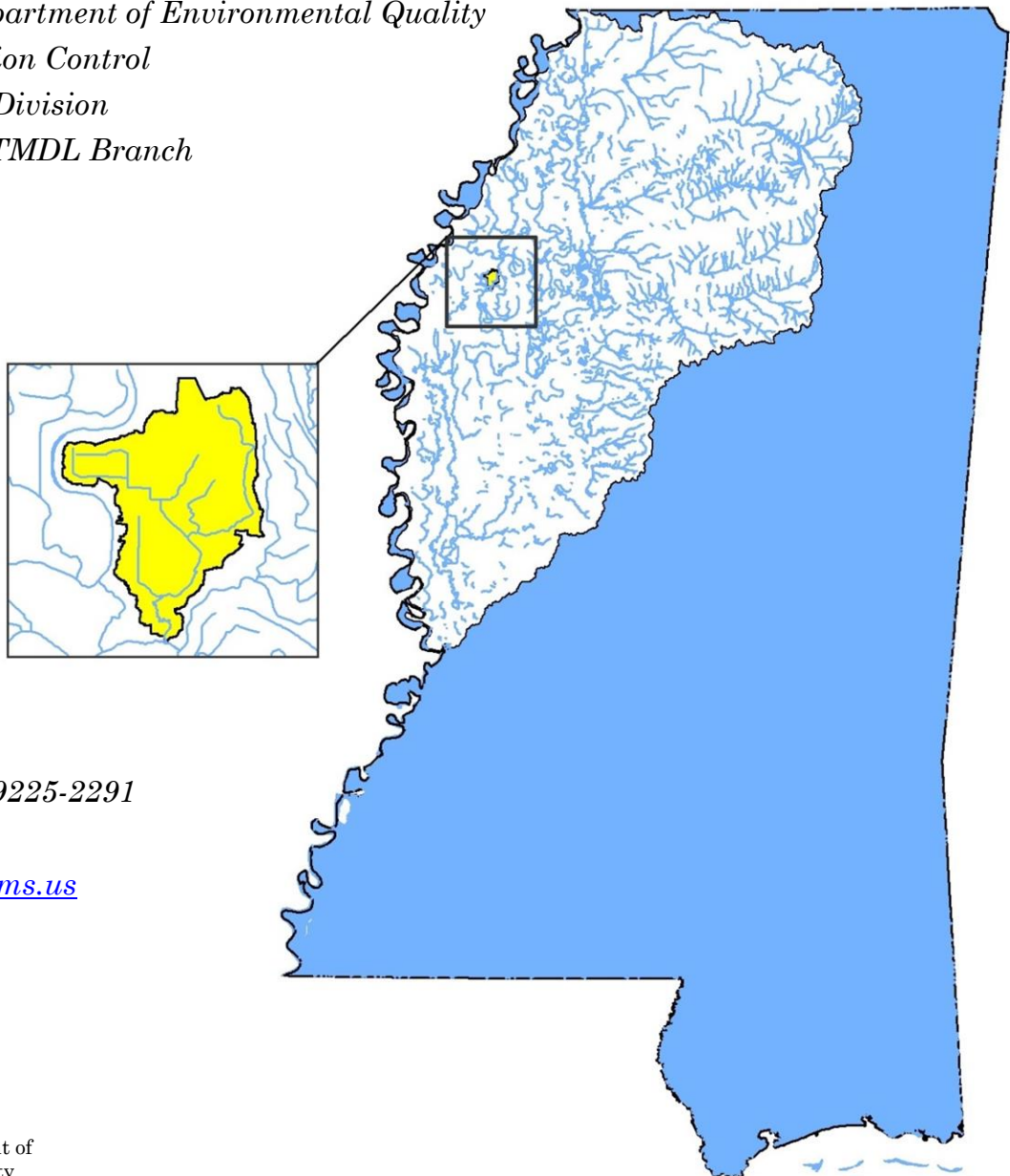


Organic Enrichment / Low DO TMDL for Beaver Bayou Watershed

Yazoo River Basin
Bolivar and Sunflower Counties, Mississippi

Prepared By

*Mississippi Department of Environmental Quality
Office of Pollution Control
Surface Water Division
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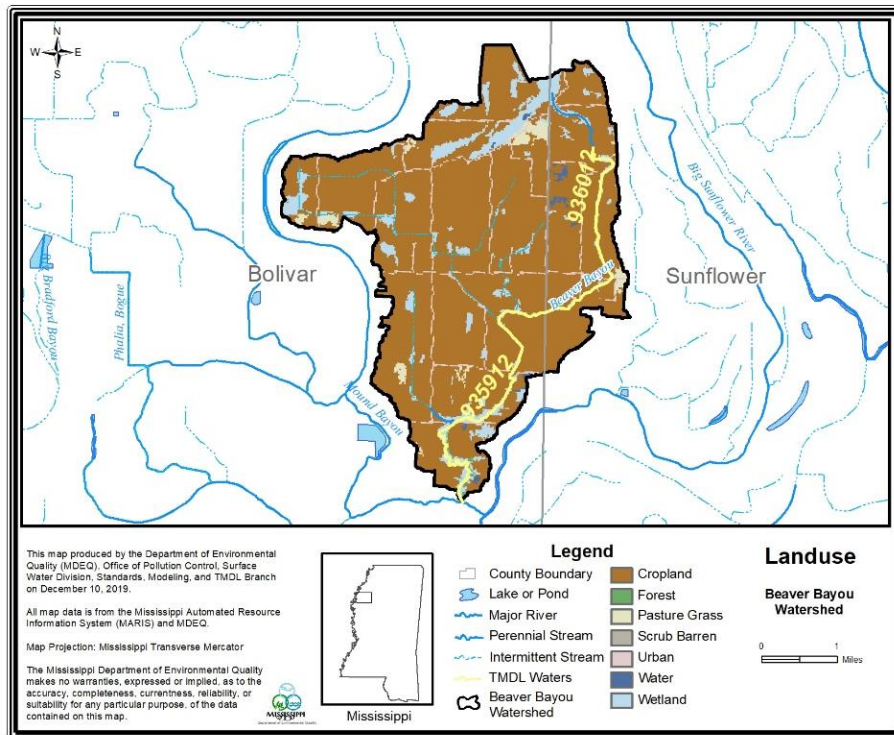


Mississippi Department of
Environmental Quality

TMDL Fact Sheet

Organic Enrichment / Low Dissolved Oxygen TMDL For Beaver Bayou Watershed

Beaver Bayou is located east of Mound Bayou, Mississippi. There are no NPDES point sources in the watershed. The landuse of the watershed is predominantly agriculture (84.8%). MDEQ collected water quality data in 2007 and 2008, which indicated an impairment of the dissolved oxygen water quality. This report prescribes the Total Maximum Daily Load (TMDL) of the combined point source and non-point source loadings that will still meet the dissolved oxygen standard.



	Point Source Load (lbs/day)	Non- Point Source Load (lbs/day)
CBOD _u	0	16.73
NBOD _u	0	10.47
Total TMDL	0	27.20

The TMDL prescribes a **60.4% reduction** of loading in order to meet the dissolved oxygen water quality standard, based on the STREAM model. Best management practices are encouraged to reduce loads from leaving the agricultural fields.

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EXECUTIVE SUMMARY

Beaver Bayou is a Mississippi Delta stream located east of Drew, Mississippi in Sunflower County in Figure1, and listing information in Table 1. The length of the water body is approximately 11.5 miles from the headwaters to the Quiver River. There are no NPDES permitted point sources or MS4s in the watershed. The landuse of the watershed is predominantly (84.8%) agriculture.

Table 1 Listing Information

Name	ID	County	Impaired Use	Impairment
Beaver Bayou	935912/ 936012	Sunflower	Fish and Wildlife	Organic Enrichment / Low Dissolved Oxygen

MDEQ collected water quality monitoring data in 2007 and 2008 which indicate impairment of the dissolved oxygen water quality standard. This TMDL will provide an allocation for TBODu for the watershed to meet the current water quality standard shown in Table 2. According to the data, the TBODu load in the water body exceeds the assimilative capacity of Beaver Bayou for organic material at critical conditions. Therefore, either reductions in TBODu are required, or the designated use classification of the stream could be modified.

Table 2 Water Quality Standards

Parameter	Beneficial use	Water Quality Criteria
Dissolved Oxygen	Aquatic Life Support	DO concentrations shall be maintained at a daily average of not less than 5.0 mg/l with an instantaneous minimum of not less than 4.0 mg/l

MDEQ has modeled this water body with the STREAM model to determine the reductions needed for this Delta stream to meet the water quality standards. MDEQ may also consider modification of the water quality standard of this and similar Delta streams based in part on this analysis.

Changes to water quality standards would require Commission Action, public review, and EPA approval. This document will inform that process should MDEQ proceed toward water quality standards modification.

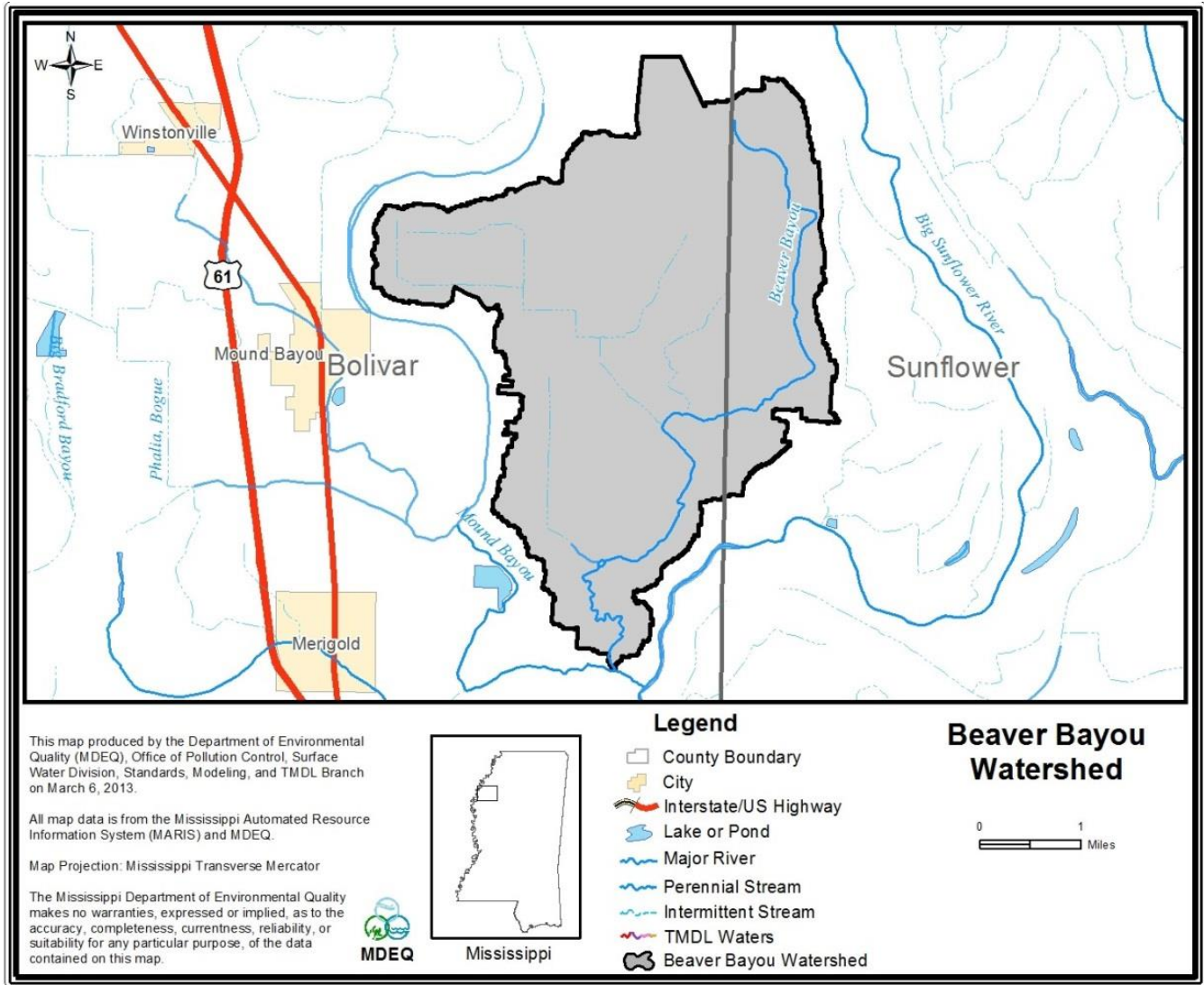


Figure 1 Beaver Bayou Watershed

INTRODUCTION

1.1 Background

The identification of water bodies not meeting their designated use and the development of total maximum daily loads (TMDLs) for those water bodies are required by Section 303(d) of the Clean Water Act and the Environmental Protection Agency's (EPA) Water Quality Planning and Management Regulations (40 CFR part 130). The TMDL process is designed to identify impairment and restoration alternatives, and maintain the quality of those impaired water bodies through the establishment of pollutant specific allowable loads. This TMDL is for the 2018 §303(d) listed segments shown in Figure 2. The impaired segments of 935912 and 936012 in stream are shown in the figure.

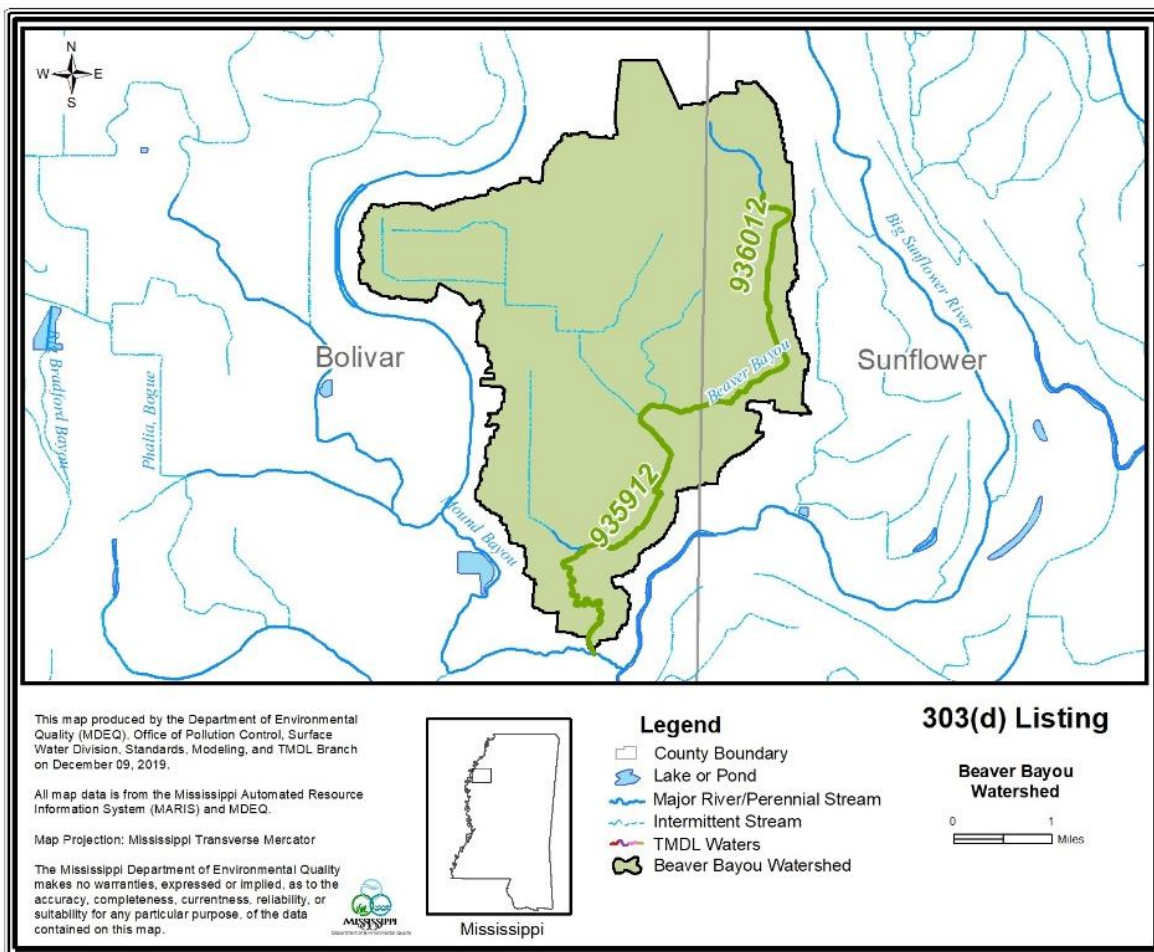


Figure 2 Beaver Bayou Impaired Segment

1.2 Listing History

The impaired segment is listed on the 2018 Section 303(d) List of Impaired Water Bodies. The organic enrichment / low dissolved oxygen impairment was assessed based on diel DO data collected during a water quality study on Beaver Bayou in 2007. There are also 4 quarterly grab samples from the 2008 Nutrient Monitoring Study available for this study.

1.3 Applicable Water Body Segment Use

The water use classifications are established by the State of Mississippi in the document *11 Mississippi Administration Code Part 6, Chapter 2 (MDEQ 2016)*. The designated beneficial use for the listed segment is fish and wildlife, with natural conditions being seen in Figure 3.



Figure 3 Beaver Bayou

1.4 Applicable Water Body Segment Standard

The water quality standard applicable to the use of the water body and the pollutant of concern is defined in the *11 Mississippi Administration Code Part 6, Chapter 2 (MDEQ 2016)*.

The applicable standard specifies:

"Dissolved Oxygen: Dissolved oxygen concentrations shall be maintained at a daily average of not less than 5.0 mg/l with an instantaneous minimum of not less than 4.0 mg/l. When possible, samples should be taken from ambient sites according to the following guidelines:

For water bodies that are not stratified, samples should be taken: At mid-depth if the total water column depth is 10 feet or less. At 5 feet from the water surface if the total water column depth is greater than 10 feet.

For water bodies that are stratified, samples should be taken: At mid-depth of the epilimnion if the epilimnion depth is 10 feet or less; At 5 feet from the water surface if the epilimnion depth is greater than 10 feet."

This TMDL will investigate the natural condition clause within Admin Code pt. 6 to consider the site specific modification of the designated use for this stream. It may be feasible to modify the water quality standards for dissolved oxygen based on the natural dissolved oxygen levels found in this stream. The natural conditions statement says:

"Natural conditions are defined as background water quality conditions due only to non-anthropogenic sources. The criteria herein apply specifically with regard to substances attributed to sources (discharges, nonpoint sources, or instream activities) as opposed to natural phenomena. Waters may naturally have characteristics outside the limits established by these criteria. Therefore, naturally occurring conditions that fail to meet criteria should not be interpreted as violations of these criteria."

WATER BODY ASSESSMENT

2.1 Beaver Bayou Water Quality Data

Water quality data for Beaver Bayou was gathered in 2007 and 2008. According to the collected data this water body was not supporting the use of aquatic life and indicates an impairment of dissolved oxygen (DO). This conclusion was based on data collected at station A1330007 Delta Nutrient Project 2007 (Brooks Road near Drew). The data is shown in Tables 3 and 4; and Figures 4, 5, and 6.

Table 3 Water Quality Data

Date	Time	Temp	pH	Sp Cond	DO % sat	DO mg/l
6/27/2013	17:00:00	33.37	7.84	543	143.7	10.23
6/27/2013	17:15:00	33.29	7.83	543	139.4	9.93
6/27/2013	17:30:00	33.21	7.82	543	136.7	9.76
6/27/2013	17:45:00	33.16	7.81	544	133.4	9.53
6/27/2013	18:00:00	33.11	7.8	544	130.2	9.31
6/27/2013	18:15:00	33.04	7.8	543	125.9	9.01
6/27/2013	18:30:00	32.97	7.79	543	122.1	8.75
6/27/2013	18:45:00	32.92	7.78	544	119.1	8.54
6/27/2013	19:00:00	32.85	7.77	543	114.6	8.23
6/27/2013	19:15:00	32.8	7.77	543	112.3	8.07
6/27/2013	19:30:00	32.76	7.76	543	109.1	7.84
6/27/2013	19:45:00	32.69	7.75	543	105.2	7.57
6/27/2013	20:00:00	32.64	7.74	543	101.8	7.34
6/27/2013	20:15:00	32.57	7.73	543	98	7.07
6/27/2013	20:30:00	32.51	7.72	543	94.1	6.8
6/27/2013	20:45:00	32.45	7.71	543	90.6	6.55
6/27/2013	21:00:00	32.38	7.7	542	86.7	6.28
6/27/2013	21:15:00	32.27	7.69	542	82	5.95
6/27/2013	21:30:00	31.92	7.68	540	79.4	5.79
6/27/2013	21:45:00	31.7	7.69	534	77.4	5.67
6/27/2013	22:00:00	31.56	7.68	535	72.5	5.32
6/27/2013	22:15:00	31.36	7.67	534	70.2	5.17
6/27/2013	22:30:00	31.28	7.65	534	65.7	4.84

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6/27/2013	22:45:00	31.17	7.63	534	61.5	4.54
6/27/2013	23:00:00	31.01	7.63	533	60.2	4.46
6/27/2013	23:15:00	30.87	7.64	531	58.6	4.35
6/27/2013	23:30:00	30.7	7.63	528	56.4	4.2
6/27/2013	23:45:00	30.56	7.63	527	53.8	4.02
6/28/2013	0:00:00	30.48	7.62	528	52.1	3.9
6/28/2013	0:15:00	30.4	7.61	528	50.5	3.78
6/28/2013	0:30:00	30.37	7.61	529	49.7	3.72
6/28/2013	0:45:00	30.3	7.6	529	48.6	3.64
6/28/2013	1:00:00	30.25	7.59	527	47.5	3.56
6/28/2013	1:15:00	30.16	7.58	528	46.1	3.46
6/28/2013	1:30:00	30.07	7.57	527	44.3	3.34
6/28/2013	1:45:00	29.96	7.56	529	42.3	3.19
6/28/2013	2:00:00	29.87	7.56	530	40.4	3.05
6/28/2013	2:15:00	29.73	7.55	531	39.5	2.99
6/28/2013	2:30:00	29.61	7.54	533	38.6	2.93
6/28/2013	2:45:00	29.48	7.54	534	37.3	2.83
6/28/2013	3:00:00	29.24	7.53	538	36.6	2.8
6/28/2013	3:15:00	29.02	7.52	540	36.1	2.77
6/28/2013	3:30:00	28.78	7.52	541	35.3	2.72
6/28/2013	3:45:00	28.56	7.52	541	35.2	2.72
6/28/2013	4:00:00	28.33	7.52	541	34.7	2.69
6/28/2013	4:15:00	28.16	7.52	540	33.9	2.64
6/28/2013	4:30:00	28.01	7.52	539	33.6	2.62
6/28/2013	4:45:00	27.81	7.52	536	32.9	2.57
6/28/2013	5:00:00	27.67	7.52	534	32.7	2.57
6/28/2013	5:15:00	27.55	7.52	532	32.2	2.54
6/28/2013	5:30:00	27.43	7.53	530	32.1	2.53
6/28/2013	5:45:00	27.34	7.53	529	31.5	2.49
6/28/2013	6:00:00	27.27	7.52	527	30.9	2.44
6/28/2013	6:15:00	27.21	7.53	525	30.7	2.43
6/28/2013	6:30:00	27.17	7.53	524	29.7	2.36
6/28/2013	6:45:00	27.14	7.53	523	29.5	2.34
6/28/2013	7:00:00	27.14	7.53	523	29.2	2.31

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6/28/2013	7:15:00	27.16	7.53	523	29	2.3
6/28/2013	7:30:00	27.2	7.54	523	28.4	2.24
6/28/2013	7:45:00	27.26	7.54	524	28.3	2.24
6/28/2013	8:00:00	27.34	7.54	525	28.6	2.26
6/28/2013	8:15:00	27.43	7.55	526	29.1	2.29
6/28/2013	8:30:00	27.54	7.56	526	29.2	2.3
6/28/2013	8:45:00	27.64	7.56	527	29.7	2.33
6/28/2013	9:00:00	27.78	7.57	527	30.7	2.41
6/28/2013	9:15:00	27.89	7.57	528	30.9	2.41
6/28/2013	9:30:00	28	7.57	528	31.3	2.44
6/28/2013	9:45:00	28.08	7.57	527	31.8	2.48
6/28/2013	10:00:00	28.19	7.58	527	33.8	2.63
6/28/2013	10:15:00	28.29	7.59	527	35.9	2.78
6/28/2013	10:30:00	28.39	7.59	526	38.5	2.98
6/28/2013	10:45:00	28.49	7.6	527	42.3	3.28
6/28/2013	11:00:00	28.63	7.62	526	48	3.71
6/28/2013	11:15:00	28.83	7.63	528	53.8	4.13
6/28/2013	11:30:00	28.97	7.65	528	59.7	4.58
6/28/2013	11:45:00	29.2	7.67	527	66.6	5.09
6/28/2013	12:00:00	29.4	7.69	527	73.7	5.61
6/28/2013	12:15:00	29.66	7.71	525	81.1	6.15
6/28/2013	12:30:00	29.92	7.72	524	89	6.71
6/28/2013	12:45:00	30.19	7.74	522	96	7.22
6/28/2013	13:00:00	30.46	7.76	520	102.9	7.7
6/28/2013	13:15:00	30.68	7.78	518	107.9	8.04
6/28/2013	13:30:00	30.91	7.79	516	113.6	8.43
6/28/2013	13:45:00	31.12	7.8	514	117.5	8.69
6/28/2013	14:00:00	31.33	7.82	512	122.4	9.02
6/28/2013	14:15:00	31.52	7.82	511	126.2	9.26
6/28/2013	14:30:00	31.69	7.83	509	128.8	9.43
6/28/2013	14:45:00	31.85	7.84	507	131.9	9.63
6/28/2013	15:00:00	31.99	7.85	505	135	9.83
6/28/2013	15:15:00	32.09	7.86	504	136.5	9.93
6/28/2013	15:30:00	32.18	7.87	502	137.6	9.99

Organic Enrichment / Low DO TMDL for Beaver Bayou Watershed

6/28/2013	15:45:00	32.21	7.87	501	137.1	9.95
6/28/2013	16:00:00	32.15	7.87	500	134.7	9.79
6/28/2013	16:15:00	32.09	7.86	499	131.8	9.59
6/28/2013	16:30:00	32.03	7.86	499	129	9.39
6/28/2013	16:45:00	31.96	7.86	498	127	9.26
6/28/2013	17:00:00	31.9	7.85	498	123.9	9.04
6/28/2013	17:15:00	31.87	7.85	498	120.7	8.81
6/28/2013	17:30:00	31.84	7.84	498	118	8.62
6/28/2013	17:45:00	31.83	7.84	498	116.7	8.52
6/28/2013	18:00:00	31.82	7.84	497	112.8	8.24
6/28/2013	18:15:00	31.81	7.84	497	111.3	8.13
6/28/2013	18:30:00	31.77	7.83	497	108.9	7.96
6/28/2013	18:45:00	31.75	7.82	498	106.3	7.78
6/28/2013	19:00:00	31.71	7.81	498	102.8	7.52
6/28/2013	19:15:00	31.68	7.8	499	100.3	7.35
6/28/2013	19:30:00	31.63	7.79	498	96.7	7.09
6/28/2013	19:45:00	31.59	7.78	500	93	6.82
6/28/2013	20:00:00	31.55	7.75	500	90	6.6
6/28/2013	20:15:00	31.49	7.75	501	86.4	6.35
6/28/2013	20:30:00	31.41	7.74	501	83.1	6.11
6/28/2013	20:45:00	31.34	7.72	501	78.3	5.77
6/28/2013	21:00:00	31.24	7.71	501	76.6	5.65
6/28/2013	21:15:00	31.14	7.7	501	73.7	5.45
6/28/2013	21:30:00	31.05	7.69	501	71.1	5.26
6/28/2013	21:45:00	30.95	7.68	501	67.9	5.04
6/28/2013	22:00:00	30.84	7.66	500	65.7	4.88
6/28/2013	22:15:00	30.74	7.65	500	63.4	4.72
6/28/2013	22:30:00	30.64	7.64	500	61.4	4.58
6/28/2013	22:45:00	30.53	7.63	499	58	4.33
6/28/2013	23:00:00	30.43	7.63	498	57.9	4.34
6/28/2013	23:15:00	30.31	7.62	499	55.9	4.19
6/28/2013	23:30:00	30.2	7.62	498	54.9	4.13
6/28/2013	23:45:00	30.09	7.61	497	53	3.99
6/29/2013	0:00:00	29.97	7.6	499	52	3.92

Organic Enrichment / Low DO TMDL for Beaver Bayou Watershed

6/29/2013	0:15:00	29.86	7.6	499	51	3.85
6/29/2013	0:30:00	29.75	7.6	500	49.5	3.75
6/29/2013	0:45:00	29.63	7.59	494	48.8	3.7
6/29/2013	1:00:00	29.52	7.59	498	47.3	3.6
6/29/2013	1:15:00	29.4	7.59	499	46.2	3.52
6/29/2013	1:30:00	29.3	7.58	500	45.2	3.45
6/29/2013	1:45:00	29.19	7.58	498	44.4	3.39
6/29/2013	2:00:00	29.09	7.58	498	43.2	3.31
6/29/2013	2:15:00	29	7.57	499	42.3	3.24
6/29/2013	2:30:00	28.91	7.57	499	41.4	3.18
6/29/2013	2:45:00	28.82	7.57	499	40.8	3.14
6/29/2013	3:00:00	28.74	7.57	499	40.7	3.13
6/29/2013	3:15:00	28.67	7.56	499	39.9	3.07
6/29/2013	3:30:00	28.59	7.56	499	39.4	3.04
6/29/2013	3:45:00	28.52	7.55	499	38.6	2.99
6/29/2013	4:00:00	28.44	7.56	498	37.7	2.92
6/29/2013	4:15:00	28.36	7.56	499	38.3	2.97
6/29/2013	4:30:00	28.28	7.55	499	37.7	2.93
6/29/2013	4:45:00	28.22	7.55	494	36.7	2.86
6/29/2013	5:00:00	28.16	7.55	500	36.4	2.83
6/29/2013	5:15:00	28.09	7.55	501	35.9	2.79
6/29/2013	5:30:00	28.02	7.54	501	35.4	2.76
6/29/2013	5:45:00	27.95	7.54	501	35.3	2.75
6/29/2013	6:00:00	27.88	7.54	502	35.2	2.75
6/29/2013	6:15:00	27.8	7.54	504	34.7	2.72
6/29/2013	6:30:00	27.74	7.55	505	35.1	2.76
6/29/2013	6:45:00	27.67	7.54	506	33.8	2.65
6/29/2013	7:00:00	27.6	7.54	507	35	2.75
6/29/2013	7:15:00	27.52	7.54	509	34.9	2.74
6/29/2013	7:30:00	27.42	7.55	511	35.2	2.77
6/29/2013	7:45:00	27.36	7.56	513	35.5	2.8
6/29/2013	8:00:00	27.31	7.55	514	36.2	2.86
6/29/2013	8:15:00	27.24	7.56	515	36.8	2.91
6/29/2013	8:30:00	27.18	7.57	519	37.5	2.97

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6/29/2013	8:45:00	27.15	7.58	520	38.8	3.07
6/29/2013	9:00:00	27.14	7.58	522	40	3.17
6/29/2013	9:15:00	27.15	7.59	524	41.4	3.28
6/29/2013	9:30:00	27.19	7.6	526	43.6	3.46
6/29/2013	9:45:00	27.22	7.6	528	45.8	3.62
6/29/2013	10:00:00	27.28	7.61	527	48	3.79
6/29/2013	10:15:00	27.37	7.62	529	50.3	3.97
6/29/2013	10:30:00	27.45	7.62	532	53	4.18
6/29/2013	10:45:00	27.61	7.63	533	56.9	4.47
6/29/2013	11:00:00	27.81	7.65	534	61.7	4.84
6/29/2013	11:15:00	28.05	7.66	534	67.5	5.26
6/29/2013	11:30:00	28.29	7.67	534	73.3	5.69
6/29/2013	11:45:00	28.57	7.69	535	79.9	6.17
6/29/2013	12:00:00	28.83	7.69	534	84.9	6.53
6/29/2013	12:15:00	29.07	7.71	533	90	6.89
6/29/2013	12:30:00	29.32	7.72	533	95.3	7.26
6/29/2013	12:45:00	29.51	7.73	531	98.7	7.51
6/29/2013	13:00:00	29.72	7.73	531	102.5	7.76
6/29/2013	13:15:00	29.88	7.74	530	105.4	7.96
6/29/2013	13:30:00	30.09	7.74	528	110	8.28
6/29/2013	13:45:00	30.3	7.74	527	115.2	8.64
6/29/2013	14:00:00	30.51	7.74	524	118.6	8.86
6/29/2013	14:15:00	30.77	7.74	521	123.2	9.16
6/29/2013	14:30:00	30.98	7.74	520	127	9.41
6/29/2013	14:45:00	31.25	7.74	517	130.8	9.65
6/29/2013	15:00:00	31.45	7.74	514	133.1	9.79
6/29/2013	15:15:00	31.62	7.74	507	134.4	9.85
6/29/2013	15:30:00	31.76	7.73	505	135.9	9.94
6/29/2013	15:45:00	31.8	7.72	500	135.4	9.89
6/29/2013	16:00:00	31.83	7.7	495	133.6	9.76
6/29/2013	16:15:00	31.77	7.69	491	131.4	9.61
6/29/2013	16:30:00	31.68	7.68	487	128.1	9.38
6/29/2013	16:45:00	31.54	7.66	483	122.6	9
6/29/2013	17:00:00	31.37	7.63	479	118.3	8.71

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6/29/2013	17:15:00	31.19	7.62	476	113	8.35
6/29/2013	17:30:00	31.06	7.59	473	108.5	8.03
6/29/2013	17:45:00	30.97	7.58	469	105.6	7.83
6/29/2013	18:00:00	30.86	7.56	467	101.6	7.55
6/29/2013	18:15:00	30.74	7.55	464	98.3	7.32
6/29/2013	18:30:00	30.64	7.54	463	94.5	7.05
6/29/2013	18:45:00	30.55	7.52	462	90.6	6.78
6/29/2013	19:00:00	30.43	7.51	461	88	6.59
6/29/2013	19:15:00	30.28	7.49	460	84	6.3
6/29/2013	19:30:00	30.15	7.48	460	80.5	6.05
6/29/2013	19:45:00	30	7.47	460	77.6	5.85
6/29/2013	20:00:00	29.88	7.46	461	74.5	5.63
6/29/2013	20:15:00	29.74	7.45	462	71.5	5.42
6/29/2013	20:30:00	29.61	7.44	462	69.8	5.3
6/29/2013	20:45:00	29.45	7.44	463	68.1	5.18
6/29/2013	21:00:00	29.3	7.43	460	66.4	5.07
6/29/2013	21:15:00	29.13	7.43	465	64.7	4.95
6/29/2013	21:30:00	28.96	7.43	466	63.7	4.89
6/29/2013	21:45:00	28.77	7.42	469	62.1	4.78
6/29/2013	22:00:00	28.58	7.43	470	60.9	4.71
6/29/2013	22:15:00	28.39	7.43	472	59.9	4.64
6/29/2013	22:30:00	28.18	7.43	473	59.3	4.62
6/29/2013	22:45:00	27.96	7.43	477	58.3	4.56
6/29/2013	23:00:00	27.74	7.44	479	56.3	4.41
6/29/2013	23:15:00	27.54	7.44	482	56.3	4.43
6/29/2013	23:30:00	27.32	7.45	484	55.1	4.36
6/29/2013	23:45:00	27.1	7.45	485	54.8	4.34
6/30/2013	0:00:00	26.9	7.46	488	54.3	4.33
6/30/2013	0:15:00	26.7	7.46	489	53.5	4.27
6/30/2013	0:30:00	26.53	7.47	491	53.4	4.28
6/30/2013	0:45:00	26.36	7.47	490	48.8	3.93
6/30/2013	1:00:00	26.21	7.48	495	52.1	4.2
6/30/2013	1:15:00	26.06	7.48	497	52.8	4.27
6/30/2013	1:30:00	25.92	7.49	498	53.1	4.3

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6/30/2013	1:45:00	25.8	7.49	499	52.6	4.27
6/30/2013	2:00:00	25.66	7.5	500	52.6	4.28
6/30/2013	2:15:00	25.55	7.5	502	52.7	4.3
6/30/2013	2:30:00	25.45	7.51	503	52.5	4.29
6/30/2013	2:45:00	25.35	7.51	505	52.3	4.28
6/30/2013	3:00:00	25.26	7.51	506	52.3	4.29
6/30/2013	3:15:00	25.18	7.52	506	52.2	4.29
6/30/2013	3:30:00	25.07	7.52	505	52.1	4.28
6/30/2013	3:45:00	24.98	7.53	503	50.1	4.13
6/30/2013	4:00:00	24.89	7.53	509	52.4	4.32
6/30/2013	4:15:00	24.78	7.53	510	52.2	4.32
6/30/2013	4:30:00	24.67	7.54	512	52.2	4.33
6/30/2013	4:45:00	24.58	7.54	513	51.9	4.31
6/30/2013	5:00:00	24.48	7.55	515	52.1	4.33
6/30/2013	5:15:00	24.38	7.55	514	51.8	4.32
6/30/2013	5:30:00	24.3	7.55	516	52	4.34
6/30/2013	5:45:00	24.22	7.56	514	51.9	4.34
6/30/2013	6:00:00	24.14	7.56	519	52	4.36
6/30/2013	6:15:00	24.05	7.57	518	52.4	4.4
6/30/2013	6:30:00	23.99	7.57	521	52	4.37
6/30/2013	6:45:00	23.93	7.57	522	51.7	4.35
6/30/2013	7:00:00	23.87	7.57	522	52.6	4.42
6/30/2013	7:15:00	23.82	7.58	521	52.3	4.41
6/30/2013	7:30:00	23.78	7.58	521	52.9	4.46
6/30/2013	7:45:00	23.74	7.58	521	53.2	4.49
6/30/2013	8:00:00	23.7	7.58	520	53.8	4.54
6/30/2013	8:15:00	23.68	7.59	520	54.1	4.57
6/30/2013	8:30:00	23.67	7.59	519	54	4.56
6/30/2013	8:45:00	23.65	7.59	519	54.9	4.64
6/30/2013	9:00:00	23.67	7.59	518	55.1	4.66
6/30/2013	9:15:00	23.71	7.6	517	56.2	4.74
6/30/2013	9:30:00	23.78	7.6	517	57.7	4.87
6/30/2013	9:45:00	23.86	7.6	516	59	4.97
6/30/2013	10:00:00	23.99	7.6	514	61.1	5.13

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6/30/2013	10:15:00	24.13	7.61	512	62.6	5.24
6/30/2013	10:30:00	24.35	7.61	509	64.8	5.4
6/30/2013	10:45:00	24.65	7.62	504	67.7	5.61
6/30/2013	11:00:00	24.98	7.63	500	71.7	5.91
6/30/2013	11:15:00	25.3	7.63	495	75.2	6.16
6/30/2013	11:30:00	25.69	7.65	490	80.4	6.54
6/30/2013	11:45:00	26.07	7.66	486	84.3	6.81
6/30/2013	12:00:00	26.38	7.67	482	87.2	7
6/30/2013	12:15:00	26.71	7.68	478	91.7	7.33
6/30/2013	12:30:00	27.01	7.69	475	95.1	7.56
6/30/2013	12:45:00	27.28	7.71	473	97.7	7.72
6/30/2013	13:00:00	27.52	7.72	470	100.7	7.93
6/30/2013	13:15:00	27.75	7.74	468	103.2	8.09
6/30/2013	13:30:00	28.06	7.75	466	107.5	8.38
6/30/2013	13:45:00	28.35	7.77	464	110.8	8.6
6/30/2013	14:00:00	28.56	7.78	463	114.3	8.84
6/30/2013	14:15:00	28.73	7.8	462	114.9	8.86
6/30/2013	14:30:00	28.94	7.81	460	117.4	9.01
6/30/2013	14:45:00	29.05	7.82	460	120	9.2
6/30/2013	15:00:00	29.23	7.84	458	121.4	9.28
6/30/2013	15:15:00	29.4	7.85	458	123.6	9.41
6/30/2013	15:30:00	29.61	7.86	454	125.7	9.54
6/30/2013	15:45:00	29.72	7.87	457	126.1	9.55
6/30/2013	16:00:00	29.81	7.86	453	125.7	9.51
6/30/2013	16:15:00	29.85	7.87	458	125.5	9.48
6/30/2013	16:30:00	29.92	7.87	459	124.8	9.42
6/30/2013	16:45:00	29.9	7.85	460	123.1	9.3
6/30/2013	17:00:00	29.86	7.86	460	120.7	9.12
6/30/2013	17:15:00	29.77	7.85	462	117.5	8.89
6/30/2013	17:30:00	29.7	7.85	464	113.9	8.63
6/30/2013	17:45:00	29.62	7.84	465	111.2	8.46
6/30/2013	18:00:00	29.59	7.85	465	109.2	8.29
6/30/2013	18:15:00	29.54	7.84	468	106.8	8.12
6/30/2013	18:30:00	29.54	7.84	470	105.7	8.03

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6/30/2013	18:45:00	29.51	7.83	472	102.1	7.77
6/30/2013	19:00:00	29.46	7.82	474	100.8	7.67
6/30/2013	19:15:00	29.36	7.81	476	97.7	7.44
6/30/2013	19:30:00	29.27	7.8	478	94.3	7.2
6/30/2013	19:45:00	29.2	7.8	480	91.1	6.96
6/30/2013	20:00:00	29.13	7.8	482	88.1	6.74
6/30/2013	20:15:00	29.06	7.79	480	85.5	6.55
6/30/2013	20:30:00	28.97	7.77	487	82.3	6.32
6/30/2013	20:45:00	28.88	7.76	489	79.1	6.08
6/30/2013	21:00:00	28.77	7.75	490	75.6	5.82
6/30/2013	21:15:00	28.68	7.74	492	72	5.55
6/30/2013	21:30:00	28.58	7.73	494	70.5	5.45
6/30/2013	21:45:00	28.5	7.72	496	67.2	5.2
6/30/2013	22:00:00	28.39	7.71	497	64.8	5.03
6/30/2013	22:15:00	28.28	7.7	499	62.4	4.85
6/30/2013	22:30:00	28.2	7.68	485	59.4	4.62
6/30/2013	22:45:00	28.11	7.69	501	58.2	4.53
6/30/2013	23:00:00	28.02	7.69	503	55.8	4.35
6/30/2013	23:15:00	27.92	7.69	504	54.7	4.28
6/30/2013	23:30:00	27.82	7.66	504	53.1	4.16
6/30/2013	23:45:00	27.73	7.68	506	51.6	4.05
7/1/2013	0:00:00	27.65	7.66	507	47.6	3.74
7/1/2013	0:15:00	27.57	7.67	508	48.9	3.84
7/1/2013	0:30:00	27.48	7.67	509	48	3.78
7/1/2013	0:45:00	27.4	7.65	510	46.9	3.7
7/1/2013	1:00:00	27.3	7.67	510	45.4	3.58
7/1/2013	1:15:00	27.21	7.67	511	44.9	3.55
7/1/2013	1:30:00	27.13	7.66	512	44.1	3.49
7/1/2013	1:45:00	27.04	7.67	513	43.1	3.42
7/1/2013	2:00:00	26.94	7.66	513	41.6	3.31
7/1/2013	2:15:00	26.86	7.66	514	37.4	2.98
7/1/2013	2:30:00	26.76	7.65	515	39.9	3.18
7/1/2013	2:45:00	26.67	7.66	515	39.6	3.17
7/1/2013	3:00:00	26.58	7.65	515	38.9	3.11

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7/1/2013	3:15:00	26.48	7.65	516	37.3	2.99
7/1/2013	3:30:00	26.39	7.65	517	36.7	2.95
7/1/2013	3:45:00	26.28	7.65	517	35.4	2.85
7/1/2013	4:00:00	26.19	7.64	518	34.1	2.75
7/1/2013	4:15:00	26.07	7.64	518	32.5	2.63
7/1/2013	4:30:00	25.96	7.64	519	32.6	2.64
7/1/2013	4:45:00	25.92	7.64	519	31.8	2.58
7/1/2013	5:00:00	25.79	7.64	519	31.3	2.54
7/1/2013	5:15:00	25.67	7.64	517	30.3	2.46
7/1/2013	5:30:00	25.59	7.64	517	30.2	2.46
7/1/2013	5:45:00	25.5	7.64	519	27.9	2.28
7/1/2013	6:00:00	25.41	7.64	519	28.3	2.32
7/1/2013	6:15:00	25.31	7.64	518	27.2	2.23
7/1/2013	6:30:00	25.23	7.63	519	26.5	2.17
7/1/2013	6:45:00	25.16	7.63	518	24.6	2.02
7/1/2013	7:00:00	25.1	7.63	520	25.5	2.1
7/1/2013	7:15:00	25.03	7.63	518	24.6	2.03
7/1/2013	7:30:00	24.97	7.63	520	23.3	1.92
7/1/2013	7:45:00	24.92	7.62	517	24.5	2.02
7/1/2013	8:00:00	24.89	7.62	515	23.1	1.91
7/1/2013	8:15:00	24.85	7.62	519	22.4	1.85
7/1/2013	8:30:00	24.82	7.62	519	23	1.9
7/1/2013	8:45:00	24.81	7.62	516	21.5	1.78
7/1/2013	9:00:00	24.8	7.61	517	20.8	1.72
7/1/2013	9:15:00	24.82	7.61	518	21.3	1.76
7/1/2013	9:30:00	24.86	7.6	487	21.7	1.8
7/1/2013	9:45:00	24.91	7.61	520	23.1	1.9
7/1/2013	10:00:00	25.03	7.62	516	27.1	2.24
7/1/2013	10:15:00	25.14	7.61	517	28.6	2.35
7/1/2013	10:30:00	25.19	7.61	516	27.2	2.24
7/1/2013	10:45:00	25.32	7.62	517	30.9	2.53
7/1/2013	11:00:00	25.39	7.62	519	34.2	2.8
7/1/2013	11:15:00	25.51	7.62	517	36.3	2.96
7/1/2013	11:30:00	25.54	7.62	515	37	3.02

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7/1/2013	11:45:00	25.59	7.61	517	38	3.1
7/1/2013	12:00:00	25.76	7.64	517	44	3.57
7/1/2013	12:15:00	25.76	7.62	516	42.2	3.43
7/1/2013	12:30:00	26.05	7.65	517	52	4.2
7/1/2013	12:45:00	26.48	7.68	514	59.5	4.77
7/1/2013	13:00:00	26.43	7.67	515	60.8	4.88
7/1/2013	13:15:00	26.6	7.68	514	64.9	5.19
7/1/2013	13:30:00	26.89	7.71	513	72.4	5.77
7/1/2013	13:45:00	27.23	7.72	514	78.3	6.2
7/1/2013	14:00:00	27.24	7.71	514	79.2	6.27
7/1/2013	14:15:00	27.38	7.74	512	83.9	6.62
7/1/2013	14:30:00	27.53	7.74	512	86.6	6.82
7/1/2013	14:45:00	27.67	7.73	511	88.2	6.92
7/1/2013	15:00:00	27.88	7.77	510	94.9	7.42
7/1/2013	15:15:00	27.9	7.76	510	94.1	7.36
7/1/2013	15:30:00	27.91	7.75	507	96.7	7.56
7/1/2013	15:45:00	27.98	7.78	507	98	7.65
7/1/2013	16:00:00	27.97	7.78	507	99.6	7.78
7/1/2013	16:15:00	28.06	7.8	507	101.3	7.9
7/1/2013	16:30:00	28.18	7.8	506	103.3	8.04
7/1/2013	16:45:00	28.18	7.81	503	103.8	8.08
7/1/2013	17:00:00	28.15	7.79	505	101.2	7.88
7/1/2013	17:15:00	28.07	7.8	501	101.8	7.94
7/1/2013	17:30:00	28.13	7.8	504	98.6	7.68
7/1/2013	17:45:00	28.14	7.81	503	99.9	7.78
7/1/2013	18:00:00	28.14	7.8	503	96.7	7.53
7/1/2013	18:15:00	28.15	7.8	503	98.2	7.64
7/1/2013	18:30:00	28.14	7.8	502	97.1	7.56
7/1/2013	18:45:00	28.04	7.79	501	95.2	7.43
7/1/2013	19:00:00	27.96	7.78	501	92.6	7.23
7/1/2013	19:15:00	27.89	7.78	500	92.2	7.21
7/1/2013	19:30:00	27.83	7.78	499	90.8	7.11
7/1/2013	19:45:00	27.81	7.78	496	89.5	7.01
7/1/2013	20:00:00	27.76	7.78	496	88	6.9

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7/1/2013	20:15:00	27.71	7.78	497	87.9	6.9
7/1/2013	20:30:00	27.67	7.78	495	87.3	6.86
7/1/2013	20:45:00	27.65	7.79	494	86.4	6.79
7/1/2013	21:00:00	27.64	7.79	494	85.2	6.69
7/1/2013	21:15:00	27.63	7.78	494	81.8	6.43
7/1/2013	21:30:00	27.59	7.77	495	77.7	6.11
7/1/2013	21:45:00	27.47	7.75	488	73	5.75
7/1/2013	22:00:00	27.35	7.73	498	67.9	5.36
7/1/2013	22:15:00	27.23	7.7	500	63	4.98
7/1/2013	22:30:00	27.06	7.7	503	59.3	4.71
7/1/2013	22:45:00	26.89	7.69	505	55.6	4.43
7/1/2013	23:00:00	26.75	7.69	506	53.3	4.25
7/1/2013	23:15:00	26.59	7.67	494	49.7	3.98
7/1/2013	23:30:00	26.46	7.67	505	47.4	3.8
7/1/2013	23:45:00	26.33	7.66	507	44.8	3.6
7/2/2013	0:00:00	26.19	7.65	509	43.4	3.5
7/2/2013	0:15:00	26.07	7.65	508	40.1	3.24
7/2/2013	0:30:00	25.95	7.64	508	39.9	3.23
7/2/2013	0:45:00	25.83	7.65	507	38.5	3.13
7/2/2013	1:00:00	25.71	7.65	506	37.4	3.04
7/2/2013	1:15:00	25.63	7.65	504	37.1	3.02
7/2/2013	1:30:00	25.57	7.66	502	37.2	3.03
7/2/2013	1:45:00	25.54	7.64	499	37.3	3.05
7/2/2013	2:00:00	25.53	7.66	495	37.2	3.03
7/2/2013	2:15:00	25.51	7.66	497	37.9	3.09
7/2/2013	2:30:00	25.48	7.66	495	38.6	3.15
7/2/2013	2:45:00	25.47	7.66	496	36.8	3.01
7/2/2013	3:00:00	25.45	7.66	495	39.2	3.2
7/2/2013	3:15:00	25.41	7.66	497	39.1	3.2
7/2/2013	3:30:00	25.34	7.66	498	38.6	3.16
7/2/2013	3:45:00	25.3	7.66	500	38.5	3.15
7/2/2013	4:00:00	25.23	7.66	501	38.2	3.14
7/2/2013	4:15:00	25.14	7.67	502	37.9	3.11
7/2/2013	4:30:00	25.06	7.67	504	37.9	3.12

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7/2/2013	4:45:00	24.95	7.68	505	38.1	3.14
7/2/2013	5:00:00	24.85	7.69	506	39	3.22
7/2/2013	5:15:00	24.73	7.7	504	39.6	3.28
7/2/2013	5:30:00	24.62	7.7	507	40.9	3.39
7/2/2013	5:45:00	24.5	7.72	507	42.7	3.55
7/2/2013	6:00:00	24.39	7.72	507	44	3.67
7/2/2013	6:15:00	24.28	7.73	507	45.5	3.8
7/2/2013	6:30:00	24.2	7.74	506	46.8	3.92
7/2/2013	6:45:00	24.11	7.75	504	48	4.02
7/2/2013	7:00:00	24.04	7.75	507	48.9	4.1
7/2/2013	7:15:00	23.99	7.76	507	50	4.2
7/2/2013	7:30:00	23.95	7.76	507	51.6	4.34
7/2/2013	7:45:00	23.92	7.77	507	52.8	4.44
7/2/2013	8:00:00	23.91	7.78	506	54.1	4.55
7/2/2013	8:15:00	23.91	7.78	505	56	4.71
7/2/2013	8:30:00	23.92	7.79	504	56.9	4.79
7/2/2013	8:45:00	23.93	7.8	503	58.2	4.89
7/2/2013	9:00:00	23.96	7.8	501	59.5	5
7/2/2013	9:15:00	24	7.81	503	44.9	3.77
7/2/2013	9:30:00	24.07	7.81	501	62.5	5.24
7/2/2013	9:45:00	24.14	7.82	503	64.2	5.37
7/2/2013	10:00:00	24.22	7.82	504	66.4	5.55
7/2/2013	10:15:00	24.34	7.83	504	68.4	5.71
7/2/2013	10:30:00	24.47	7.84	502	71.5	5.95
7/2/2013	10:45:00	24.64	7.85	507	74.4	6.17
7/2/2013	11:00:00	24.81	7.86	509	78.1	6.46
7/2/2013	11:15:00	25	7.87	510	82	6.76
7/2/2013	11:30:00	25.21	7.88	512	86.3	7.08
7/2/2013	11:45:00	25.36	7.9	514	90.2	7.38
7/2/2013	12:00:00	25.6	7.91	516	94.2	7.68
7/2/2013	12:15:00	25.78	7.93	517	98	7.96

Table 4 Nutrient Data 2008

Date	TN, Ammonia Mg/L	Nitrite- Nitrate Mg/L	TKN Mg/L	TP Mg/L	Ortho Mg/L
09/11/2007 13:30	< MDL (0.04)	0.07	0.9	0.17	0.148
03/26/2008 15:00	< MDL (0.04)	0.07	1.32	0.08	0.049
07/08/2008 20:30	0.39	0.43	1.81	0.17	
09/24/2008 09:20	< MDL (0.04)	< MDL (0.02)	0.72	0.12	0.038

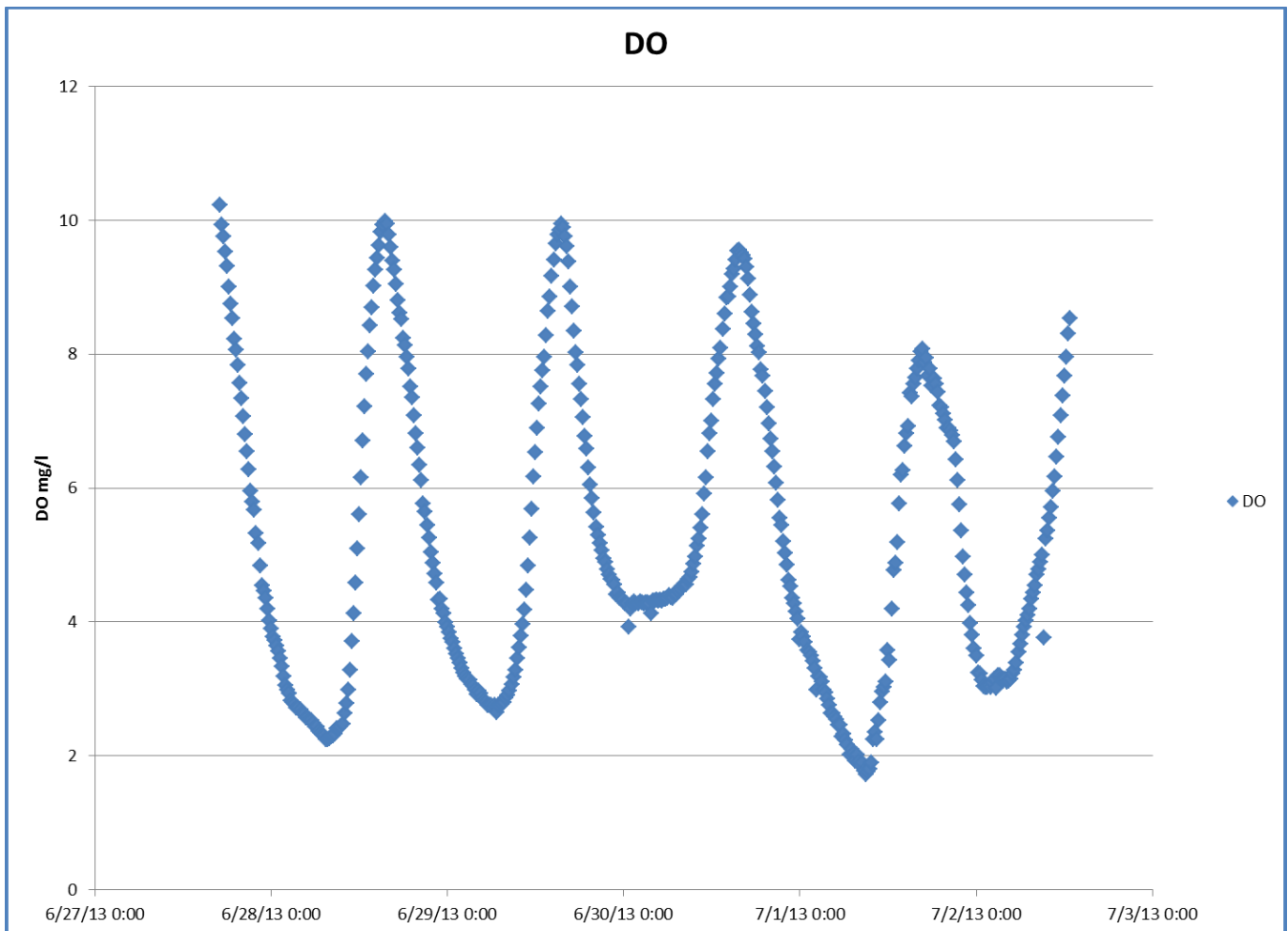


Figure 4 Diel DO Data

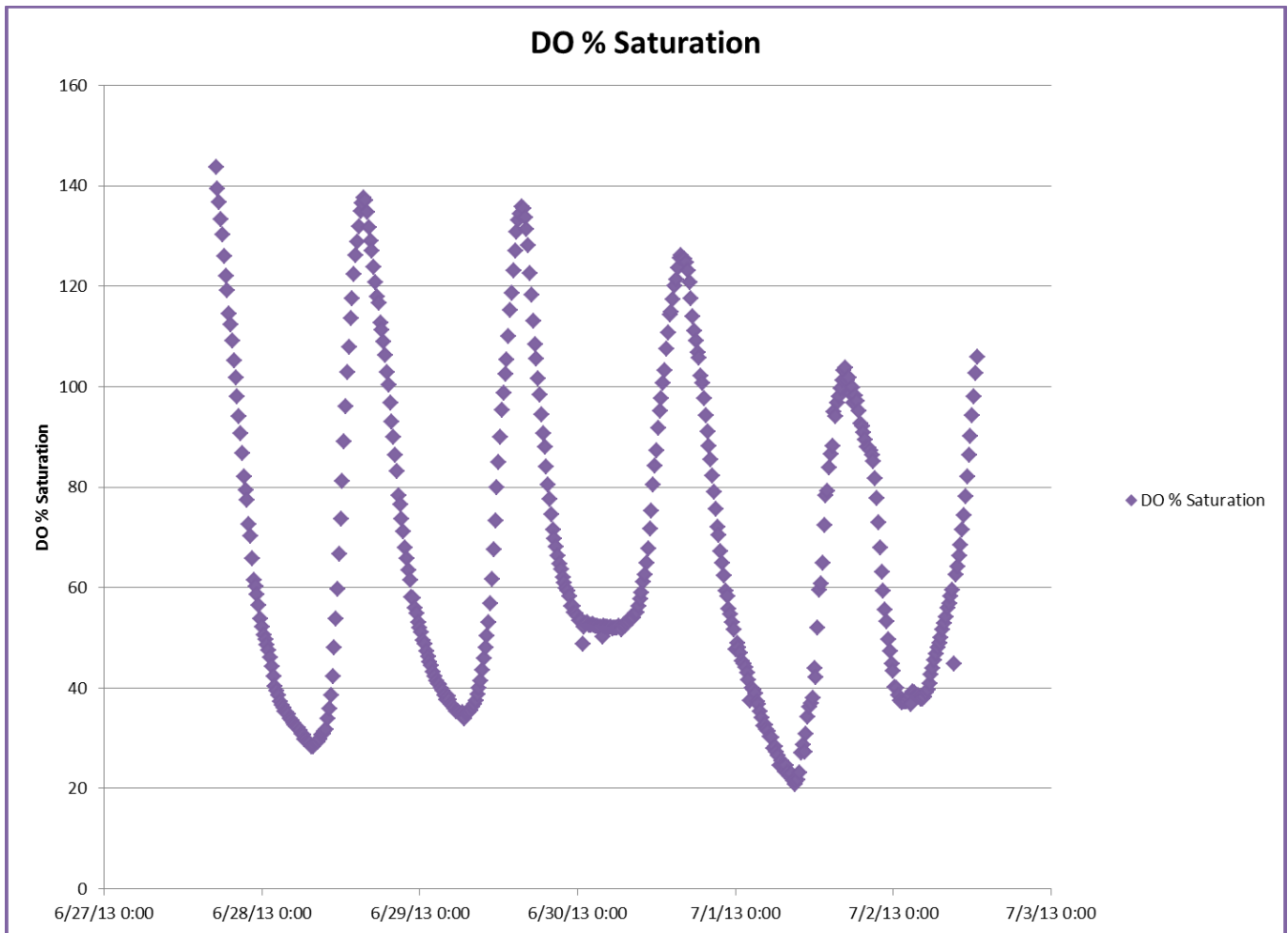


Figure 5 Diel DO Saturation Data

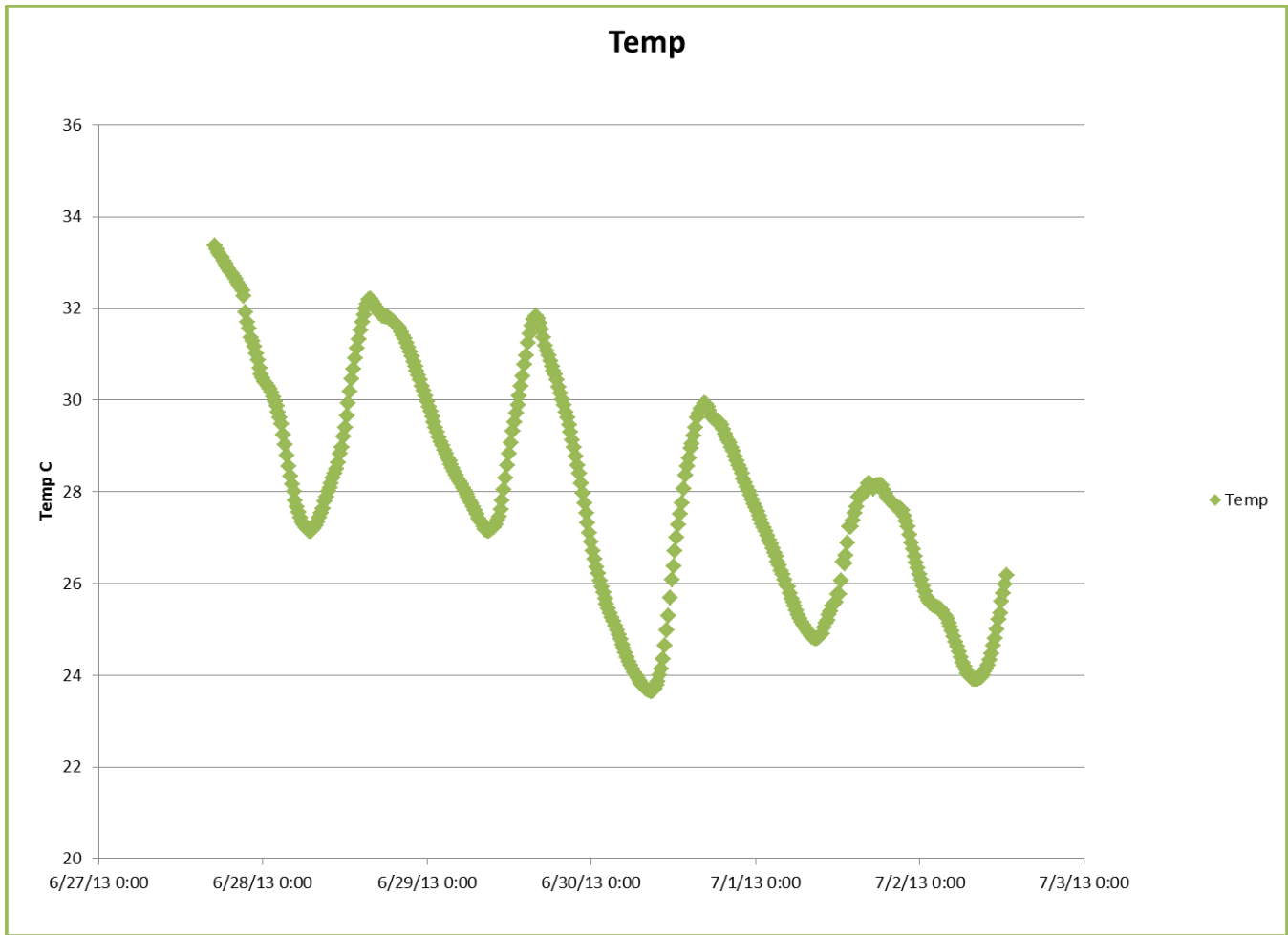


Figure 6 Diel TEMP Data

2.2 Assessment of Data

The diel DO data shows the water body went below the 4.0 mg/l water quality standard for minimum DO in the stream in the early mornings of June 28, June 29, July 1, and July 2 of 2013. Figure 7 shows the location of the monitoring station. The data suggest photosynthesis produced very high DO saturation in the afternoon, and during the night, respiration exerted a load sufficient to fall below the minimum DO standard. The nutrient data measured in 2008 is within the targets established for this ecoregion by MDEQ for the Yazoo Delta nutrient TMDLs.

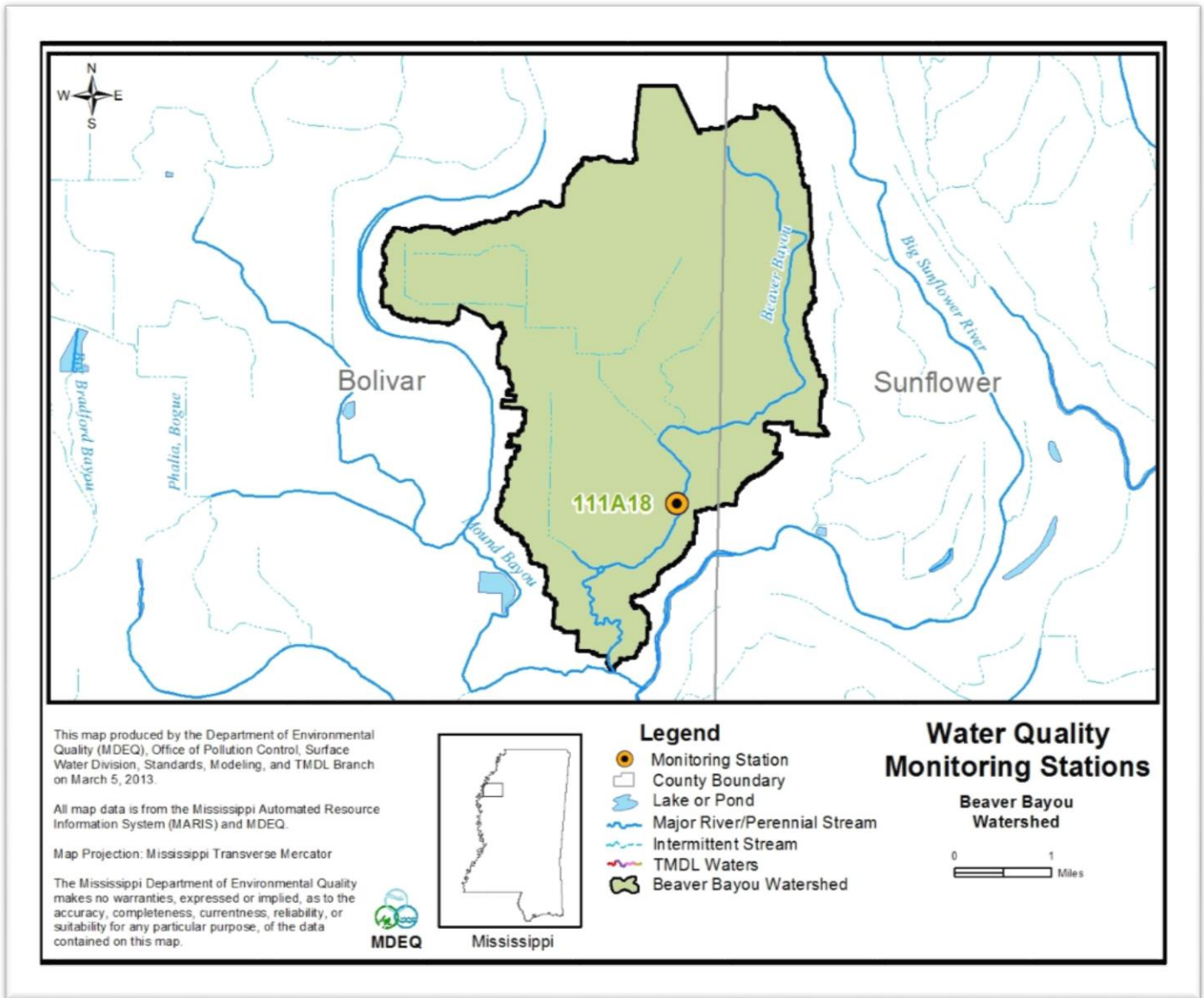


Figure 7 Sample Station

2.3 Assessment of Point Sources

An important part of the TMDL analysis is the identification of individual sources, source categories, or source subcategories in the watershed and the amount of pollutant loading contributed by each source. Under the CWA, sources are broadly classified as either point or nonpoint sources. Under 40 CFR §122.2, a point source is defined as a discernible, confined, and discrete conveyance from which pollutants are or may be discharged to surface waters.

The National Pollutant Discharge Elimination System (NPDES) program regulates point source discharges. Point sources can be described by two broad categories: 1) NPDES regulated municipal, commercial, and industrial wastewater treatment plants (WWTPs) and 2) NPDES regulated activities, which include construction activities and municipal storm water discharges (Municipal Separate Storm Sewer Systems [MS4s]).

The Beaver Bayou Watershed has no NPDES permitted point sources. There are no MS4s in this area. Therefore the WLA will be set to zero for this TMDL. This WLA may be revised based on new information in the future.

2.3 Assessment of Nonpoint Sources

Nonpoint loading of organic material in a water body results from the transport of the pollutants into receiving waters by overland surface runoff, groundwater infiltration, and atmospheric deposition.

The Beaver Bayou watershed landuse is primarily agricultural. The land use information for the watershed is based on the 2006 National Land Cover Database (NLCD). The landuse distribution for the Beaver Bayou Watershed is shown in Table 5 and Figure 8.

Table 5 Landuse Distribution

Area	Water	Urban	Forest	Pasture	Cropland	Wetland	Total
Acres	51.60	325.81	19.79	167.46	7912.81	847.32	9324.79
Percentage	0.6%	3.5%	0.2%	1.8%	84.9%	9.1%	100.0

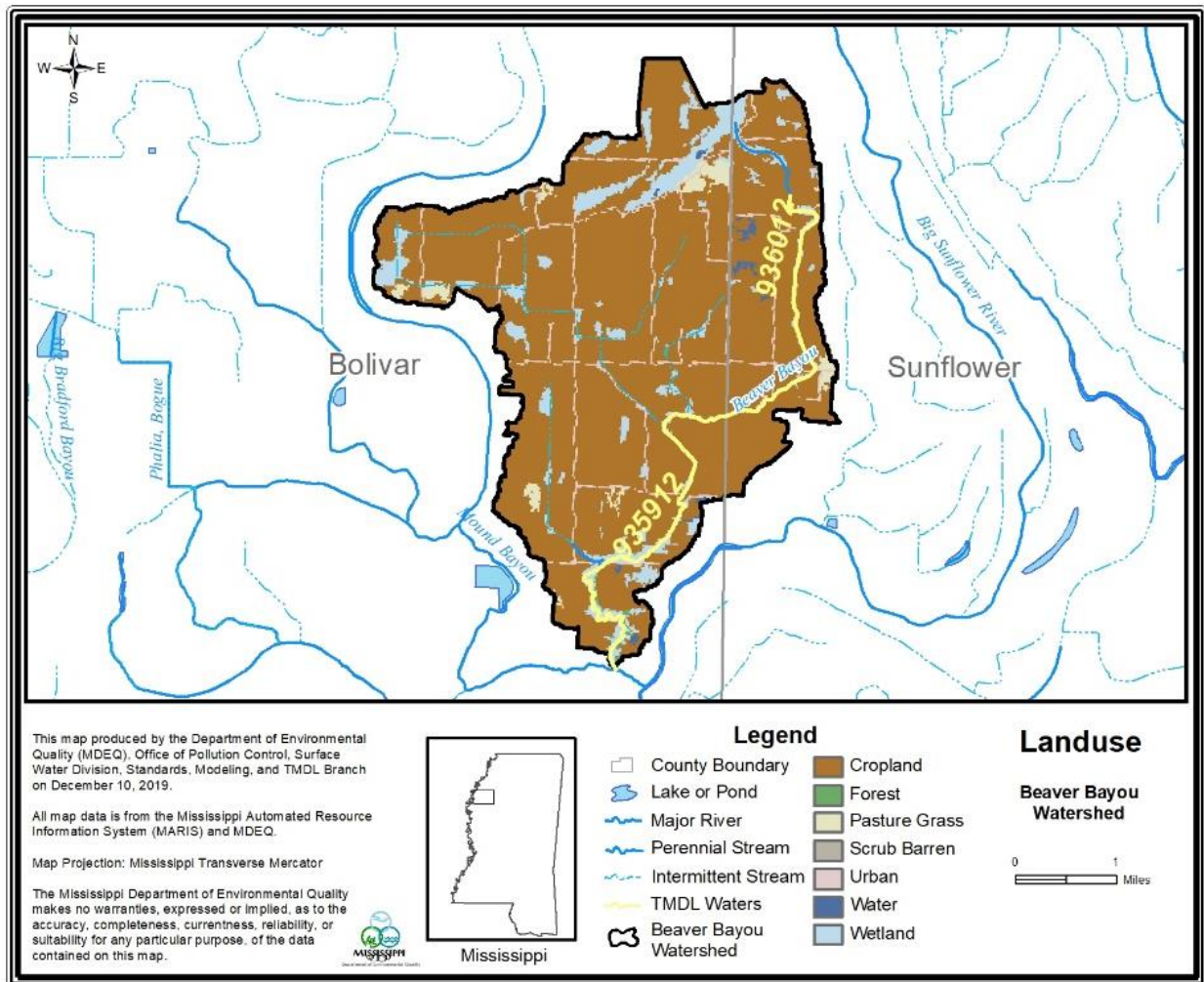


Figure 8 Beaver Bayou Watershed Landuse

MODELING PROCEDURE: LINKING THE SOURCES TO THE ENDPOINT

Establishing the relationship between the instream water quality target and the source loading is a critical component of TMDL development. It allows for the evaluation of management options that will achieve the desired source load reductions. The link can be established through a range of techniques, from qualitative assumptions based on sound scientific principles to sophisticated modeling techniques. Ideally, the linkage will be supported by monitoring data that allow the TMDL developer to associate certain water body responses to flow and loading conditions. In this section, the selection of the modeling tools, setup, and model application are discussed.

3.1 Modeling Framework Selection

MDEQ's steady state water quality model, Steady Riverine Environmental Assessment Model (STREAM), for DO distribution in freshwater streams was used for developing the TMDL. The use of STREAM is promulgated in the *Wastewater Regulations for National Pollutant Discharge Elimination System (NPDES) Permits, Underground Injection Control (UIC) Permits, State Permits, Water Quality Based Effluent Limitations and Water Quality Certification WPC-1* (MDEQ, 2010). This model is approved by EPA and used extensively at MDEQ. A key reason for using the STREAM model in TMDL development is its ability to assess instream water quality conditions in response to point and nonpoint source loadings.

3.2 Model Setup

The STREAM model for this TMDL was created with 5 stream segments based on the NHDplus stream coverage. A diagram showing the model setup is shown in Figure 9. The model segments are identified by the river mile at the head of the segment. Table 6 below provides the model inputs used.

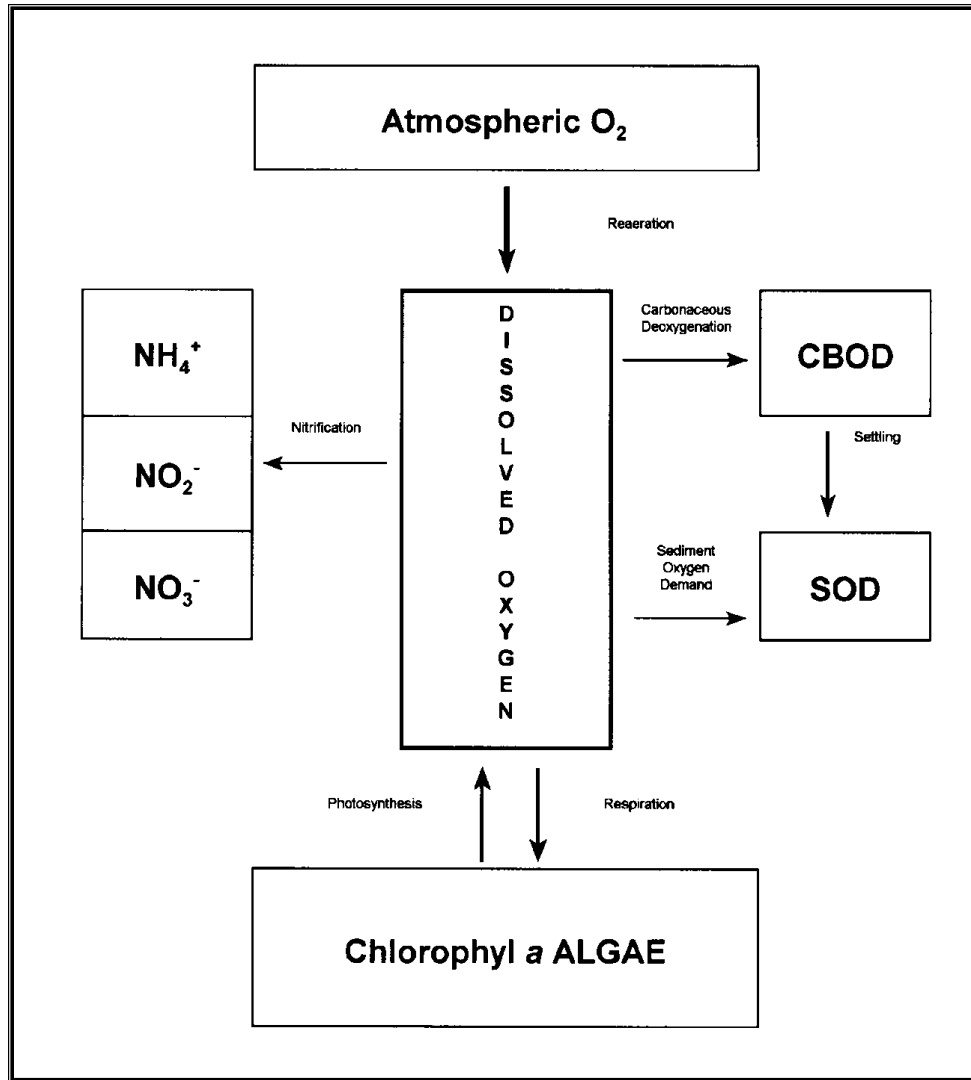


Figure 9 Instream Processes in a Typical DO Model

Table 6 STREAM Model Variables

River Mile	Temp °C	Slope Ft/mile	Kr Day ⁻¹	Kd Day ⁻¹	Kn Day ⁻¹	Escape Coeff	Velocity fps
11.5	30.94	1.02	0.3	0.3	0.3	0.11	0.1
9.4	30.94	0.68	0.3	0.3	0.3	0.11	0.1
6.3	30.94	2.33	0.3	0.3	0.3	0.11	0.1
4.4	30.94	1.93	0.3	0.3	0.3	0.11	0.1
0.8	30.94	11.29	0.3	0.3	0.3	0.11	0.1

Segment divisions were made at locations where there is a change in hydrological and water quality characteristics, such as the confluence of a point source or tributary or change in slope. The modeled segments were divided into computational elements of 0.1 mile. The simulated hydrological and water quality characteristics were calculated and output by the model for each computational element.

3.2.1 Base Equations

STREAM is a steady-state, daily average computer model that solves the partial differential modified Streeter-Phelps DO sag equation. Instream processes simulated by the model include CBOD_u decay, nitrification (NBOD_u load expresses as oxygen), reaeration, sediment oxygen demand, and respiration and photosynthesis of algae. Figure shows how these processes are related in a typical DO model. Reaction rates for the instream processes are input by the user and corrected for temperature by the model. The model output includes water quality conditions in each computational element for DO, CBOD_u, and NH₃-N concentrations. The hydrological processes simulated by the model include stream velocity and flow from point sources and spatially distributed inputs.

3.2.2 Reaeration

The model calculates reaeration within each reach using the Tsivoglou formulation. The Tsivoglou formulation calculates the reaeration rate, K_a (day⁻¹ base e), within each reach according to Equation 1.

$$K_a = C*S*U \quad \text{(Eq. 1)}$$

C is the escape coefficient, U is the reach velocity in mile/day, and S is the average reach slope in feet per mile. The value of the Tsivoglou escape coefficient is assumed to be 0.11 for streams with flows less than 10 cfs and 0.0597 for stream flows equal to or greater than 10 cfs.

Reach velocities were calculated using an empirical equation based on stream slope and flow. The slope of each reach was measured with 2010 LIDAR coverage and input into the model in units of feet per mile.

3.2.3 Temperature and Flow

The STREAM model simulates the critical flow and temperature conditions, which were determined to be the critical condition for this TMDL. MDEQ Regulations state that when the flow in a water body is less than 50 cfs, the temperature used in the model is 26°C. However, to match the measured data, 30.94 °C was used. The instream CBOD_u decay rate at K_d at 20°C was input as 0.3 day⁻¹ (base e) as specified in MDEQ regulations. The model adjusts the K_d rate based on temperature, according to Equation 2.

$$K_{d(T)} = K_{d(20^{\circ}\text{C})}(1.047)^{T-20} \quad (\text{Eq. 2})$$

Where K_d is the CBOD_u decay rate and T is the assumed instream temperature. The assumptions regarding the instream temperatures, background DO saturation, and CBOD_u decay rate are required by the *Wastewater Regulations for National Pollutant Discharge Elimination System (NPDES) Permits, Underground Injection Control (UIC) Permits, State Permits, Water Quality Based Effluent Limitations and Water Quality Certification WPC-1* (MDEQ, 2010). Also based on MDEQ Regulations, the rates for photosynthesis, respiration, and sediment oxygen demand were set to zero because data for these model parameters are not available.

There are no USGS gages located on Beaver Bayou. The flow for the model was taken from average flow estimates for incremental flow in the NHDplus database.

3.2.4 Organic Enrichment Loading

Organic material discharged to a stream from an NPDES permitted point source is typically quantified as 5-day biochemical oxygen demand (BOD₅). BOD₅ is a measure of the oxidation of carbonaceous and nitrogenous material over a 5-day incubation period. However, oxidation of nitrogenous material, called nitrification, usually does not take place within the 5-day period because the bacteria that are responsible for nitrification are normally not present in large numbers and have slow reproduction rates (Metcalf and Eddy, 1991). Thus, BOD₅ is generally considered equal to CBOD₅. Because permits for point source facilities are written in terms of CBOD₅ while TMDLs are typically developed using CBOD_u, a ratio between the two terms is needed, Equation 3.

$$\text{CBOD}_u = \text{CBOD}_5 * f \text{ Ratio} \quad (\text{Eq.3})$$

The CBOD_u to CBOD₅ ratios are given in *Wastewater Regulations for National Pollutant Discharge Elimination System (NPDES) Permits, Underground Injection Control (UIC) Permits, State Permits, Water Quality Based Effluent Limitations and Water Quality Certification WPC-1* (MDEQ, 2010). These values are recommended for use by MDEQ regulations when actual field data are not available. The value of the ratio depends on the wastewater treatment type. The f ratios were not used in this model.

Organic enrichment sources were represented in the model by adding CBOD_u and NBOD_u loads. The spatially distributed loads were distributed evenly into each computational element of the modeled water body. The dissolved oxygen level was initiated at 6.0 mg/l but was lowered to match the 4.63 measured in the stream for the spatially distributed loads.

Direct measurements of background concentrations of CBOD_u were not available for the Beaver Bayou Watershed. Because there were no background data available, the background concentrations of CBOD_u and NH₃-N were estimated based on the measured data.

3.2.5 Nitrogen Loading

In order to convert the ammonia nitrogen (NH₃-N) loads to an oxygen demand, a factor of 4.57 pounds of oxygen per pound of ammonia nitrogen (NH₃-N) oxidized to nitrate nitrogen (NO₃-N) was used. Using this factor is a conservative modeling assumption because it assumes that all of the ammonia is converted to nitrate through nitrification. The oxygen demand caused by nitrification of ammonia is equal to the NBOD_u load. The sum of CBOD_u and NBOD_u is equal to the load of TBOD_u shown in Equation 4. The loads of TBOD_u from the calibrated STREAM model are given in Table 8 Calibrated Model Loads .

$$\text{TBOD}_u = \text{CBOD}_u + \text{NBOD}_u \quad (\text{Eq. 4})$$

3.2.6 STREAM Model Identification

There are two STREAM models in this study. The segment modeled is shown in figure 10. The first is the calibrated model. The calibrated model setup was based on the critical condition measured on 7/8/2008. See Table 7. The measured dissolved oxygen value of 4.6 was matched with the data output of the model at river mile 0.8 where the monitoring station is located.

The second model takes the conditions established in the calibrated model and adjusts the loads to meet the water quality standard. This second model is the reduced model. The modeled outputs are displayed in Figure 11.

Table 7 Quarterly Chemical Data 2008

Date	Depth Feet	TOC Mg/L	COD Mg/L	Chlorophyll A Ug/L	Conductivity Umhos/Cm@25c	DO % Sat	DO Mg/L	pH S.U.	Temp °C
09/11/2007 13:30	0.8	7	26	1.4	336	175.9	14.07	7.8 9	26.51
03/26/2008 15:00	1	10	27	1.5	188	150.2	12.96		22.97
07/08/2008 20:30	2	9	< 10	8	403	63.3	4.63	7.2 5	30.94
09/24/2008 09:20	0.5	7	17	2.7	226	86.9	7.81	7.7 7	21.58

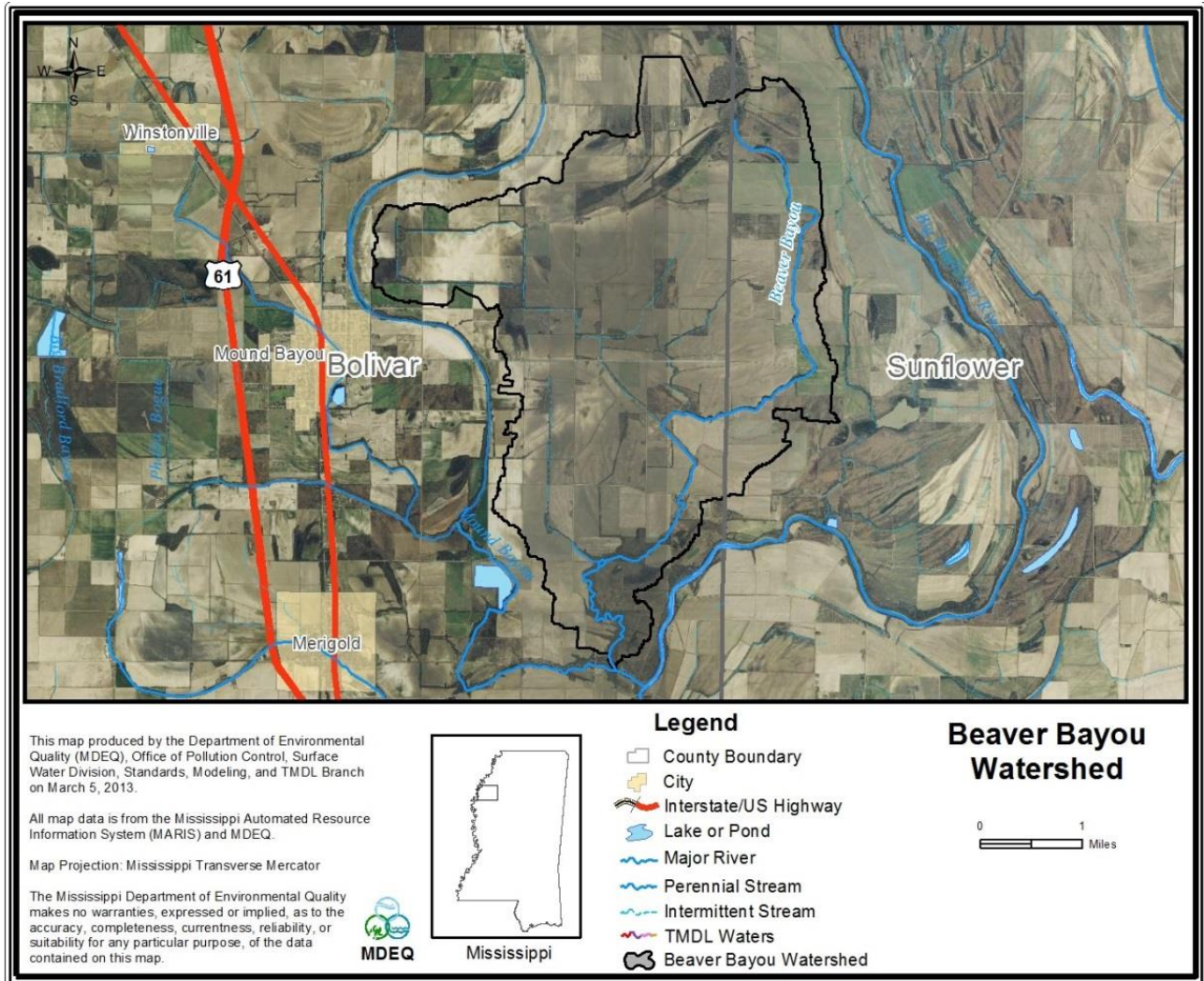


Figure 10 Model Segment with River Mile shown

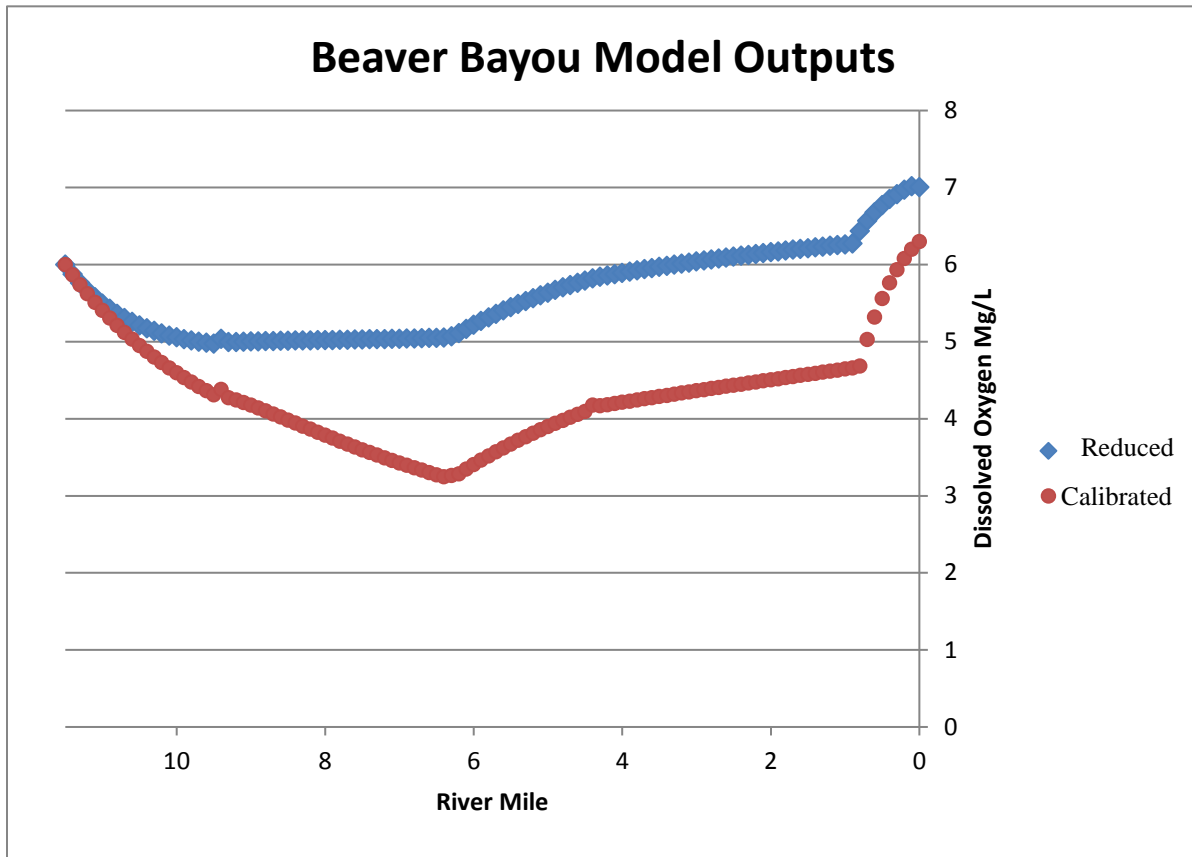


Figure 11 Model Output

3.3 Source Representation

The background concentration used in modeling for CBOD₅ is 1.33 mg/l and for NH₃-N is 0.1 mg/l. These concentrations are used as estimates for the CBOD₅ and NH₃-N levels of water entering the water bodies through nonpoint source flow and tributaries. It is noted that because there were DO violations indicated, higher values of CBOD₅ and NH₃-N for the nonpoint source concentrations were used to reflect the measured instream average DO value. This was done to calibrate the model to the data.

Nonpoint source flows were included in the model to account for water entering due to groundwater infiltration, overland flow, and small, unmeasured tributaries. The nonpoint source loads were assumed to be distributed evenly on a river mile basis throughout the modeled reaches.

3.4 Model Results

As shown previously in Figure 11 Model Output the calibrated model was below the water quality standard target of 5.0 mg/l of dissolved oxygen. A second model was constructed to match the standard. Table 8 shows the loads used in this model. The TBODu shown in Table 9 is the TMDL for this stream, 27.2 lbs. per day. The percent reduction in the loads from Table 8 to Table 9 is 60.4%. This is the targeted reduction for this TMDL.

CBODu is calculated by multiplying the concentration in mg/L by the flow in MGD and a conversion factor of 8.34. (Equation 5)

$$\text{CBODu (lbs/day)} = \text{CBODu mg/L} * \text{Flow (MGD)} * 8.34 \quad (\text{Eq. 5})$$

NBODu is similarly calculated with the addition of a multiplier of 4.57 which converts the equivalent oxygen load. (Equation 6)

$$\text{NBODu (lbs/day)} = \text{NBODu mg/L} * \text{Flow (MGD)} * 8.34 * 4.57 \text{ lbs O}_2 \quad (\text{Eq. 6})$$

Table 8 Calibrated Model Loads

Segment	Spatial Flow (cfs)	CBODu (lbs/day)	NH3-N (mg/L)	NBODu (lbs/day)	TBODu (lbs/day)
11.5	.10	2.05	.39	0.96	3.01
9.4	.32	20.86	.39	3.07	23.93
6.3	.17	5.86	.39	1.63	7.49
4.4	.35	25.08	.39	3.36	28.44
0.8	.15	4.44	.39	1.44	5.89

ALLOCATION

The allocation for this TMDL involves the load reduction necessary for attainment of water quality standards in the Beaver Bayou Watershed.

4.1 Wasteload Allocation

There is no point source included in the model for the Beaver Bayou Watershed. The WLA is therefore zero.

4.2 Wasteload Allocation Stormwater

There is no MS4 designation in this watershed. Stormwater NPDES permits require the establishment of controls or BMPs to reduce the pollutants entering the environment. The WLA for stormwater is zero.

4.3 Load Allocation

The load allocation for the TBODu TMDL is shown in Table 9 TMDL Loads. Because the water body indicates DO standard violations, loadings should be reduced to meet the standard.

Table 9 TMDL Loads

Segment	Spatial Flow (cfs)	CBODu (lbs/day)	NH3-N (mg/L)	NBODu (lbs/day)	TBODu (lbs/day)
11.5	.10	0.59	.39	0.96	1.55
9.4	.32	6.03	.39	3.07	9.11
6.3	.17	1.65	.39	1.63	3.28
4.4	.35	7.17	.39	3.36	10.53
0.8	.15	1.29	.39	1.44	2.73

4.4 Incorporation of a Margin of Safety

The margin of safety is a required component of a TMDL and accounts for the uncertainty about the relationship between pollutant loads and the quality of the receiving water body. The two types of MOS development are to implicitly incorporate the MOS using conservative model assumptions or to explicitly specify a portion of the total TMDL as the MOS. The MOS selected for this TMDL is implicit.

4.5 Calculation of the TMDL

The TMDL is calculated based on the following equation. (Equation 7)

$$\text{TMDL} = \text{WLA} + \text{WLA}_{\text{sw}} + \text{LA} + \text{MOS} \text{ (Eq. 7)}$$

The TBOD_u allocation in Table 10 where WLA is the Wasteload Allocation, WLA_{sw} is Wasteload Allocation from stormwater activities, LA is the Load Allocation, and MOS is the Margin of Safety.

Table 10 TBOD_u TMDL

	WLA (lbs/day)	WLA _{sw} (lbs/day)	LA (lbs/day)	MOS (lbs/day)
CBOD _u	0	0	16.73	Implicit
NBOD _u	0	0	10.47	Implicit
TBOD _u	0	0	27.20	Implicit

4.6 Seasonality and Critical Condition

This TMDL accounts for seasonal variability by requiring allocations that ensure year-round protection of water quality standards, including during critical conditions.

CONCLUSION

A 60.4% reduction from organic enrichment loading is necessary to meet the dissolved oxygen water quality standard based on the STREAM model. This reduction may not be possible due to the land use in this agricultural watershed. There are no point sources to be reduced. The reduction has to come from nonpoint sources. Best management practices are encouraged to reduce sediment and nutrients from leaving the fields. These will help reduce the organic load as well.

The natural condition of this watershed may be better defined in the future with a modified designated use for this stream. It is believed that the stream is supportive of aquatic life in its current condition, but due to MDEQ's water quality standard, the stream will be unable to ever meet a minimum of 4.0 mg/l of dissolved oxygen during the hot summer conditions. Recognition of this fact and a more appropriate designation of this stream as an agricultural drainage stream may return this stream to a fully supporting designation.

5.1 Next Steps

MDEQ's Basin Management Approach and Nonpoint Source Program emphasize restoration of impaired waters with developed TMDLs. During the watershed prioritization process to be conducted by the Yazoo River Basin Team, this TMDL will be considered as a basis for implementing possible restoration projects. The basin team is made up of state and federal resource agencies and stakeholder organizations and provides the opportunity for these entities to work with local stakeholders to achieve quantifiable improvements in water quality. Together, basin team members work to understand water quality conditions, determine causes and sources of problems, prioritize watersheds for potential water quality restoration and protection activities, and identify collaboration and leveraging opportunities. The Basin Management Approach and the Nonpoint Source Program work together to facilitate and support these activities.

The Nonpoint Source Program provides financial incentives to eligible parties to implement appropriate restoration and protection projects through the Clean Water Act's Section 319 Nonpoint Source (NPS) Grant Program. This program makes grants each year for restoration and protections efforts.

Mississippi Soil and Water Conservation Commission (MSWCC) is the lead agency

responsible for abatement of agricultural NPS pollution through training, promotion, and installation of BMPs on agricultural lands. USDA Natural Resource Conservation Service (NRCS) provides technical assistance to MSWCC through its conservation districts located in each county. NRCS assists animal producers in developing nutrient management plans and grazing management plans. MDEQ, MSWCC, NRCS, and other governmental and nongovernmental organizations work closely together to reduce agricultural runoff through the Section 319 NPS Program. (Natural Resources Conservation Service, 2000)

5.2 Public Participation

This TMDL will be published for a 30-day public notice. During this time, the public will be notified by publication in the statewide newspaper. The public will be given an opportunity to review the TMDLs and submit comments. MDEQ also distributes all TMDLs at the beginning of the public notice to those members of the public who have requested to be included on a TMDL mailing list. Anyone wishing to become a member of the TMDL mailing list should contact Shawn Clark at sclark@mdeq.ms.govs.

All comments should be directed to Shawn Clark at sclark@mdeq.ms.gov or Shawn Clark, MDEQ, PO Box 2261, Jackson, MS 39225. All comments received during the public notice period and at any public hearings become a part of the record of this TMDL and will be considered in the submission of this TMDL to EPA Region 4 for final approval.

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