# TMDLS FOR SEDIMENT/SILTATION, TURBIDITY, AND TDS FOR SUBSEGMENTS 100701 AND 100704 IN THE RED RIVER BASIN, LOUISIANA

**REVISED DRAFT**
**July 6, 2006**

# TMDLS FOR SEDIMENT/SILTATION, TURBIDITY, AND TDS FOR SUBSEGMENTS 100701 AND 100704 IN THE RED RIVER BASIN, LOUISIANA

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# EXECUTIVE SUMMARY

Section 303(d) of the Federal Clean Water Act requires states to identify water bodies that are not meeting water quality standards, and to develop total maximum daily pollutant loads for those water bodies. 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 allocated to point sources and nonpoint sources discharging to the waterbody. This report presents TMDLs that have been developed for turbidity, sediment/siltation, and total dissolved solids (TDS) for Black Lake Bayou (subsegment 100701); and TDS for Kepler Creek (subsegment 100704).

The subsegments are located in the Red River basin in northwestern Louisiana. Black Lake Bayou (subsegment 100701) begins at the headwaters of Black Lake Bayou, located near Minden, Louisiana and ends at the Webster-Bienville Parish Line. The watershed for this subsegment is 123 $mi^2$, and is primarily forested. Kepler Creek is a tributary to Kepler Creek Lake, located near Bienville, Louisiana. The watershed for Kepler Creek (subsegment 100704) is approximately 26 $mi^2$, and is also primarily forest land.

Both of these water bodies were included on the Louisiana Department of Environmental Quality (LDEQ) final 2004 303(d) list as not supporting their fish and wildlife propagation designated use, and were ranked as priority #1 for TMDL development. No suspected sources of impairment were identified for these water bodies.

LDEQ historical water quality data at monitoring locations located in the subsegments were analyzed for long term trends, seasonal patterns, relationships between concentration and stream flow, and relationships between turbidity and total suspended solids (TSS). No historical trends, seasonal patterns, nor relationships with flow were apparent in these data.

Because turbidity cannot be expressed as a mass load, the turbidity TMDL was expressed using TSS as a surrogate for turbidity. A regression between TSS and turbidity was developed for the water quality station in subsegment 100701. This regression relationship was used to estimate a target TSS concentration for the subsegment (13 mg/L), based on the numeric criteria for turbidity in the Louisiana water quality standards.

All three TMDLs (one turbidity and two TDS) were developed using the load duration curve methodology. This method determines allowable loading at a wide range of stream flow conditions. The steps for applying this methodology for the TMDLs in this report were:

1. Developing a flow duration curve,
2. Converting the flow duration curve to load duration curves,
3. Plotting observed loads with load duration curves,
4. Calculating the TMDL components, and
5. Calculating percent reductions.

For the turbidity, TSS, and sediment/siltation TMDL, an implicit margin of safety (MOS) was incorporated through the use of conservative assumptions. The primary conservative assumption was to treat TSS as a conservative parameter that does not settle out of the water column. For the TDS TMDLs, an explicit MOS was established as 10% of the TMDL. Both the TDS and TSS TMDLs had an explicit future growth (FG) that was set equal to 10% of the TMDL.

Because point sources were considered to have negligible effect on existing violations of the TSS and TDS water quality standards water quality standard, all of the load reductions were assigned to nonpoint sources. The wasteload allocation (WLA) for point sources, the load allocation (LA) for nonpoint sources, and the nonpoint source percent reduction needed for each TMDL are summarized in Tables ES.1 and ES.2.

Table ES.1. Turbidity and sediment/siltation TMDL for subsegment 100701.

| Subsegment Number | Stream Name | Loads (tons/day of TSS) | | | | | Percent Reduction Needed |
|---|---|---|---|---|---|---|---|
| | | WLA | LA | MOS | FG | TMDL | |
| 100701 | Black Lake Bayou | 0.01 | 4.47 | 0 | 0.50 | 4.98 | 69% |

Table ES.2. Summary of TDS TMDLs.

| Subsegment Number | Stream Name | Loads (tons/day of TDS) | | | | | Percent Reduction Needed |
|---|---|---|---|---|---|---|---|
| | | WLA | LA | MOS | FG | TMDL | |
| 100701 | Black Lake Bayou | 0 | 24.20 | 3.02 | 3.02 | 30.24 | 24% |
| 100704 | Kepler Creek | 0 | 4.12 | 0.52 | 0.52 | 5.16 | 16% |

Hurricane Katrina made landfall on Monday, August 29, 2005 as a category 4 hurricane. The storm brought heavy winds and rain to southeast Louisiana, breaching several levees and flooding up to 80% of New Orleans and large areas of coastal Louisiana. Much of the area that was flooded in Hurricane Katrina was re-flooded by storm surge from Hurricane Rita. Both Hurricanes Katrina and Rita have caused a significant amount of change in sediment and water quality in south Louisiana. Many wastewater treatment facilities were temporarily or permanently damaged. Some wastewater treatment facilities will rebuild while others will relocate. The hurricanes expedited the loss of coastal land and modified the hydrology of some of the coastal waterbodies. Several federal and state agencies including United States Environmental Protection Agency (US EPA) and LDEQ are engaged in collecting environmental data and assessing the recovery of the Gulf of Mexico waters. The proposed TMDLs were developed based on the pre-hurricane conditions. Therefore, the post-hurricane conditions and other factors may delay the implementation of the proposed TMDLs or render the proposed TMDLs obsolete or may require modifications of the TMDLs.

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# 1.0 INTRODUCTION

This report presents total maximum daily loads (TMDLs) for sediment/siltation, turbidity, and total dissolved solids (TDS) for two subsegments in the Red River basin in northwestern Louisiana. These two subsegments are Black Lake Bayou (100701) and Kepler Creek (100704). Both of these subsegments were included on the Louisiana Department of Environmental Quality (LDEQ) final 2004 303(d) list (LDEQ 2005a) as not supporting their designated use of fish and wildlife propagation. The suspected sources of contamination and causes of impairment from the LDEQ 303(d) list are shown in Table 1.1. The TMDLs in this report were developed in accordance with Section 303(d) of the Federal Clean Water Act and the United States Environmental Protection Agency's (US EPA) regulations in 40 CFR 130.7.

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 water quality standard in a waterbody. The TMDL is the sum of the wasteload allocation (WLA), load allocation (LA), future growth (FG), 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, including natural background. The MOS is a percentage of the TMDL that takes into account any lack of knowledge concerning the relationship between pollutant loadings and water quality and the FG is reserved for future growth.

Table 1.1. Subsegments and parameters for impairments addressed in this report.

| Subsegment number | Subsegment name | Source of information[1] | Impaired use[2] | Suspected causes of impairment | | | | | | | Suspected sources of impairment | TMDL priority (1 = highest) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Chloride | Sulfate | TDS | Sediment/Siltation | TSS | Turbidity | Fecal Coliforms | | |
| 100701 | Black Lake Bayou | LDEQ 303(d) | FWP | | | X | X | | X | | Source unknown (Sediment, turbidity). Natural conditions (TDS). | 1 |
| 100704 | Kepler Creek | LDEQ 303(d) | FWP | | | X | | | | | Source unknown | 1 |

Notes:
1. Source of information is the final 2004 LDEQ 303(d) list.
2. FWP=Fish and Wildlife Propagation

# 2.0 BACKGROUND INFORMATION

## 2.1 General Information

The study area for this project consists of the headwaters of Black Lake Bayou (subsegment 100701) and Kepler Creek (subsegment 100704) in the Red River Basin in northwest Louisiana (Figure A.1 in Appendix A). The headwaters of Black Lake Bayou begin northeast of Minden, Louisiana. Kepler Creek is a tributary of Black Lake Bayou, with headwaters just west of Bryceland, Louisiana. The Black Lake Bayou subsegment (100701) is bounded on the north and northwest by Bayou Dorcheat, on the west by Lake Bistineau, on the south by Black Lake Bayou (subsegment 100702), on the east by Leatherman Creek (which is in subsegment 100702), and on the northeast by Lake Clabourne. Kepler Creek is bounded on the north and west by Black Lake Bayou (subsegment 100702), on the south by Kepler Lake, and on the east by Saline Bayou. Black Lake Bayou and its tributaries (including Kepler Creek) are included in the United States Geological Survey (USGS) Hydrologic Unit 11140209. Subsegment 100701 encompasses approximately 123 $mi^2$, and subsegment 100704 encompasses approximately 26 $mi^2$.

## 2.2 Topography

Topography of the Black Lake Bayou watershed is characterized by gently to strongly sloping dissected coastal plain, underlain by unconsolidated sand, silts, and clays (CLIWS 1990).

## 2.3 Soils

Soil textures for subsegment 100701 (Table 2.1) were compiled from the STATSGO database, which is maintained by the United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS). Soil textures for subsegment 100704 are not included here because that subsegment is not impaired by total suspended solids (TSS), turbidity, or sediment.

Table 2.1. Soil textures for subsegment 100701.

| Soil Texture | Percentage of subsegment |
|---|---|
| Fine sandy loam | 48% |
| Gravelly loamy fine sand | 19% |
| Loamy fine sand | 9% |
| Silt loam | 16% |
| Other textures | 8% |
| Total | 100% |

## 2.4 Land Use

Land use characteristics for the study area were compiled from the USGS National Land Cover Dataset (USGS 2000). Although these data were based on satellite imagery from the early 1990's, more recent land use data for this area are not available at this time. The spatial distribution of these land uses is shown on Figure A.2 (located in Appendix A) and land use percentages are shown in Table 2.2. These data indicate that over 80% of the study area is forested.

Table 2.2. Land use percentages for subsegments 100701 and 100704.

| Land Use | Percent Coverage | |
|---|---|---|
| | 100704 | 100701 |
| Water | 0.6% | 0.9% |
| Urban/Transportation | 0.0% | 0.2% |
| Barren | 4.7% | 0.7% |
| Forest | 86.0% | 76.1% |
| Shrubland/Grassland | 0.0% | 0.0% |
| Pasture/Hay | 2.5% | 7.9% |
| Row Crops | 1.8% | 4.9% |
| Small Grains | 0.0% | 0.0% |
| Wetlands | 4.5% | 9.3% |
| Total | 100.0% | 100.0% |

## 2.5 Description of Hydrology

Average precipitation for the study area is about 55 inches per year (www.nationalatlas.gov). Average monthly precipitation values for Minden, Louisiana are shown on Figure 2.1; these values are highest during winter and spring and lowest during summer and early fall (July through October).

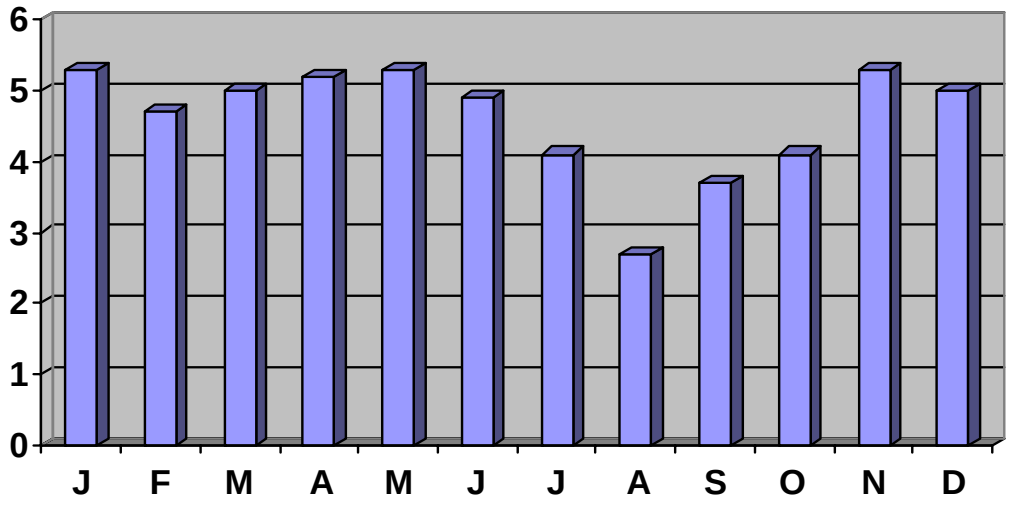


Figure 2.1 Average monthly precipitation at Minden, Louisiana (from http://www.city-data.com/city/Minden-Louisiana.html).

There is no current USGS flow gaging station located on Black Lake Bayou or Kepler Creek. The nearest USGS flow gaging station with recent data is Saline Bayou near Lucky (07352000), which is approximately 7 miles south of Bienville. Flows for Black Lake Bayou and Kepler Creek were estimated from Saline Bayou flows per unit of watershed area.

## 2.6 Water Quality Standards

Water quality standards for Louisiana are included in the Title 33 Environmental Regulatory Code (LDEQ 2005b). Designated uses for the Black Lake Bayou and Kepler Creek subsegments are primary and secondary contact recreation, fish and wildlife propagation, and agriculture. The numeric criterion for TDS for both Black Lake Bayou and Kepler Creek is 79 mg/L.

The Title 33 Environmental Regulatory Code does not include turbidity criteria for freshwater creeks and bayous that are not designated as scenic or outstanding natural resource waters. Black Lake Bayou downstream of the Webster-Bienville parish line (subsegment 100702) is designated as outstanding natural resource water and has a turbidity criterion of 25 NTU. LDEQ assesses the turbidity of subsegments just upstream of outstanding natural resource waters using the outstanding natural resources waters standards, since a downstream receiving waterbody could not be expected to meet a lower criterion than the upstream waterbody that flows into it. Therefore, the value of 25 NTU will be used as the turbidity criterion for subsegment 100701 (Black Lake Bayou). A turbidity criterion was not established for subsegment 100704 because that subsegment was not impaired by turbidity, TSS, or sediment/siltation.

## 2.7 Nonpoint Sources

No suspected sources of pollutants are specified in the 303(d) listings for subsegments 100701 and 100704 for TDS, turbidity, and sediment/siltation. However, there is silviculture activity in these subsegments, which has the potential to contribute these pollutants (Personal communication July 2005, T. Hardaway LDEQ Northwest Regional Office).

## 2.8 Point Sources

A list of point source discharges in the study area was generated by LDEQ using their TEMPO and PTS databases. Based on this list, there is only one permitted point source discharge located in subsegment 100701 (Table 2.3), and there are no permitted point source discharges in subsegment 100704. Information for the permitted discharger in the study area was obtained by FTN Associates, Ltd. (FTN) from LDEQ's Electronic Document Management System (EDMS). Because the one permitted discharger in subsegment 100701 does not have permit limits for TDS, it was assumed to not have a source of TDS; therefore it was not included in the TDS TMDL. Because this facility does have permit limits for TSS (25 mg/L monthly average), it was included in the turbidity and sediment/siltation TMDLs. However, stormwater runoff from the facility drains into a large pond; from where is pumped back to the plant and re-used. Because of

this operational procedure, discharges are infrequent. The facility has not had a discharge in over 12 months.

Table 2.3. Point sources located in the study area.

| Subsegment | File Number | Facility Name | Location | Outfall | Expected Flows | Receiving Water | Included in TMDL? |
|---|---|---|---|---|---|---|---|
| 100701 | LA0051098 | U.S. Silica Co. Dubberly Plant | Dubberly, 4 m SE on Ph. Rd 168 | 002 | Intermittent | Natural Drainage – Black Lake Bayou | TSS – Yes<br>TDS – No |

## 2.9 Previous Water Quality Studies

One previous water quality study was found for subsegment 100701. The LDEQ 1990 Black Lake Bayou Survey Report included this subsegment. The purpose of the survey was to document water quality and uses of Black Lake Bayou as part of an evaluation of the bayou for use as a “least impacted stream” for the Red River Basin and the South Central Plains ecoregion (CLIWS 1990).

There are no known previous water quality studies for subsegment 100704.

# 3.0 EXISTING WATER QUALITY FOR TURBIDITY AND TSS

## 3.1 General Description of Data

Within the study area, only one subsegment (100701) was impaired for sediment/siltation and turbidity. Turbidity and TSS data have been collected by LDEQ at one station (1186) in this subsegment. The location of the sampling site is shown on Figure A.1 (located in Appendix A). Table 3.1 shows a summary of the data, including percentages of values above the turbidity criterion of 25 NTU. TSS data are included in this summary because TSS is needed as a surrogate parameter for expressing the sediment/siltation and turbidity TMDLs. Time series plots of data for the entire period at the station are shown on Figure B.1 for turbidity and Figure B.2 for TSS (located in Appendix B). These data were obtained from LDEQ.

Table 3.1. Summary of available turbidity and TSS data from station 1186.

| Description | Turbidity (NTU) | TSS (mg/L) |
|---|---|---|
| Period of Record | 1/14/02 – 12/9/02 | 1/14/02 – 12/9/02 |
| No. of Values | 12 | 11 |
| Minimum | 2.2 | 4.0 |
| Maximum | 60.0 | 37.0 |
| Median | 26.5 | 21.3 |
| No. Values > 25 NTU | 6 | NA |
| % Values > 25 NTU | 50% | NA |

## 3.2 Seasonal Patterns

A slight seasonal pattern may exist at station 1186. Based on the one year of data available for turbidity and TSS, it appears that the turbidity and TSS measurements are both higher in the summer months than in the winter months (Figures B.1 and B.2 in Appendix B). However, additional years of data would be needed to confirm a seasonal pattern.

## 3.3 Relationships For Turbidity and TSS vs. Flow

Plots of turbidity and TSS versus estimated stream flow were also developed to examine any correlation between these water quality parameters and stream flow rates (Figures B.3 and

B.4 in Appendix B). Stream flow data from Saline Bayou near Lucky were used for these plots. Generally these plots show little or no correlation between turbidity or TSS and stream flow.

## 3.4 Relationships Between TSS and Turbidity

A plot of TSS versus turbidity for this station (Figure B.5 in Appendix B) shows a noticeable correlation, with higher turbidity levels tending to correspond with higher TSS concentrations. Linear regression was preformed on the natural logarithms of turbidity and TSS and yielded the following relationship: Turbidity = $5.92^* (TSS)^{0.5695}$. The regression was performed using the natural logarithms of the data (rather than the raw data values) because turbidity and TSS usually fit a lognormal distribution better than a normal distribution.

The strength of the linear regression relationship is measured by the coefficient of determination ($R^2$) calculated during the regression analysis (Zar 1996). The $R^2$ value is the percentage of the total variation in turbidity that is explained or accounted for by the fitted regression (TSS). For station 1186, 87% of the variation in turbidity is accounted for by TSS, and the remaining 13% of variation in turbidity is unexplained. The unexplained portion is attributed to factors other than turbidity. At station 1186 the correlation between TSS and turbidity was determined to be good with an $R^2$ value of 0.87.

The statistical significance for the regression was evaluated by computing the “P value” for the slope for the regression. The P value is essentially the probability that the slope of the regression line is really zero. Thus, a low P value indicates that a non-zero slope calculated from the regression analysis is statistically significant. For station 1186, the P value of the regression was 2.42E-05, which is considered statistically significant.

# 4.0 EXISTING WATER QUALITY FOR TDS

## 4.1 General Description of Data

Within the study area, both subsegments (100701 and 100704) were impaired for TDS. TDS data have been collected by LDEQ at one site in each subsegment (Table 4.1). Locations of these sampling sites are shown on Figure A.1 (Appendix A). Table 4.1 shows summaries of these data, including percentages of values above the criterion. Time series plots of TDS data for the entire period of record at each station are shown on Figures C.1 and C.2 (Appendix C).

Table 4.1. Summary of TDS data at stations 283 and 1186.

| | **Station 283** | **Station 1186** |
|---|---|---|
| Station Description | Kepler Creek west of Bienville, Louisiana | Black Lake Bayou at Highway 793, southeast of Dubberly, Louisiana |
| Period of Record | 2/13/90 – 4/13/98, 1/14/02 – 12/9/02 | 1/14/02 – 12/9/02 |
| No. of Values | 62 | 12 |
| Minimum (mg/L) | 10 | 38 |
| Maximum (mg/L) | 146 | 114 |
| Median (mg/L) | 67 | 84 |
| No. Values > 79 mg/L | 23 | 6 |
| % Values > 79 mg/L | 37% | 50% |

## 4.2 Seasonal Patterns

The TDS data were examined for seasonal patterns at both stations. Because multiple years of data were available for station 283, a seasonal plot was developed for those data (Figure C.3). On the plots of the one-year of data available for TDS at station 1186 (subsegment 100701) and the multiple years of data available at station 283 (subsegment 100704), some of the TDS measurements at both stations were higher in the summer months than in the winter months. Black Lake Bayou in subsegment 100701 and Kepler Creek in subsegment 100704 tend to get very dry in the summer. Evaporation of the water from these streams during the dry summer period could result in slightly increased concentrations of TDS in the remaining water (T. Hardaway LDEQ Northwest Regional Office, personal

communication, July 2005). This could explain the tendency for slightly higher TDS concentrations during summer since there are no point sources contributing elevated concentrations of TDS.

## 4.3 Relationships Between Concentration and Flow

Plots of TDS versus estimated stream flow were also developed to examine any correlation between concentration and flow (Figures C.4 and C.5 in Appendix C). These plots do not indicate a consistent relationship between TDS concentration and estimated stream flow. However, the highest TDS concentrations do occur during low flow conditions.

# 5.0 TMDL DEVELOPMENT

## 5.1 Seasonality and Critical Conditions

US EPA 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. Also, both Section 303(d) of the Clean Water Act and regulations at 40 CFR 130.7 require TMDLs to consider seasonal variations for meeting water quality standard. Therefore, the historical data and analyses discussed in Sections 3.0 and 4.0 were used to evaluate whether there were certain flow conditions or certain periods of the year that could be used to characterize critical conditions.

For turbidity, no significant relationships were found between turbidity and estimated stream flow. Although turbidity (and TSS) values appeared to be slightly higher during the summer months, there were not enough data to confirm the pattern. For TDS, some of the high concentrations occurred at low stream flows and during the summer months, but there was not a strong, consistent relationship between concentration and flow, or between concentration and season. Based on these analyses, the TMDLs in this report were not developed on a seasonal basis. The methodology used to develop these TMDLs (load duration curve) addresses a wide range of flow conditions.

## 5.2 Water Quality Targets

Turbidity is an expression of the optical properties in a water sample that cause light to be scattered or absorbed and is caused by suspended matter, such as clay, silt, finely divided organic and inorganic matter; soluble colored organic compounds; and plankton and other microscopic organisms (Standard Methods 1999). Turbidity and sediment/siltation cannot be expressed as a load as preferred for TMDLs. To achieve a load-based value, the numerical standard for turbidity is often correlated with a surrogate parameter, such as TSS, that can be expressed as a load. For the turbidity and sediment/siltation TMDLs for subsegment 100701, the relationship between turbidity and TSS presented in Section 3.4 was used to develop a target TSS concentration (i.e., numeric endpoint for the TMDL). The target TSS concentration calculated from the turbidity criterion of 25 NTU was 13 mg/L.

The water quality targets for TDS were simply the water quality standard shown in Table 2.3 (79 mg/L TDS for both Kepler Creek and Black Lake Bayou). TDS can easily be expressed as mass, so there was no need to use surrogate parameters.

## 5.3 Methodology for TMDL Calculations

The methodology used for all of the TMDLs in the report is the load duration curve. Because loading capacity varies as a function of the flow present in the stream, these TMDLs represent a continuum of allowable loads over all flow conditions, rather than fixed at a single value. The basic elements of this procedure are documented on the Kansas Department of Health and Environment (KDHE) web site (2005). This method was used to determine allowable loadings for a wide range of flows. The steps for how this methodology was applied for the TMDLs in this report can be summarized as follows:

1. Develop a flow duration curve (Section 5.4);
2. Develop targets load duration curves from the flow duration curve (Section 5.5);
3. Plot observed loads with target load duration curves (Section 5.6);
4. Calculate TMDL, MOS, FG, WLA, and LA (Sections 5.7 – 5.10); and
5. Calculate percent reductions required to meet assessment criteria (Section 5.11).

## 5.4 Flow Duration Curve

A flow per unit area duration curve was developed for each subsegment. Daily streamflow measurements from Saline Bayou near Lucky (USGS Gage Number 07352000) were sorted in increasing order and the percentile ranking of each flow was calculated. The data from the Saline Bayou gage were used because the load duration methodology requires that the same flow data be used for developing the flow duration as for calculating observed loads from sampling data. The Saline Bayou gage was the closest flow gage with data during the years that water quality sampling occurred.

## 5.5 Load Duration Curves

For each TMDL parameter (TSS and TDS), the flows per unit area from the flow duration curves were multiplied by the appropriate target concentration (from Section 5.2) to

make an allowable load per unit area duration curve. Each load duration curve is a plot of tons per day per $mi^2$ of drainage area versus the percent exceedances from the flow duration curves. The three load duration curves are presented in the following appendices:

APPENDIX D: load duration curve for subsegment 100701 for TSS
APPENDIX E: load duration curve for subsegment 100701 for TDS
APPENDIX F: load duration curve for subsegment 100704 for TDS

The calculations for these load duration curves are shown in Tables D.1, E.1 and F.1.

The load duration curve is beneficial when analyzing monitoring data plotted as a load with its corresponding flow information. This allows the monitoring data to be plotted in relation to its place in the flow continuum. Assumptions of the probable source or sources of the impairment can often be made from the plotted data.

The load duration curve shows the calculation of the TMDL at any flow rather than at a single critical flow. The official TMDL number is reported as a single number, but the curve is provided to demonstrate the value of the acceptable load at any flow. This will allow analysis of load cases in the future for different flow regimes.

## 5.6 Observed Loads

For each sampling station, observed loads were calculated by multiplying each observed concentration of TSS or TDS by the flow per unit area on the sampling day. These observed loads were then plotted versus the percent exceedance of the flow per unit area on the sampling day and placed on the same plot as the load duration curve. These plots are shown in the appendices of this report as follows:

Figure D.1: plot of loads for TSS in subsegment 100701
Figure E.1: plot of loads for TDS in subsegment 100701
Figure F.1: plot of loads for TDS in subsegment 100704

These plots provide visual comparisons between observed and allowable loads under different flow conditions. Observed loads that are plotted above the load duration curve (identified as “TMDL – MOS” curve in the legend for the TSS plots and “TMDL – MOS – FG"

in the TDS TMDLs) represent conditions where observed water quality concentrations exceed the target concentrations. Observed loads below the load duration curve represent conditions where observed water quality concentrations are less than target concentrations (i.e., not violating water quality standard).

## 5.7 TMDL, MOS, and FG

Each TMDL was calculated as the area under the load duration curve. Because the load duration curves were expressed in mass per unit drainage area, the area under the curve (lb/day/mi$^2$) was multiplied by the subsegment drainage area.

Both Section 303(d) of the Clean Water Act and regulations at 40 CFR 130.7 require TMDLs to include a MOS to account for uncertainty in available data or in the actual effect that controls will have on the loading reductions and receiving water quality. The MOS may be expressed explicitly as unallocated assimilative capacity or implicitly through conservative assumptions used in establishing the TMDL. For the turbidity, and sediment/siltation TMDL, an implicit MOS was incorporated through the use of conservative assumptions. The primary conservative assumption was calculating the TMDL assuming that TSS was a conservative parameter and did not settle out of the water column. For the TDS TMDLs, an explicit MOS was established as 10% of the TMDL. Both the TSS and TDS TMDLS had a FG set equal to 10% of the TMDL (in addition to the MOS).

## 5.8 Point Source Loads

For the turbidity and sediment/siltation TMDL, the WLA for the point source in subsegment 100701 (US Silica Company Dubberly, LA facility) was set equal to the current monthly average permit limit for TSS (25 mg/L) multiplied by an effluent flow rate that was assumed to be reasonable whenever the facility discharged (0.01 MGD). As discussed in Section 2.8, this facility operates to avoid discharges and has not had a discharge during the last 12 months. No reductions in TSS permit limits are proposed for this facility because it is located along the western edge of the subsegment (i.e., a significant distance away from the impaired

waterbody) and it rarely has a discharge. Therefore, it appears that this facility is not having any impact on turbidity and sediment/siltation in Black Lake Bayou.

For the TDS TMDLs, there were no point source discharges in either subsegment that had elevated concentrations of TDS. Therefore, the WLAs for TDS were set to zero for both subsegments. New point sources could begin discharging to these subsegments and grow without being limited by these TMDLs as long as their discharge concentrations were at or below the water quality standard for TDS and the TMDL target for TSS.

## 5.9 Nonpoint Source Loads

For each of the TMDLs in this report, the LA for nonpoint sources was set equal to the TMDL minus the MOS and WLA. For the turbidity and sediment/siltation TMDLs, the LA was effectively the TMDL minus the WLA and FG (because the MOS was implicit). For the TDS TMDLs, the LA was effectively the TMDL minus the MOS and FG (because the WLA was zero).

Calculations for the TMDLs, MOSs, and LAs are shown in the appendices of this report as follows:

| | |
|---|---|
| Table D.2: | calculations for TSS TMDL for subsegment 100701 |
| Table E.2: | calculations for TDS TMDL for subsegment 100701 |
| Table F.2: | calculations for TDS TMDL for subsegment 100704 |

## 5.10 Percent Reductions

In addition to calculating allowable loads, estimates were made for percent reductions of nonpoint source loads that would be needed for all of the observed loads to be on below the load duration curve. The observed loads at each sampling station were reduced until there were no loads above the load duration curve. The results of these percent reduction calculations are shown in Tables 5.1 and 5.2; the detailed calculations are in Tables D.2, E.2, and F.2.

Table 5.1. Turbidity and sediment/siltation TMDL for subsegment 100701.

| Subsegment Number | Stream Name | Loads (tons/day of TSS) | | | | | Percent Reduction Needed |
|---|---|---|---|---|---|---|---|
| | | WLA | LA | MOS | FG | TMDL | |
| 100701 | Black Lake Bayou | 0.01 | 4.47 | 0 | 0.50 | 4.98 | 69% |

Table 5.2. Summary of TDS TMDLs.

| Subsegment Number | Stream Name | Loads (tons/day of TDS) | | | | | Percent Reduction Needed |
|---|---|---|---|---|---|---|---|
| | | WLA | LA | MOS | FG | TMDL | |
| 100701 | Black Lake Bayou | 0 | 24.20 | 3.02 | 3.02 | 30.24 | 24% |
| 100704 | Kepler Creek | 0 | 4.12 | 0.52 | 0.52 | 5.16 | 16% |

# 6.0 OTHER RELEVANT INFORMATION

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

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

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

The LDEQ has implemented a watershed approach to surface water quality monitoring. Through this approach, the entire state is sampled over a 4-year cycle. Long-term trend monitoring sites at various locations on the larger rivers and Lake Pontchartrain are sampled throughout the 4-year cycle. Sampling is conducted on a monthly basis to yield approximately 12 samples per site each year the site is monitored. Sampling sites are located where they are considered to be representative of the waterbody. Under the current monitoring schedule, approximately one half of the State's waters are newly assessed for each 305(b) and 303(d) listing biennial cycle, with sampling occurring statewide each year. The 4-year cycle follows an initial 5-year rotation that covered all basins in the state according to the TMDL priorities. This will allow the LDEQ to determine whether there has been any improvement in water quality

following implementation of the TMDLs. As the monitoring results are evaluated at the end of each year, waterbodies may be added to or removed from the 303(d) list.

Hurricane Katrina made landfall on Monday, August 29, 2005 as a category 4 hurricane. The storm brought heavy winds and rain to southeast Louisiana, breaching several levees and flooding up to 80% of New Orleans and large areas of coastal Louisiana. Much of the area that was flooded in Hurricane Katrina was re-flooded by storm surge from Hurricane Rita. Both Hurricanes Katrina and Rita have caused a significant amount of change in sediment and water quality in south Louisiana. Many wastewater treatment facilities were temporarily or permanently damaged. Some wastewater treatment facilities will rebuild while others will relocate. The hurricanes expedited the loss of coastal land and modified the hydrology of some of the coastal waterbodies. Several federal and state agencies including US EPA and LDEQ are engaged in collecting environmental data and assessing the recovery of the Gulf of Mexico waters. The proposed TMDLs were developed based on the pre-hurricane conditions. Therefore, the post-hurricane conditions and other factors may delay the implementation of the proposed TMDLs or render the proposed TMDLs obsolete or may require modifications of the TMDLs.

# 7.0 PUBLIC PARTICIPATION

When US EPA establishes a TMDL, federal regulations require US EPA to publicly notice and seek comment concerning the TMDL. These TMDLs were prepared under contract to US EPA. After development of the TMDLs, US EPA will prepare a notice seeking comments, information, and data from the general public and affected public. Any comments, data, or information submitted during the public comment period will be addressed in the final TMDL, which will then be transmitted to LDEQ for implementation and for incorporation into LDEQ's current water quality management plan.

# 8.0 REFERENCES

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Zar, J.H. 1996. Biostatistical Analyses, 3rd ed. Prentice Hall. New Jersey.

# APPENDIX A

**Maps**

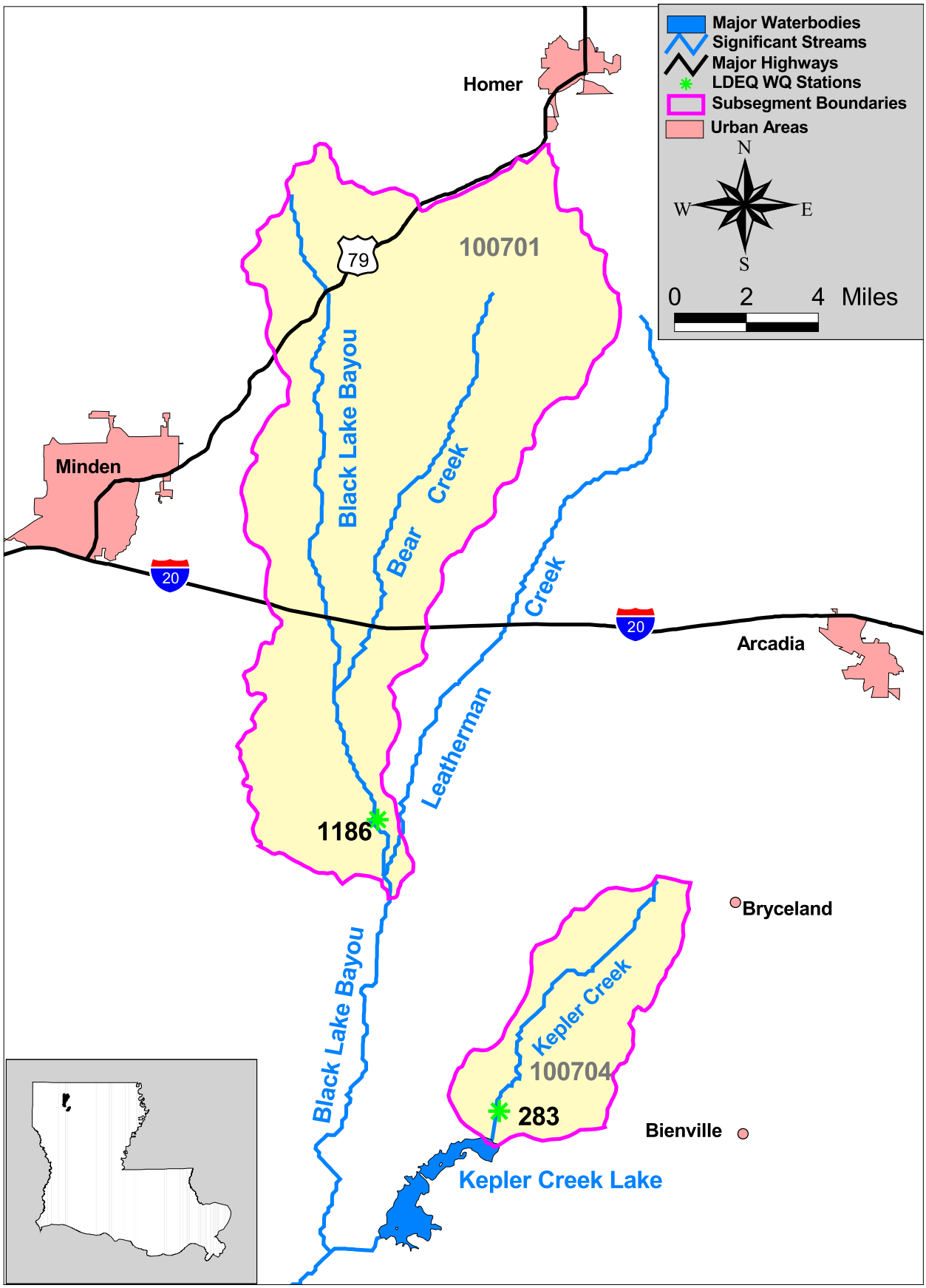



Figure A.1. Watershed map for subsegments 100701 and 100704.

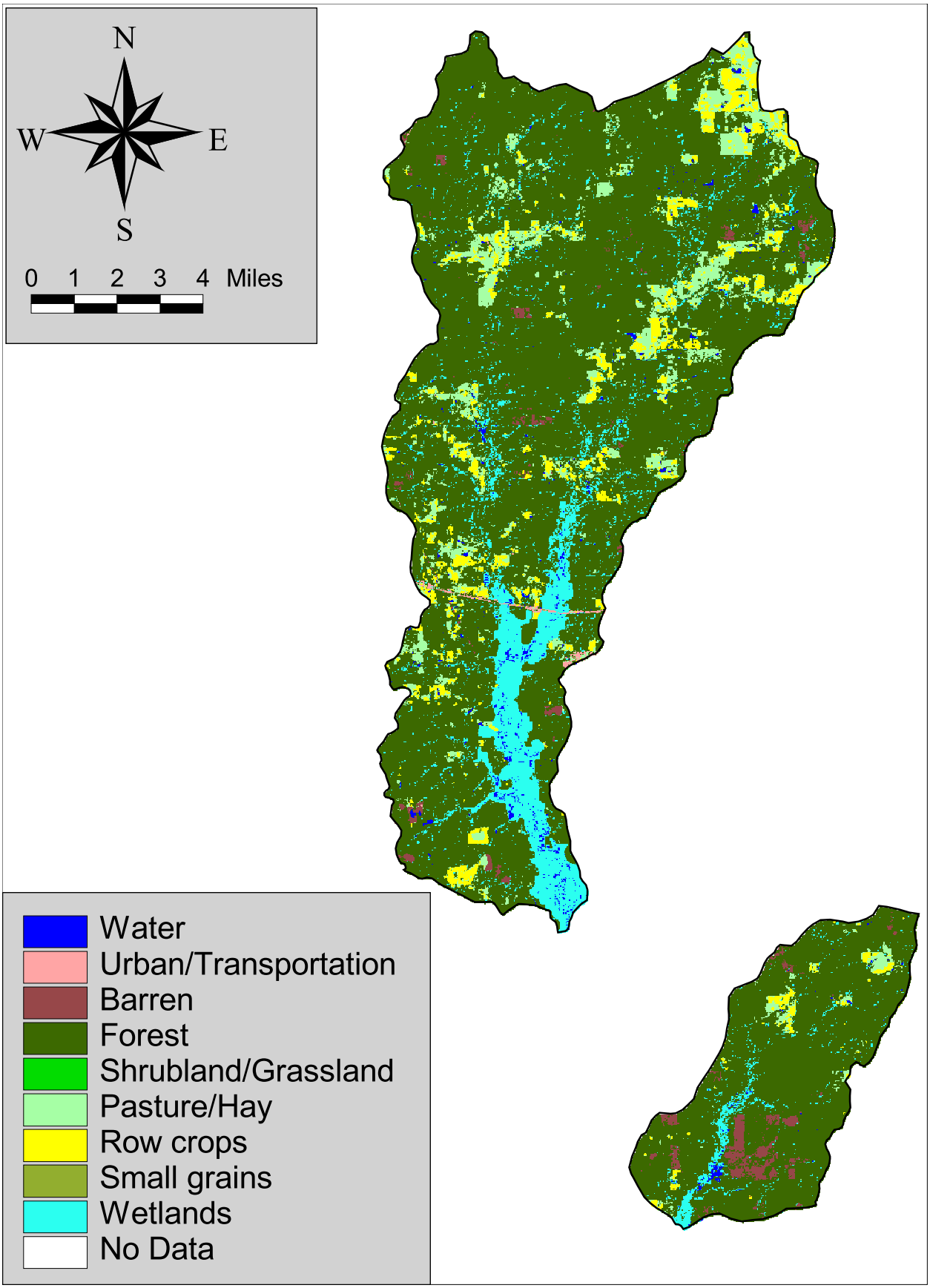



Figure A.2. Land use for subsegments 100701 and 100704.

# APPENDIX B

**Plots of Turbidity and TSS**

**Figure B.1 Turbidity for Black Lake Bayou at Highway 793, southeast of Dubberly, LA (1186)**

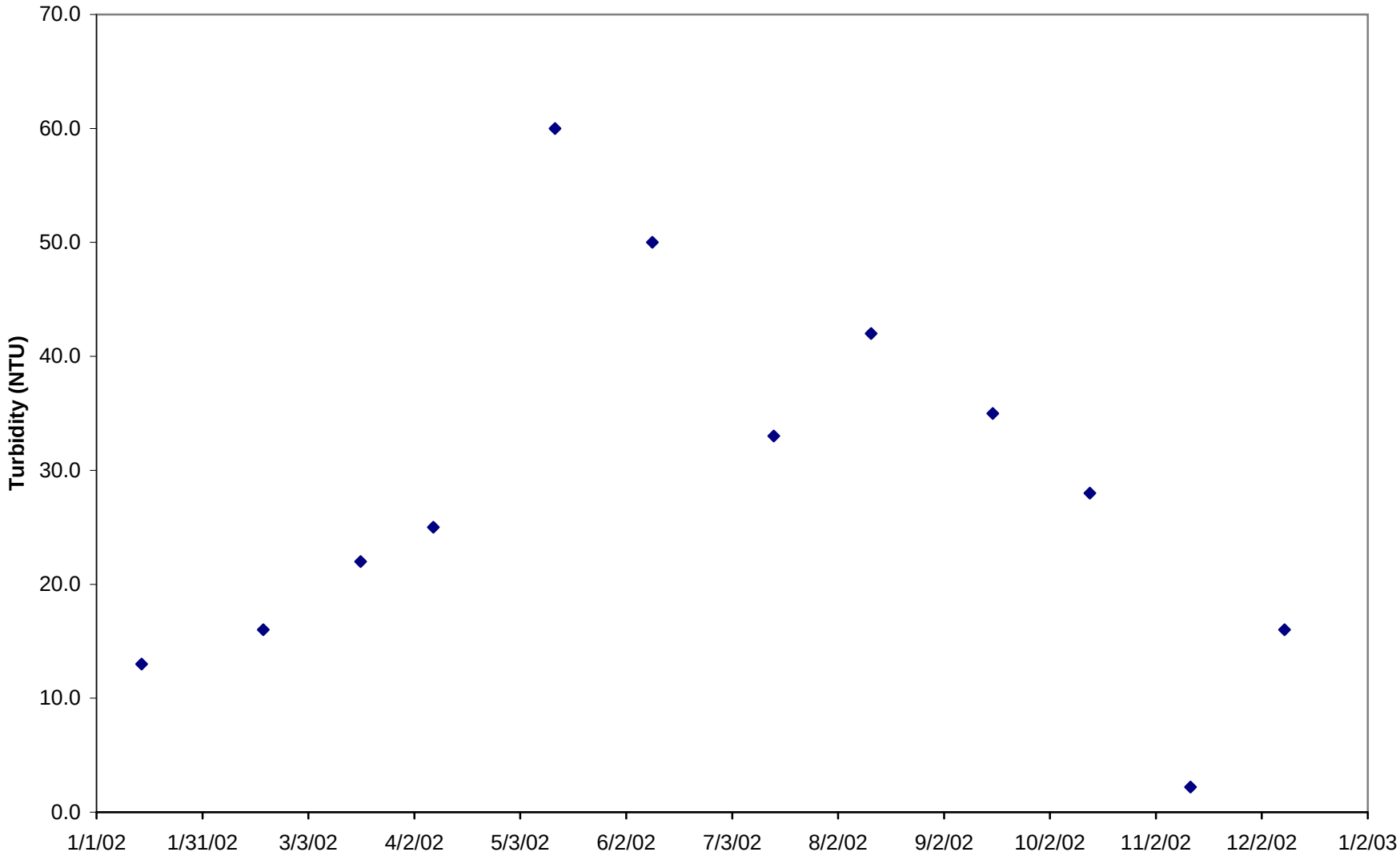


**Figure B.2 TSS for Black Lake Bayou at Highway 793, southeast of Dubberly, LA (1186)**

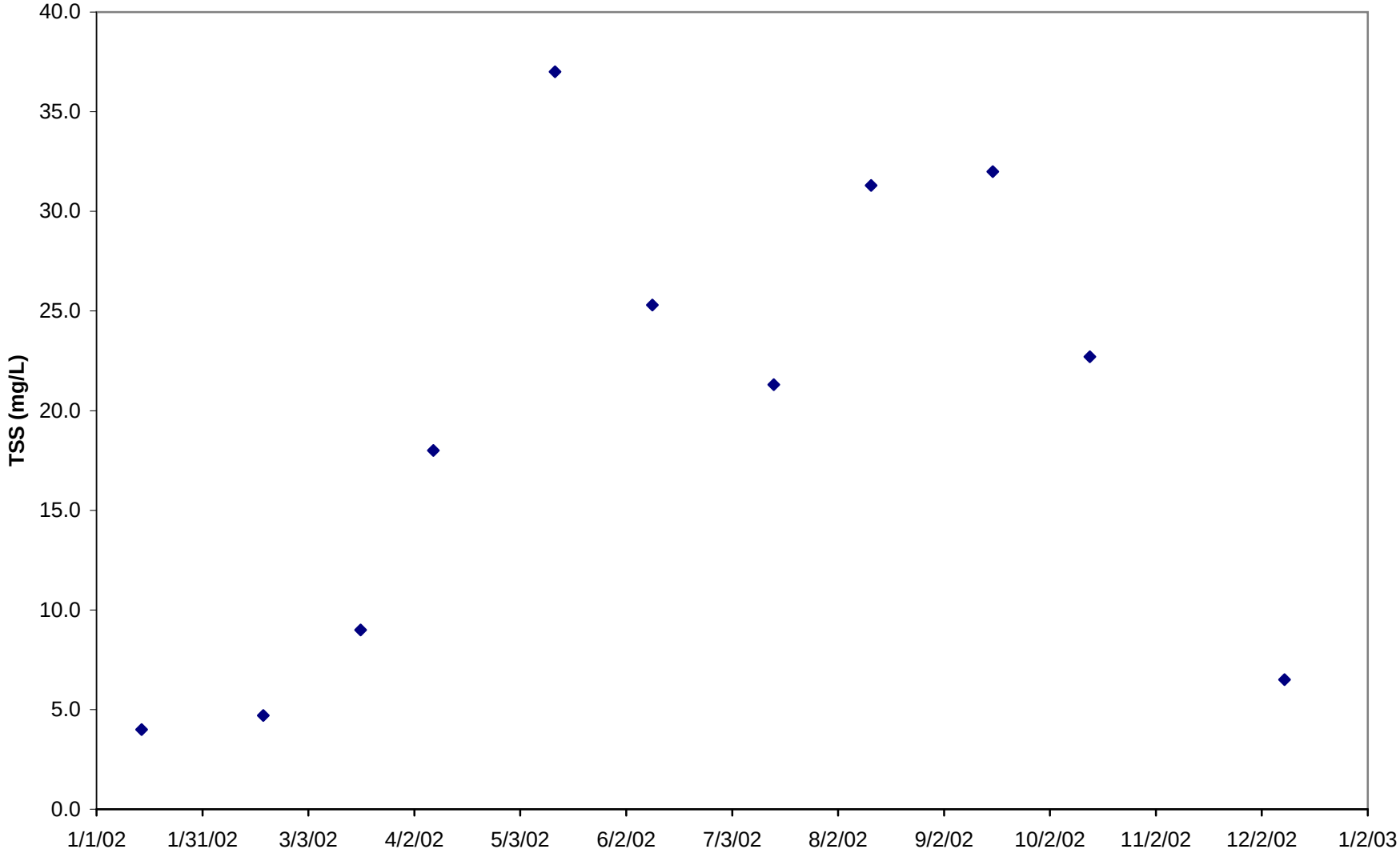


**Figure B.3 Turbidity vs Flow for Black Lake Bayou at Highway 793, southeast of Dubberly, LA (1186)**

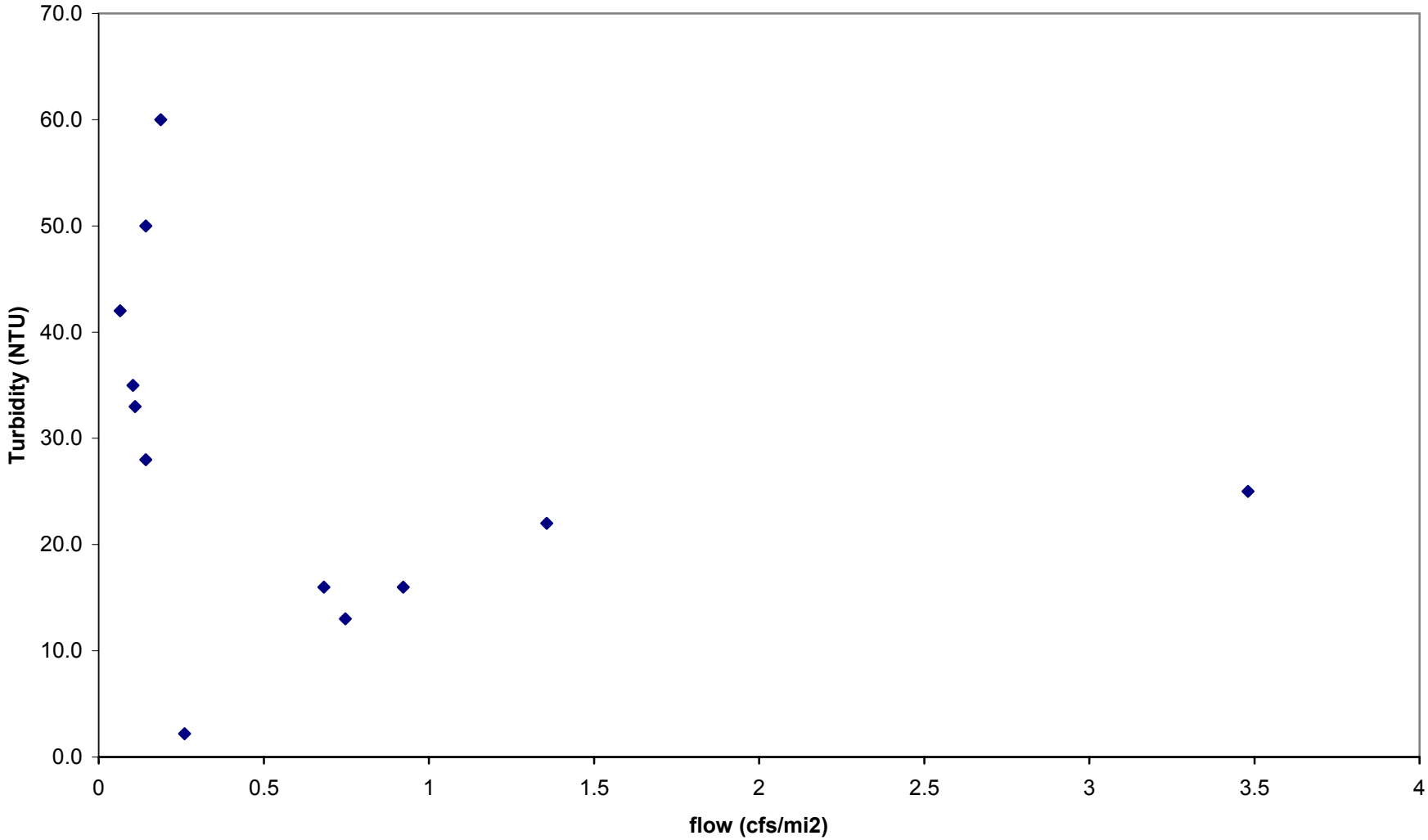


**Figure B.4 TSS vs Flow for Black Lake Bayou at Highway 793, southeast of Dubberly, LA (1186)**

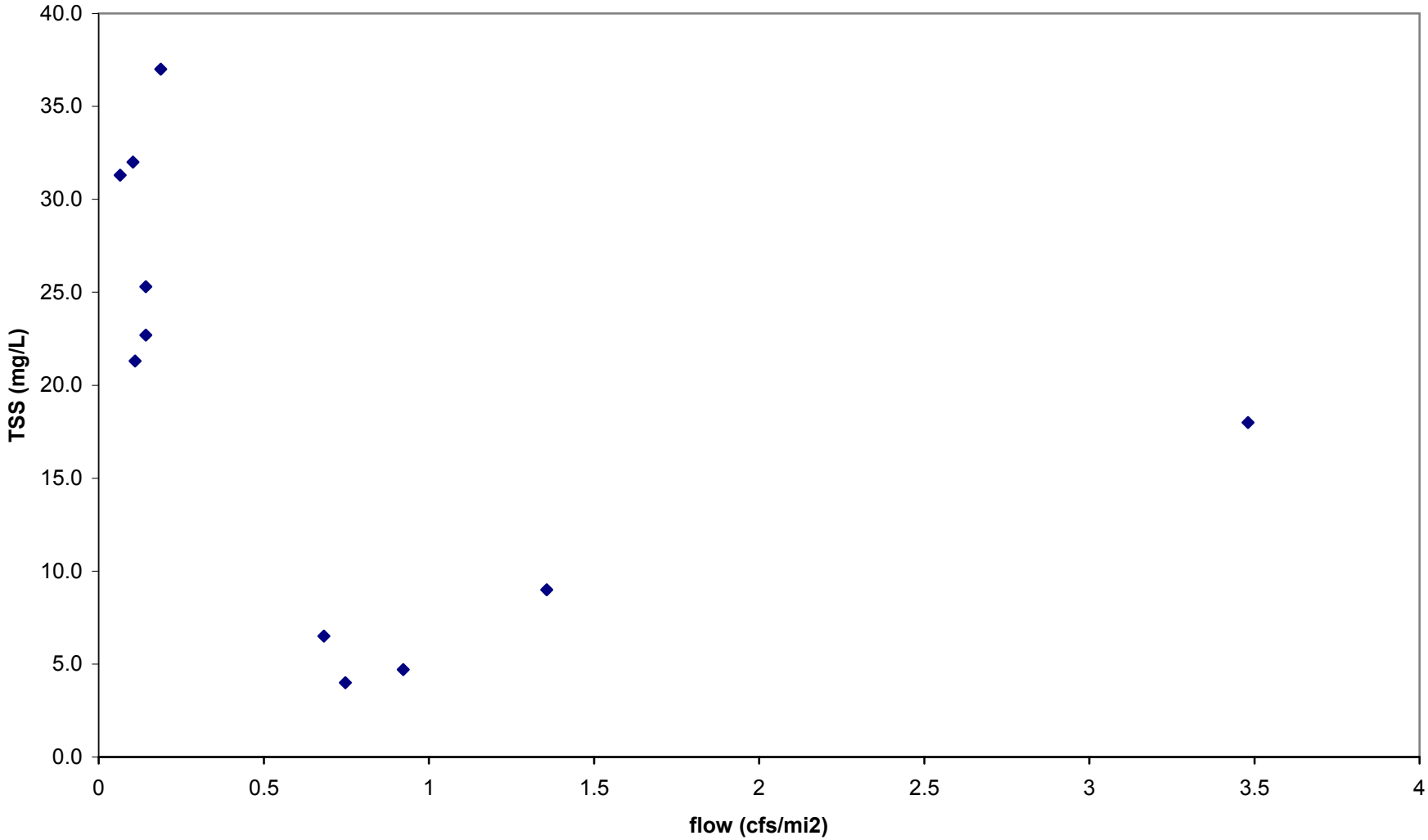
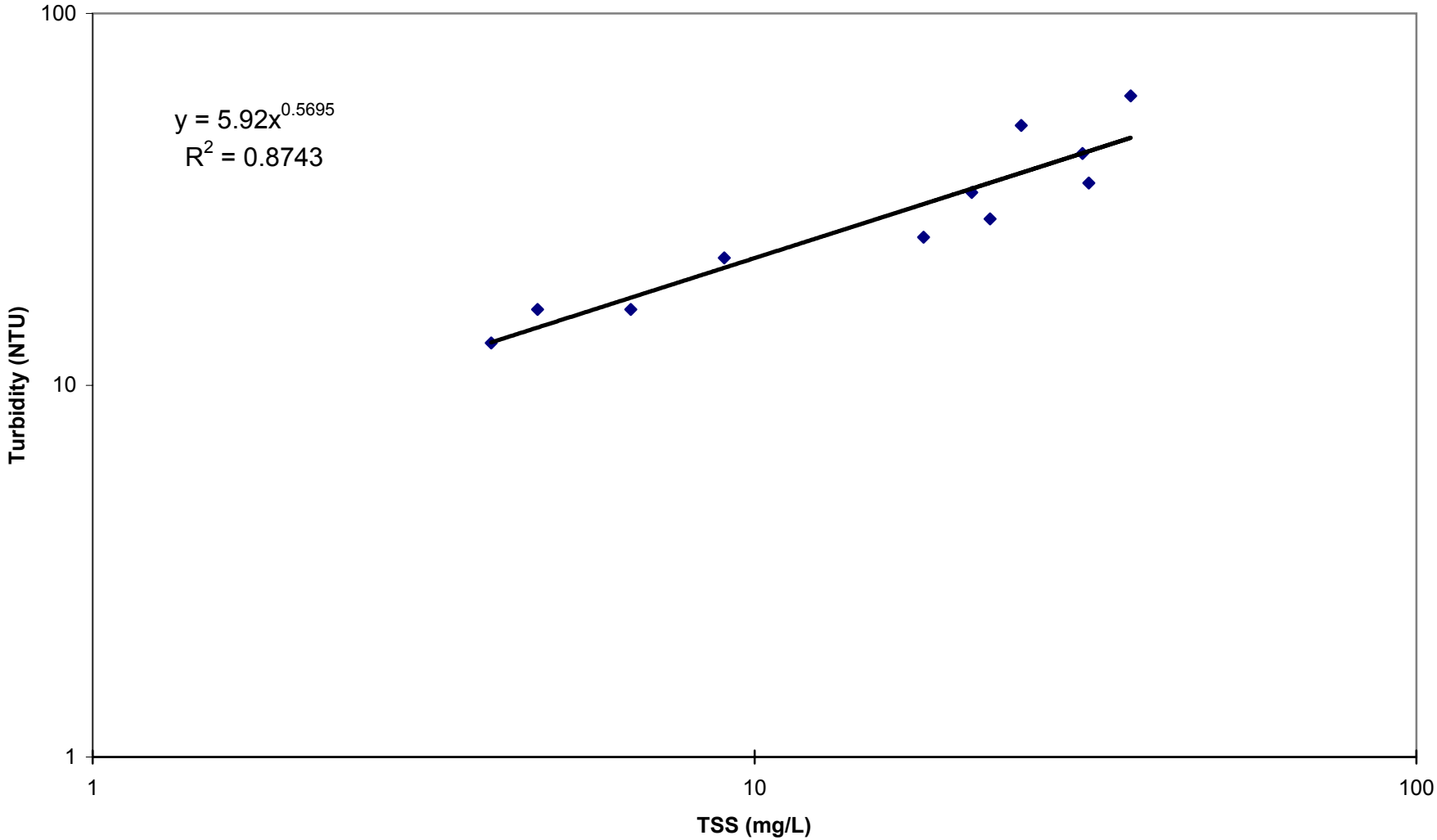


**Figure B.5 Turbidity vs TSS for Black Lake Bayou at Highway 793, southeast of Dubberly, LA (1186)**



# APPENDIX C

**Plots of TDS**

**Figure C.1 TDS for Kepler Creek west of Bienville, LA (0283)**

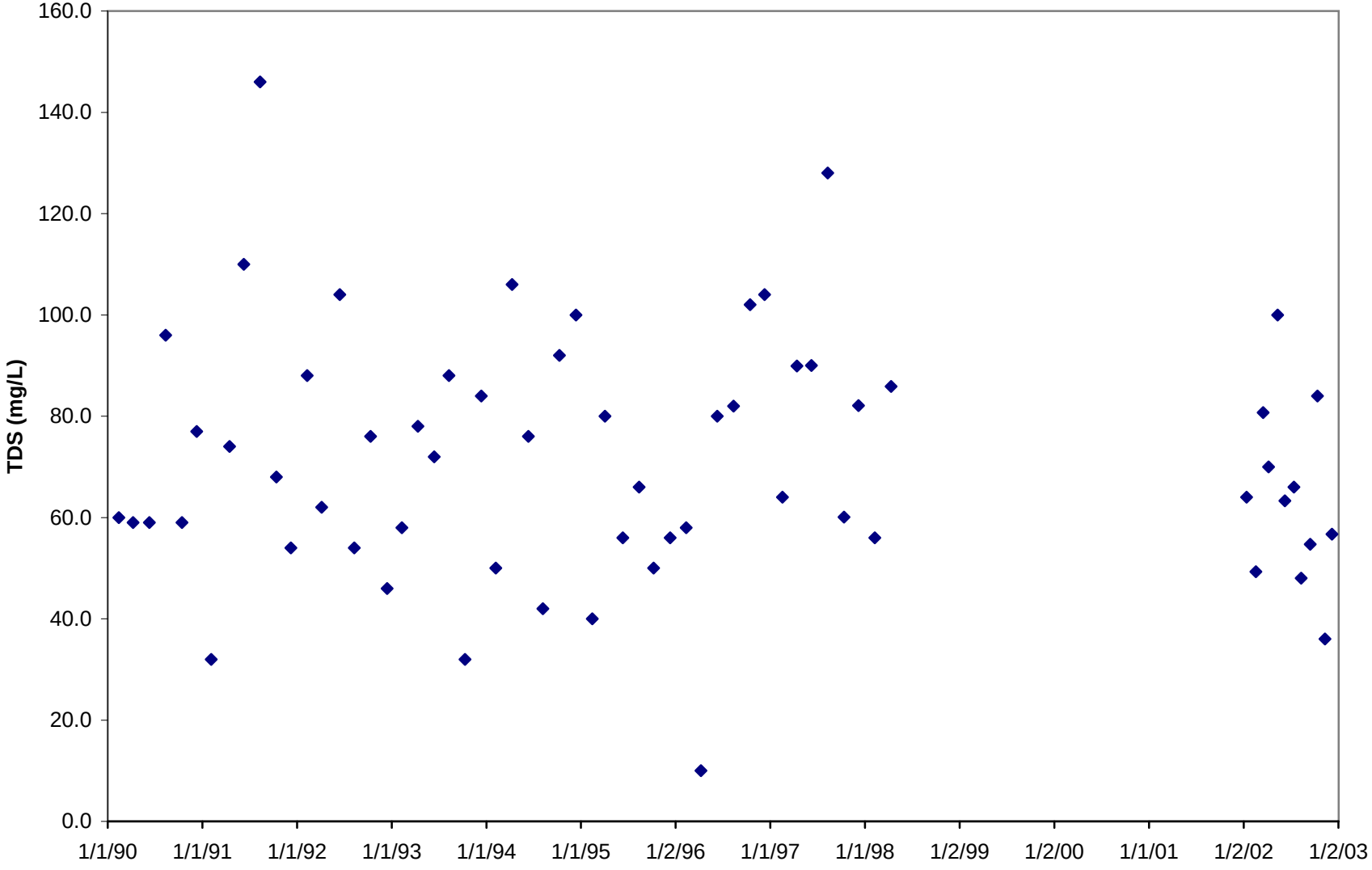


**Figure C.2 TDS for Black Lake Bayou at Highway 793, southeast of Dubberly, LA (1186)**

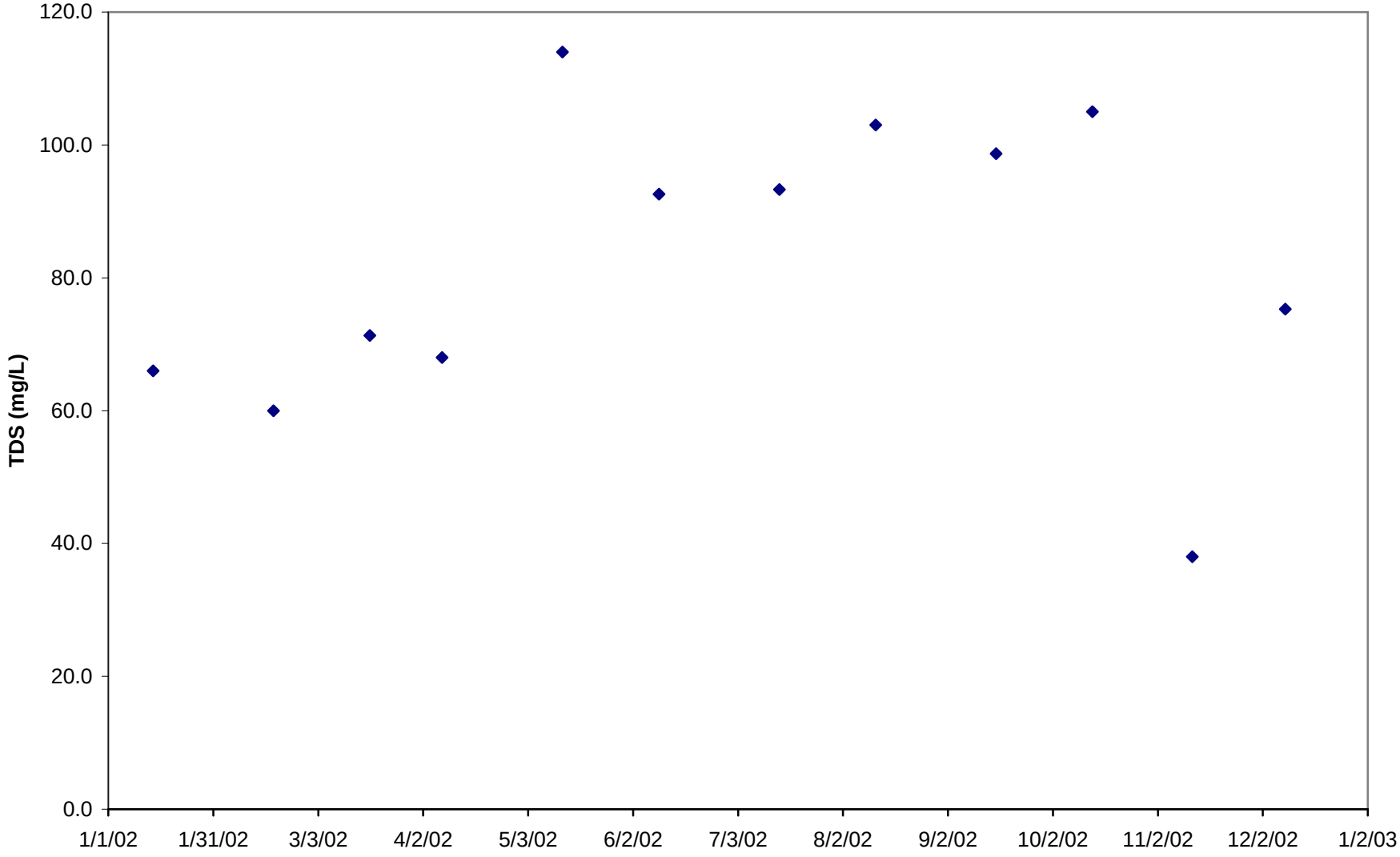


**Figure C.3 Seasonal Plot of TDS for Kepler Creek west of Bienville, LA (0283)**

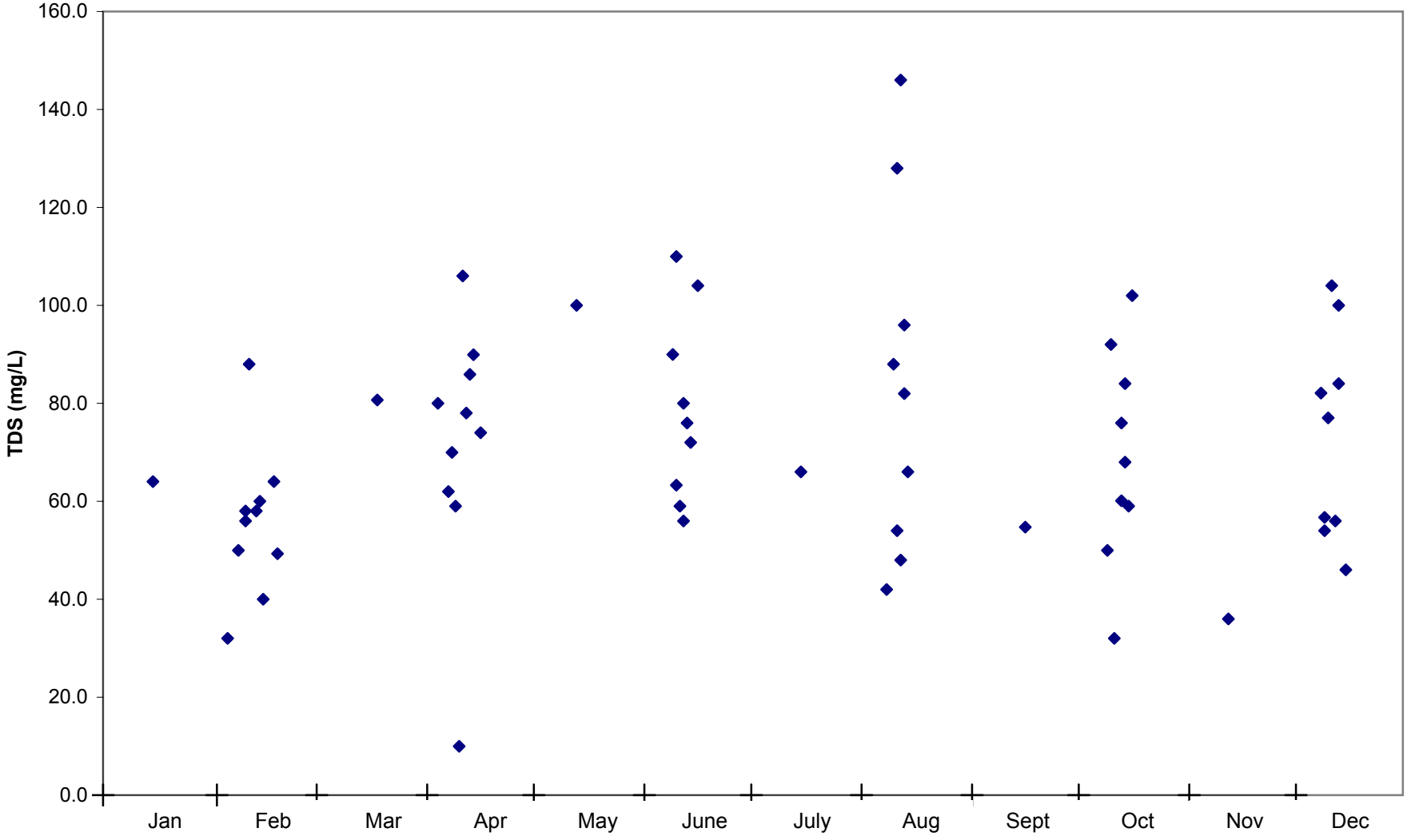


**Figure C.4 TDS vs Flow for Kepler Creek west of Bienville, LA (0283)**

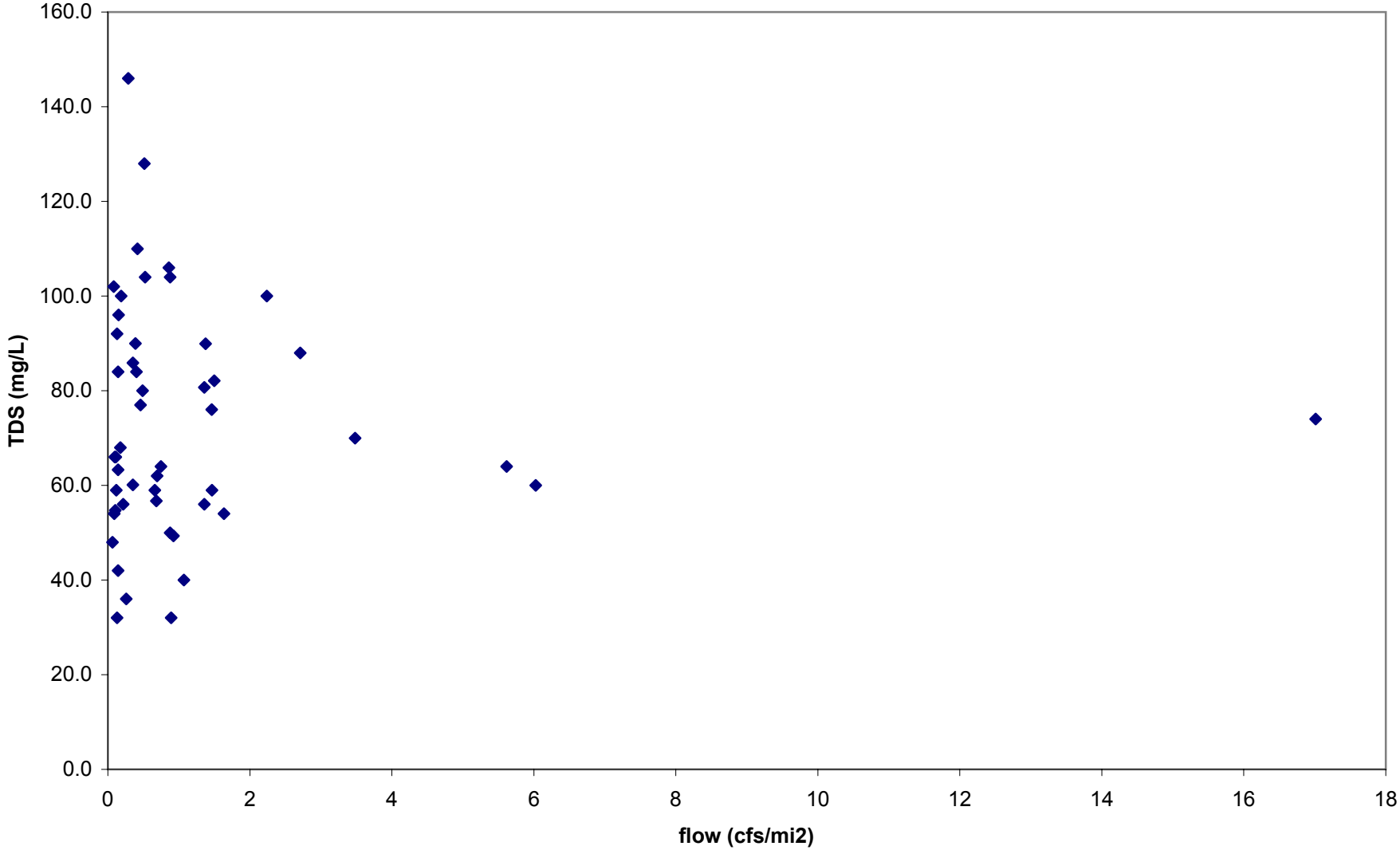
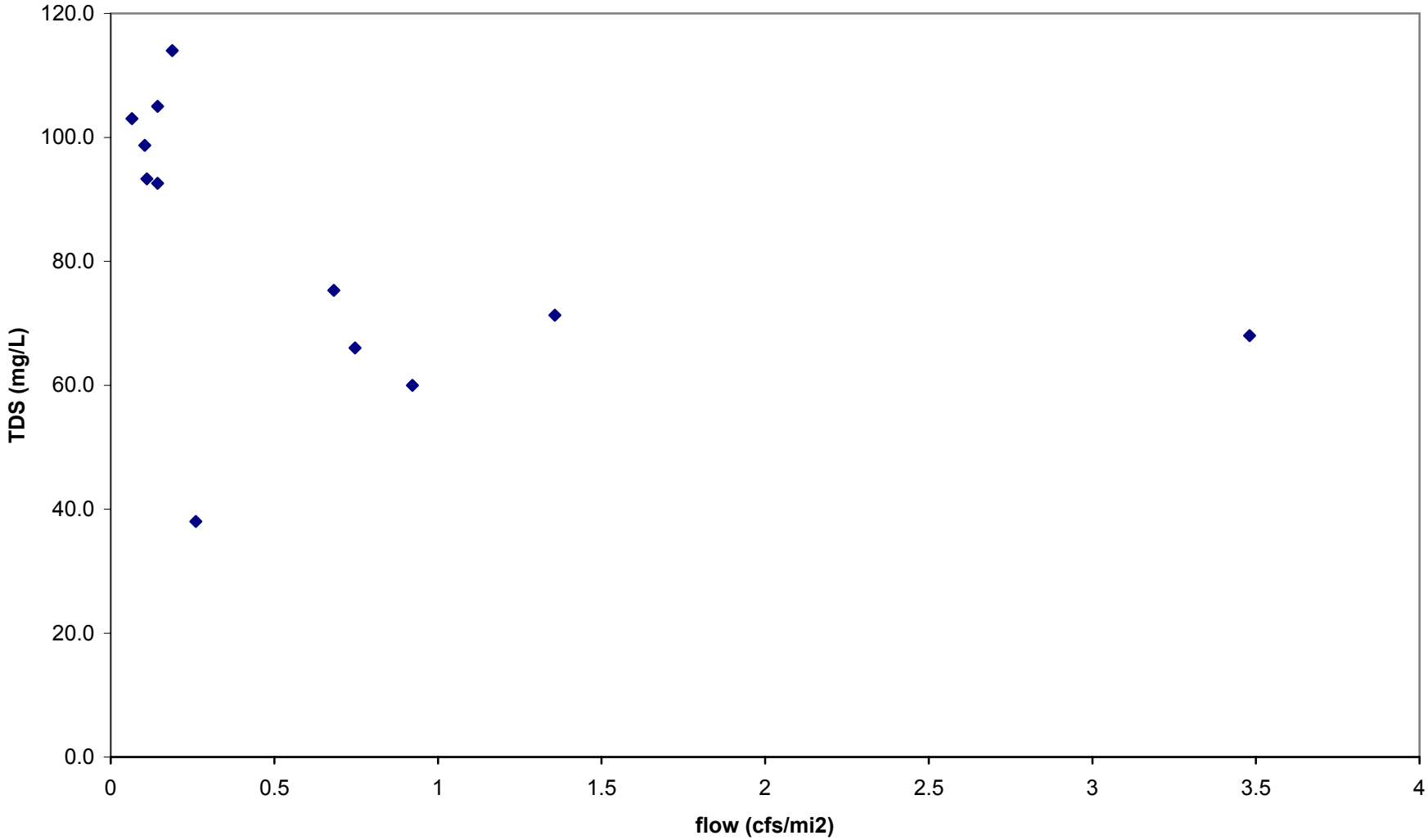


**Figure C.5 TDS vs Flow for Black Lake Bayou at Highway 793, southeast of Dubberly, LA (1186)**



# APPENDIX D

**Calculations for subsegment 100701**

**Figure D.1 TSS Load Duration Curve for Black Lake Bayou (Subsegment 100701)**

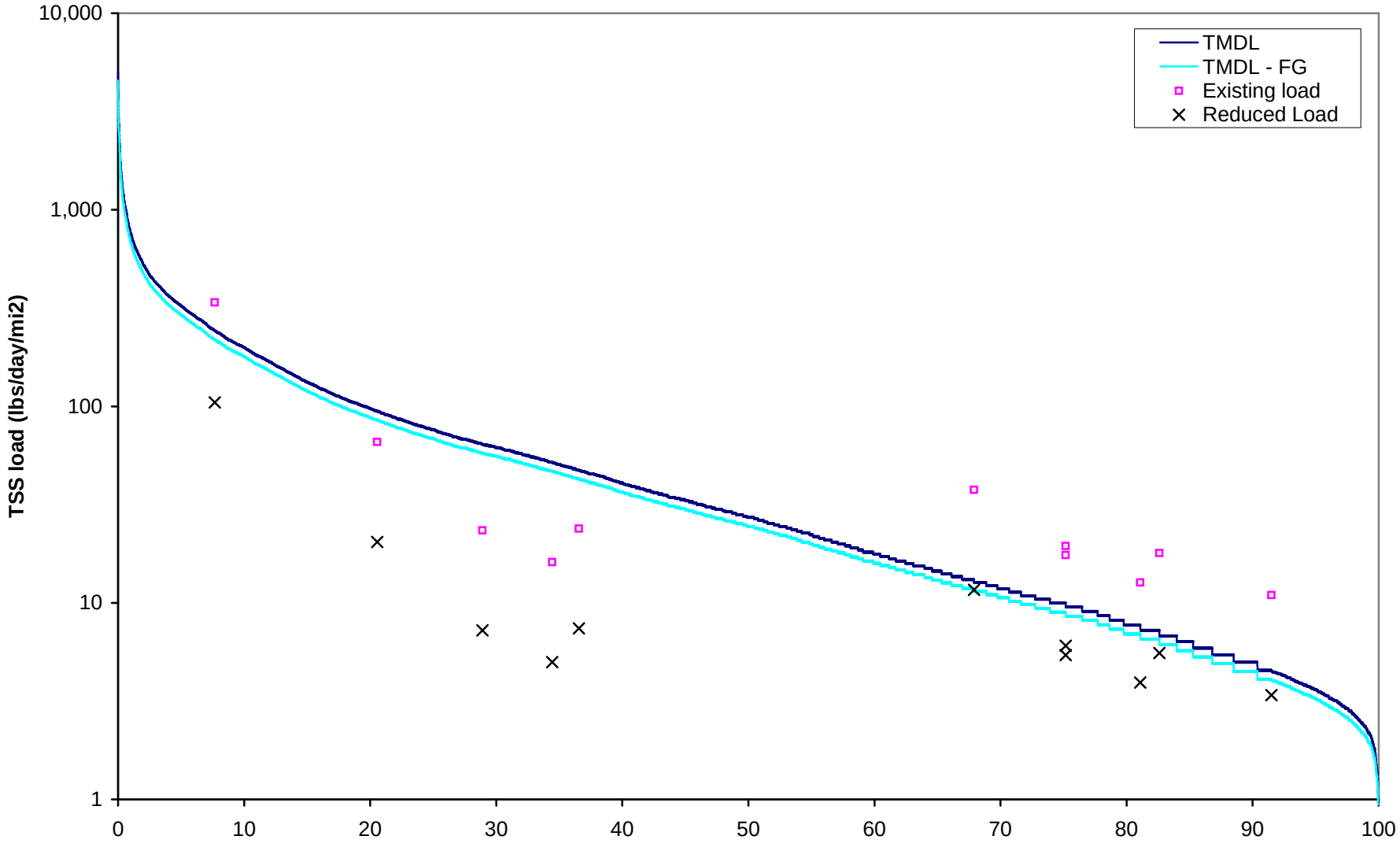


TABLE D.1 ALLOWABLE LOAD FOR TSS FOR BLACK LAKE BAYOU AT HIGHWAY 793, LA (1186)

Turbidity Criterion = 25 NTU
TSS target = 13 mg/L

drainage 154 mi2, of gage
123.38 mi2, of watershed (100701)

TSS Target = 80.65 lbs/day/mi2

| Date | Saline Bayou flow (cfs) | Percent non exceed-ance | Percent exceed-ance | Flow per unit area (cfs/mi2) | Flow per unit area (cms/mi2) | Width on plot between data points (unitless) | TSS TMDL load (lbs/day/mi2) | TSS TMDL - FG load (lbs/day/mi2) | TMDL curve (width times TMDL load) (lbs/day/mi2) |
|---|---|---|---|---|---|---|---|---|---|
| 9/6/2000 | 1.4 | 0.00 | 100.00 | 9.0909E-03 | 2.5739E-04 | 0.00449 | 0.64 | 0.57 | 2.86E-05 |
| 8/31/2000 | 1.8 | 0.01 | 99.99 | 1.1688E-02 | 3.3093E-04 | 0.00449 | 0.82 | 0.74 | 3.68E-05 |
| 9/1/2000 | 1.8 | 0.01 | 99.99 | 1.1688E-02 | 3.3093E-04 | 0.00449 | 0.82 | 0.74 | 3.68E-05 |
| 8/30/2000 | 2.0 | 0.02 | 99.98 | 1.2987E-02 | 3.6770E-04 | 0.00449 | 0.91 | 0.82 | 4.09E-05 |
| 9/5/2000 | 2.0 | 0.02 | 99.98 | 1.2987E-02 | 3.6770E-04 | 0.00449 | 0.91 | 0.82 | 4.09E-05 |
| 8/16/2000 | 2.1 | 0.02 | 99.98 | 1.3636E-02 | 3.8608E-04 | 0.00449 | 0.96 | 0.86 | 4.29E-05 |
| 9/2/2000 | 2.1 | 0.03 | 99.97 | 1.3636E-02 | 3.8608E-04 | 0.00449 | 0.96 | 0.86 | 4.29E-05 |
| 9/4/2000 | 2.1 | 0.03 | 99.97 | 1.3636E-02 | 3.8608E-04 | 0.00449 | 0.96 | 0.86 | 4.29E-05 |

For brevity, most of the rows in this spreadsheet have been hidden (between the 99.98% and the 0.02% exceedances).

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 12/13/2001 | 6,970 | 99.97 | 0.03 | 45.26 | 1.28 | 0.00449 | 3,173.04 | 2,855.74 | 1.42E-01 |
| 5/19/1942 | 7,380 | 99.97 | 0.03 | 47.92 | 1.36 | 0.00449 | 3,359.69 | 3,023.72 | 1.51E-01 |
| 5/17/1953 | 7,730 | 99.98 | 0.02 | 50.19 | 1.42 | 0.00449 | 3,519.02 | 3,167.12 | 1.58E-01 |
| 5/19/1989 | 8,050 | 99.98 | 0.02 | 52.27 | 1.48 | 0.00449 | 3,664.70 | 3,298.23 | 1.64E-01 |
| 4/2/1945 | 8,300 | 99.98 | 0.02 | 53.90 | 1.53 | 0.00449 | 3,778.51 | 3,400.66 | 1.70E-01 |
| 1/30/1999 | 8,590 | 99.99 | 0.01 | 55.78 | 1.58 | 0.00449 | 3,910.53 | 3,519.48 | 1.76E-01 |
| 4/23/1995 | 9,730 | 99.99 | 0.01 | 63.18 | 1.79 | 0.00449 | 4,429.51 | 3,986.56 | 1.99E-01 |
| 1/1/1945 | 11,100 | 100.00 | 0.00 | 72.08 | 2.04 | 0.00337 | 5,053.19 | 4,547.87 | 1.70E-01 |
| | | | | | | | | TOTAL = | 80.65 |

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TABLE D.2 EXISITNG TSS LOAD AND PERCENT REDUCTION FOR BLACK LAKE BAYOU AT HIGHWAY 793, LA (1186)

WQ target for TSS = 13 mg/L
Percent reduction = 69%

Error check for reduction is / is not needed: ok
Error check for less or more reduction needed: ok

| Date | Observed TSS at 1186 (mg/L) | Flow per unit area on sampling day (cms/mi2) | Percent exceedance for flow on sampling day | Current TSS load (lbs/day)/mi2 | Reduced TSS load (lbs/day)/mi2 | Allowable TSS load with MOS and FG incorporated (lbs/day)/mi2 | Reduced load less than or equal to allow. load? | Is load reduced by 68% still at or below allowable load? |
|---|---|---|---|---|---|---|---|---|
| 1/14/02 | 4.0 | 0.0211 | 34.44 | 16.11 | 4.99 | 47.12 | Yes | Yes |
| 2/18/02 | 4.7 | 0.0261 | 28.91 | 23.37 | 7.25 | 58.18 | Yes | Yes |
| 3/18/02 | 9.0 | 0.0384 | 20.56 | 65.87 | 20.42 | 85.63 | Yes | Yes |
| 4/8/02 | 18.0 | 0.0985 | 7.67 | 337.86 | 104.74 | 219.61 | Yes | Yes |
| 5/13/02 | 37.0 | 0.0053 | 67.90 | 37.58 | 11.65 | 11.88 | Yes | No |
| 6/10/02 | 25.3 | 0.0040 | 75.17 | 19.49 | 6.04 | 9.01 | Yes | Yes |
| 7/15/02 | 21.3 | 0.0031 | 81.09 | 12.68 | 3.93 | 6.97 | Yes | Yes |
| 8/12/02 | 31.3 | 0.0018 | 91.49 | 10.96 | 3.40 | 4.10 | Yes | Yes |
| 9/16/02 | 32.0 | 0.0029 | 82.60 | 17.93 | 5.56 | 6.56 | Yes | Yes |
| 10/14/02 | 22.7 | 0.0040 | 75.17 | 17.49 | 5.42 | 9.01 | Yes | Yes |
| 12/9/02 | 6.5 | 0.0193 | 36.55 | 23.90 | 7.41 | 43.02 | Yes | Yes |

Total number of values = 11
Allowable % of exceedances = 0%
Allowable no. of exceedances = 0
No. of exceedances before reductions = 7
No. of exceedances after reductions = 0

Total allowable loading per unit area to meet TSS target (from Table D.1) = 80.65 lbs/day/mi2
Total allowable loading for Subsegment 100701 TMDL = 80.65 * 123 mi2 = 4.98 tons/day

Explicit MOS for TSS for Subsegment 100701 (implicit) = 0.00 tons/day
Future growth for TSS for Subsegment 101701 (10% of TMDL) = 0.50 tons/day

Sum of design flows for point sources of TSS for Subsegment 100701 = 4.381E-04 cms
Assumed effluent TSS concentration for point sources = 25 mg/L

| | | |
|---|---|---|
| Existing point source TSS load for Subsegment 100701 = | 0.01 | tons/day |
| WLA for TSS for Subsegment 100701 (same as existing Point Source load) = | 0.01 | tons/day |
| LA for TSS for Subsegment 100701 = total - MOS - WLA - FG = | 4.47 | tons/day |

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# APPENDIX E

**Calculations for subsegment 100701 TDS TMDL**

**Figure E.1 TDS Load Duration Duration Curve for Black Lake Bayou at (Subsegment 100701)**

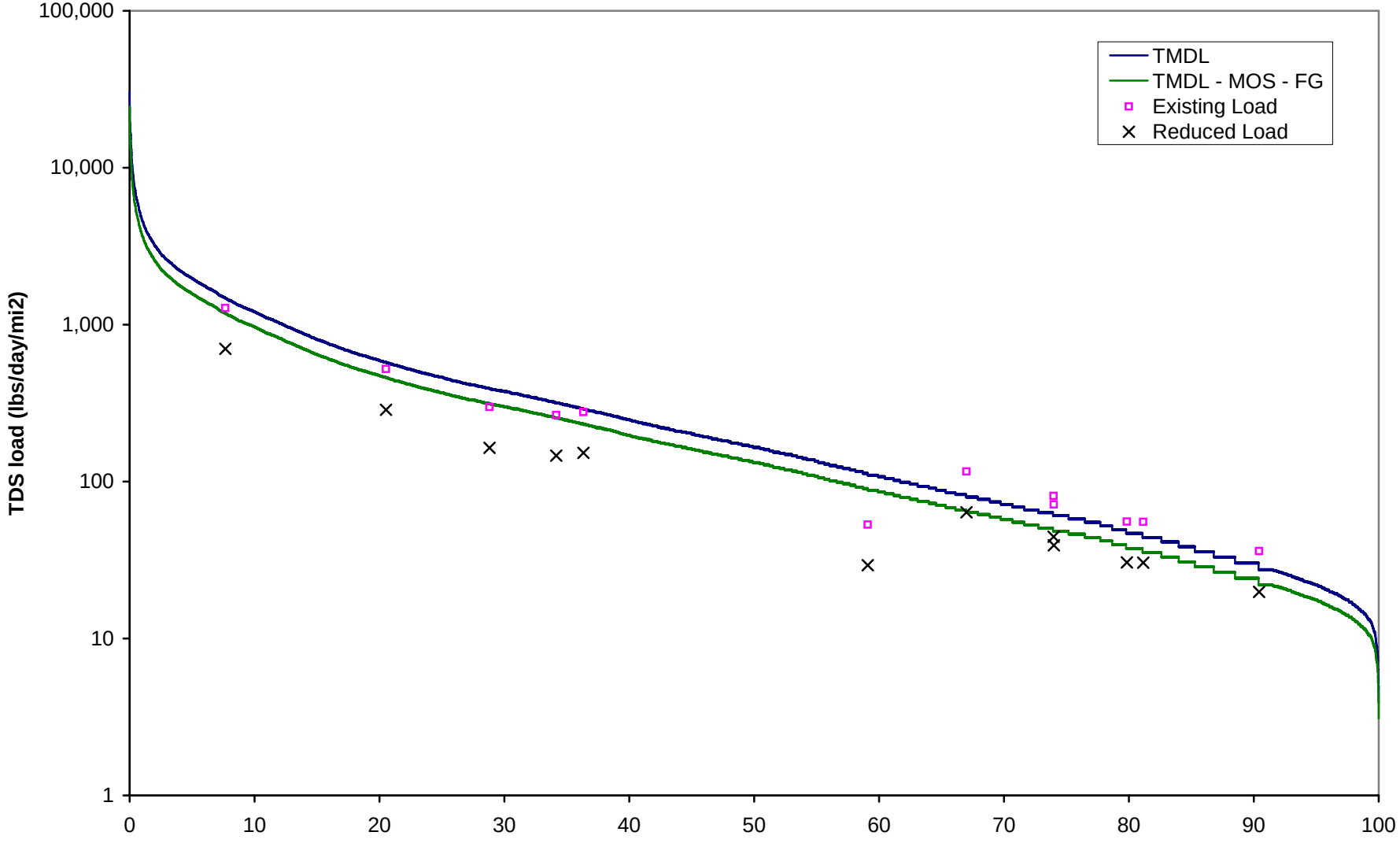

TABLE E.1 ALLOWABLE LOAD FOR TDS FOR BLACK LAKE BAYOU AT HIGHWAY 793, LA (1186)

drainage 154 mi2, of gage TDS Std 79 mg/L
123.38 mi2, of watershed (100701)

TDS target = 490 lbs/day/mi2

| Date | Saline Bayou flow (cfs) | Percent non exceed-ance | Percent exceed-ance | Flow per unit area (cfs/mi2) | Flow per unit area (cms/mi2) | Width on plot between data points (unitless) | Allowable TDS TMDL load to meet standard (lbs/day/mi2) | Allowable TDS TMDL - FG and MOS load to meet standard (lbs/day/mi2) | area under TMDL curve (lbs/day/mi2) |
|---|---|---|---|---|---|---|---|---|---|
| 9/6/2000 | 1.4 | 0.00 | 100.00 | 9.0909E-03 | 2.5739E-04 | 0.00449 | 3.87 | 3.10 | 1.74E-04 |
| 8/31/2000 | 1.8 | 0.01 | 99.99 | 1.1688E-02 | 3.3093E-04 | 0.00449 | 4.98 | 3.98 | 2.24E-04 |
| 9/1/2000 | 1.8 | 0.01 | 99.99 | 1.1688E-02 | 3.3093E-04 | 0.00449 | 4.98 | 3.98 | 2.24E-04 |
| 8/30/2000 | 2.0 | 0.02 | 99.98 | 1.2987E-02 | 3.6770E-04 | 0.00449 | 5.53 | 4.43 | 2.48E-04 |
| 9/5/2000 | 2.0 | 0.02 | 99.98 | 1.2987E-02 | 3.6770E-04 | 0.00449 | 5.53 | 4.43 | 2.48E-04 |
| 8/16/2000 | 2.1 | 0.02 | 99.98 | 1.3636E-02 | 3.8608E-04 | 0.00449 | 5.81 | 4.65 | 2.61E-04 |
| 9/2/2000 | 2.1 | 0.03 | 99.97 | 1.3636E-02 | 3.8608E-04 | 0.00449 | 5.81 | 4.65 | 2.61E-04 |
| 9/4/2000 | 2.1 | 0.03 | 99.97 | 1.3636E-02 | 3.8608E-04 | 0.00449 | 5.81 | 4.65 | 2.61E-04 |

For brevity, most of the rows in this spreadsheet have been hidden (between the 99.97% and the 0.03% exceedances).

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 12/13/2001 | 6,970 | 99.97 | 0.03 | 45.26 | 1.28 | 0.00449 | 19,282.31 | 15,425.85 | 0.87 |
| 5/19/1942 | 7,380 | 99.97 | 0.03 | 47.92 | 1.36 | 0.00449 | 20,416.57 | 16,333.25 | 0.92 |
| 5/17/1953 | 7,730 | 99.98 | 0.02 | 50.19 | 1.42 | 0.00449 | 21,384.83 | 17,107.87 | 0.96 |
| 5/19/1989 | 8,050 | 99.98 | 0.02 | 52.27 | 1.48 | 0.00449 | 22,270.10 | 17,816.08 | 1.00 |
| 4/2/1945 | 8,300 | 99.98 | 0.02 | 53.90 | 1.53 | 0.00449 | 22,961.72 | 18,369.38 | 1.03 |
| 1/30/1999 | 8,590 | 99.99 | 0.01 | 55.78 | 1.58 | 0.00449 | 23,764.00 | 19,011.20 | 1.07 |
| 4/23/1995 | 9,730 | 99.99 | 0.01 | 63.18 | 1.79 | 0.00449 | 26,917.78 | 21,534.22 | 1.21 |
| 1/1/1945 | 11,100 | 100.00 | 0.00 | 72.08 | 2.04 | 0.00337 | 30,707.85 | 24,566.28 | 1.03 |
| | | | | | | | | TOTAL = | 490.12 |

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TABLE E.2 EXISITNG TDS LOAD AND PERCENT REDUCTION FOR BLACK LAKE BAYOU AT HIGHWAY 793, LA (1186)

WQ standard for TSS = 79 mg/L
Percent reduction = 45%

Error check for reduction is / is not needed: ok
Error check for less or more reduction needed: ok

| Date | Observed TDS at 1186 (mg/L) | Flow per unit area on sampling day (cms/mi2) | Percent exceedance for flow on sampling day | Current TDS load (lbs/day)/mi2 | Reduced TDS load (lbs/day)/mi2 | Allowable TDS load with MOS and FG incorporated (lbs/day)/mi2 | Reduced load less than or equal to allow. load? |
|---|---|---|---|---|---|---|---|
| 1/14/02 | 66.0 | 0.021 | 34.15 | 265.79 | 146.19 | 254.52 | Yes |
| 2/18/02 | 60.0 | 0.026 | 28.81 | 298.36 | 164.10 | 314.27 | Yes |
| 3/18/02 | 71.3 | 0.038 | 20.51 | 521.84 | 287.01 | 462.56 | Yes |
| 4/8/02 | 68.0 | 0.099 | 7.66 | 1,276.37 | 702.00 | 1,186.27 | Yes |
| 5/13/02 | 114.0 | 0.005 | 66.99 | 115.77 | 63.67 | 64.18 | Yes |
| 6/10/02 | 92.6 | 0.004 | 73.99 | 71.34 | 39.24 | 48.69 | Yes |
| 7/15/02 | 93.3 | 0.003 | 79.84 | 55.54 | 30.55 | 37.62 | Yes |
| 8/12/02 | 103.0 | 0.002 | 90.42 | 36.07 | 19.84 | 22.13 | Yes |
| 9/16/02 | 98.7 | 0.003 | 81.15 | 55.30 | 30.42 | 35.41 | Yes |
| 10/14/02 | 105.0 | 0.004 | 73.97 | 80.89 | 44.49 | 48.69 | Yes |
| 11/12/02 | 38.0 | 0.007 | 59.10 | 53.23 | 29.28 | 88.53 | Yes |
| 12/9/02 | 75.3 | 0.019 | 36.33 | 276.88 | 152.28 | 232.38 | Yes |

Total number of values = 12
Allowable % of exceedances = 0%
Allowable no. of exceedances = 0
No. of exceedances before reductions = 6
No. of exceedances after reductions = 0

Total allowable loading per unit area to meet stds (from Table E.1) = 490.12 lbs/day/mi2
Total allowable loading for Subsegment 100701 TMDL = 490.12 * 123 mi2 = 30.24 tons/day

Explicit MOS for TDS for Subsegment 100701 (10% * 30.24) = 3.02 tons/day
Future Growth for TDS for Subsegment 100701 (10% * 30.24) = 3.02 tons/day

Sum of design flows for point sources of TDS for Subsegment 100701 = 0.000 cms

| | | |
|---|---|---|
| Assumed effluent TDS concentration for point sources = | 425 | mg/L |
| Existing point source TDS load for Subsegment 100701 = | 0.00 | tons/day |
| WLA for TDS for Subsegment 100701 (same as existing Point Source load) = | 0.00 | tons/day |
| LA for TDS for Subsegment 100701 = total - MOS - WLA - FG = | 24.20 | tons/day |

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# APPENDIX F

**Calculations for subsegment 100704 TDS TMDL**

**Figure F.1. TDS Load Duration Curve for Kepler Creek (Subsegment 100704)**

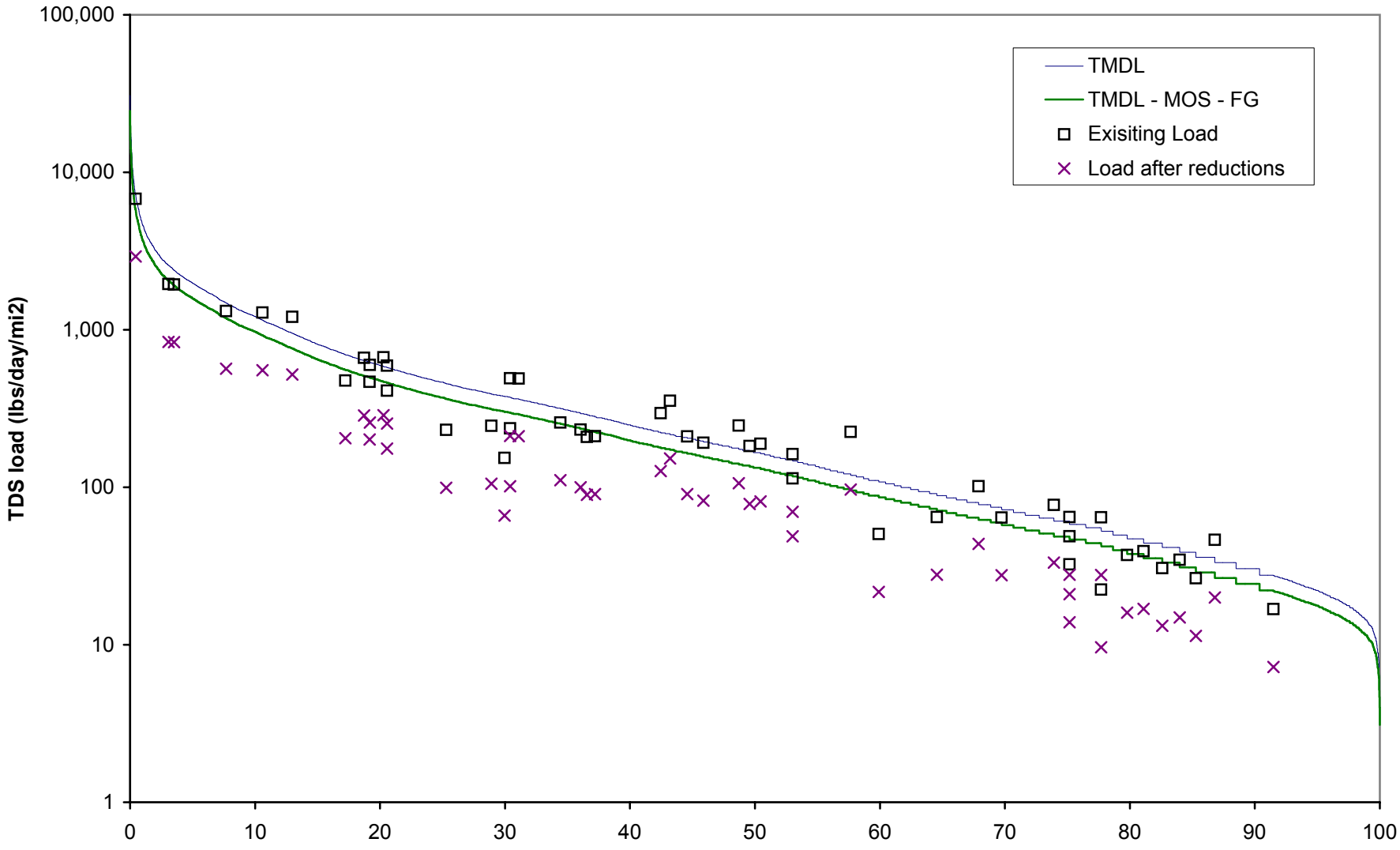

TABLE F.1. ALLOWABLE LOAD FOR TDS FOR KEPLER CREEK WEST OF BIENVILLE, LA (0283)

Drainage 154 mi2, of USGS gage 79 mg/L = TDS standard
26.28 mi2, of subsegment (100704)

TDS Target = 392.37 lb/day/mi2

| Date | Saline Bayou flow (cfs) | Percent non exceed-ance | Percent exceed-ance | Flow per unit area (cfs/mi2) | Flow per unit area (cms/mi2) | Width on plot between data points (unitless) | Allowable TDS load (lbs/day/mi2) | Area under TMDL curve (width times allowable load) (lbs/day/mi2) |
|---|---|---|---|---|---|---|---|---|
| 9/6/2000 | 1.40 | 0.00 | 100.00 | 0.009 | 0.00026 | 0.00449 | 3.10 | 1.39E-04 |
| 8/31/2000 | 1.80 | 0.01 | 99.99 | 0.012 | 0.00033 | 0.00449 | 3.98 | 1.79E-04 |
| 9/1/2000 | 1.80 | 0.01 | 99.99 | 0.012 | 0.00033 | 0.00449 | 3.98 | 1.79E-04 |
| 8/30/2000 | 2.00 | 0.02 | 99.98 | 0.013 | 0.00037 | 0.00449 | 4.43 | 1.99E-04 |
| 9/5/2000 | 2.00 | 0.02 | 99.98 | 0.013 | 0.00037 | 0.00449 | 4.43 | 1.99E-04 |
| 8/16/2000 | 2.10 | 0.02 | 99.98 | 0.014 | 0.00039 | 0.00449 | 4.65 | 2.09E-04 |
| 9/2/2000 | 2.10 | 0.03 | 99.97 | 0.014 | 0.00039 | 0.00449 | 4.65 | 2.09E-04 |
| 9/4/2000 | 2.10 | 0.03 | 99.97 | 0.014 | 0.00039 | 0.00449 | 4.65 | 2.09E-04 |

For brevity, most of the rows in this spreadsheet have been hidden (between the 99.97% and the 0.03% exceedances).

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 12/13/2001 | 6,970.00 | 99.97 | 0.03 | 45.260 | 1.28142 | 0.00449 | 15,425.85 | 6.92E-01 |
| 5/19/1942 | 7,380.00 | 99.97 | 0.03 | 47.922 | 1.35680 | 0.00449 | 16,333.25 | 7.33E-01 |
| 5/17/1953 | 7,730.00 | 99.98 | 0.02 | 50.195 | 1.42114 | 0.00449 | 17,107.87 | 7.68E-01 |
| 5/19/1989 | 8,050.00 | 99.98 | 0.02 | 52.273 | 1.47998 | 0.00449 | 17,816.08 | 8.00E-01 |
| 4/2/1945 | 8,300.00 | 99.98 | 0.02 | 53.896 | 1.52594 | 0.00449 | 18,369.38 | 8.25E-01 |
| 1/30/1999 | 8,590.00 | 99.99 | 0.01 | 55.779 | 1.57925 | 0.00449 | 19,011.20 | 8.53E-01 |
| 4/23/1995 | 9,730.00 | 99.99 | 0.01 | 63.182 | 1.78884 | 0.00449 | 21,534.22 | 9.67E-01 |
| 1/1/1945 | 11,100.00 | 100.00 | 0.00 | 72.078 | 2.04071 | 0.00449 | 24,566.28 | 1.10E+00 |
| | | | | | | | TOTAL = | 392.37 |

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TABLE F.2. EXISTING LOAD AND PERCENT REDUCTIONS FOR KEPLER CREEK WEST OF BIENVILLE, LA (0283)

WQ standard for TDS = 79 mg/L
Percent reduction = 57%

Error check for reduction is / is not needed: ok
Error check for less or more reduction needed: ok

| Date | Observed TDS at station 283 (mg/L) | Flow per unit area on sampling day (cms/mi2) | Percent exceedance for flow on sampling day | Current TDS load (lbs/day/mi2) | Reduced TDS load (lbs/day)/mi2 | Allowable TDS load with MOS and FG incorporated (lbs/day)/mi2 | Reduced load less than or equal to allow. load? |
|---|---|---|---|---|---|---|---|
| 12-Aug-02 | 48.0 | 0.0018 | 91.49 | 16.81 | 7.23 | 22.13 | Yes |
| 11-Oct-93 | 32.0 | 0.0037 | 77.71 | 22.41 | 9.64 | 44.26 | Yes |
| 10-Aug-92 | 54.0 | 0.0026 | 85.28 | 26.47 | 11.38 | 30.98 | Yes |
| 16-Sep-02 | 54.7 | 0.0029 | 82.60 | 30.65 | 13.18 | 35.41 | Yes |
| 8-Aug-94 | 42.0 | 0.0040 | 75.17 | 32.36 | 13.91 | 48.69 | Yes |
| 14-Aug-95 | 66.0 | 0.0028 | 83.98 | 34.67 | 14.91 | 33.20 | Yes |
| 15-Oct-90 | 59.0 | 0.0033 | 79.77 | 37.19 | 15.99 | 39.84 | Yes |
| 15-Jul-02 | 66.0 | 0.0031 | 81.09 | 39.29 | 16.90 | 37.62 | Yes |
| 15-Oct-96 | 102.0 | 0.0024 | 86.80 | 46.43 | 19.97 | 28.77 | Yes |
| 10-Jun-02 | 63.3 | 0.0040 | 75.17 | 48.77 | 20.97 | 48.69 | Yes |
| 12-Nov-02 | 36.0 | 0.0074 | 59.90 | 50.43 | 21.68 | 88.53 | Yes |
| 14-Oct-91 | 68.0 | 0.0050 | 69.74 | 64.29 | 27.65 | 59.76 | Yes |
| 10-Oct-94 | 92.0 | 0.0037 | 77.71 | 64.43 | 27.71 | 44.26 | Yes |
| 12-Jun-95 | 56.0 | 0.0061 | 64.56 | 64.71 | 27.83 | 73.04 | Yes |
| 14-Oct-02 | 84.0 | 0.0040 | 75.17 | 64.71 | 27.83 | 48.69 | Yes |
| 13-Aug-90 | 96.0 | 0.0042 | 73.92 | 77.32 | 33.25 | 50.90 | Yes |
| 13-May-02 | 100.0 | 0.0053 | 67.90 | 101.55 | 43.67 | 64.18 | Yes |
| 13-Oct-97 | 60.1 | 0.0099 | 53.02 | 113.65 | 48.87 | 119.51 | Yes |
| 4-Feb-91 | 32.0 | 0.0252 | 29.95 | 153.52 | 66.01 | 303.21 | Yes |
| 13-Apr-98 | 85.9 | 0.0099 | 53.02 | 162.44 | 69.85 | 119.51 | Yes |
| 13-Dec-93 | 84.0 | 0.0114 | 49.57 | 182.38 | 78.42 | 137.22 | Yes |
| 9-Jun-97 | 90.0 | 0.0110 | 50.44 | 189.10 | 81.31 | 132.79 | Yes |
| 10-Dec-90 | 77.0 | 0.0131 | 45.88 | 191.45 | 82.32 | 157.14 | Yes |
| 9-Dec-02 | 56.7 | 0.0193 | 36.55 | 208.48 | 89.65 | 232.38 | Yes |
| 4-Apr-95 | 80.0 | 0.0138 | 44.57 | 210.11 | 90.35 | 165.99 | Yes |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 11-Jun-90 | 59.0 | 0.0188 | 37.20 | 210.74 | 90.62 | 225.75 | Yes |
| 12-Aug-91 | 146.0 | 0.0081 | 57.66 | 224.96 | 96.73 | 97.38 | Yes |
| 14-Feb-95 | 40.0 | 0.0303 | 25.30 | 231.12 | 99.38 | 365.18 | Yes |
| 6-Apr-92 | 62.0 | 0.0197 | 36.05 | 232.31 | 99.90 | 236.81 | Yes |
| 7-Feb-94 | 50.0 | 0.0248 | 30.42 | 236.38 | 101.64 | 298.78 | Yes |
| 18-Feb-02 | 49.3 | 0.0261 | 28.91 | 245.15 | 105.42 | 314.27 | Yes |
| 10-Jun-91 | 110.0 | 0.0118 | 48.71 | 246.53 | 106.01 | 141.64 | Yes |
| 14-Jan-02 | 64.0 | 0.0211 | 34.44 | 257.74 | 110.83 | 254.52 | Yes |
| 10-Dec-96 | 104.0 | 0.0149 | 42.46 | 295.00 | 126.85 | 179.27 | Yes |
| 11-Aug-97 | 128.0 | 0.0145 | 43.20 | 354.11 | 152.27 | 174.84 | Yes |
| 9-Feb-98 | 56.0 | 0.0384 | 20.56 | 409.86 | 176.24 | 462.56 | Yes |
| 9-Apr-90 | 59.0 | 0.0415 | 19.16 | 466.94 | 200.78 | 500.18 | Yes |
| 9-Dec-91 | 54.0 | 0.0463 | 17.22 | 476.54 | 204.91 | 557.72 | Yes |
| 11-Apr-94 | 106.0 | 0.0243 | 31.10 | 489.98 | 210.69 | 292.14 | Yes |
| 15-Jun-92 | 104.0 | 0.0248 | 30.42 | 491.66 | 211.42 | 298.78 | Yes |
| 18-Mar-02 | 80.7 | 0.0384 | 20.56 | 590.64 | 253.97 | 462.56 | Yes |
| 13-Jun-94 | 76.0 | 0.0414 | 19.19 | 598.82 | 257.49 | 497.97 | Yes |
| 8-Dec-97 | 82.1 | 0.0425 | 18.72 | 664.14 | 285.58 | 511.25 | Yes |
| 14-Apr-97 | 89.9 | 0.0390 | 20.28 | 667.42 | 286.99 | 469.20 | Yes |
| 13-Dec-94 | 100.0 | 0.0634 | 12.97 | 1,208.15 | 519.50 | 763.55 | Yes |
| 10-Feb-92 | 88.0 | 0.0767 | 10.60 | 1,285.05 | 552.57 | 922.90 | Yes |
| 8-Apr-02 | 70.0 | 0.0985 | 7.67 | 1,313.91 | 564.98 | 1,186.27 | Yes |
| 17-Feb-97 | 64.0 | 0.1590 | 3.53 | 1,938.64 | 833.62 | 1,914.41 | Yes |
| 13-Feb-90 | 60.0 | 0.1706 | 3.08 | 1,949.85 | 838.43 | 2,053.84 | Yes |
| 16-Apr-91 | 74.0 | 0.4817 | 0.45 | 6,789.45 | 2,919.46 | 5,798.55 | Yes |

| | |
|---|---|
| Total number of values = | 50 |
| Allowable % of exceedances = | 0% |
| Allowable no. of exceedances = | 0 |
| No. of exceedances before reductions = | 23 |
| No. of exceedances after reductions = | 0 |

| | | |
|---|---|---|
| Total allowable loading per unit area to meet stds (from Table F.1) = | 392.37 | lbs/day/mi2 |
| Total allowable loading for Subsegment 100704 = 392.37 * 26 mi2 = | 5.16 | tons/day |
| | | |
| Explicit MOS for TDS for Subsegment 100704 (10% * 5.16) = | 0.52 | tons/day |
| Explicit MOS for TDS for Subsegment 100704 (10% * 5.16) = | 0.52 | tons/day |



Table F.2

Percent Reduction

| | | |
|---|---|---|
| Sum of design flows for point sources of TDS for Subsegment 100704 = | 0.000 | cms |
| Assumed effluent TDS concentration for point sources = | 425 | mg/L |
| Existing point source TDS load for Subsegment 100704 = | 0.00 | tons/day |
| | | |
| WLA for TDS for Subsegment 100704 (same as existing Point Source load) = | 0.00 | tons/day |
| | | |
| LA for TDS for Subsegment 100704 = total - MOS - WLA - FG = | 4.12 | tons/day |

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