waste tributaries load is composed of loads associated with inflow from the headwater and un-modeled tributaries and like incremental load includes CBODu, Organic-N and Ammonia-N. Point source load is load from the permitted stationary or fixed facilities from which pollutants are discharged directly into a waterbody.

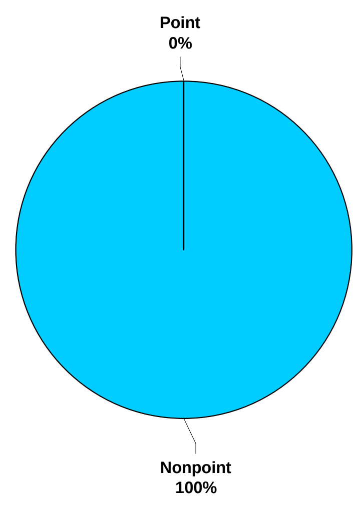


Figure 3.1. Percentage point and nonpoint source pollution contribution to total oxygen demand load for Bayou Boeuf, Halpin Canal and Theriot Canal and Lake Boeuf watershed (Data source: FTN Associates, 2004)

3.2. Reach TMDL Modeling for Sub-segments 020102 and 020103

For modeling purposes, Bayou Boeuf, Halpin Canal and Theriot Canal and Lake Boeuf watershed was divided into 19 reaches (Table 3.1 and Figure 3.2) representing varying depths and widths along the stream to capture the likely water quality variation in the different sections of the stream.

With an exception of reaches 1, 2, and 3 all of the other reaches generally have high total oxygen demand loads (Figure 3.3). However, the specific reaches to focus on will be 9, 6, 10, 12, 11, 13, 7, and 8 in the order of priority, all with TOC loads greater than 10 g O_2/m^2/day. In addition, the partitioned oxygen demand for sub-segments 020102 and 020103 indicates high amount of partitioned oxygen demand at 19.8 km, 17.3 km and 5.8 km from reach to confluence corresponding to reaches 9, 10 and 6 respectively in which the contribution to nonpoint loading was from SOD, nonpoint, headwaters, tributaries and incremental sources (Figure 3.4). The other locations shown in Figure 3.4 that would need attention are 14.9 km, 12.4 km and 10.3 km from the confluence corresponding to reaches 11, 12 and 13 in which the contributing sources include SOD, Nonpoint, and incremental sources.

Table 3.1 Calibration model reach description (data from FTN Associates, 2004)

Reach number	**Calibration model reach length (km)**	**Calibration model reach width (m)**	**Ending river kilometer of reach**
1	3.70	20.90	17.10
2	1.50	14.00	15.60
3	3.80	1748.00	11.80
4	4.30	47.85	7.50
5	7.50	23.20	8.00
6	2.20	23.80	5.80
7	5.80	24.40	0.00
8	1.50	41.50	6.00
9	2.20	19.50	19.80
10	2.50	32.50	17.30
11	2.40	29.26	14.90
12	2.50	22.25	12.40
13	1.90	28.10	10.50
14	1.90	36.70	8.60
15	2.00	32.92	6.60
16	1.80	35.35	4.80
17	4.80	34.42	0.00
18	1.40	69.03	4.60
19	4.60	62.80	0.00

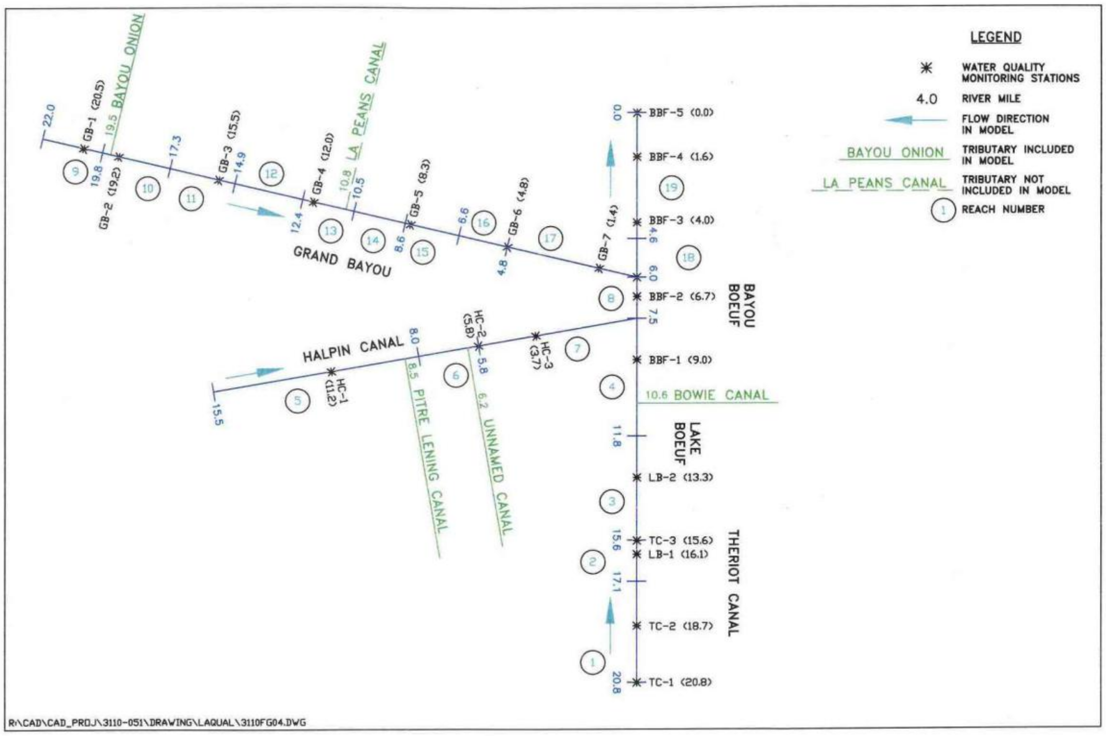


Figure 3.2 Boeuf System (Source: FTN Associates, 2004)

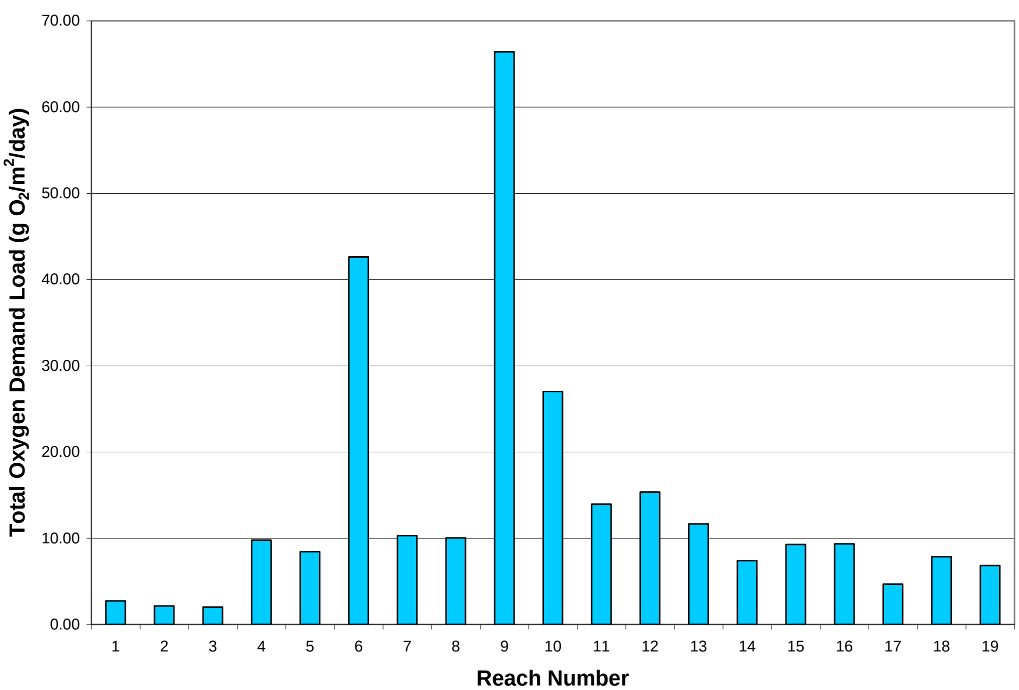


Figure 3.3. Distribution of total oxygen demand load by reach in Bayou Boeuf, Halpin Canal and Theriot Canal and Lake Boeuf watershed (Data source: FTN Associates, 2004)

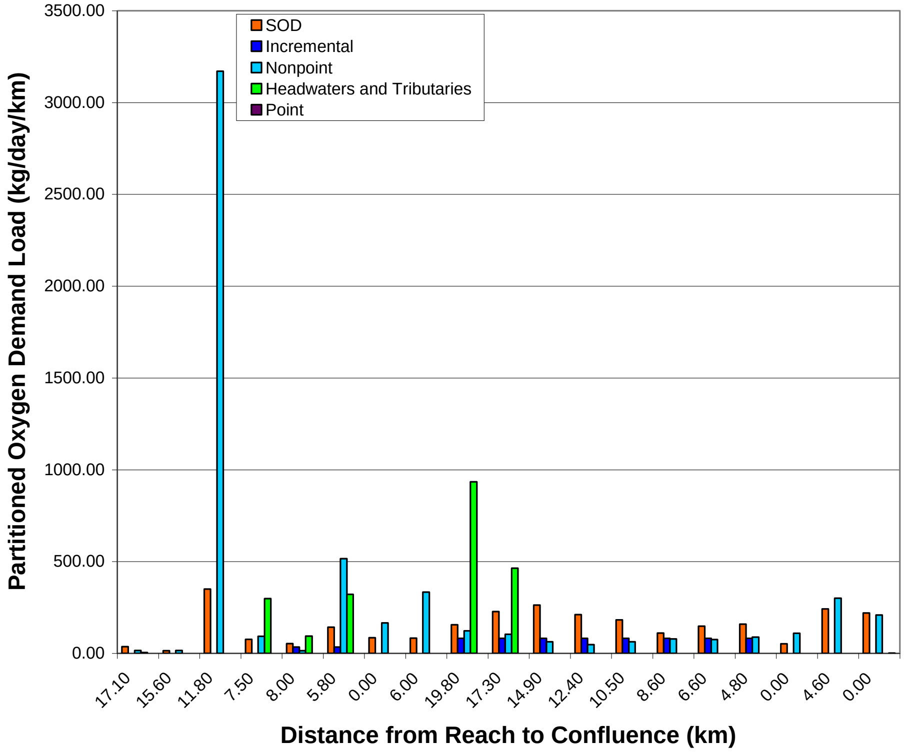


Figure 3.4. Partitioned total oxygen demand load in Bayou Boeuf, Halpin Canal and Theriot Canal and Lake Boeuf watershed (Data source: FTN Associates, 2004)

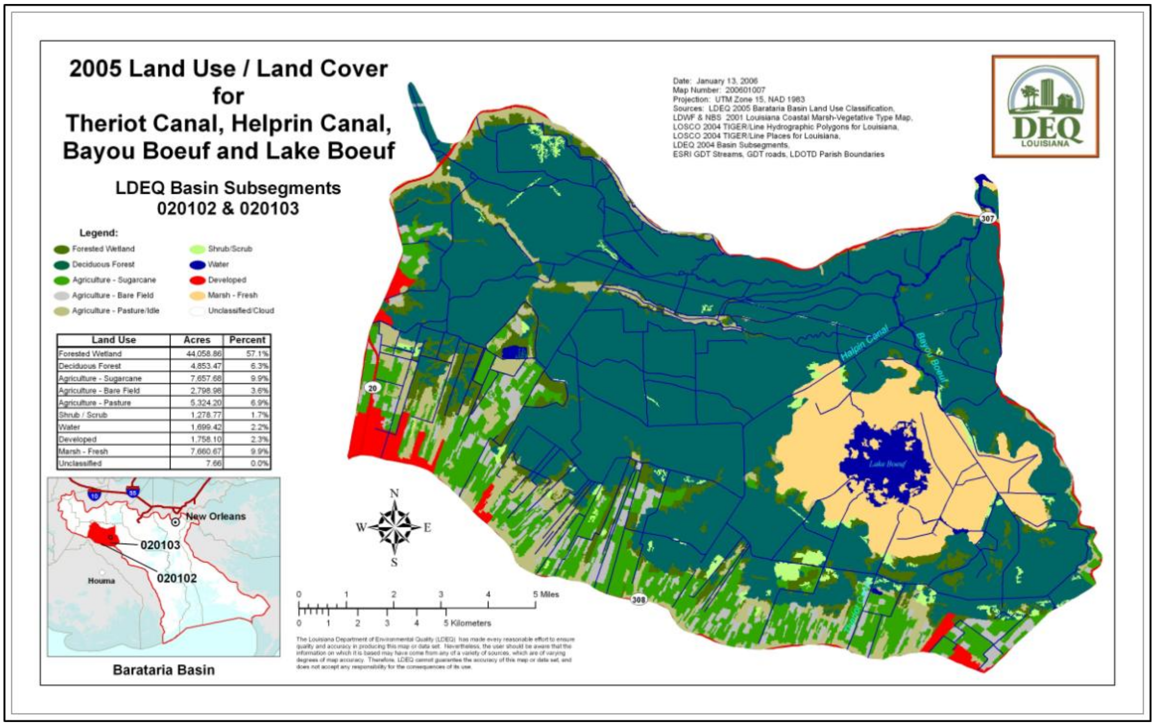
3.4. Recommendations

Based on the TMDL data, the largest contributing nonpoint oxygen demand sources in sub-segments 020102 and 020103 are nonpoint biochemical oxygen demand (BOD) and sediment oxygen demand (SOD) and to some extent headwaters and tributaries BOD and SOD. BOD is the amount of oxygen consumed by bacteria while decomposing organic matter under aerobic conditions and is comprised of nitrogenous biochemical oxygen demand (NBOD) and carbonaceous biochemical oxygen demand (CBOD). The sediment oxygen demand (SOD) is the rate of oxygen consumption exerted by the bottom sediment on the overlying water due to the decomposition of organic matter deposited on the bottom sediment. In shallow nutrient-rich waters, where algal blooms frequently occur, there is a potential of very high SOD (due to the decomposition of settled algal detritus) levels. This may lead to severe oxygen depletion, resulting in massive fish kills. The SOD is often a significant component of the dissolved oxygen budget and therefore, its analysis is important. Carbonaceous biochemical oxygen demand (CBOD) is a term that describes the consumption of oxygen through the oxidation of carbon by bacteria in water. On the other hand, nitrogenous biochemical oxygen demand (NBOD) describes the consumption of oxygen through the nitrification of organic materials and ammonia.

It is therefore recommended that the sources of these substances (SOD and CBOD and NBOD) within sub-segments 020102 and 020103 be accounted for so that the necessary best management practices can be applied. In addition, all the processes that deplete dissolved oxygen including algal respiration, due to high nutrient levels, should also be considered.

4.0 WATERSHED LAND USE

The two predominant land uses in sub-segment 020102 are wetland forest (57.1%) and agriculture (20.4%) as shown in Figure 4.1. Most of the agricultural land in sub-segment 020102 is located near the ridge along Bayou Lafourche, with the primary crop being sugarcane. Other land uses observed during the site visit on May 24, 2005 are residential areas along sub-segment 020102 bank, but no noticible farming activities along the bank.



Land Use	Acres	Percent
Forested Wetland	44,058.86	57.1%
Deciduous Forest	4,853.47	6.3%
Agriculture - Sugarcane	7,657.68	9.9%
Agriculture - Bare Field	2,798.98	3.6%
Agriculture - Pasture	5,324.20	6.9%
Shrub / Scrub	1,278.77	1.7%
Water	1,699.42	2.2%
Developed	1,758.10	2.3%
Marsh - Fresh	7,660.67	9.9%
Unclassified	7.66	0.0%

Figure 4.1. LDEQ Land Use Map for Theriot Canal, Helprin Canal, Bayou Boeuf and Lake Boeuf

5.0 SOURCES OF NONPOINT SOURCE POLLUTION LOADING

Nonpoint source (NPS) pollution can directly or indirectly impair the quality of water of a given waterbody, which may render the waterbody unsuitable for its designated uses. To prevent NPS pollution in order to maintain allowable water quality standards for any particular waterbody designated uses, it is essential to determine the specific NPS pollution sources. Some NPS pollution in sub-segments 020102 and 020103 could originate from various sources within the watershed including crop production, natural sources (decomposed organic matter in wetland forest), petroleum activities, and residential settlements along the stream banks.

5.1. Row Crop Agriculture

Crop agriculture was listed as one of the two dominant land uses in sub-segment 020102 in 2004 (FTN Associates, 2004) and confirmed during a field trip to sub-segments 020102 and 020103 on May 24, 2005. The main crop grown in this area is sugarcane (Figure 5.1). In planting cane fields, mature cane stalks are cut into sections and laid horizontally in furrows which are prepared conventionally. Planting is in rows about 6 feet apart to make possible cultivation and use of herbicides for early weed control. Sugarcane harvesting in Louisiana is highly mechanized and the cane leaves are burned while the sugarcane is standing just before harvesting or the trash is burned after harvesting.

Common agricultural practices, such as tillage and nutrient, herbicide and pesticide application, can lead to water pollution. Conventional tillage and sugarcane harvesting expose land to high energy raindrops especially before crops grow to provide cover, which makes land more susceptible to water runoff carrying sediments, nutrients such as nitrogen, phosphorus and potassium, herbicides and pesticides into destination water bodies. Additionally, tillage can lead to reduced soil moisture content due to high evaporation, which could lead to fewer microorganisms needed to convert applied nutrients into forms available for plant uptake. The unconverted nutrients are washed off the fields as runoff leading to nutrient pollution in the receiving water body.

Figure 5.1. A conventional tilled sugarcane field near the ridge along Bayou Lafourche

Tillage can also delay the growth and development of arbuscular mycorrhizas essential in mineral nutrient uptake. Arbuscular mycorrhizas are roots with specific types of fungi inside them and in the surrounding soil. This type of mycorrhiza is formed by fungi in a group generally referred to as arbuscular mycorrhizal fungi. Although some kinds of soil fungi can be associated with plant and animal disease, the fungi that form arbuscular mycorrhizas belong to a group of soil fungi that can be very beneficial. The name "mycorrhiza" means "fungus root" and this is derived from the close association of the fungi with plant roots - in fact, arbuscular mycorrhizal fungi cannot complete their life cycle unless they are connected to plant roots (Anonymous, 2005). Generally, it is not possible to grow these fungi without the support of the plant. Mycorrhizas get their carbohydrate (energy) from the plant root they are living in/on and they usually help the plants by transferring phosphorus from the soil into the root.

According to Paul and Clark (1996), plants grown with a reduced number of arbuscular mycorrhizas due to tillage have a lower phosphorus uptake and lower yields relative to no till. Reduced phosphorus uptake leaves excess soil phosphorus which is easily transported in runoff as dissolved phosphorus or attached to the soil particles (sediments) after a rain event.

5.2. Fresh Marsh

Approximately ten percent of the total area in sub-segments 020102 and 020103 are listed under fresh marsh (Table 1-1). This is supported by observations during a site visit in May 2005 (Figure 5.2).

Figure 5.2. Expanse of Lake Boeuf north of Theriot canal, LA

The population of the fresh marsh and other invasive plants changes from one season to another, with growth increasing as the summer season approaches. It becomes almost impossible to navigate through the waters during the summer. Some of the common plants/vegetation included water hyacinth, lilies and anachris or elodea. Although these plants may increase oxygen during the daylight hours as a result of photosynthesis, too many of them within the lake block sunlight from reaching algae deep in the lake. These algae and other plants die and become food for the bacteria which use up the oxygen while decomposing the dead algae and plants. Also observed during the survey was a bird rookery which could be a source of fecal nutrients that could encourage the growth of water plants which directly compete for the dissolved oxygen or which when they die, the decomposing bacteria use up the oxygen.

5.3. Forestry

About 57% of the total surface area in sub-segments 020102 and 020103 is covered by wetland forest with most of it in the riparian buffer zone along Bayou Boeuf and its tributaries. There was no logging activities noted during the field visit in May, 2005, but dead leaves and trees on decomposition form organic matter which is carried into the stream during storm events thus contributing to pollution (natural source). However, care needs to be taken to ensure that proper forestry best management practices are followed during harvesting. The Science Working Group (SWG) on Coastal Wetland Forest Conservation recommends that the Louisiana Governor's Office:

1. Adopt the following statement of mission and intent regarding coastal wetland forest ecosystem policy: The State of Louisiana will place priority on conserving, restoring, and managing coastal wetland forests, including collaborative efforts among public and private entities, to ensure that their functions and ecosystem services will be available to present and future citizens of Louisiana and the United States.
2. Recognize the regeneration condition classes (Finding 5) for cypress-tupelo forests developed by the Science Working Group (SWG) and use them to classify existing coastal forest site conditions for management, restoration, protection, and use purposes.
3. Place priority on maintaining hydrologic conditions on SWG Regeneration Condition Class I lands.
4. Delay timber harvesting on Condition Class III lands because these lands will not regenerate to forests. The goal is to allow time for hydrologic restoration and improvement of stand conditions to Class I or Class II lands. Place an interim moratorium on harvesting on state-owned Condition Class III lands. Develop mechanisms to delay timber harvesting on privately owned Condition Class III lands.
5. Before harvesting SWG Condition Class I and II sites, a written forest management plan with specific plans for regeneration must be reviewed by a state-approved entity so appropriate practices can be suggested based on local site conditions. The intent is to ensure that cypress-tupelo regeneration and long-term establishment take place and that species or wetland type conversion does not occur.

6. Develop spatially explicit data regarding SWG Condition Classes, existing hydrologic and geomorphic conditions, and current and future threats to coastal wetland forests. These data should be collected, evaluated, and updated by a consortium of state, local and federal agencies, universities and non-governmental organizations and made available to all entities. Adding remotely-sensed data to this data set should be aggressively pursued. Such data are critical to wisely manage and care for the coastal forest wetland ecosystem of Louisiana.
7. Establish and maintain a system of long-term monitoring of coastal wetland forest conditions, supplemental to FIA and Coastal Reference Monitoring System (CRMS) datasets, expanded to include the entire SWG coastal wetland forest area. Additionally, monitoring of restoration should occur, and include measures to evaluate success. This may entail some long-term efforts because forests may take 25 years to establish functioning stands.
8. Direct all state and local agencies to review, evaluate and coordinate their activities in coastal wetland forests and develop guidelines and practices to prevent the loss and degradation of habitat, functions, and ecosystem services through official actions. The Governor should also officially request that federal agencies do the same.
9. Review and modify current accepted practices for mitigation of impacts on coastal wetland forests. Given the uniqueness of Louisiana's coastal wetland forests, all mitigation must be of the same forest type and occur within the same watershed where the impacts are located.
10. Encourage conservation and protection of coastal wetland forest areas by developing a Coastal Wetland Forest Reserve System.
11. Actively pursue restoration of degraded wetland forests, regardless of the SWG condition class. Encourage collaborative efforts between public and private entities including the development or modification of federal legislation to include degraded coastal wetland forests in landowner incentives programs.
12. Enhance wetland forest ecosystem functions and values as part of all hydrological management decisions, including management of point- and nonpoint-source inputs, floodways, creation of diversions, levee and highway construction, and coastal management.
13. Develop policies to ensure implementation of the above recommendations. Various incentive mechanisms should be explored as part of policy implementation.

Based on existing knowledge about coastal wetland forests and the compilation of new information from field surveys and federally-sponsored forest inventories, the SWG strongly recommends appropriate science-based management of Louisiana's coastal wetland forests.

Figure 5.3. Wetland forest along the stream with a few invasive plants at the stream edges

5.4. Hydromodification

Hydromodification is the alteration of the "natural" flow of water through a landscape, and often takes the form of channel modification or channelization. Most of the time hydromodification is undertaken out of a desire to improve the ability to use land or water resources, or to protect human health or safety. Sometimes however, it doesn't completely accomplish its objectives or it results in greater negative impacts than benefits in the long run. In most cases, hydromodification results in water quality and habitat impacts.

Although there was no noticeable dredging activities during the visit in May, 2005, there were signs indicating that dredging activities have taken place before (Figure 5.4). If the dredged materials are not well disposed off, the sediments will end up in the streams and cause pollution. There is also a possibility of petroleum activities, which shows that some modifications may have been made on the bayou. Such activities could be possible sources of pollution.

Figure 5.4. Gas pipeline and no dredging sign on Grand Bayou near Kraemer, LA

5.5. Urban/Residential Development

Urban development does not appear to be a problem in sub-segments 020102 and 020103, but there are some residential houses noted along Grand Bayou near Chegby and residential houses and houseboats near Kraemer, LA on Bayou Boeuf. Although there was no noticeable dumping of materials into the streams, these residential settlements could discharge into the water bodies and thereby contribute to water pollution.

Figure 5.5. Residential houses and houseboat at Kraemer north of LA 307

6.0 NONPONT SOURCE POLLUTION SOLUTIONS

Best management practices (BMPs) are schedules of activities, prohibitions of practices, maintenance procedures and other management practices designed to prevent or reduce the pollution of the waters of the state, including treatment requirements, operating procedures, and practices to control plant site runoff, spillage or leaks, sludge, or waste disposal, or drainage from raw material storage (LDEQ, 2005). BMPs are one of the most important methods for controlling nonpoint source pollution where runoff occurring from diffuse sources makes regulations in the form of discharge permits unpractical.

Many effective and up-to-date BMP practices for different types of crop farming practices have been recommended (Appendix D). The recommended wetland forest harvest operation BMPs include, harvesting during dry periods if possible to minimize rutting, using low pressure/ high flotation tires or wide tracks where possible to avoid excessive damage to residual stands, keeping skidder loads light when rutting is evident, felling trees away from watercourses if possible, removing any obstructions in the channels resulting from harvesting operations and limiting operations on sensitive sites during periods of wet weather. These BMP practices are often the culmination of years of research and demonstrations conducted by agricultural research scientists and soil engineers. A summary of the effectiveness of favorable BMPs is provided in Louisiana's Nonpoint Source Management Plan (LDEQ, 2000).
http://nonpoint.deq.louisiana.gov/wqa/default.htm

It is important to note contribution by natural sources (without manmade source contributions), which yielded minimum DO of 3.5 mg/L for summer and 5.6 mg/L for winter (FTN, Associates, 2004). This suggests that the existing DO standard for these sub-segments is not appropriate for summer. Although there is a possibility of a big contribution of natural sources to nonpoint pollution, BMPs need to be implemented in sub-segments 020102 and 020103 to help in the reduction of pollution from manmade sources by 100% in summer and 92% in winter, and from natural background sources by 37% in summer and thereby increase the D.O. level to the standard of 5 mg/L to allow it to support its designated uses.

LSU AgCenter has produced BMP manuals for sugar cane, other crops and forests, which are available on their website http://www.lsuagcenter.com/Subjects/bmp/index.asp. For all entities involved in silvicultural operations, the Recommended Forestry Best Management Practices for Louisiana manual has been and will continue to be an invaluable source of information and recommendations (LDEQ, 2000).

7.0 MAKING THE IMPLEMENTATION PLAN WORK

Reducing the nonpoint source (NPS) pollution load in sub-segments 020102 and 020103, like any other watershed, requires financial and technical assistance from federal, state and local individuals. The residents and landowners in the watershed are the most important group in improving water quality in sub-segments 020102 and 020103. Currently, the only requirement for public participation is that there be a 30–day comment period after the TMDL is issued. The stakeholders are informed by mailed public notices and notices in newspapers. Eventually, the public needs to be the most important part of the implementation of best management practices to reduce pollution especially non-point source pollution where there are few regulations. Programs such as Master Farmer will be beneficial in getting information to landowners and farmers and building participation in such areas.

7.1. Regulatory Authority

Section 319 of the Clean Water Act (PL 100-4, February 4, 1987) was enacted to specifically address problems attributed to nonpoint sources of pollution. Its objective is to restore and maintain the chemical, physical, and biological integrity of the nation's waters (Sec. 101; PL 100-4). Section 319 directs the governor of each state to prepare and submit a non-point source management program for reduction and control of pollution from non-point sources to navigable waters within the state by implementation of a four-year plan, submitted within 18 months of the day of enactment (LDEQ, 2000).

In response to the federal law, the State of Louisiana passed the Revised Statute 30:2011, which had been signed by the Governor in 1987, as Act 272. Act 272 designated the Louisiana Department of Environmental Quality (LDEQ) as the Lead Agency to develop and implement of the State's Nonpoint Source Management Plan. LDEQ's Office of Water Resources (OWR) was charged with the responsibility to protect and preserve the quality of waters in the State and has developed the nonpoint source management program, ground water quality program and a conservation and management plan for estuaries. These programs and plan were developed in coordination with the appropriate State agencies such as the Department of Natural Resources, the Department of Wildlife and Fisheries, the Department of Agriculture and Forestry and the State Soil and Water Conservation Committees in various jurisdictions (La.R.S. 30:20). LDEQ's Office of Water Resources is therefore responsible for receiving federal funds to ensure clean water, providing matching State funds when required and complying with terms and conditions necessary to receive federal grants.

The water quality standards are described in LAC 33:IX.1101.D in chapter 11 (LDEQ, 2003). These standards are applicable to surface waters of the state and are utilized through the wasteload allocation and permit process to develop effluent limitations for point source discharges to surface waters of the State. The water quality standards also form the basis for implementing the best management practices for control of non-point sources of water pollution.

Chapter 11 also describes the anti-degradation policy (LAC 33:IX.1109.A.2) which states that the administrative authority will not approve any wastewater discharge or certify any activity for federal permit that would impair water quality or use of state waters. Waste discharges must comply with applicable state and federal laws for the attainment of water quality goals. Any new, existing, or expanded point source or non-point source discharging into state waters, including land clearing, which is the subject of a federal permit application, will be required to provide the necessary level of waste treatment to protect state waters as determined by the administrative authority. Further, the highest statutory and regulatory requirements shall be achieved for all existing point sources and best management practices (BMPs) for non-point sources. Additionally, no degradation shall be allowed in high-quality waters that constitute outstanding natural resources, such as waters of ecological significance as designated by the office. Those water bodies presently designated as outstanding resources are listed in LAC 33:IX.1123.

7.2. Actions Being Implemented by LDEQ

LDEQ is presently the designated lead agency to implement the Louisiana State Nonpoint Source Program. LDEQ Nonpoint Source unit provides United States Environmental Protection Agencies (USEPA) §319(h) funds to assist in the implementation of BMPs to address water quality problems on sub-segments listed on the §303(d) list. USEPA §319(h) funds are utilized to sponsor cost sharing, monitoring, and education projects. These monies are available to all private, profit and nonprofit organizations that are authentic legal entities, or governmental jurisdictions including: cities, counties, tribal entities, federal agencies, or agencies of the State. Currently, LDEQ works in cooperation with such entities on approximately 40 nonpoint source projects that are active throughout the state.

7.3. Actions Being Implemented by other Agencies

The Louisiana Department of Agriculture and Forestry (LDAF) now receives USEPA §319(h) funds from USEPA specifically for the implementation of BMPs in impaired watersheds. Further information regarding these funds can be obtained from LDAF Office of Soil and Water Conservation.

The U.S. Department of Agriculture (USDA) and Natural Resource Conservation Service (NRCS) offer landowners financial, technical and educational assistance to implement conservation practices and/or BMPs on privately owned land to reduce soil erosion, improve water quality, and enhance crop land, forest land, wetlands, grazing lands and wildlife habitat. The 2003 Farm Bill provides funding to various conservation programs for each state by way of the NRCS and local Soil and Water Conservation Districts (SWCD). The following includes a brief summary of the programs available through the local SWCD under the oversight of USDA and NRCS. The descriptions of the programs are general and are subject to change.

7.3.1. 2003 Farm Bill Conservation Programs and Potential Funding Sources

Environmental Quality Incentive Program (EQIP) provides 75% - 90% cost share for environmentally beneficial structural and management alterations, primarily 60% to livestock operations. Applications prioritized for benefits. It is considered the “Working Lands” program.

Wildlife Habitat Incentive Program (WHIP) also provides 75% - 90% cost share but for the costs of wildlife habitat restoration and enhancement on private lands. This program available to eligible private property owners and lessees for installing riparian buffers, native pine & hardwoods, wildlife corridors and other wildlife enhancing measures for 5 – 10 year contracts.

Wetland Reserve Program (WRP) is a voluntary program for wetland restoration, enhancement and protection on private lands. WRP provides annual payments and restoration costs for 10 year, 30 year, or perpetual easements on prior converted wetlands. Louisiana leads the US in WRP participation. The 2002 Farm Bill total funding allocation was $1.5 billion and it expanded the program to purchase long-term easements and cost sharing to agriculture producers.

Conservation Reserve Program (CRP): The 1985 Farm Bill established CRP as a voluntary program to protect highly erodible and environmentally sensitive lands. CRP places a positive value on rural environment by improving soil, water, and wildlife, and extends a pilot sub-program called the Conservation Reserve Enhancement program.

Conservation Security Program (CSP) is a new national incentive payment program for maintaining and increasing farm and ranch stewardship practices. The CSP is designed to correct a policy disincentive in which independently conducted resource stewardship has disqualified many farmers from receiving conservation program assistance. CSP features an optional "tiered" level of farmer participation where higher tiers receive greater funding for greater conservation practices.

Farmland Protection Program (FPP) provides funding to states, tribes, or local governments and to nonprofit organizations to help purchase development rights and protect farmlands with prime, unique, or productive soil; historical or archaeological significance; or farmlands threatened by urban sprawl. Louisiana does not currently have any FPP contracts.

Grassland Reserve Program (GRP) is also a new program created to enroll up to 2 million acres of virgin and improved pastureland. GRP easements would be divided 40/60 between agreements of 10, 15, or 20-years, agreements and easements for 30-years and permanent easements to restore grassland, rangeland and pasture through annual rental payments.

Small Watershed Rehabilitation Program (SWRP) provides essential funding for the rehabilitation of aging small watershed impoundments and dams that have been constructed over the past 50 years.

Although information is not currently available for conservation treatments specifically in sub-segments 020102 and 020103, they are available for Lafourche parish where these sub-segments are located. During the fiscal year 2005, the following conservation practices have been planned or applied in Lafourche parish (USDA-NRCS, 2005): conservation crop rotation (structural code 328), 3,605 acres; fence (382), 2,423 ft; grade stabilization structure (410) 25 planned and 13 applied; heavy use protection area (561), 4 acres; pest management (595), 198 acres; nutrient management (590), 203 acres; prescribed grazing (528A), 5 acres; residue management, seasonal (344), 5,531 acres; structure for water control (587), 3; wetland enhancement (659), 1,390 acres; and wetland wildlife habitat management (644), 1,390 acres.

In addition to the programs mentioned above, the following organizations have signed an MOU with LDEQ within the state's NPS Management Plan that each will aid LDEQ in achieving the goals of the management plan: Louisiana Department of Agriculture and Forestry, Louisiana Department of Health and Hospitals, Louisiana Department of Wildlife and Fisheries, Louisiana Department of Transportation and Development, Louisiana Department of Natural Resources, Louisiana State University Agricultural Center, Natural Resources Conservation Service, USDA – Farm Services Agency, Louisiana Forestry Association, US Fish and Wildlife Service, USDA Forest Service, US Army Corps of Engineers, US Geological Survey, Federal Emergency Management Agency and Louisiana Farm Bureau Federation.

7.3.2. Master Farmer Program

The Master Farmer Program, developed by Louisiana State University Agricultural Center, is to encourage on-the-ground BMP implementation with a focus on environmental stewardship. The LSU AgCenter is promoting this program to help farmers address environmental stewardship through voluntary, effective and economically achievable BMPs. The program will be implemented through a multi-agency/organization partnership including the Louisiana Farm Bureau (LFBF), the Natural Resources Conservation Service (NRCS), the Louisiana Cooperative Extension Service (LCES), USDA-Agriculture Research Service (ARS), LDEQ and agricultural producers.

The Master Farmer Program has three components: environmental stewardship, agricultural production and farm management. The environmental stewardship component has three phases. Phase one focuses on environmental education and implementation of crop-specific BMPs. Phase two of the environmental component includes in-the-field viewing of implemented BMPs on Model Farms. Phase three involves the development and implementation of farm-specific and comprehensive conservation plans by the participants. A member must participate in all three phases in order to gain program status and receive the distinction of being considered a master farmer.

This program can help to initiate and distribute the use of BMPs throughout Joes Bayou Watershed. Participants will set an example for the rest of the agricultural community and will work closely with NRCS staff and other Master Farmers to identify potential problem areas in the watershed. They will receive information on new and innovative ways to reduce soil and nutrient loss from their fields. They will be kept informed of the water quality monitoring occurring in the watershed and alerted of any degradation or improvements.

7.3.3. Master Logger Program

The master logger program serves as a model for development of the master farmer program, and has been very successful at educating foresters on how to implement BMPs. This program was developed by the Louisiana Forestry Association, which is a private organization, along with the Louisiana Department of Agriculture and Forestry Office of Forestry.

7.4. Tracking and Evaluation

As stated in the Louisiana Nonpoint Management Plan, program tracking and evaluation will be done at several levels to determine if the watershed approach is an effective method to reduce non-point source pollution and improve water quality. The steps for tracking and evaluation are as follows:

1. Tracking of actions outlined with the Watershed Restoration Action Strategy (short-term)
2. Tracking of BMPs implemented as a result of Section 319, EQIP, or other sources of cost-share ant technical assistance within the watershed (short term)
3. Tracking the progress in reducing non-point source pollutants such as solids, nutrients and organic carbon from the various land uses (rice, soybeans, pastureland grazing) within the watershed (short-term)
4. Tracking water quality improvement in the bayou for instance decreases in total organic carbon and increases in total dissolved oxygen (short and long term)
5. Documenting results of the tracking to the Nonpoint Source Interagency Committee, residents within the watershed, and EPA (short and long term)
6. Submitting semi-annual and annual reports to EPA which summarize results of the watershed restoration actions (short and long term)
7. Revising LDEQ's web-site to include information on the progress made in watershed restoration actions, non-point source pollutant load reductions, and water quality improvement in the bayou (short and long term).

8.0 TIMELINE FOR IMPLEMENTATION

The NPS Implementation Plan for sub-segments 020102 and 020103 outlines a 5-year management plan to reduce NPS pollutants reaching the watershed. LDEQ intensively samples each watershed in the state once every 5 years to see if the waterbodies are meeting water quality standards. The 5-year cyclic sampling began during 2000 for the Barataria River Basin for some of the watersheds, and will end in 2015 (Table 9.1). Sub-segments 020102 and 020103 are currently at objective three of timeline implementation, which is the development of watershed management plan to implement the NPS component of TMDL. The data from 2000 will be used as a baseline to measure the rate of water quality improvement in samples taken in subsequent years. If no improvement in water quality is witnessed by the 2015 sampling, LDEQ will revise the NPS Implementation Plan to include additional corrective actions to bring the waterway into compliance. Additional BMPs and or other options will be employed, if necessary, until water quality standards are achieved and sub-segments 020102 and 020103 are restored to their designated uses.

Table 9.1. Revised timeline for watershed planning and implementation

	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Mermentau																			
Vermilion																			
Calcasieu																			
Ouachita																			
Barataria																			
Terrebonne																			
Pontchartrain																			
Pearl																			
Red																			
Sabine																			
Mississippi																			
Atchafalaya																			

1- Black Stripes = Collect Water Quality Data to Develop Total Maximum Daily Loads (TMDLs) and to Track Water Quality Improvement at the Watershed Level **[Objective 1**]
2- Light Blue = Develop Total Maximum Daily Loads for the Watersheds on the 303(d) List [**Objective 2]**
3- Green = Develop Watershed Management Plans to Implement the NPS Component of the TMDL **[Objective 3]**
4- Yellow = Implement the Watershed Management Plans **[Objectives 4-8]**
5- Dark Blue = Develop and Implement Additional Corrective Actions Necessary to Restore the Designated Uses to the Water Bodies **[Objective 9-10]**

9.0 SUMMARY OF SUB-SEGMENTS 020102 AND 020103 WATERSHED IMPLEMENTATION PLAN

Sub-segments 020102 and 020103 do not meet the water quality standards for dissolved oxygen and nutrients. In order to restore the water quality and designated use of Fish and Wildlife Propagation in these sub-segments, 100% pollution reduction in summer and 92% in winter from manmade sources, and a reduction of 37% from natural background sources in summer is required. To meet this load reduction goal, a concerted effort from all of the stakeholders within the watershed, including government (local, state, and federal), special interest groups, and local citizens, is needed. Everyone who lives in subsegments 020102 and 020103 and/or owns property in the watershed is a “stakeholder” and stands to benefit from their contribution toward protecting water quality. Public education is the first critical element for accomplishing goals and objectives, because it is necessary that they understand and support efforts to implement BMPs. Successful outcomes are more likely, when citizens understand what is occurring and why.

Any type of land use activity that disturbs the soil and/or leaves an area of barren earth for a period of time without implementation of BMPs has an increased probability of contributing to NPS loading. The most predominant land uses in sub-segments 020102 and 020103 are wetland forest (57.1%) and agriculture (20.4%).,Most of the agricultural land in sub-segment 020102 is located near the ridge along Bayou Lafourche, with the primary crop being sugarcane. BMPs and regulations are available for reducing NPS pollutant loads from these land uses and, if implemented and followed properly, should reduce sediment and nutrient runoff into sub-segments 020102 and 020103.

Although, some of the BMPs and the recommended course of action were described within this plan, a consolidated list of BMPs recommended for each of these land uses can be viewed in the State of Louisiana Water Quality Management Plan, Volume 6 (LDEQ, 2000). Detailed BMP manuals for agronomic crops, rice, poultry, sugar cane, dairy, sweet potato, swine, beef, and aquaculture have been produced by LSU AgCenter and are available on their website http://www.lsuagcenter.com/Subjects/bmp/index.asp. For all entities involved in silvicultural operations, the Recommended Forestry Best Management Practices for Louisiana manual has been and will continue to be an invaluable source of information and recommendations (LDEQ, 2000).

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APPENDIX A: TDS, TSS AND TURBIDITY

Introduction

Total dissolved solids (TDS) comprise inorganic salts and small amounts of organic matter that are dissolved in water and are expressed in units of mg per unit volume of water (mg/L), also referred to as parts per million (ppm). In the field it is usually checked by a device that measures the conductivity of the water. The greater the conductivity of the water the more dissolved material there is in the water. Some dissolved solids come from organic sources such as leaves, silt, plankton, and industrial waste and sewage. Other sources come from runoff from urban areas, road salts used on street during the winter, and fertilizers and pesticides used on lawns and farms. Dissolved solids also come from inorganic materials such as rocks and air that may contain calcium bicarbonate, nitrogen, iron phosphorous, sulfur, and other minerals. Many of these materials form salts, which are compounds that contain both a metal and a nonmetal. Salts usually dissolve in water forming ions. Ions are particles that have a positive or negative charge. Water may also pick up metals such as lead or copper as they travel through pipes used to distribute water to consumers.

The EPA Secondary Regulations advise a maximum contamination level (MCL) of 500mg/liter (500 parts per million (ppm)) for TDS (EPA, 2005). Numerous water supplies exceed this level. When TDS levels exceed 1000mg/L it is generally considered unfit for human consumption. A high level of TDS is an indicator of potential concerns, and warrants further investigation. Most often, high levels of TDS are caused by the presence of potassium, chlorides and sodium. These ions have little or no short-term effects, but toxic ions (lead arsenic, cadmium, nitrate and others) may also be dissolved in the water. TDS is removed from water using water filtering purification systems such as carbon filters, reverse osmosis and distillation.

Total suspended solids (TSS) concentrations and turbidity both indicate the amount of solids suspended in the water, whether mineral (e.g., soil particles) or organic (e.g., algae). However, the TSS test measures an actual weight of material per volume of water, while turbidity measures the amount of light scattered from a water sample (more suspended particles cause greater scattering). High concentrations of particulate matter affect light penetration and productivity, recreational values, and habitat quality, and cause lakes to fill in faster. Particles also provide attachment places for other pollutants, notably metals and bacteria. TSS concentrations are reported in units of milligrams of suspended solids per liter of water – mg/L. Turbidity is reported as nephelometric (NTU) or Jackson turbidity units (JTU), depending on the instrument used to perform the measurement.

TSS and turbidity values vary naturally for two main reasons – one physical, the other biological. Heavy rains and fast-moving water are erosive. They can pick up and carry enough dirt and debris to make even an unpolluted inflowing stream look muddy. So, heavy rainfall may cause higher TSS concentrations or turbidity, especially where the stream flows into the lake. In lakes, the most important reason for variation in these parameters is caused by seasonal changes in algae growth. Warm temperatures, prolonged daylight, and release of nutrients from decomposition may cause algae blooms that increase turbidity or TSS concentrations.

Pollution or general human activities usually result in higher TSS concentrations or turbidity. For example, loss of vegetation due to development exposes more soil to erosion, allows more runoff to form, and simultaneously reduces the watershed's ability to filter the nutrients and organic matter from runoff before it reaches the inflowing streams. Although much of the particulate matter may settle to the lake bottom, the addition of nutrients will eventually cause increased algae growth.

Based on the ambient TSS and turbidity data for sub-segments 020102 and 020103, there were no exceedances of the LDEQ's numeric turbidity standard value of 50 NTU and the "target" TSS value of 40 mg/L for bayous. This could be attributed to limited agricultural activities in both sub-segments.

Ambient General Data Table for Bayou Boeuf at Halpin Canal, Louisiana (http://159.39.17.125/discoverer/viewer?cn=cf_a104&nlsl=en-us&wbk=AMBIENTSITES&wsk=1052)

DATE	TIME	DEPTH (m)	ALKALINITY (mg/L)	CL (mg/L)	COLOR (PT-CO units)	HARD (mg/L)	T.D.S. (mg/L)	T.S.S. (mg/L)	TURB (NTU)	SO4 (mg/L)
JAN-2000	09:11	1.0	63.4	44.4	70	81.4	198	13	9.9	8.1
FEB-2000	09:30	1.0	64.5	97	55	103	272	9	23	16.6
MAR-2000	09:15	1.0	47.7	78.9	65	90.7	235	12.5	22	9.9
APR-2000	09:42	1.0	67.1	62.8	60	92.1	216	10	7.3	6.4
MAY-2000	09:36	1.0	86.2	421	110	228	840	16	8	38.8
JUN-2000	09:21	1.0	80.9	1134	55	477	2046	19.2	10	139
JUL-2000	09:45	1.0	91.9	472	55	230	882	17	6.7	39.6
AUG-2000	09:37	1.0	69.6	1499	50	574	2694	9.3	9.1	159
SEP-2000	09:50	1.0	40.1	1571	48	542	5580	24	18	168
OCT-2000	09:41	1.0	61.1	395	100	202	798	9.6	12	13.8
NOV-2000	09:41	1.0	25.7	2117	30	708	3708	13.7	11	212
DEC-2000	08:55	1.0	44.2	252	200	149	586	9	7.1	7.1
JAN-2004	09:35	1.0	48.8	26.7	65	55.4	139	5	6.4	3.8
FEB-2004	09:30	1.0	34.8	25.3	70	43.2	114	13.5	28	2.4
MAR-2004	09:35	1.0	51.4	20.7	65	53.8	115	6.5	5.4	1.6
APR-2004	09:50	1.0	43.9	27.4	55	45.7	124	11.5	10	2.7

Ambient General Data Table for Lake Boeuf North of Theriot Canal, Louisiana
(http://159.39.17.125/discoverer/viewer?cn=cf_a104&nlsl=en-us&wbk=AMBIENTSITES&wsk=1052)

DATE	TIME	DEPTH (m)	ALKALINITY (mg/L)	CL (mg/L)	COLOR (PT-CO units)	HARD (mg/L)	T.D.S. (mg/L)	T.S.S. (mg/L)	TURB (NTU)	SO4 (mg/L)
JAN-2000	08:55	1.5	65.2	44.8	65	75.5	168	4	3.5	3.8
FEB-2000	09:11	0.5	60.3	93.9	55	101	252	4	12	15.9
MAR-2000	08:55	0.5	63.5	108	50	98.1	276	4	4.3	8.9
APR-2000	09:25	1.0	70	69.7	55	92.3	224	4	1.5	5.3
MAY-2000	09:16	0.5	85.1	141	60	178	608	10.7	4.7	21.5
JUN-2000	09:02	1.0	81.2	716	65	308	1296	6.7	3.9	61.4
JUL-2000	09:30	1.0	94.7	186	55	154	448	26.7	10	8
AUG-2000	09:25	1.0	76.8	1416	50	559	2576	10	8.3	146
SEP-2000	09:35	1.0	43	1591	42	539	2726	19	13	165
OCT-2000	10:00	1.0	79.7	531	55	238	996	4	1.8	23.1
NOV-2000	09:25	1.0	25.2	204	30	679	3492	5.7	6.4	246
DEC-2000	09:15	1.0	60.6	184	90	113	428	6	7.5	11.5
JAN-2004	09:15	1.0	45.2	28.5	55	52.9	130	0	1.9	2.9
FEB-2004	09:10	1.0	89.6	67.2	70	101.4	232		3.3	5.5
MAR-2004	09:10	1.0	43	29.5	90	46.4	112		2	
APR-2004	09:30	1.0	87.6	55.1	110	96.5	238	11.5	12.4	4.6

Analysis of Ambient Data

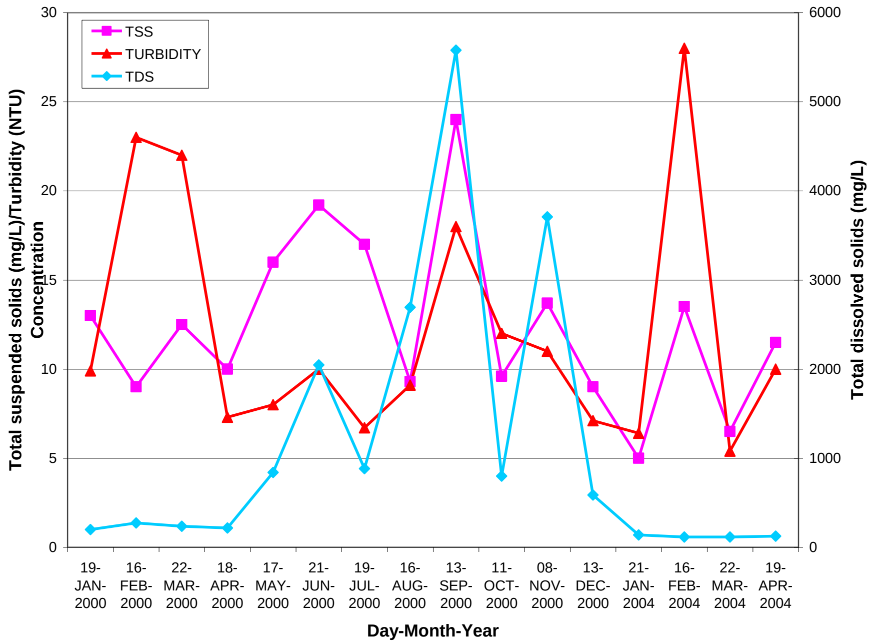

Figure A.1. Seasonal TDS, TSS, and Turbidity concentration variations for sub-segment 020102

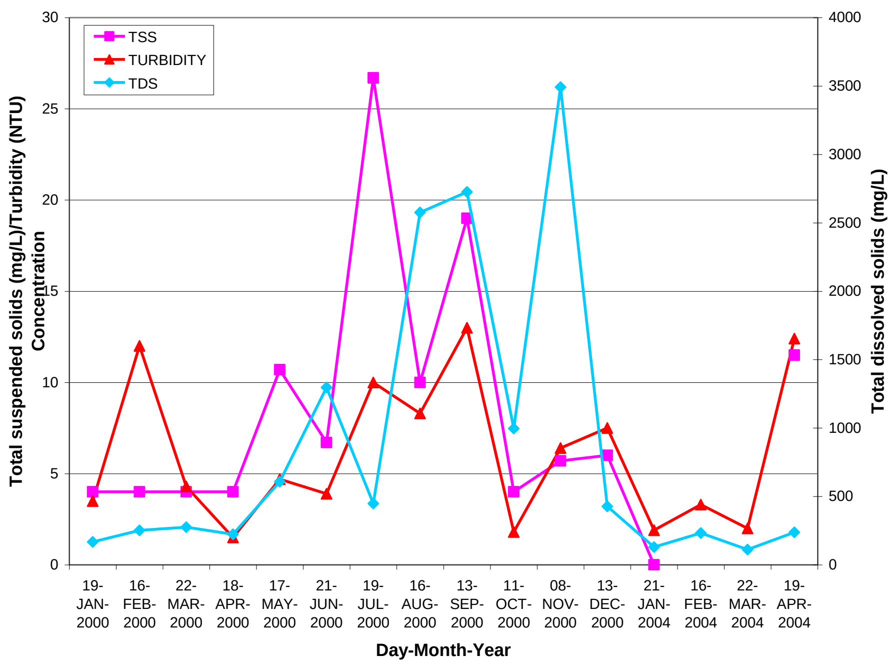

Figure A.2. Seasonal TDS, TSS and Turbidity concentration variations for sub-segment 020103

APPENDIX B: FECAL COLIFORM

Introduction

Fecal coliforms are bacteria that live in the digestive tract of warm-blooded animals (humans, pets, farm animals, and wildlife) and are excreted in the feces. In themselves, fecal coliforms generally do not pose a danger to people or animals but they indicate the presence of other disease-causing bacteria, such as those that cause typhoid, dysentery, hepatitis A, and cholera.

The presence of fecal coliform bacteria in aquatic environments indicates that the water has been contaminated with the fecal material of humans or other animals. Fecal contamination can arise from sources such as combined sewer overflows, leaking septic tanks, sewer malfunction, contaminated storm drains, animal feedlots, non-point sources of human and animal waste and other sources. Rainfall is frequently associated with increased abundance of fecal coliforms in water due to stormwater runoff.

Louisiana's numerical criteria for fecal coliform for waters that are designated for both primary and secondary contact recreation (swimming and boating) are more than 25% of the samples collected annually attaining a minimum of 400 fecal coliform bacteria counts/100mls sample and 2000 fecal coliform bacteria counts/100mls sample (LDEQ, 2000). The data collected in 2000 and part of 2004 in sub-segments 020102 and 020103 shows that these standards were exceeded once in 14 months in sub-segment 020102 (see Table below and Figure B.1).

Ambient Fecal Coliform Data Table for Bayou Boeuf at Halpin Canal, Louisiana
(http://159.39.17.125/discoverer/viewer?cn=cf_a104&nlsl=en-us&wbk=AMBIENTSITES&wsk=1052

DATE	FECAL COLIFORM (MPN/100mls)
19-JAN-2000	50
16-FEB-2000	140
22-MAR-2000	110
18-APR-2000	17
17-MAY-2000	170
21-JUN-2000	8
19-JUL-2000	90
16-AUG-2000	22
13-SEP-2000	50
11-OCT-2000	1700
08-NOV-2000	50
13-DEC-2000	23
21-JAN-2004	23
16-FEB-2004	400

Ambient Fecal Coliform DataTable for Lake Boeuf North of Theriot Canal, Louisiana (http://159.39.17.125/discoverer/viewer?cn=cf_a104&nlsl=en-us&wbk=AMBIENTSITES&wsk=1052

DATE	FECAL COLIFORM (MPN/100mls)
19-JAN-2000	90
16-FEB-2000	300
22-MAR-2000	230
18-APR-2000	30
17-MAY-2000	80
21-JUN-2000	30
19-JUL-2000	30
16-AUG-2000	22
13-SEP-2000	30
11-OCT-2000	300
08-NOV-2000	50
13-DEC-2000	80
21-JAN-2004	23
19-JAN-2000	90

Analysis of Ambient Data

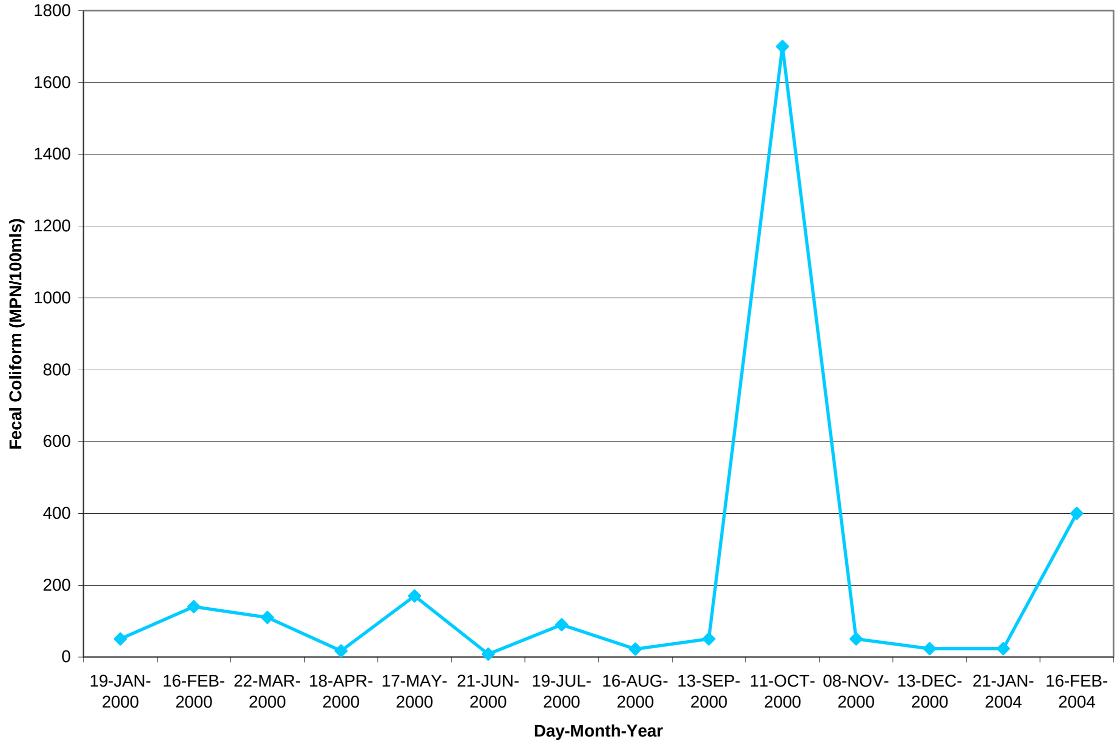

Figure B.1. Seasonal fecal coliform concentration variations for sub-segment 020102

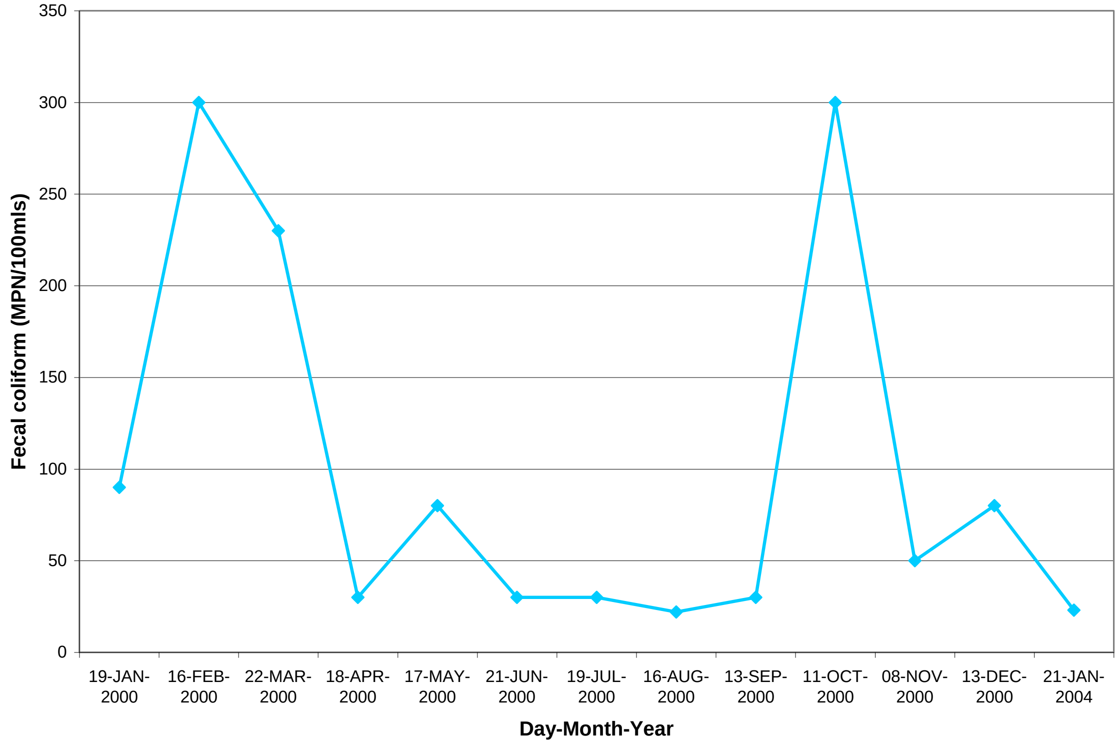

Figure B.1. Seasonal fecal coliform concentration variations for sub-segment 020103

APPENDIX C: HEAVY METALS

Introduction:

A heavy metal is any metallic chemical element that has a relatively high density and is toxic or poisonous at low concentrations on both aquatic life and humans. These include Cadmium (Cd), Chromium (Cr), Copper (Cu), Mercury (Hg), Nickel (Ni), and Lead (Pb).

Ambient Metals Data Table for Bayou Boeuf at Halpin Canal, Louisiana

DATE	TIME	DEPTH (m)	AS (µg/l)	CD (µg/l)	CR (µg/L)	CU (µg/L)	HG (µg/L)	NI (µg/L)	PB (µg/L)	ZN (µg/L)
JUN2000	09:21	1.0	5	0.5	2.5	2.5	0.05	5	5	
SEP2000	09:50	1.0	5	0.5	2.5	2.5	0.05	5	5	
DEC2000	08:55	1.0	5	0.5	2.5	2.5	0.05	5	5	
MAR2004			1.38	0.014	0.32	0.78	0.00092	2.46	0.556	2.96
JUN-2004			1.01	0.015		0.11	0.00144	0.4		0.68

Ambient Metals Data Table for Lake Boeuf North of Theriot Canal, Louisiana

DATE	TIME	DEPTH (m)	AS (µg/l)	CD (µg/l)	CR (µg/L)	CU (µg/L)	HG (µg/L)	NI (µg/L)	PB (µg/L)	ZN (µg/L)
JUN2000	09:02	1.0	5	1.4	2.5	2.5	0.05	5	5	
SEP2000	09:35	1.0	5	0.5	2.5	2.5	0.05	5	5	
DEC2000	09:15	1.0	5	0.5	2.5	2.5	0.05	5	5	
MAR2004			1.15	0.013	0.45	2.99	0.00063	1.03	0.218	1.56
JUN-2004			0.89			0.08	0.00102	0.31		0.39

Analysis of Ambient Data

Analysis on heavy metals ambient data shows a decrease in the concentrations of all heavy metals for both sub-segments 020102 and 020103 between 2000 and 2004 (Figures C.1 and C.2). The only exception is copper (Cu) reading for sub-segment 020103 that had a higher value in March 2004 than the three values taken in 2000, although this value significantly decreased in April 2004. A possible reason for the decline in the metal concentrations for these sub-segments was that LDEQ changed the sample collection method in 2001. However, based on the LDEQ's numerical criteria for metals (Table C.1), there were some exceedances for some of the metals. Based on sub-segments 020102 and 020103 ambient data, there was an exceedance for the aquatic life protection, fresh water chronic criteria for lead in 2000. Also there were exceedances for aquatic life protection, chronic levels for both fresh water and marine water for mercury. The only other exceedance was cadmium in June 2000 for sub-segment 020103. Although there is no indication that the metal concentration exceedances are targeted for clean metals, heavy metals are typically found in urban runoff and therefore steps need to be taken to reduce runoff from urban areas. A detailed description of urban best management practices that need to be implemented to reduce the metal concentrations that exceed the state criteria is given under Statewide Educational Programs – Urban Runoff within LDEQ (2000)

Table C.1. Numerical criteria for metals and organics in µg/L unless designated otherwise (Data source: LDEQ, 2005)

	Aquatic life Protection				Human Health Protection	
	Fresh Water		Marine Water		Drinking water supply[1]	Non-drinking water supply[2]
Toxic Substance	**Acute**	**Chronic**	**Acute**	**Chronic**		
Arsenic	339.8	150	69.00	36.00	50.0	--
Cadmium[3,4]	15	0.62	45.35	10.00	10.0	--
	32	1.03				
	67	1.76				
Chromium III[3,4]	310	103	515.00	103.00	50.0	--
	537	181				
	980	318				
Zinc[3,4]	64	58	90.00	81.00	5.0 mg/L	--
	117	108				
	205	187				
Copper[3,4]	10	7	3.63	3.63	1.0 mg/L	--
	18	12				
	35	22				
Mercury[4]	2.04	0.012[5]	2	0.025[5]	2.0	--
Nickel[3,4]	788	88	74	8.2	--	--
	1397	160				
	2495	279				
Lead[3,4]	30	1.2	209	8.08	50.0	--
	65	2.5				
	138	5.31				

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[1] Applies to surface water bodies designated as a Drinking Water Supply and also protects for primary and secondary contact recreation and fish consumption.

[2] Applies to surface water bodies designated as a Drinking Water Supply and also protects for primary and secondary contact recreation and fish consumption.

[3] Hardness-dependent criteria for freshwater are based on the developed natural logarithm formulas (LDEQ,2004) multiplied by conversion factors (CF) for acute and chronic protection (in descending order, numbers represent criteria in µg/L at hardness values of 50, 100, and 200 mg/L CaCO3, respectively)

[4] Freshwater and saltwater metals criteria are expressed in terms of the dissolved metal in the water column. The standard was calculated by multiplying the previous water quality criteria by a conversion factor (CF). The CF represents the EPA-recommended conversion factors found in 60 FR 68354-68364 (December 10, 1998) and shown in Table 1A in LDEQ (2004).

[5] If the four-day average concentration for mercury exceeds 0.012 µg/L in freshwater or 0.025 µg/L in saltwater more than once in a three-year period the edible portion of aquatic species of concern must be analyzed to determine whether the concentration of methyl mercury exceeds the FDA action level (1.0 mg/Kg). If the FDA action level is exceeded, the state must notify the appropriate EPA Regional Administrator, initiate a revision of its mercury criterion in its water quality standards so as to protect designated uses, and take other appropriate action such as issuance of a fish consumption advisory for the affected area.

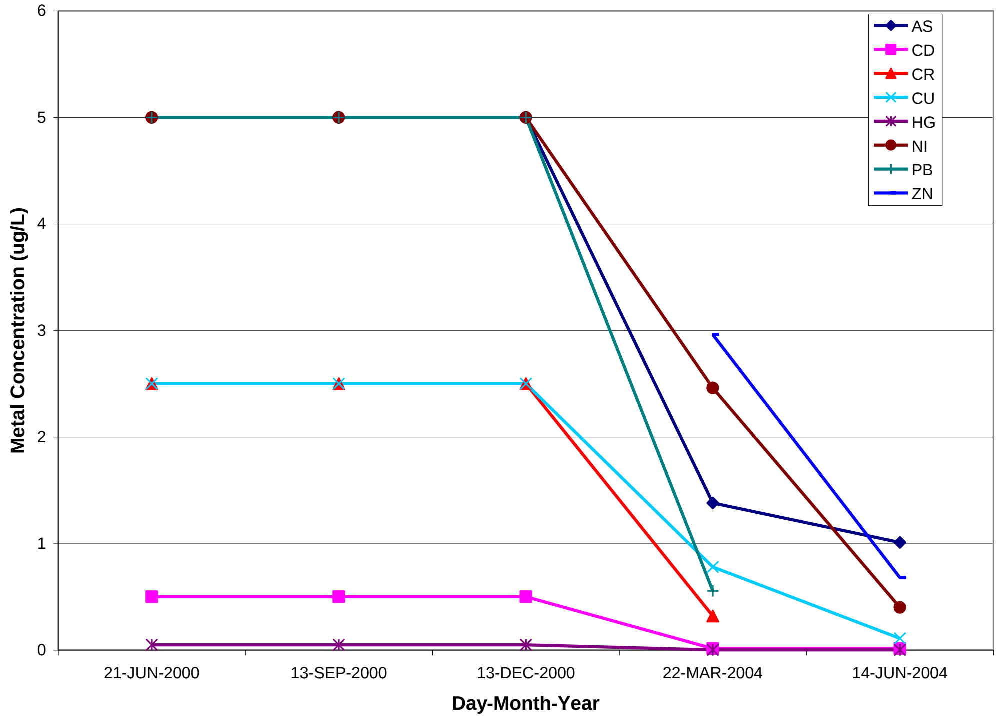

Figure C.1 Seasonal heavy metal concentration trends for sub-segment 020102

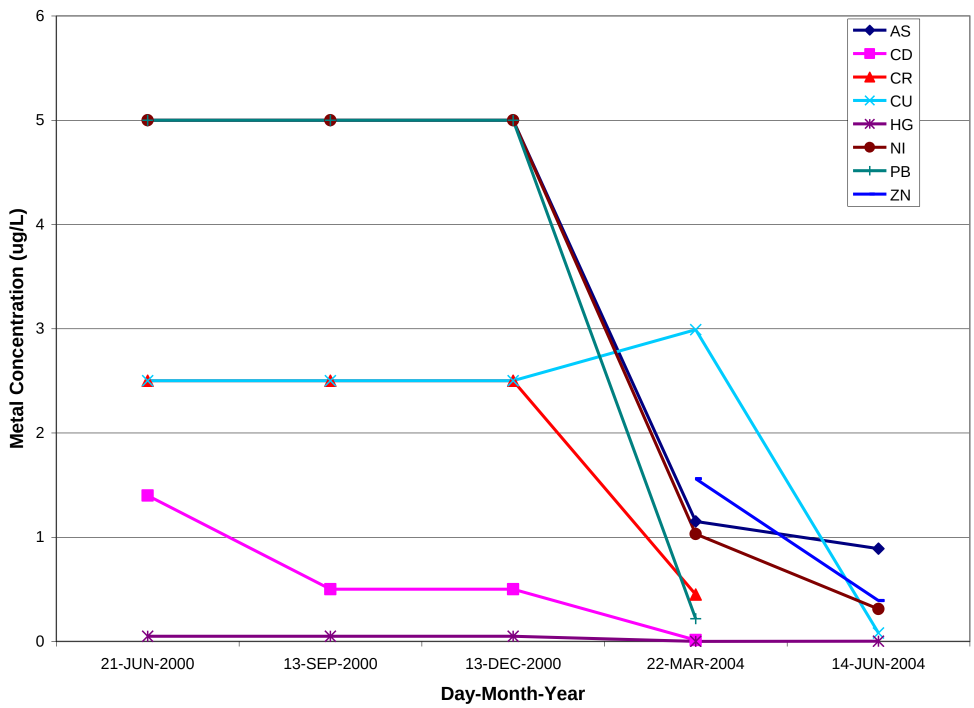

Figure C.2. Seasonal heavy metal concentration trends for sub-segment 020103

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