BROWN'S CREEK WATERSHED DISTRICT
2009 WATER MONITORING REPORT

Prepared for:

BROWN'S CREEK
WATERSHED DISTRICT

Prepared By:

WASHINGTON CONSERVATION DISTRICT

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ABBREVIATIONS, ACRONYMS, AND SYMBOLS

CAMP	Citizen-Assisted Lake Monitoring Program
cfs	cubic feet per second
Chl-*a*	Chlorophyll-*a*
BCWD	Brown's Creek Watershed District
COD	Total Chemical Oxygen Demand
DO	Dissolved Oxygen
E. Coli	*Escherichia coli*
mg/L	milligram per liter
MN DNR	Minnesota Department of Natural Resources
MPCA	Minnesota Pollution Control Agency
MPN	most probable number
NTU	nephelometric turbidity units
OHW	Ordinary High Water level
Ortho-P	Ortho-phosphate
TBOD	Total Biochemical Oxygen Demand
TKN	Total Kjeldahl Nitrogen
TMDL	Total Maximum Daily Load
TOC	Total Organic Carbon
TP	Total Phosphorus
TSI	Trophic State Index
TSMP	Trout Stream Mitigation Project
TSS	Total Suspended Solids
µg/L	microgram per liter
µmhos/cm	micromhos per centimeter
VSS	Volatile Suspended Solids
WCD	Washington Conservation District

2009 BCWD Baseline Water Quality Monitoring
EXECUTIVE SUMMARY

This report focuses on the summary and comparison of the lake and stream water quality data collected by the Washington Conservation District (WCD) from 2000-2009 and previous monitoring seasons. In 2009, one stream monitoring site was added to the monitoring program with the goal of assessing the performance and effectiveness of the Ecostorm Plus Filtration System; Tributary to Long Lake at the Herberger's Pond Outlet. In addition to this site, BCWD continued to monitor Masterman Lake, Bass Lake East (82-0124), Bass Lake West (82-0123), Lynch Lake, July Avenue Wetland, Wood Pile Lake, Pat Lake, Goggin's Lake, Kismet Basin, Long Lake, South School Section Lake, Benz Lake, and Plaisted Lake. Brown's Creek was monitored at Highway 15, McKusick Road, Stonebridge and the Creek Outlet at Highway 96; Long Lake drainage sites were monitored at 62nd St. and the Marketplace Pond; the tributary to McKusick Lake was monitored at the Brown's Creek Diversion Structure; and the Diversion drainage was monitored at Long Lake outlet, Jackson WMA outlet, and Boutwell Rd. crossing. Four additional branches of the Diversion drainage were also monitored beginning in 2009 (Figure 1).

In 2009, the thirteen lakes monitored had good to very poor water quality ratings and were classified as, mesotrophic (Bass Lake East), eutrophic (Bass Lake West, Benz, Kismet Basin, Long Lake, Masterman Lake, Pat Lake, South School Section Lake and Wood Pile Lake) and hypereutrophic (Goggin's Lake, Plaisted Lake, July Avenue Wetland, and Lynch Lake). The overall 2009 lake grades for BCWD lakes were: Bass Lake East – B-, Wood Pile Lake – B-, South School Section Lake – B-, Bass Lake West – C+, Masterman Lake – C+, Pat Lake – C+, Long Lake – C+, Kismet Basin – C, Goggin's Lake – D+, Benz Lake – D+, Plaisted Lake –D+, July Avenue Wetland – D-, Lynch Lake – F. Of the lakes that were monitored in 2008, three lakes showed a slight deterioration in water quality for the 2009 season (Bass Lake West, Benz Lake and July Avenue Wetland), four lakes maintained their water quality (Long Lake, Plaisted Lake, Goggin's Lake and Lynch Lake), and six lakes improved in water quality (Bass Lake East, Woodpile Lake, Pat Lake, Masterman Lake, Kismet Basin and South School Section Lake). Goggin's Lake, Kismet Basin, Plaisted Lake and Lynch Lake were considered worse than the ecoregion range for total phosphorus, total Kjeldahl nitrogen, chlorophyll-*a*, and Secchi disk transparency. Bass Lake West was the only lake within the ecoregion range for total phosphorus, total Kjeldahl nitrogen, chlorophyll-*a*, and Secchi disk transparency. In 2009, the Washington Conservation District conducted Kendall Tau statistical analysis of all lakes monitored by WCD to determine any long-term water quality trends. For Brown's Creek Watershed District lakes, only two lakes had a significant trend. Goggin's Lake had a statistically significant decreasing Secchi transparency trend ($p<0.10$) and Long Lake had significantly increasing Secchi disk transparency and improving total phosphorus trends.

In 2009, BCWD added one stream monitoring station to its existing network of stream monitoring sites in an effort to assess the performance of the Ecostorm Plus Filtration

System that was installed at the outlet of the Herberger's stormwater pond. The new station was installed to measure discharge, water chemistry, and water quality at the outlet of Herberger's Pond, post treatment by the Ecostorm system. BCWD continued monitoring stream/stormwater sites at: Brown's Creek Outlet at Hwy 96, Brown's Creek at McKusick Road, Brown's Creek at Hwy 15, the Brown's Creek Diversion Structure, Long Lake Inlet at 62nd St., and Long Lake Inlet at Marketplace Pond (Figure 1).

Of the stream/stormwater sites monitored in BCWD, Brown's Creek at Hwy 15, Brown's Creek Outlet, Brown's Creek at McKusick Road and Long Lake Inlet at 62nd Street showed decreased total discharges in 2009 compared to 2008 (Figure 10 and Figure 11). These same sites showed reduced TP loads in 2009 compared to 2008 (Figure 10). Brown's Creek at Highway 15, McKusick Road and at the Stonebridge, Long lake Inlet at 62nd Street and Long Lake Inlet at Marketplace Pond showed reductions in total loads of TSS during the 2009 season compared to 2008 (Figure 11). The total phosphorus load from Brown's Creek to the St. Croix River in 2009 was **2,448 lbs (0.27 lbs per acre of watershed land)**, determined by the Brown's Creek Outlet station results.

Temperatures in Brown's Creek for 2009 displayed some interesting results when looking at thermal impacts. As in 2008, the Highway 15, McKusick Road and Stonebridge sites recorded no daily minimum temperatures above 20° C (Figure 29 through Figure 31). The minimum daily temperature at the outlet of Brown's Creek never exceeded 20° C (Figure 32), which is the temperature threshold where low impacts to trout survival are observed. One important and equally interesting note is that the temperature difference between the McKusick Road and Stonebridge sites did not vary as significantly as they did in 2008 (Figure 35). This is difficult to explain, but may be due to the lack of precipitation in the summers of 2008 and 2009. This lack of rainfall may have prevented the stormwater pond that enters the creek downstream of the McKusick Road site from reaching capacity. This would have an effect on stream temperature because it would have prevented warm, stagnant water from discharging from the pond into the creek.

The MPCA and the MN DNR, as part of the Brown's Creek TMDL, conducted fisheries surveys in 2008 as well as historically as part of their biological monitoring programs. No DNR survey was conducted in 2009, but one is planned for 2010. The MPCA did conduct biological surveys in 2009. Data pertaining to historical fisheries surveys can be found by contacting the MPCA Biological Monitoring Section (http://www.pca.state.mn.us/water/biomonitoring/bio-staffdirectory.html) or MN DNR Division of Fish and Wildlife area fisheries office (http://www.dnr.state.mn.us/areas/fisheries/eastmetro/index.html). Due to differences in sampling procedures between agencies, variation in results, and the complexity of reporting these results while not being the organization that collected the data, those data are not shown in this report. Annual fish stocking occurred as it usually does on a yearly basis. In 2009, 1000 brown trout were stocked in Brown's Creek. This stocking follows the MN DNR long-term management plan for trout stocking efforts in Brown's Creek.

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I. INTRODUCTION

This report focuses on the summary and comparison of lake and stream water quality data collected by the Washington Conservation District (WCD) from 2000-2009 and previous monitoring seasons. In 2009, Brown's Creek Watershed District (BCWD) monitored thirteen lakes: Bass Lake (East), Bass Lake (West), Benz Lake, Goggin's Lake, July Avenue Wetland, Kismet Basin, Long Lake, Lynch Lake, Masterman Lake, Pat Lake, Plaisted Lake, South School Section Lake, and Wood Pile Lake. Nine stream/stormwater sites were monitored and located at: Brown's Creek at Highway 15, McKusick Road, Stonebridge, Brown's Creek Outlet at Highway 96, Brown's Creek Diversion Structure, Long Lake Inlet at 62nd St., Long Lake Inlet at Herberger's Pond and Long Lake Inlet at Marketplace Pond (Figure 1). Field flow measurements and water quality grab samples were collected along the diversion drainage to McKusick Lake at Long Lake Outlet, Jackson WMA Pond Outlet, and the drainage crossing at Boutwell Rd. Four additional sites, named North Branch, South Branch, West Branch 1 and West Branch 2, were added along this drainage in 2009 (Figure 2). Multiple water quality parameters were monitored at each lake and stream/stormwater site. Also included in this report are 15-minute continuous temperature data for all sites on Brown's Creek. The purpose of this monitoring was to assess and document the current water quality conditions of the lakes and streams, identify problem resources or areas, and to continue a long-term monitoring program which will enable the BCWD to identify trends associated with land use changes in their watershed.

The work plan for 2009 included the following activities: bi-weekly sampling (14 sampling sessions) of Benz Lake, Masterman Lake, Goggin's Lake, Kismet Basin, Long Lake, Woodpile Lake, Lynch Lake and South School Section Lake from April through October, monthly sampling (7 sampling sessions) of Bass Lake (East), Bass Lake (West), July Avenue Wetland, Pat Lake, and Plaisted Lake from April through October, and water elevation readings on seventeen water bodies. Four continuous monitoring stations were installed on Brown's Creek at Highway 15, McKusick Road, Stonebridge, and at the Brown's Creek Outlet, three continuous monitoring stations were installed on inlets to Long Lake at 62nd St., Herberger's Pond and Marketplace Pond, and one continuous monitoring station was installed at the Brown's Creek Diversion Structure. Table 1 summarizes monitoring site locations and parameters monitored in 2009. The WCD performed the water quality sampling for the BCWD. Metropolitan Council Environmental Services Lab performed the analytical lab analyses on lake samples and samples from continuous monitoring stations. Minnesota Valley Testing Laboratories performed the analytical analyses on samples collected along the diversion drainage to McKusick Lake.

In 2007, BCWD in partnership with the WCD and MPCA began a Total Maximum Daily Load study on Brown's Creek. The purpose of a TMDL is to specifically identify and address the stressor(s) of impaired water(s). Brown's Creek was listed as impaired due to its poor macroinvertebrate IBI (index of biotic integrity) and lack of coldwater assemblage for trout and other coldwater fish species. During the early phase of this

study, different agencies collected data that were needed to identify the stressor(s) that could be affecting macroinvertebrates and the coldwater assemblage. Agencies or individuals collecting or working with the data for this study included the WCD, BCWD, Emmons and Olivier Resources, Inc, MPCA, MN DNR, and Len Ferrington of the University of Minnesota. Data collected in 2008 was used as additional or supportive data for the TMDL. For further information about this TMDL please visit www.pca.state.mn.us/water/tmdl/index.html, or contact the MPCA or BCWD.

Table 1. Monitoring Site Location, Description, and Parameter(s) Monitored

Site Description	Map Site ID#	Site Name	General Site Location	Monitored Parameters*
Stream Monitoring	**1**	Brown's Creek Outlet at Hwy 96	Hwy 95 & 96	Discharge and Water Quality Composite Samples
Stream Monitoring	**2**	Brown's Creek at McKusick Road	McKusick Road	Discharge and Water Quality Composite Samples
Stream Monitoring	**3**	Browns' Creek at Hwy 15	Hwy 15	Discharge and Water Quality Composite Samples
Stream Monitoring	**4**	Tributary to Long Lake at 62nd St.	62nd St.	Discharge and Water Quality Composite Samples
Stream Monitoring	**5**	Tributary to Long Lake at Marketplace Pond	Market Dr.	Discharge and Water Quality Composite Samples
Stream Monitoring	**6**	Tributary to McKusick Lake at Brown's Creek Diversion	Neal Ave.	Discharge and Water Quality Composite Samples
Stream Monitoring	**7**	Brown's Creek at Stonebridge Trail	Stonebridge Trail	Discharge and Water Quality Composite Samples
Stream Monitoring	**8**	Herberger's Pond Outlet	Frontage Rd., Hwy. 36	Discharge and Water Quality Composite Samples
Stream Monitoring	**9**	Long Lake Outlet	Long Lake Dr.	Field Discharge Measurements and Grab Samples
Stream Monitoring	**10**	Jackson WMA Outlet	Hwy 12	Field Discharge Measurements and Grab Samples
Stream Monitoring	**11**	Boutwell Road	Boutwell Road	Field Discharge Measurements and Grab Samples
Stream Monitoring	**12**	Brown's Creek Diversion North Branch	Morgan Ave. N	Field Discharge Measurements and Grab Samples
Stream Monitoring	**13**	Brown's Creek Diversion South Branch	Morgan Ave. N	Field Discharge Measurements and Grab Samples
Stream Monitoring	**14**	Brown's Creek Diversion West Branch 1	Boutwell Road	Field Discharge Measurements and Grab Samples
Stream Monitoring	**15**	Brown's Creek Diversion West Branch 2	Morgan Ave. N	Field Discharge Measurements and Grab Samples
Lake Monitoring	**16**	Kismet Basin	--	Surface Water Quality Samples, Elevation
Lake Monitoring	**17**	Long Lake	--	Surface Water Quality Samples (3 Locations), Elevation
Lake Monitoring	**18**	Goggin's Lake	--	Surface Water Quality Samples, Elevation, Macrophyte Survey
Lake Monitoring	**19**	South School Section Lake	--	Surface Water Quality Samples, Elevation, Macrophyte Survey
Lake Monitoring	**20**	Benz Lake	--	Surface Water Quality Samples, Elevation, Macrophyte Survey
Lake Monitoring	**21**	Masterman Lake	--	Surface Water Quality Samples, Elevation
Lake Monitoring	**22**	Wood Pile Lake	--	Surface Water Quality Samples, Elevation
Lake Monitoring	**23**	Lynch Lake	--	Surface Water Quality Samples, Elevation
Lake Monitoring	**24**	Bass Lake (West)	--	Surface Water Quality Samples, Elevation
Lake Monitoring	**25**	July Avenue Pond	--	Surface Water Quality Samples, Elevation
Lake Monitoring	**26**	Bass Lake (East)	--	Surface Water Quality Samples, Elevation
Lake Monitoring	**27**	Pat Lake	--	Surface Water Quality Samples, Elevation
Lake Monitoring	**28**	Plaisted Lake	--	Surface Water Quality Samples, Elevation
Lake Monitoring	**29**	Hwy 12 & Kimbro Pond	--	Elevation
Lake Monitoring	**30**	Jackson Wildlife Management Area Pond	--	Elevation
Lake Monitoring	**31**	Brown's Creek at Gateway Trail	--	Elevation
Lake Monitoring	**32**	55th St. Pond	--	Elevation

*Stream Monitoring Water Quality Sample Parameters Include: (Total Phosphorus, Total Kjeldahl Nitrogen, Dissolved Phosphorus, Total Suspended Solids, Volatile Suspended Solids, E. Coli Bacteria, Total Chlorides, Metals)--All Sites, (Turbidity, Total Chemical Oxygen Demand, Total Hardness, Total 5-day Biochemical Oxygen Demand, Total 5-day Carbonaceous Biochemical Oxygen Demand)--At All Sites on Brown's Creek, (Total Sulfates, Total Alkalinity, Ortho Phosphate, Nitrate, Nitrite, Ammonia Nitrogen)--Brown's Creek Outlet at Hwy 96

*Lake Water Quality Sample Parameters Include: Total Kjeldahl Nitrogen, Total Phosphorus, Chlorophyll-a, Secchi Disk Transparency, Temperature, Dissolved Oxygen

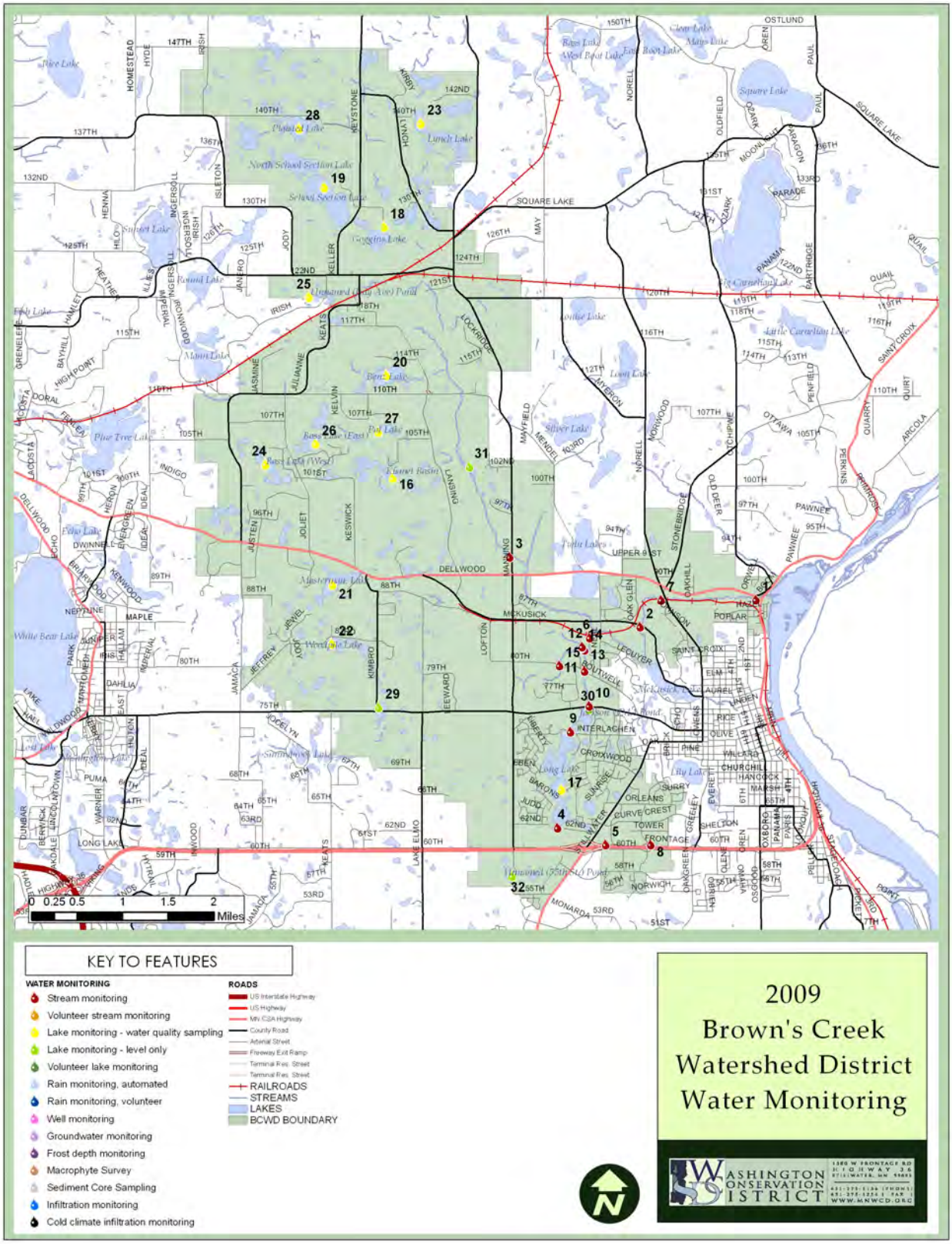


Figure 1: Sampling Location Map

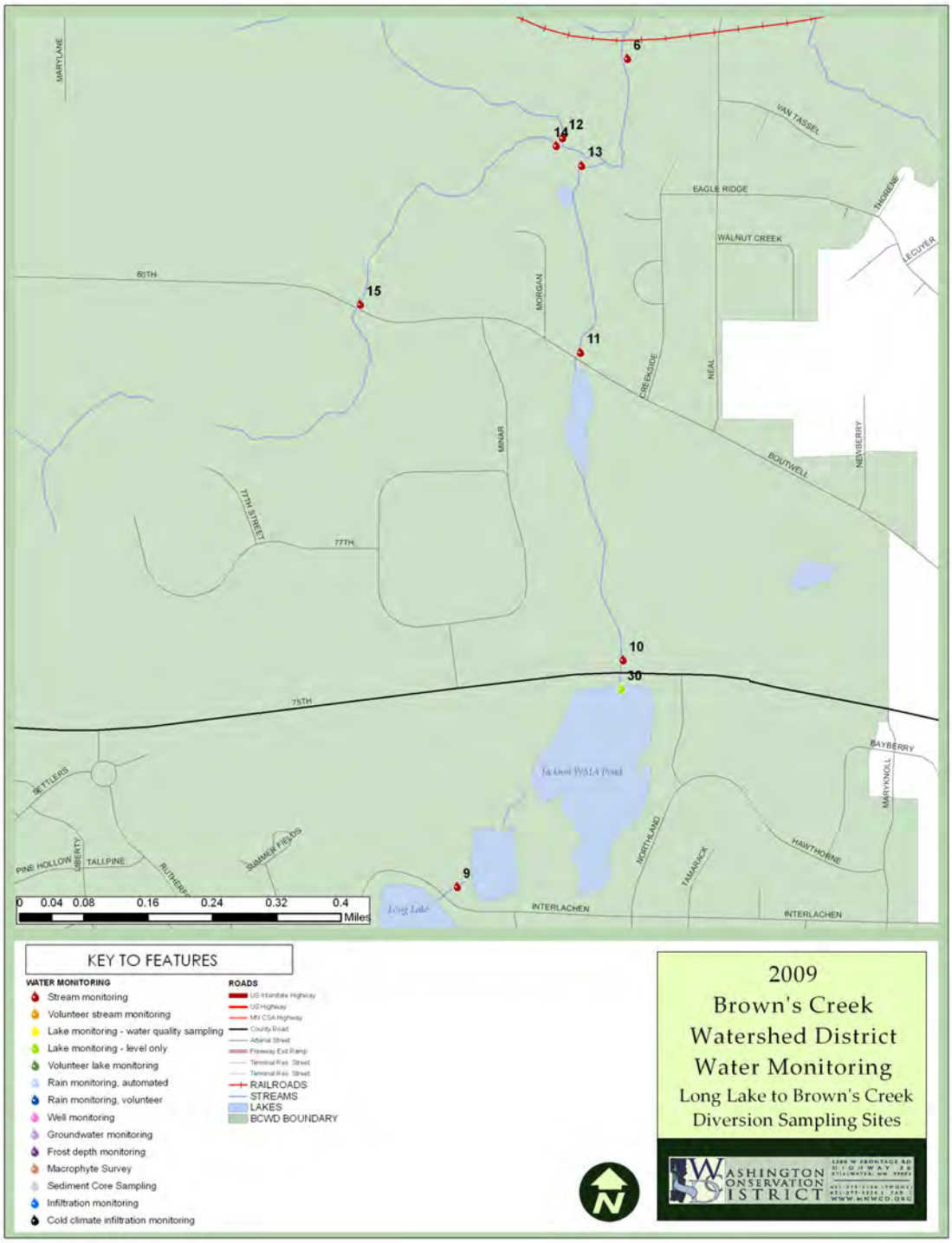


Figure 2. Long Lake to Diversion Structure Sampling Locations

II. LAKES

A. METHODS, RESULTS AND DISCUSSION

In 2009, water quality data was collected biweekly or monthly over seven consecutive months (April–October) by the WCD on Bass Lake East, Bass Lake West, Benz Lake, Goggin's Lake, July Avenue Wetland, Kismet Basin, Long Lake, Lynch Lake, Masterman Lake, Pat Lake, Plaisted Lake, South School Section Lake, and Wood Pile Lake. Additional water quality data was collected monthly on the middle and south basins of Long Lake from June to September. Two-meter (6.56 feet) integrated surface water samples were collected with a column sampler. Metropolitan Council Environmental Services Lab analyzed these samples for total phosphorus, chlorophyll-*a*, total Kjeldahl nitrogen. Additionally, hypolimnion samples were collected utilizing a Van Dorn sampler, approximately 1 meter (3.28 feet) from the lake bottom, on Goggin's Lake and South School Section Lake. Metropolitan Council Environmental Services Lab analyzed these samples for total phosphorus, total Kjeldahl nitrogen, and ortho-phosphates. A complete listing of the laboratory data is contained in Appendix A. Field measurements of Secchi disk transparency, dissolved oxygen and temperature profiles, and lake level were also recorded, as well as a user perception ranking (physical and recreational suitability) and is available via request or on the Metropolitan Council's EIMS (Environmental Information Management System) Water Quality Database website (http://es.metc.state.mn.us/eims). Measurements obtained over the sampling season are averaged for a comparison of individual lake dynamics from year to year, for differences between lakes within the watershed, and for comparison with the average North Central Hardwood Forest Ecoregion values. Average values for all parameters, as well as the typical ranges for lakes in this ecoregion, are presented in Table 2 and Appendix A. Table 5 shows the lake grade and trophic state of the lakes sampled. Figure 3 through Figure 6 shows the historic summer averages for each parameter.

Table 2: Ecoregion Values and Average 2009 Parameters

2009 Brown's Creek Watershed Lakes' Summer Averages (June-September)

Lake/Units	Total Phosphorus (mg/L)	Chlorophyll-a (ug/L)	Secchi (feet)	Kjeldahl Nitrogen (mg/L)
Eco-Region Value	*0.023-0.050*	*5.00-22.00*	*4.9-10.5*	*0.60-1.20*
Goggins	0.105	42.50	2.9	2.48
Kismet	0.033	7.63	3.0	0.94
South School Section	0.037	11.85	7.8	1.00
Long	0.048	16.12	7.0	1.39
Benz	0.093	25.13	3.9	1.83
Bass East	0.052	9.96	8.2	1.09
Bass West	0.033	12.32	5.6	0.96
July Ave	0.145	55.33	2.0	2.67
Lynch	0.544	583.00	0.5	10.52
Masterman	0.045	10.81	6.7	1.09
Pat	0.042	10.96	4.7	0.99
Wood Pile	0.040	14.68	7.9	1.11
Plaisted	0.084	47.82	3.3	2.20

1. TRANSPARENCY (SECCHI DISK)

The measurement of depth of light penetration using a Secchi disk gives a simple measure of water transparency, or clarity. It is also a possible indication of turbidity in the water, as well as, an indication of the trophic state of the lake. A reduction in water transparency is usually the result of turbidity composed of suspended sediments, organic matter and/or phytoplankton (algae). The summer average (June-September) water transparency in BCWD lakes, as measured by Secchi disk during the 2009 study can be seen in Figure 3 and Table 2. Typical ranges for this ecoregion are 4.9 - 10.5 feet. Goggin's Lake, Kismet Basin, Pat Lake, Plaisted Lake, Benz Lake, July Avenue Wetland and Lynch Lake had Secchi disk readings less (worse) than the ecoregion range, while, Bass Lake East, Bass Lake West, Long Lake, Masterman Lake, South School Section Lake, and Wood Pile Lake were within the ecoregion range. No lakes were better than the ecoregion range for Secchi transparency.

2. CHLOROPHYLL-*a*

Chlorophyll-*a* is a photosynthetic component found in algae and aquatic plants. It is also an indication of algal productivity. The 2009 summer average chlorophyll-*a* concentrations of BCWD lakes can be seen in Figure 4 and Table 2. The ecoregion value range for chlorophyll-*a* is 5-22 μg/L. Goggin's Lake, Benz Lake, July Avenue Wetland, Plaisted Lake, and Lynch Lake exceeded (were poorer than) the ecoregion range for chlorophyll-*a*. Bass Lake West, Bass Lake East, South School Section Lake, Masterman Lake, Pat Lake, Woodpile Lake, Kismet Basin and Long Lake were within the ecoregion range. No lake was better than the ecoregion range for chlorophyll-*a*.

3. PHOSPHORUS

Phosphorus is a major nutrient involved in eutrophication and is generally associated with the growth of aquatic plants and algal blooms. Common sources of phosphorus include runoff from agricultural fields, livestock areas, urban areas, lakeshore lawns, and improperly operating septic systems. In most lakes in this region, phosphorous is the least available nutrient; therefore, its abundance or scarcity controls the extent of algal growth. Algal growth in turn affects the clarity of the water and light penetration. Total phosphorous (TP) summer average concentrations in BCWD lakes for 2009 can be found in Figure 5 and Table 2. The typical range of the ecoregion values for total phosphorous is 0.023 – 0.050 mg/L. All lakes except Bass Lake West, Long Lake, Pat Lake, Masterman Lake, South School Section Lake, Kismet Basin and Woodpile Lake exceeded (were poorer than) the ecoregion range for total phosphorus in 2009.

4. NITROGEN

Several forms of nitrogen are responsible for health problems and increase the rate of lake eutrophication. Total Kjeldahl nitrogen (TKN) concentrations in BCWD lakes for 2009 can be found in Figure 6 and Table 2. The ecoregion range for total Kjeldahl

nitrogen is 0.60-1.20 mg/L. Bass Lake East, Bass Lake West, Woodpile Lake, Kismet Basin, South School Section Lake, Masterman Lake, and Pat Lake were within the ecoregion value range, but the remaining lakes exceeded (were poorer than) the ecoregion range for total Kjeldahl nitrogen.

5. TEMPERATURE AND DISSOLVED OXYGEN

In addition to surface water measurements, temperature and dissolved oxygen data were taken at each lake during each sampling event. Temperature and dissolved oxygen was recorded at one-meter increments from the surface down to the lake bottom. The data collected from these profiles are contained in a database at the WCD office and are available upon request or can be obtained using the Metropolitan Council's EIMS (Environmental Information Management System) Water Quality Database website (http://es.metc.state.mn.us/eims). These data show the extent of summer stratification and are useful in identifying the thermocline (the layer of water in which the temperature rapidly declines), if one exists. As a lake stratifies, the water column becomes more stable and mixing is less likely to occur. If mixing occurs during the growing season, bottom nutrients become available and can result in increased algal production. Long Lake, Bass Lake East, Plaisted Lake, South School Section Lake and Wood Pile Lake exhibited thermal stratification during the summer months. This shows that these lakes are less likely to completely mix during the summer months; whereas, Bass Lake West, Goggin's Lake, July Avenue Wetland, Lynch Lake, Pat Lake, South School Section Lake, Kismet Basin and Benz Lake did not stratify and were able to mix throughout the summer allowing for more internal loading from available nutrients.

6. TROPHIC STATE AND LAKE GRADES

Many water quality scientists classify lakes according to their trophic state. Average summer values of total phosphorus, chlorophyll-*a*, and transparency (measured with the Secchi disk) are most often used to determine a lake's trophic state. The Carlson Trophic State Index is used to quantify the relationship between trophic status and water quality data. Lakes with low biological productivity or oligotrophic lakes, such as lakes common in the northeast part of Minnesota, have low phosphorus concentrations, low chlorophyll-*a* concentrations, and high Secchi disk transparencies. A good local example of an oligotrophic lake is Little Carnelian Lake, located in Section 3 of Stillwater Township. Mesotrophic lakes have slightly more biological production, and are characteristic of lakes found in the north central forest regions of Minnesota. On the other end of the spectrum, lakes with high biological productivity, characterized by high phosphorus concentrations, high chlorophyll-*a* concentrations, and low Secchi disk transparencies, are eutrophic or even hypereutrophic.

Based upon the 2009 data and utilizing the Carlson's Trophic State Index (Table 3), Goggin's Lake, July Avenue Wetland, Plaisted Lake and Lynch Lake are classified as hypereutrophic; Bass Lake West, Benz Lake, Kismet Basin, Masterman Lake, Pat Lake, Long Lake, South School Section and Wood Pile Lake are classified as eutrophic; and

Bass Lake East was classified as mesotrophic (Table 5). Lakes within the hypereutrophic range typically receive excess nutrient loading from sources within their watersheds. However, some percentage of these nutrients can also be attributed to internal loading within the lake, which is typical of shallow, sediment-rich lakes.

Table 3: Trophic State Index and Ranges

	Trophic State Index	TP (ug/L)	CLA (ug/L)	Secchi (m)
Oligotrophic	<40	<10	<4	>4.8
Mesotrophic	40-50	10-30	4-10	4.8-1.8
Eutrophic	50-70	30-60	10-30	1.8-0.8
Hypereutrophic	>70	>60	>30	<0.8

To allow for a better understanding of lake water quality data and to aid in the comparison of lakes, a Lake Grading System is also used in this report (Table 4). The lake water quality grading system was developed following the 1989 sampling season by Dick Osgood, formerly of the Metropolitan Council. The concept of the lake grading system is a ranking of water quality characteristics by comparing measured values to those of other metro area lakes. The grading curve represents percentile ranges for three water quality indicators; the May through September average values for total phosphorous, chlorophyll-*a* and Secchi disk. These percentiles use ranked data from 119 lakes sampled from 1980-1988 and are shown in Table 4.

Table 4: Lake Grade Ranges

Grade	Percentile	TP (ug/l)	CLA (ug/l)	SD (m)
A	<10	<23	<10	>3.00
B	10-29	23-31	10-19	2.20-3.00
C	30-69	32-67	20-47	1.20-2.19
D	70-90	68-152	48-77	0.70-1.19
F	>90	>152	>77	<0.70

The variables used in the grading system strongly relate to open-water nuisance aspects of a lake (i.e. algal blooms), which can indicate accelerated aging (cultural eutrophication). The Lake Grading System was used for lakes sampled in 2009 with the grades presented in Table 5. Comparing the Lake Trophic Status and the Lake Grading System shows a fair to good correlation between the two systems.

Table 5: 2009 Lake Grades, Trophic State Index, and Trophic Status

Lake	Summer TP Grade & TSI	Summer CLA Grade & TSI	Summer Secchi Grade & TSI	Summer Average Grade & TSI	Trophic Status
Goggins	D	C	D	**D+**	Hypereutrophic
	71	67	62	**67**	
Kismet	C	A	D	**C**	Eutrophic
	55	51	61	**56**	
Long	C	B	C	**C+**	Eutrophic
	60	58	49	**56**	
S School Sec	C	B	B	**B-**	Eutrophic
	56	55	48	**53**	
Benz	D	C	D	**D+**	Eutrophic
	70	62	58	**63**	
Bass East	C	B	B	**B-**	Mesotrophic
	61	53	47	**54**	
Bass West	C	B	C	**C+**	Eutrophic
	55	55	52	**54**	
July Ave	D	D	F	**D-**	Hypereutrophic
	76	70	67	**71**	
Lynch	F	F	F	**F**	Hypereutrophic
	95	93	88	**92**	
Masterman	C	B	C	**C+**	Eutrophic
	59	54	50	**54**	
Pat	C	B	C	**C+**	Eutrophic
	58	54	55	**56**	
Wood Pile	C	B	B	**B-**	Eutrophic
	57	57	47	**54**	
Plaisted	D	C	D	**D+**	Hypereutrophic
	68	69	60	**66**	

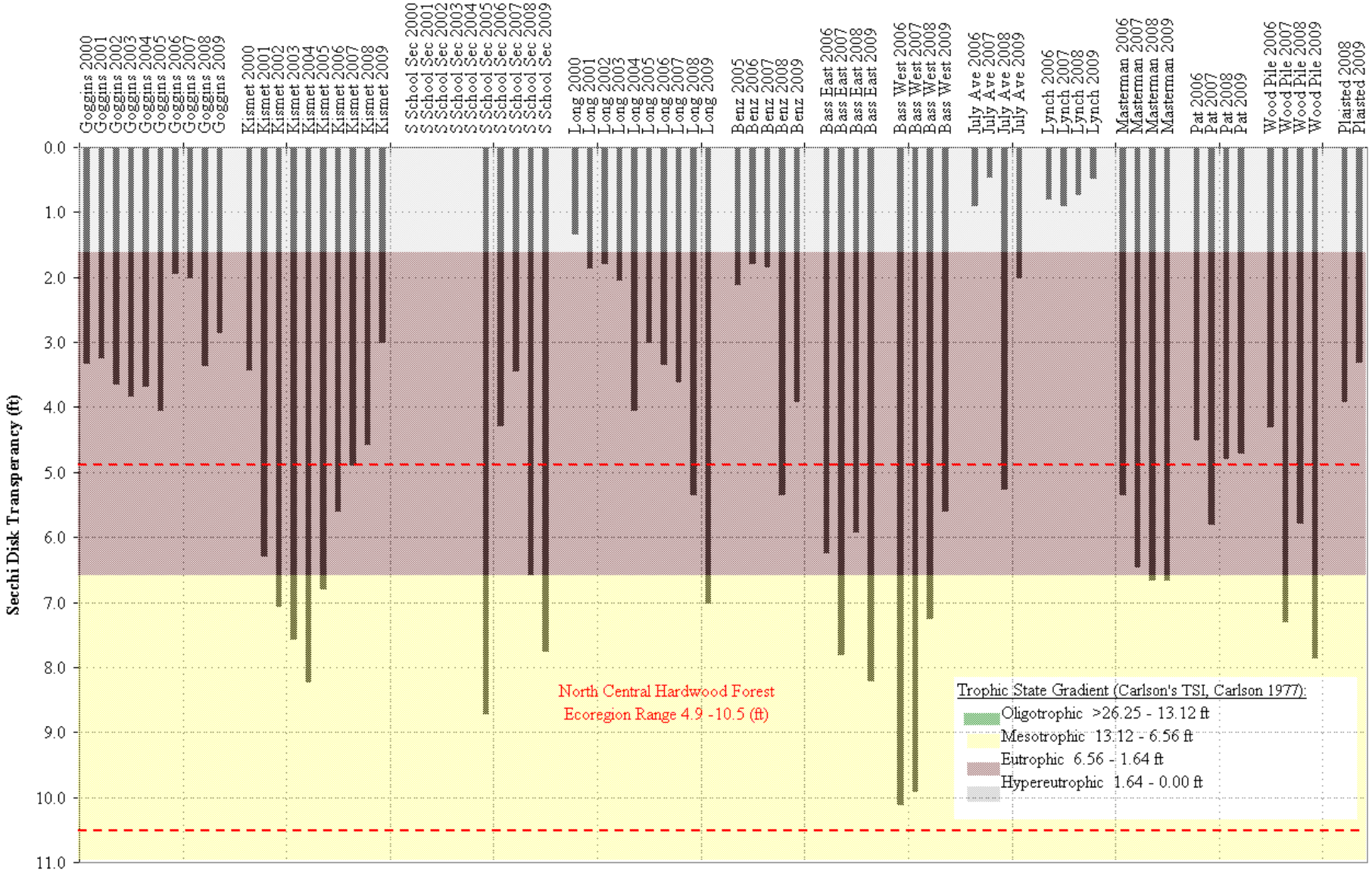


Figure 3: 2009 and Historic Secchi Data

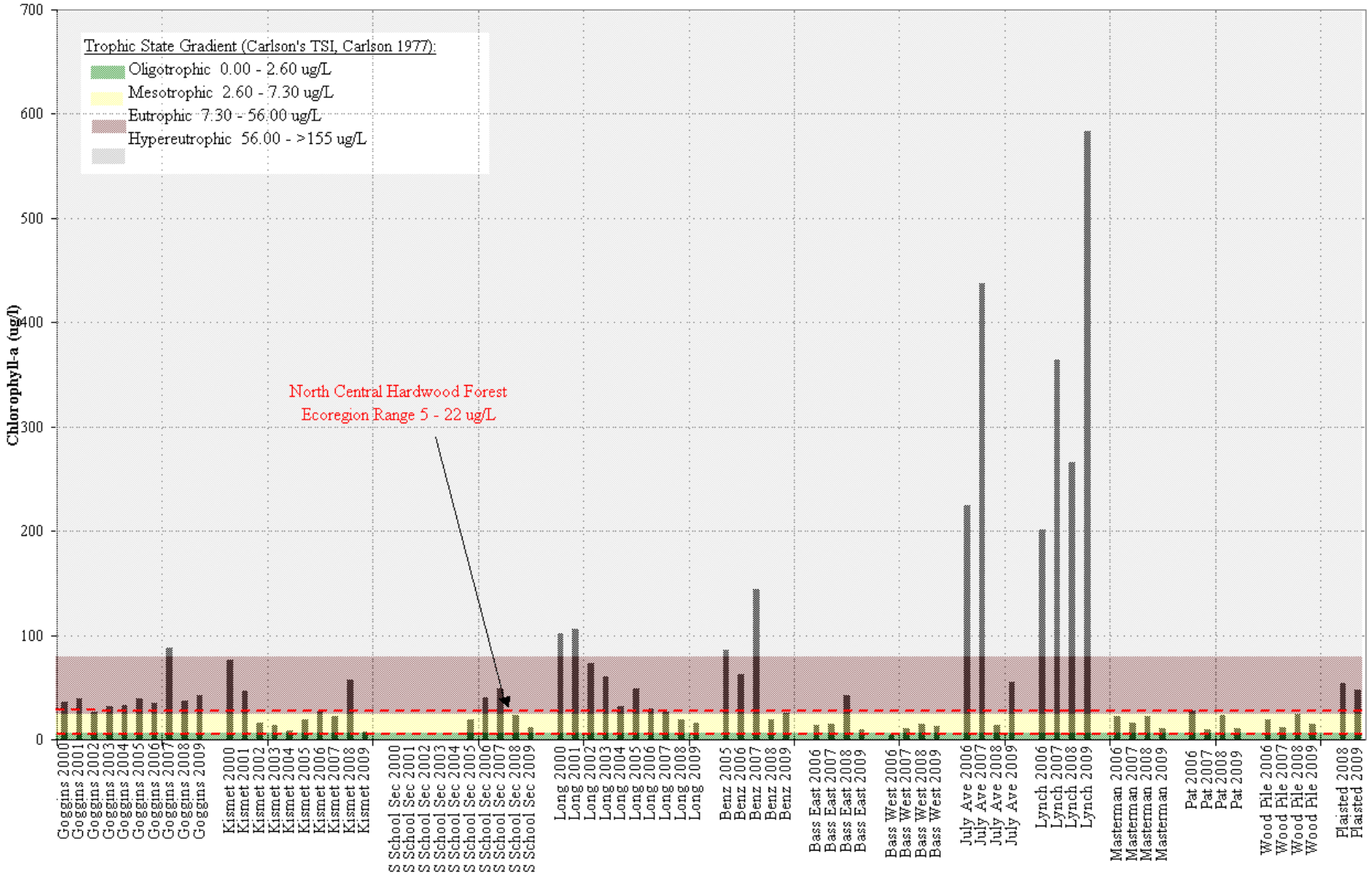


Figure 4: 2009 and Historic Chlorophyll-*a* Data

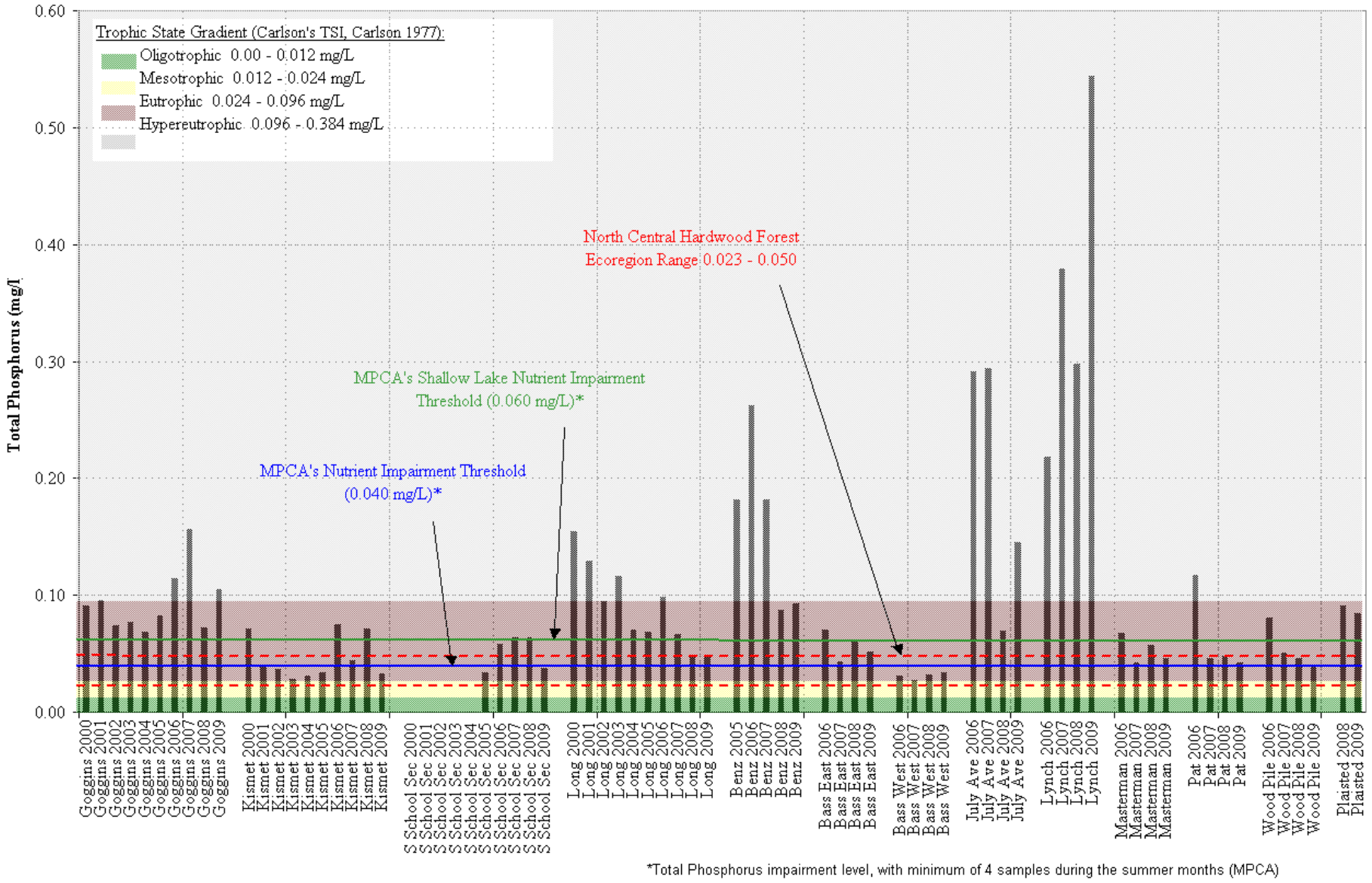


Figure 5: 2009 and Historic Total Phosphorus Data

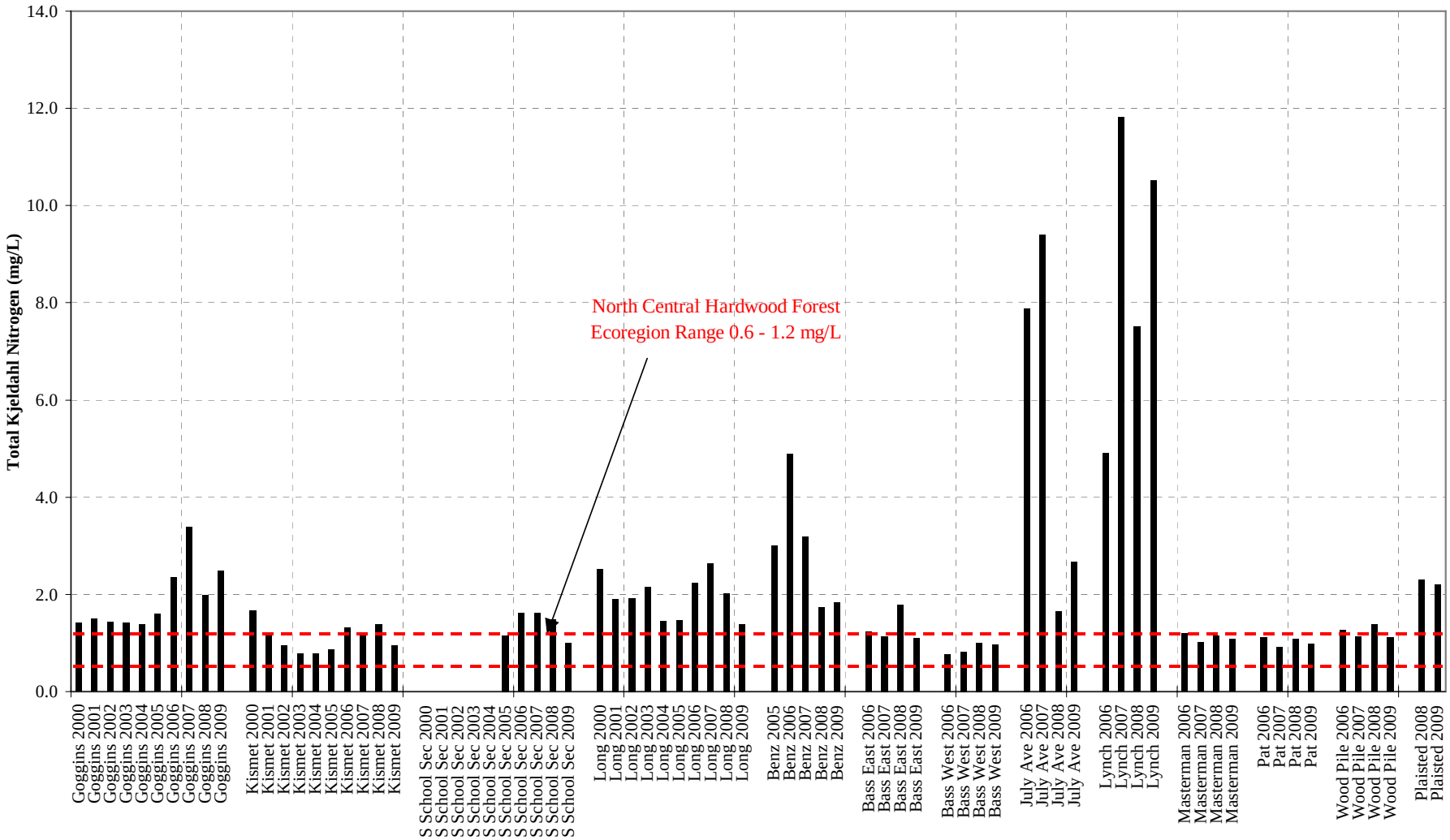


Figure 6: 2009 and Historic Total Kjeldahl Nitrogen Data

7. LAKE ELEVATIONS

Lake elevation gages are located on seventeen lakes and/or wetlands throughout BCWD and are monitored by both WCD staff and volunteers. Complete lake/wetland elevation data for 2009 can be found in Figure 8.

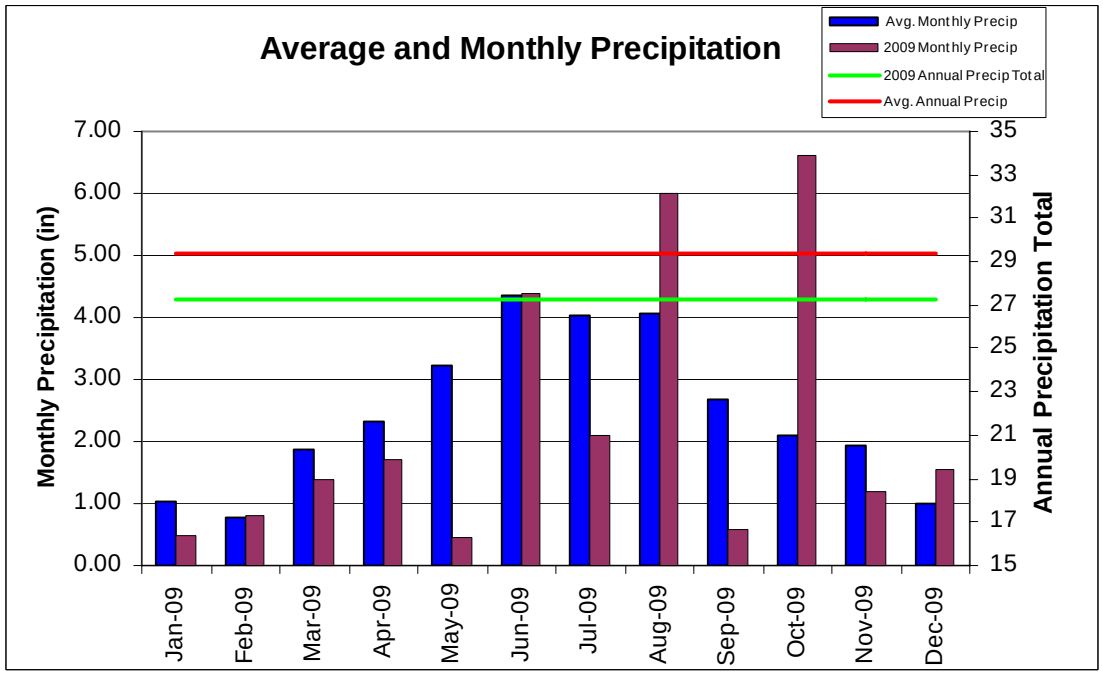
Brown's Creek Watershed District Hydrologic/Hydraulic Study November 1998 (H&H) developed an issues matrix to quantify and summarize flooding impacts. Impacts due to water elevations were determined relative to land that is normally not inundated such as septic systems, wells, residential structures, outbuildings, roads, and driveways. Low impact levels would be water levels above the MN DNR's Ordinary High Water Level that are sustained for long periods of time. Moderate impact levels affect septic systems, drinking water wells, uninhabited structures, or the lowest floor of inhabited structures. In high impact water elevations, water levels are at the lowest opening of inhabited structure or the lowest floor for sustained periods of time. The BCWD updated the H&H Study in 2003, but the issues matrix to quantify and summarize flooding impacts remained unchanged.

Due to the dry summers of 2003-2009, the elevations of the lakes in Brown's Creek Watershed District never were within these developed flooding impact ranges in 2009 (Table 6). Plaisted Lake, South School Section and Wood Pile Lake were within the low impact range for portions of 2008, and Kismet Basin was within the moderate impact range in portions of 2008. In 2009 all peak elevations were below any impact ranges.

Table 6: 2009 Water Elevation Flooding Impacts

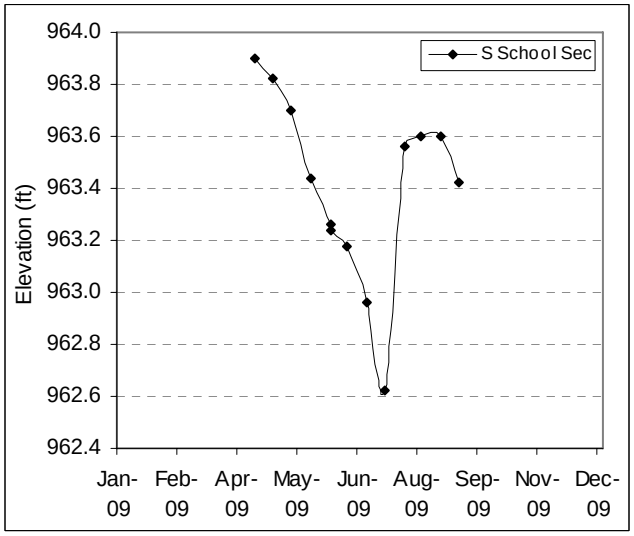
LAKE/WATERBODY	Average Elevation for 2009	Highest Elevation for 2009	Low Impact*	Moderate Impact*	High Impact*
Plaisted	964.57	965.51	*966.0-970.5*	*970.5-971.7*	*>971.7*
School Section	963.40	963.90	*965.3-971.0*	*971-977.2*	*>977.2*
Lynch	1002.75	1003.62	NA	NA	NA
Goggins	962.75	963.62	*966.5-968.2*	----	*>968.2*
July Avenue	968.75	970.08	NA	NA	NA
Benz	952.64	953.43	NA	NA	NA
Bass (West)	947.86	948.72	NA	NA	NA
Unnamed (Bass {East})	953.87	954.65	NA	NA	NA
Pat	938.53	939.28	NA	NA	NA
Kismet	938.38	939.05	*<940.6*	*940.6-946.6*	*>946.6*
BC at Gateway Trail	908.20	908.50	NA	NA	NA
Unnamed 82-0128	977.42	978.09	NA	NA	NA
Masterman	952.26	952.98	NA	NA	NA
Wood Pile	962.87	963.66	*<968.5*	NA	NA
Kimbro and Hwy 12	924.51	925.20	NA	NA	NA
Jackson WMA	889.15	890.26	NA	NA	>893.4
Long	889.54	890.02	NA	NA	*>893.4*

** Brown's Creek Watershed District Hydrologic/Hydraulic Study, February 2004, Section VI Table 21*



Data from WCD Precipitation Gage T 30N R 20W Sec 32

Figure 7: Annual and Monthly Precipitation


S School Sec
Elevation (ft)
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963.8
963.6
963.4
963.2
963.0
962.8
962.6
962.4
Jan-09
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Apr-09
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Jun-09
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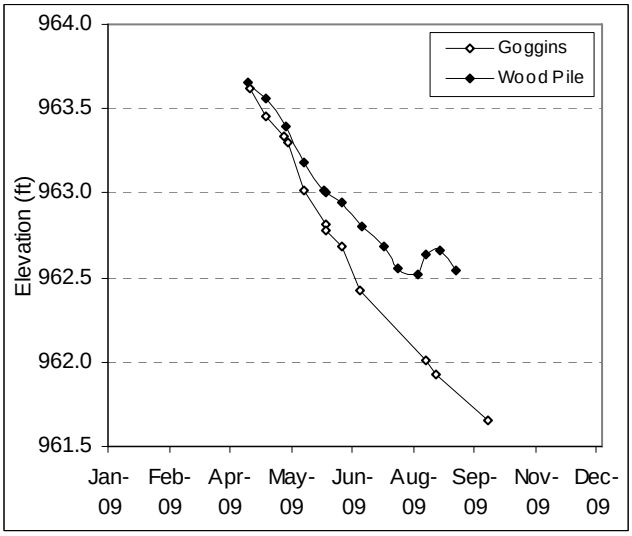
Sep-09
Nov-09
Dec-09


Goggins
Wood Pile
Elevation (ft)
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963.5
963.0
962.5
962.0
961.5
Jan-09
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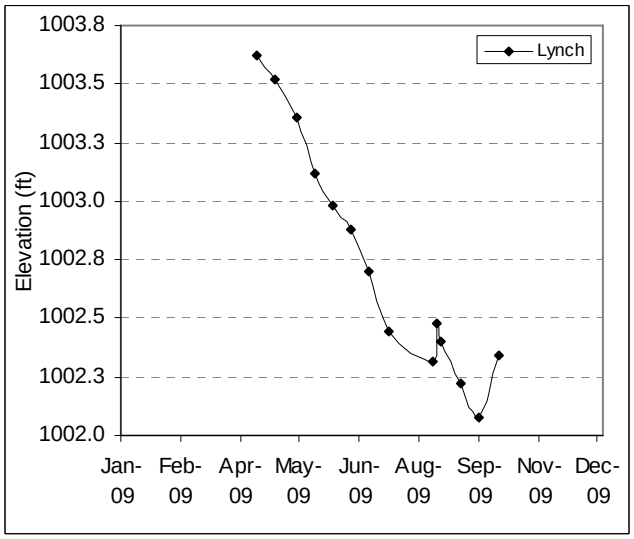
Nov-09
Dec-09


Lynch
Elevation (ft)
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1003.5
1003.3
1003.0
1002.8
1002.5
1002.3
1002.0
Jan-09
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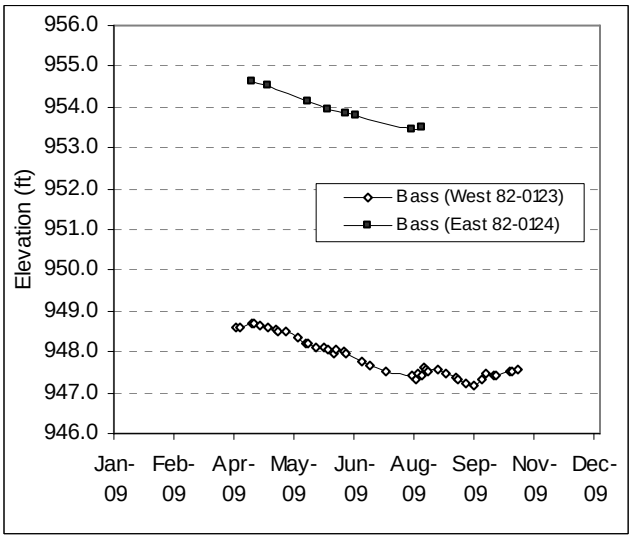
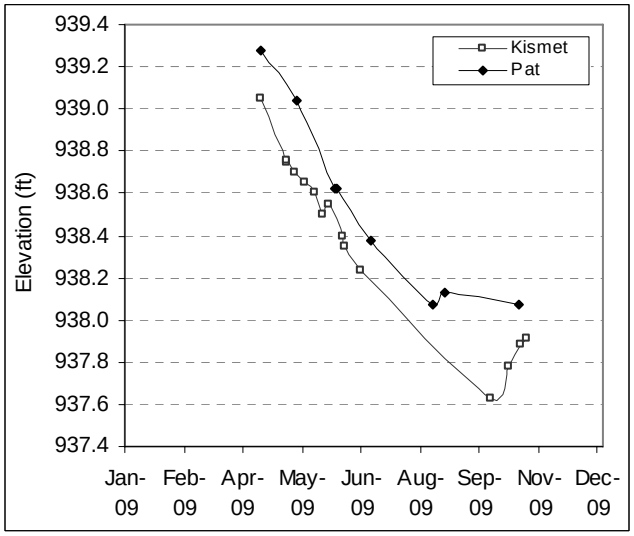
Apr-09
May-09
Jun-09
Aug-09
Sep-09
Nov-09
Dec-09


Bass (West 82-0123)
Bass (East 82-0124)
Elevation (ft)
956.0
955.0
954.0
953.0
952.0
951.0
950.0
949.0
948.0
947.0
946.0
Jan-09
Feb-09
Apr-09
May-09
Jun-09
Aug-09
Sep-09
Nov-09
Dec-09


Kismet
Pat
Elevation (ft)
939.4
939.2
939.0
938.8
938.6
938.4
938.2
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937.8
937.6
937.4
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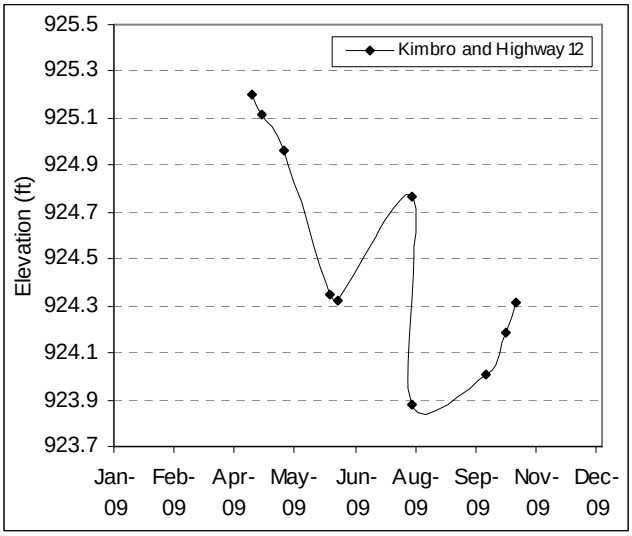
Kimbro and Highway 12
Elevation (ft)
925.5
925.3
925.1
924.9
924.7
924.5
924.3
924.1
923.9
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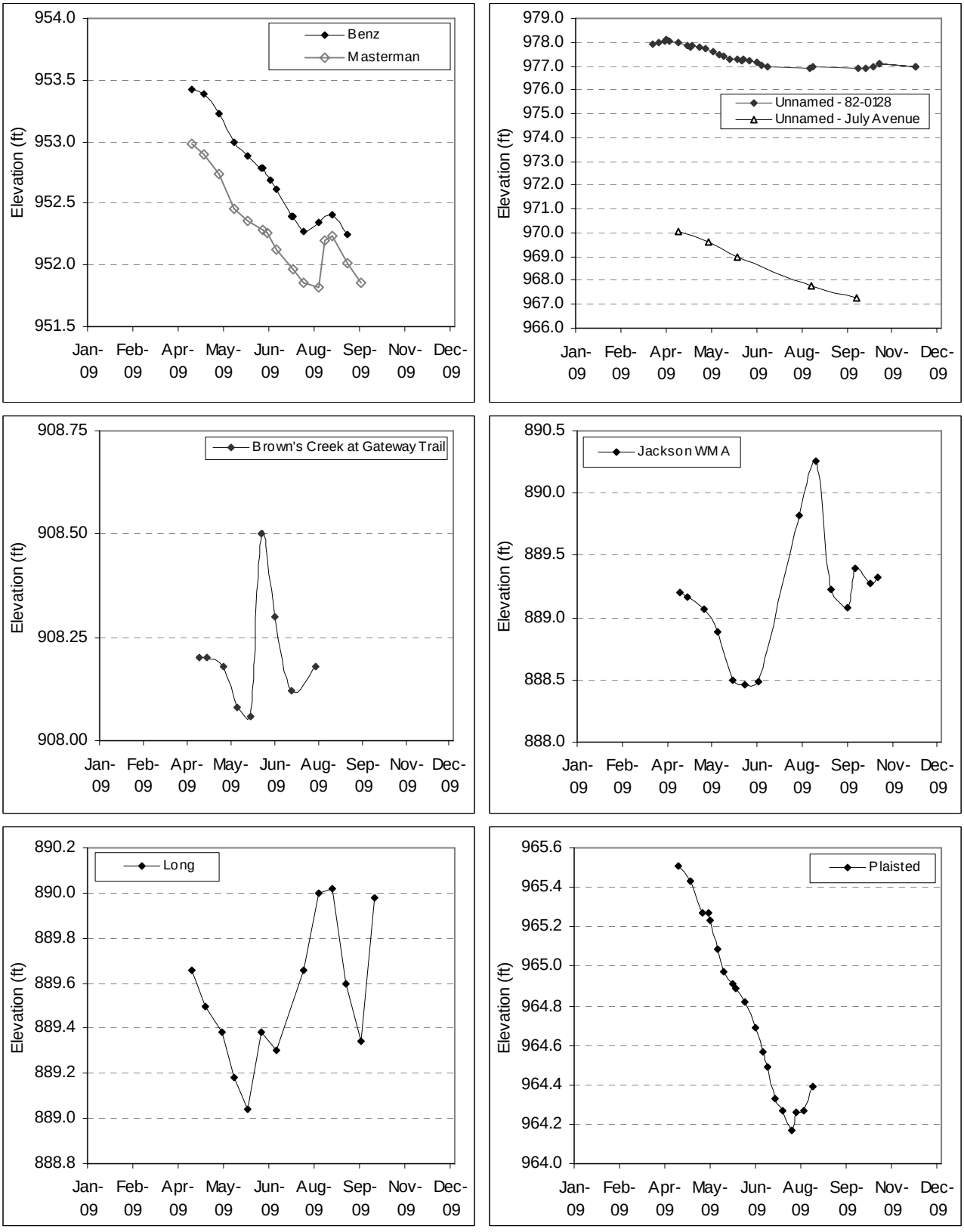


Figure 8: 2009 Lake Levels

LAKE WATER QUALITY CONCLUSIONS AND RECOMMENDATIONS

Lake monitoring in Brown's Creek Watershed District continues to provide valuable baseline water quality information. To determine the health of the lakes in BCWD, physical and chemical parameters are compared on a year-to-year basis.

In 2009, the thirteen lakes monitored had good to very poor water quality ratings and were classified as, mesotrophic (Bass Lake East), eutrophic (Bass Lake West, Benz, Kismet Basin, Long Lake, Masterman Lake, Pat Lake, South School Section Lake and Wood Pile Lake) and hypereutrophic (Goggin's Lake, Plaisted Lake, July Avenue Wetland, and Lynch Lake). The overall 2009 lake grades for BCWD lakes were: Bass Lake East – B-, Wood Pile Lake – B-, South School Section Lake – B-, Bass Lake West – C+, Masterman Lake – C+, Pat Lake – C+, Long Lake – C+, Kismet Basin – C, Goggin's Lake – D+, Benz Lake – D+, Plaisted Lake –D+, July Avenue Wetland – D-, Lynch Lake – F. Of the lakes that were monitored in 2008, three lakes showed a slight deterioration in water quality for the 2009 season (Bass Lake West, Benz Lake and July Avenue Wetland), four lakes maintained their water quality (Long Lake, Plaisted Lake, Goggin's Lake and Lynch Lake), and six lakes improved in water quality (Bass Lake East, Woodpile Lake, Pat Lake, Masterman Lake, Kismet Basin and South School Section Lake). Goggin's Lake, Kismet Basin, Plaisted Lake and Lynch Lake were considered worse than the ecoregion range for total phosphorus, total Kjeldahl nitrogen, chlorophyll-*a*, and Secchi disk transparency. Bass Lake West was within the ecoregion range for total phosphorus, total Kjeldahl nitrogen, chlorophyll-*a*, and Secchi disk transparency. Bass Lake East and South School Section Lake were worse than the ecoregion range for chlorophyll-*a*, total phosphorus and total Kjeldahl nitrogen, but within the ecoregion range for Secchi disk transparency. Benz Lake and July Avenue Wetland were worse than the ecoregion range for total phosphorus and total Kjeldahl nitrogen, and within ecoregion range for chlorophyll-*a* and Secchi disk transparency. Wood Pile Lake was worse than the ecoregion ranges for chlorophyll-*a* and total Kjeldahl nitrogen, and within the ranges for Secchi disk transparency and total phosphorus. Long Lake was worse than the ecoregion range for total Kjeldahl nitrogen, and within ecoregion range for total phosphorus, chlorophyll-*a*, and Secchi disk transparency. Pat Lake was worse than ecoregion values for chlorophyll-*a* and Secchi disk transparency, and within the ranges for total phosphorus and total Kjeldahl nitrogen.

The Washington Conservation District conducted Kendal Tau statistical analysis of all lakes monitored by the WCD to determine any long-term water quality trends. For Brown's Creek Watershed District lakes, only two lakes had a significant trend. Goggin's Lake had a statistically significant decreasing Secchi transparency trend ($p<0.10$) and Long Lake had significantly increasing Secchi disk transparency and improving total phosphorus trends.

Water quality in a lake depends on a number of different variables such as: size of the contributing watershed, depth of the lake, current amount of nutrients available, and amount of nutrients periodically released from the lake bottom and from external sources. Low water quality ratings of BCWD lakes are most likely due to the shallowness of the lakes. Shallow lakes typically will exist in a low algal production, clear-water state or a

high-algal production, turbid water state, but not in between the two states. Shallow lakes do not completely stratify in the summer; therefore they are capable of continually mixing. Mixing causes phosphorus to be distributed throughout the water column, causing more frequent heavy algal blooms. This is unlike deeper, stratified lakes where the phosphorus below the thermocline is not available for primary production. In 2009, both deep and shallow lakes throughout the county showed water quality degradation. One explanation for this reduction in water quality is the warm, dry summer that occurred. Lake elevations were lower than normal and may have contributed to higher water temperatures, more algae production, less dissolved oxygen, and in the breaking of chemical and sediment bonds, resulting in the release of more nutrients into the water. The possibility exists in some lakes with invasive/exotic macrophytes present, for these macrophytes to dieback early in the season releasing more nutrients. The warm weather certainly allowed the mixing of shallow lakes to release more phosphorous. Warmer water has less capacity to hold dissolved oxygen and when lakes or wetlands become anoxic (lacking in oxygen), the possibility of phosphorous release becomes greater. Another factor that may be contributing to the degradation in many of the shallow lakes is that many of our runoff events were intense and short in duration. More pollutants can be introduced in short, heavy storm events than in slow, less intense storm events. Controls on land use practices in the watershed may halt the decline in water quality although it may not be enough to provide short-term noticeable improvements in water quality trends. It is recommended that the BCWD continue lake water quality monitoring to track trends and identify any potential water quality impairments.

The thirteen lakes and four wetlands monitored for water elevation showed peaks from late April to late May in 2009. Levels steadily declined from May until November. The two exceptions to these are Long Lake and Jackson WMA, which had their highest levels occur in August. South School Section also experienced a jump in August, but this peak did not exceed the level of the spring. The decrease in elevation throughout the summer and fall was in large part due to the lack of precipitation during this period. All average water elevations of lakes were below flooding impact ranges, as compared to the Brown's Creek Watershed District's 2003 Hydrologic/Hydraulic Study. It is recommended that water level monitoring continue in the BCWD lakes and wetlands.

The Trophic State Index (TSI), which was developed by Carlson in 1977, is similar to the Metropolitan Council lake grading system in that it is a method to classify and rank lakes based on water quality. A lower TSI value corresponds to lower concentrations of total phosphorus and chlorophyll-*a* and greater Secchi transparencies. The TSI also provides for a method of analysis to determine how a lake is functioning. The TSI values for Secchi depth, chlorophyll-*a*, and total phosphorus are calculated such that equal values for each should occur if a lake is functioning "normally". Deviations from equality in TSI values may indicate some more detailed information about the water quality of a lake (Table 9 and Figure 9). The following tables from Carlson and Simpson (1986) describe how TSI is calculated and what information the TSI values will provide.

Table 7: Trophic State Index Equations

$$TSI(SD) = 60 - 14.41 \ln(SD)$$

$$TSI(CHL) = 9.81 \ln(CHL) + 30.6$$

$$TSI(TP) = 14.42 \ln(TP) + 4.15$$

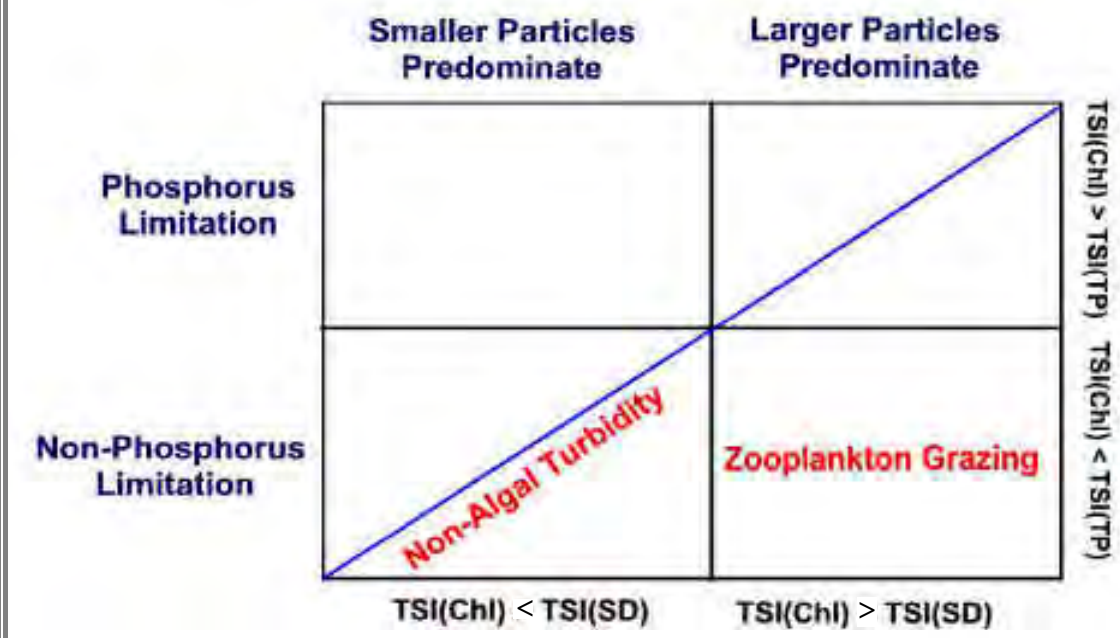
Table 8: Trophic State Gradient

A list of possible changes that might be expected in a north temperate lake as the amount of algae changes along the trophic state gradient.

TSI	CLA (µg/L)	SD (m)	TP (µg/L)	Attributes	Water Supply	Fisheries & Recreation
<30	<0.95	>8	<6	**Oligotrophy:** Clear water, oxygen throughout the year in the hypolimnion	Water may be suitable for an unfiltered water supply.	Salmonid fisheries dominate
30-40	0.95-2.6	8-4	6-12	Hypolimnia of shallower lakes may become anoxic		Salmonid fisheries in deep lakes only
40-50	2.6-7.3	4-2	12-24	**Mesotrophy:** Water moderately clear; increasing probability of hypolimnetic anoxia during summer	Iron, manganese, taste, and odor problems worsen. Raw water turbidity requires filtration.	Hypolimnetic anoxia results in loss of salmonids. Walleye may predominate
50-60	7.3-20	2-1	24-48	**Eutrophy:** Anoxic hypolimnia, macrophyte problems possible		Warm-water fisheries only. Bass may dominate.
60-70	20-56	0.5-1	48-96	Blue-green algae dominate, algal scums and macrophyte problems	Episodes of severe taste and odor possible.	Nuisance macrophytes, algal scums, and low transparency may discourage swimming and boating.
70-80	56-155	0.25-0.5	96-192	**Hypereutrophy:** (light limited productivity). Dense algae and macrophytes		
>80	>155	<0.25	192-384	Algal scums, few macrophytes		Rough fish dominate; summer fish kills possible

Table 9: Relationship between TSI Variables

Relationship Between TSI Variables	Conditions
TSI(CLA) = TSI(TP) = TSI(SD)	Algae dominate light attenuation; TN/TP ~ 33:1
TSI(CLA) > TSI(SD)	Large particulates, such as *Aphanizomenon* flakes, dominate
TSI(TP) = TSI(SD) > TSI(CHL)	Non-algal particulates or color dominate light attenuation
TSI(SD) = TSI(CHL) > TSI(TP)	Phosphorus limits algal biomass (TN/TP >33:1)
TSI(TP) >TSI(CHL) = TSI(SD)	Algae dominate light attenuation but some factor such as nitrogen limitation, zooplankton grazing or toxics limit algal biomass.



A representation of possible explanations of deviations of the Trophic State Index equations.

Figure 9: Deviations of the Trophic State Index Values for Different Parameters

III. BROWN'S CREEK

A. METHODS, RESULTS, AND DISCUSSION

Brown's Creek is a spring fed tributary of the St. Croix River. It is 9.7 miles long, flowing from its source through a variety of glacial drift landscapes. The middle reach of the stream flows through various wetlands and marshes with substrates of mucky peat, changing to course sand-gravel in areas with higher gradients. The lower reaches of the stream cut deeply into steeply sloping hills of sandstone and dolomite adjacent to the St. Croix River. Groundwater springs provide a major hydrologic input of this portion of the stream, and is the only portion that supports trout. The DNR Fisheries have stocked the lower reach annually with as many as 1000 yearling trout. Brown trout do reproduce naturally in the stream.

About 2,200 feet of Brown's Creek underwent realignment in the fall of 1999. Before the realignment the stream ran through a ditched channel in a wetland adjacent to McKusick Lake. The new channel no longer runs through the wetland and was constructed to mimic a natural gravel streambed with a series of pools and riffles. This restored channel is significantly shorter than the old channel; therefore peak flows are expected to increase downstream. The time of travel through this section of stream will decrease significantly, so water temperature should decrease as well. The macroinvertebrate and fish population may also change along with changes in hydrology, substrate, dissolved oxygen and temperature in this portion of the stream.

The City of Stillwater completed the Trout Stream Mitigation Project (TSMP) in June 2003 and has been functioning to divert stormwater from the 1800-acre Annexation Area away from Brown's Creek, through McKusick Lake to the St. Croix River. This diversion structure will keep the warmer urban stormwater from the southern tributary out of the temperature and nutrient sensitive Brown's Creek Ravine.

In 2008, the subwatershed acreages for each monitoring site were updated in accordance with the 2003 H&H study. Previous drainage areas had been based on the 1998 study. Landlocked basins, areas that do not produce runoff in a 100 year or 24 hour storm event, were not included in the new drainage acreages. Note that these changes will make current and future loading amounts per acre appear to be higher than past values. This is because the number of acres for each subwatershed decreased, thereby increasing the concentration load. Also note that the TSMP/Diversion Structure is designed to divert flows from the Long Lake drainage away from Brown's Creek up to the 1.5 year storm event under fully developed conditions. Since the diversion structure was completed in June 2003, all flows from the Long Lake drainage have been diverted away from Brown's Creek toward McKusick Lake and on to the St. Croix River. Therefore, the drainage areas for the monitoring sites downstream of the diversion structure (McKusick, Stonebridge, and the Outlet at Hwy 96) do not include the diversion drainage areas. It may be necessary in the future to add the diversion drainage areas for these sites if monitoring data shows that the flows are not being diverted in their entirety.

1. FLOW AND WATER QUALITY

In 2009, the WCD took grab samples and/or flow-weighted samples during both base flow and storm event conditions at fifteen locations within the watershed. Seven automated samplers continuously monitored stream flow and collected storm and base flow composite samples from March through November and one continuously monitored stream flow all year (Brown's Creek Outlet). Brown's Creek was monitored at Highway 15, approximately 4.5 miles from the mouth, McKusick Road, approximately 1.7 miles from the mouth, Stonebridge, approximately 1.2 miles from the mouth, and at the Creek Outlet (Figure 1). Tributaries to Long Lake were monitored at 62nd Street (south drainage to Long Lake), the Herberger's Pond (~0.95 miles southeast of Long Lake) and the Marketplace pond (~0.5 miles southeast of Long Lake). The drainage from Long Lake to McKusick Lake (at the Brown's Creek Diversion Structure) was also monitored to determine quantity and quality of water diverted to McKusick Lake. Field flow measurements and water quality grab samples were collected at Long Lake Outlet, Jackson WMA Pond Outlet, and the drainage crossing at Boutwell Rd. In 2009 field flow measurements and water quality grab samples were collected at four additional sites along the annexation area drainage (West Branch 1,West Branch 2, North Branch and South Branch). Data collected by the WCD included the total discharge, temperature, precipitation, conductivity, dissolved oxygen, pH, and analytical analysis (performed by MVTL lab) can be seen in Table 1. A list of WCD standard operating procedures can be found at http://www.mnwcd.org/water_monitoring_standards.php. All stream flow and chemistry data from 2009 can be found on pages 26-64. Historical ranges for water quality samples collected on Brown's Creek can be seen starting with Figure 10. Using a combination of composite and grab samples, total phosphorus and total suspended solid loads were calculated at all sites. The results were compared to a chart of export coefficients in a variety of land use scenarios and show the Brown's Creek Watershed within regional averages for total phosphorus at all sites. From 2003 to 2009, the total phosphorus and total suspended solids loading estimates greatly decreased (where data was available for comparison) from the loading levels of 2001-2002 (Figure 10 and Figure 11). The lack in overall runoff during the 2003 to 2009 seasons is the major contributor to the decline in total loads that were seen. The minimal snowfall in the winters of 2002-03, 2003-04, 2004-05, 2005-06, 2006-07 and 2007-08 and the dry summers of 2003-2009 primarily caused the runoff reduction experienced in 2003-2009. Also note that values after 2003 are relatively higher than expected, due to the removal of the TSMP annexation area subwatershed acreage from the loading estimates of sites downstream of the Diversion Structure, as well as updates made by the 2003 H&H study.

The total phosphorus load from Brown's Creek to the St. Croix River in 2009 was **2,448 lbs (0.27 lbs per acre of watershed land)**, determined by the Brown's Creek Outlet station results.

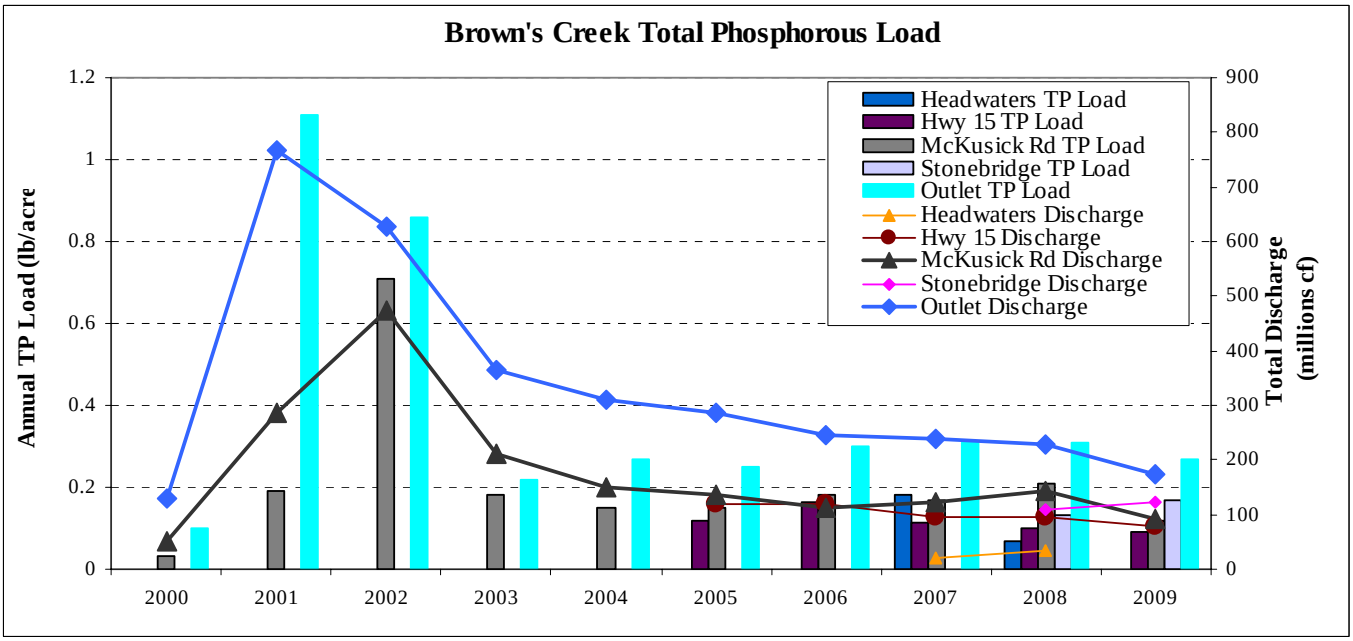


Figure 10: Brown's Creek Annual Total Phosphorus Loads

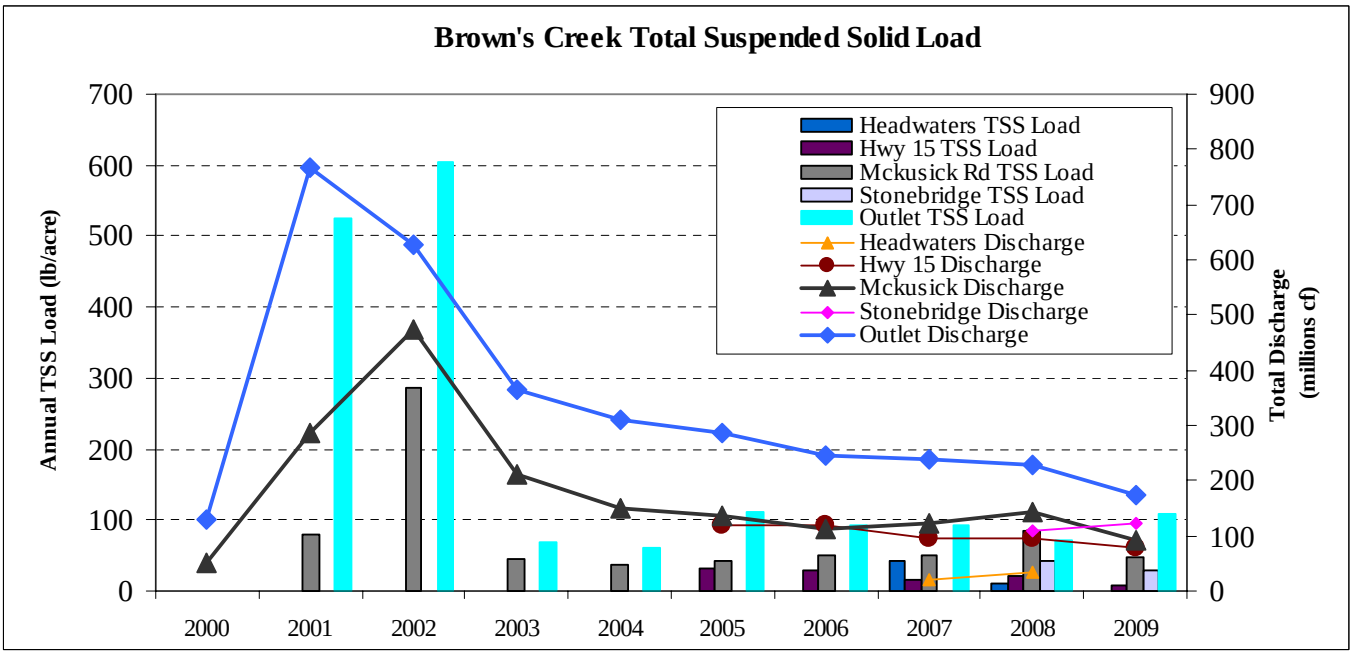


Figure 11: Brown's Creek Annual Total Suspended Solids Loads

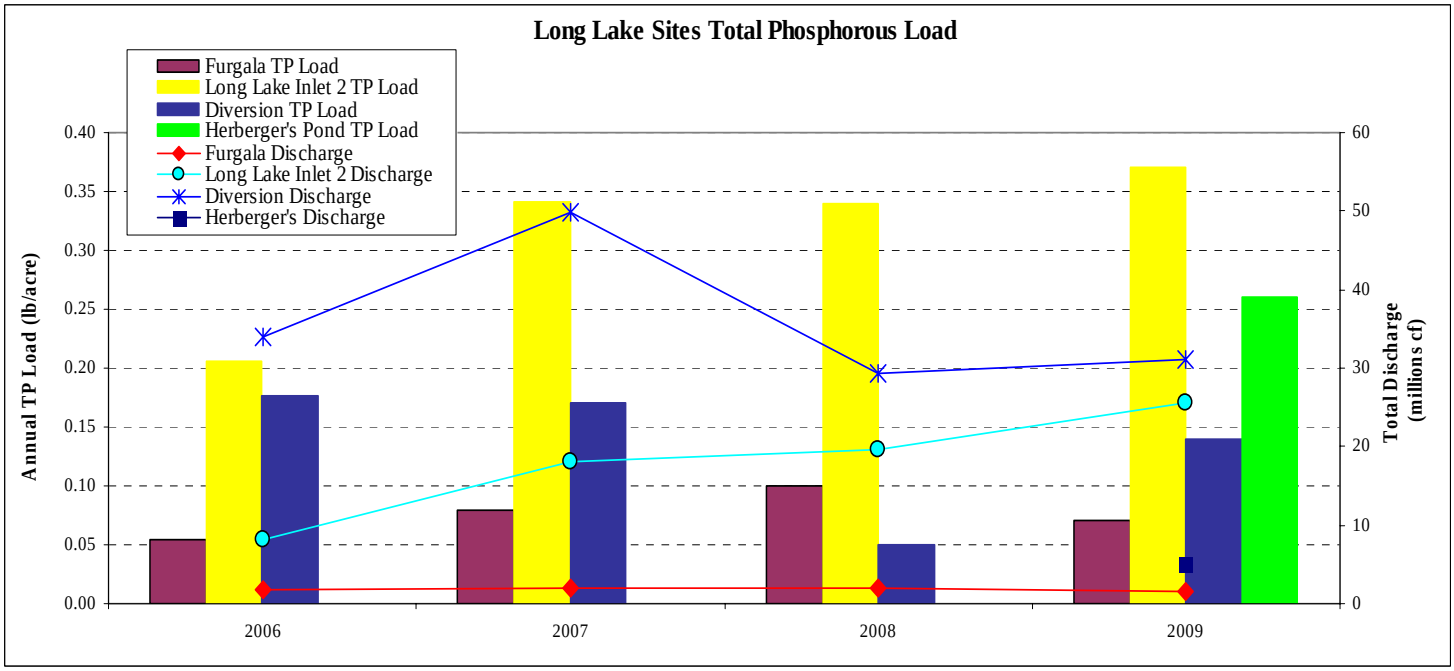


Figure 12: Long Lake Drainage Sites Total Phosphorous Loads

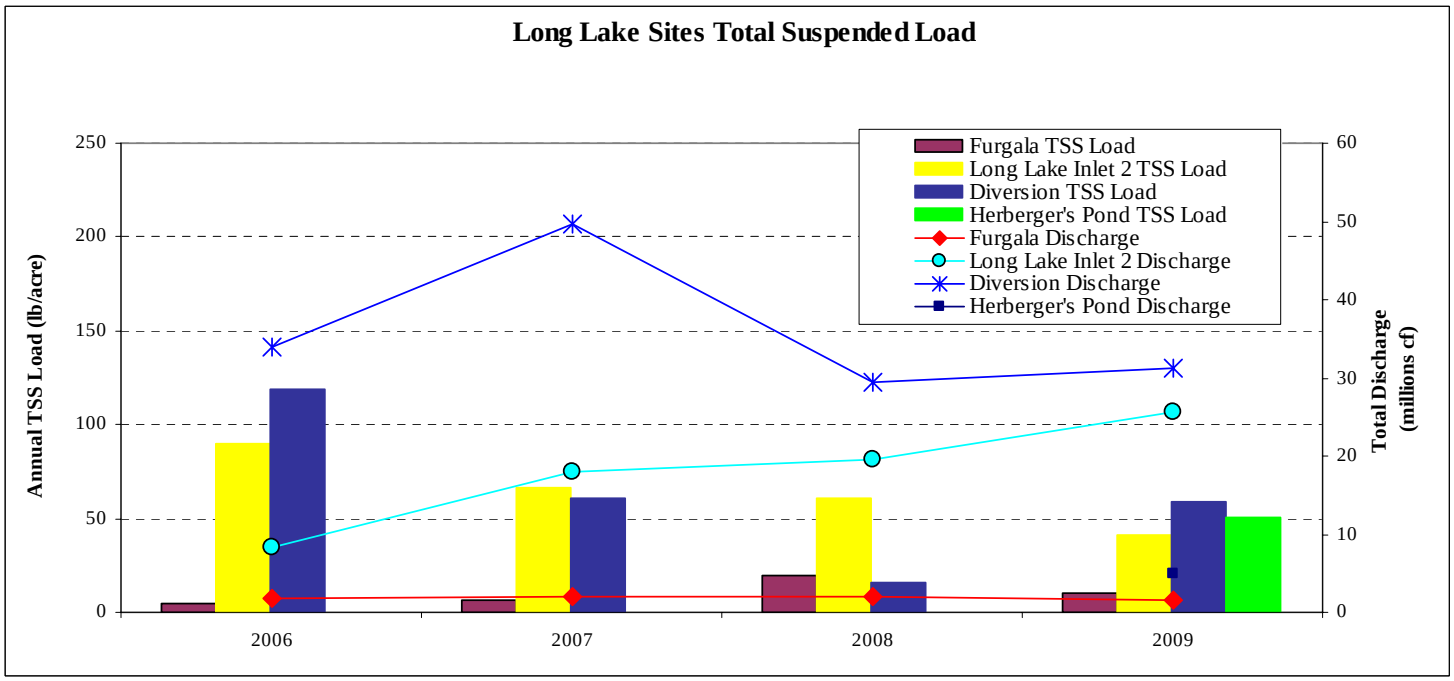


Figure 13: Long Lake Drainage Sites Total Suspended Solids Loads

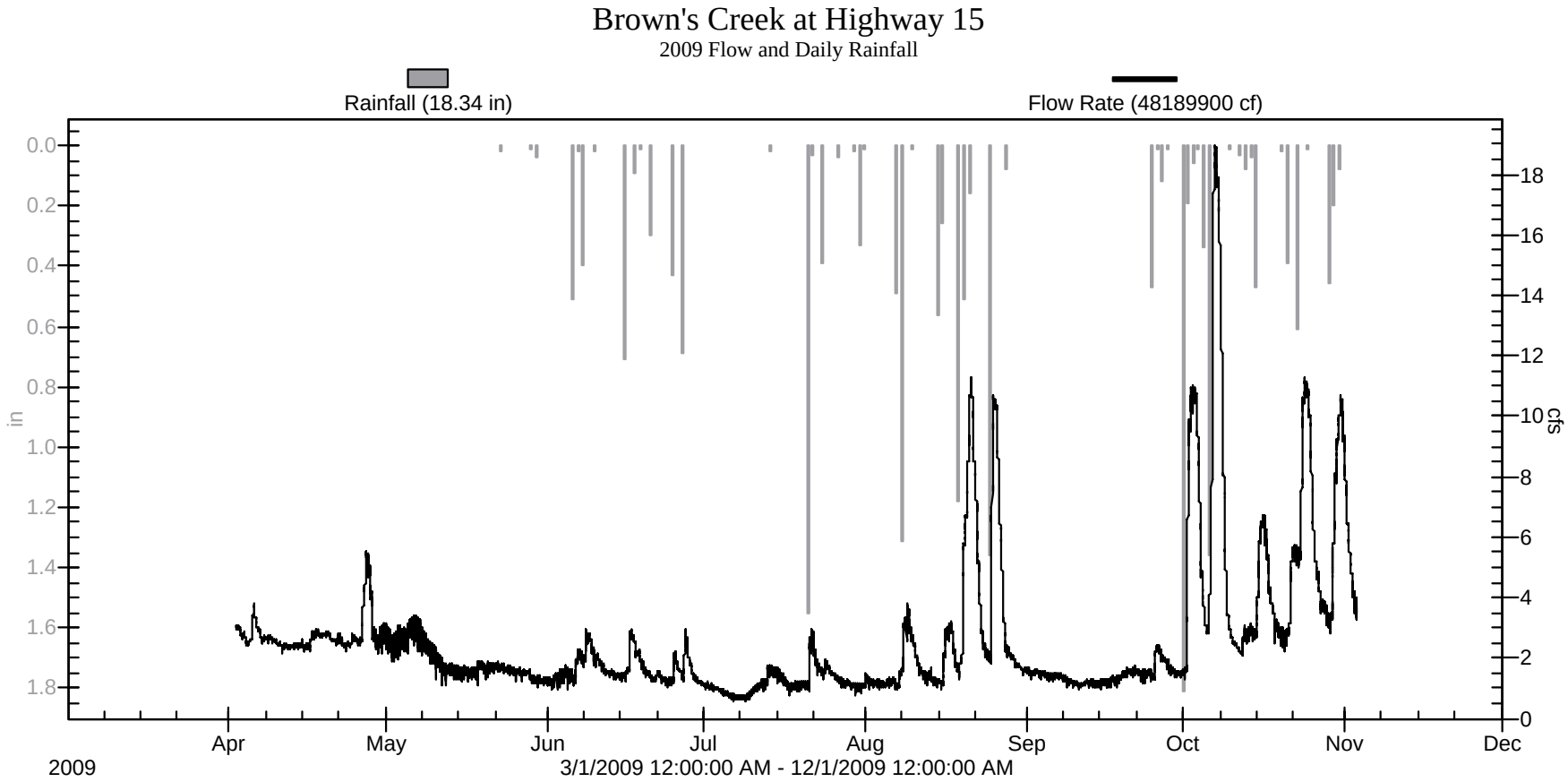


Figure 14. Brown's Creek at Highway 15 2009 Flow and Daily Rainfall

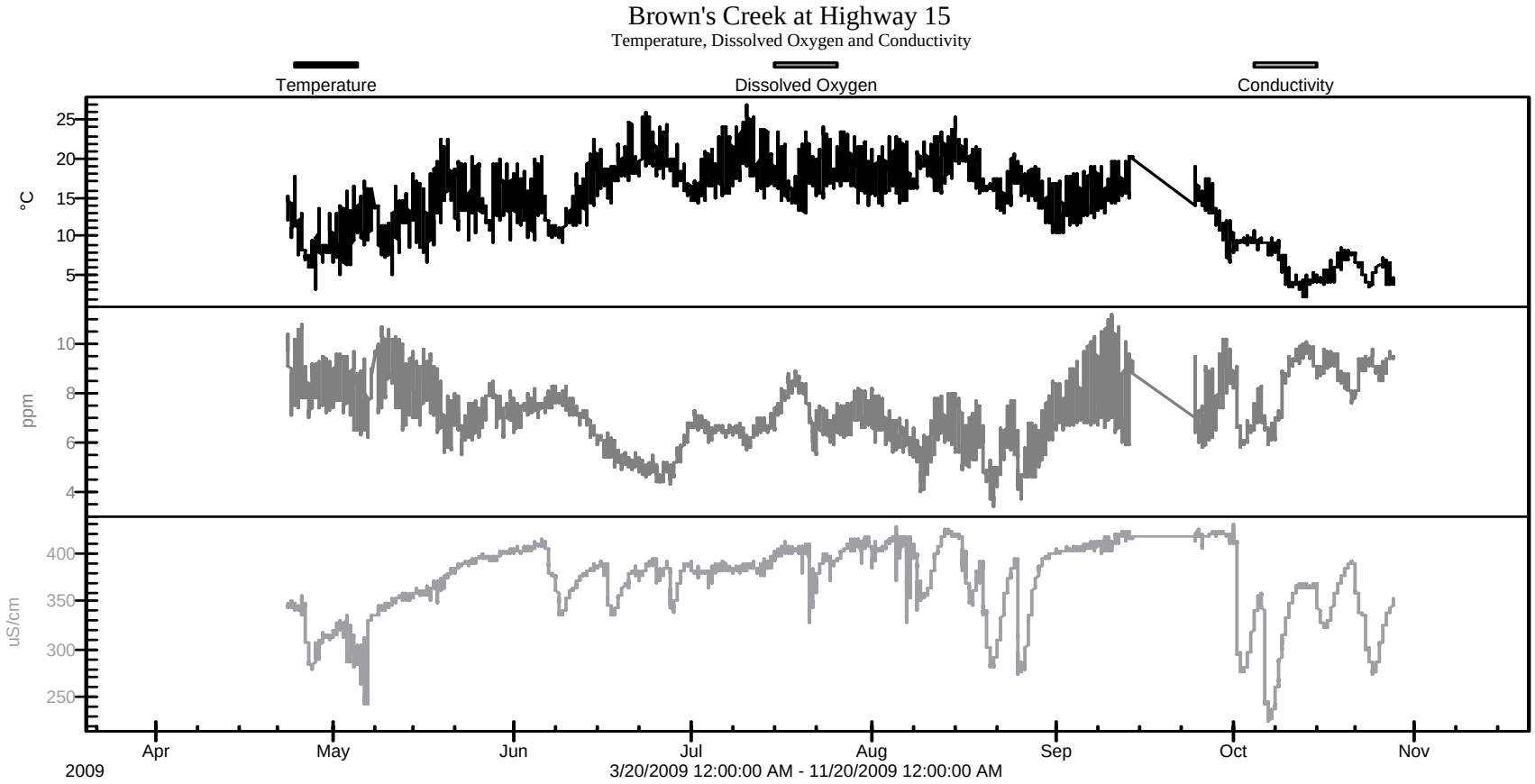


Figure 15. Brown's Creek at Hwy 15 2009 15-Minute Recorded Temperature, Dissolved Oxygen, and Conductivity

Table 10. Brown's Creek at Highway 15 2009 Total Suspended Solids (TSS) and Phosphorus (TP) Loading

	Sample Collection Time				Loading Interval					
Sample Type	**Start**	**End**	**TSS (mg/L)**	**TP (mg/L)**	**Start**	**End**	**Interval Volume (cf)**	**Interval Volume (ac-ft)**	**Interval TP (lb)**	**Interval TSS (lb)**
*Base***			*6*	*0.139*	*1/1/2009 0:00*	*3/17/2009 4:00*	*12,988,800*	*298.34*	*112.71*	*4,865*
Snowmelt Grab**	3/17/09 12:00	3/17/09 12:00	81	0.295	3/17/2009 4:00	3/18/2009 17:00	532,800	12.24	9.81	2,694
*Base***			*6*	*0.139*	*3/18/2009 17:00*	*3/24/2009 17:00*	*1,036,800*	*23.81*	*9.00*	*388*
Storm Grab**	3/24/09 8:50	3/24/09 8:50	12	0.095	3/24/2009 17:00	3/26/2009 17:00	691,200	15.88	4.10	518
*Base***			*6*	*0.139*	*3/26/2009 17:00*	*4/2/2009 11:15*	*1,168,200*	*26.83*	*10.14*	*438*
Base			*6*	*0.139*	*4/2/2009 11:15*	*4/5/2009 11:15*	*709,049*	*16.29*	*6.15*	*266*
Storm			*27*	*0.140*	*4/5/2009 11:15*	*4/6/2009 6:15*	*230,523*	*5.29*	*2.01*	*389*
Base			*6*	*0.139*	*4/6/2009 6:15*	*4/26/2009 10:15*	*4,490,006*	*103.13*	*38.96*	*1,682*
Storm			*27*	*0.140*	*4/26/2009 10:15*	*4/28/2009 0:15*	*633,735*	*14.56*	*5.54*	*1,068*
Base Grab	5/13/09 8:30	5/13/09 8:30	5	0.055	4/28/2009 0:15	5/19/2009 0:15	4,238,849	97.36	14.55	1,323
Base			*6*	*0.139*	*5/19/2009 0:15*	*6/6/2009 7:15*	*2,410,024*	*55.36*	*20.91*	*903*
Storm			*27*	*0.140*	*6/6/2009 7:15*	*6/9/2009 14:15*	*647,863*	*14.88*	*5.66*	*1,092*
Base			*6*	*0.139*	*6/9/2009 14:15*	*6/16/2009 3:15*	*919,157*	*21.11*	*8.03*	*1,549*
Storm			*27*	*0.140*	*6/16/2009 3:15*	*6/17/2009 20:15*	*338,993*	*7.79*	*2.96*	*571*
Base Grab	6/24/09 8:25	6/24/09 8:25	12	0.170	6/17/2009 20:15	6/25/2009 4:15	968,352	22.24	10.28	725
Storm			*27*	*0.140*	*6/25/2009 4:15*	*6/25/2009 21:15*	*117,563*	*2.70*	*1.03*	*198*
Base			*6*	*0.139*	*6/25/2009 21:15*	*6/27/2009 3:15*	*166,684*	*3.83*	*1.45*	*62*
Storm			*27*	*0.140*	*6/27/2009 3:15*	*6/28/2009 1:15*	*186,372*	*4.28*	*1.63*	*314*
Base Grab	7/13/09 8:56	7/13/09 8:56	5	0.095	6/28/2009 1:15	7/15/2009 1:15	1,593,543	36.60	9.45	497
Base			*6*	*0.139*	*7/15/2009 1:15*	*7/21/2009 7:15*	*656,274*	*15.07*	*5.69*	*246*
Storm			*27*	*0.140*	*7/21/2009 7:15*	*7/22/2009 9:15*	*230,901*	*5.30*	*2.02*	*389*
Base			*6*	*0.139*	*7/22/2009 9:15*	*7/24/2009 8:15*	*288,400*	*6.62*	*2.50*	*108*
Storm			*27*	*0.140*	*7/24/2009 8:15*	*7/24/2009 18:15*	*65,552*	*1.51*	*0.57*	*25*
Base			*6*	*0.139*	*7/24/2009 18:15*	*7/31/2009 21:15*	*770,645*	*17.70*	*6.69*	*289*
Storm			*27*	*0.140*	*7/31/2009 21:15*	*8/1/2009 7:15*	*48,904*	*1.12*	*0.43*	*82*
Base Grab	8/6/09 8:22	8/6/09 8:22	5	0.350	8/1/2009 7:15	8/7/2009 9:15	640,239	14.71	13.99	200
Storm Composite	8/8/09 10:45	8/10/09 2:20	28	0.168	8/7/2009 9:15	8/10/2009 3:15	601,027	13.80	6.30	1,051
Base			*6*	*0.139*	*8/10/2009 3:15*	*8/15/2009 21:15*	*763,283*	*17.53*	*6.62*	*286*
Storm Grab	8/17/09 9:24	8/17/09 9:24	9	0.121	8/15/2009 21:15	8/18/2009 1:15	494,874	11.37	3.74	278
Base			*6*	*0.139*	*8/18/2009 1:15*	*8/19/2009 3:15*	*164,509*	*3.78*	*1.43*	*62*
Storm Composite	8/19/09 17:50	8/21/2009 10:34	36	0.195	8/19/2009 3:15	8/22/2009 12:15	2,092,290	48.06	25.47	4,702
Base			*6*	*0.139*	*8/22/2009 12:15*	*8/25/2009 5:15*	*673,215*	*15.46*	*5.84*	*252*
Storm			*27*	*0.140*	8/25/2009 5:15	8/27/2009 0:15	1,354,582	31.11	11.84	2,283
Base Grab	9/8/09 10:39	9/8/09 10:39	3	0.061	8/27/2009 0:15	9/10/2009 0:15	2,083,047	47.85	7.93	390
Base			*6*	*0.139*	*9/10/2009 0:15*	*9/25/2009 12:15*	*1,790,618*	*41.13*	*15.54*	*671*
Storm			*27*	*0.140*	*9/25/2009 12:15*	*9/26/2009 16:15*	*221,882*	*5.10*	*1.94*	*374*
Base Grab	9/29/09 7:59	9/29/09 7:59	3	0.104	9/26/2009 16:15	10/1/2009 15:15	722,646	16.60	4.69	135
Storm Composite	10/1/09 17:11	10/3/2009 6:31	24	0.153	10/1/2009 15:15	10/3/2009 22:15	1,878,527	43.15	17.94	2,814
Base			*6*	*0.139*	*10/3/2009 22:15*	*10/5/2009 19:15*	*729,049*	*16.75*	*6.33*	*273*
Storm Composite	10/6/09 3:39	10/7/09 7:40	53	0.106	10/5/2009 19:15	10/8/2009 12:15	3,078,707	70.71	20.37	10,186
Base			*6*	*0.139*	*10/8/2009 12:15*	*10/15/2009 0:15*	*1,813,568*	*41.66*	*15.74*	*679*
Storm			*27*	*0.140*	*10/15/2009 0:15*	10/17/2009 5:15	1,079,371	*24.79*	*9.43*	*1,819*
Base			*6*	*0.139*	*10/17/2009 5:15*	*10/21/2009 12:15*	*1,199,677*	*27.56*	*10.41*	*449*
Storm			*27*	*0.140*	*10/21/2009 12:15*	*10/23/2009 6:15*	*811,558*	*18.64*	*7.09*	*1,368*
Storm			*27*	*0.140*	*10/23/2009 6:15*	*10/25/2009 14:15*	*1,898,662*	*43.61*	*16.59*	*3,200*
Base			*6*	*0.139*	*10/25/2009 14:15*	*10/29/2009 11:15*	*1,464,873*	*33.65*	*12.71*	*549*
Storm			*27*	*0.140*	*10/29/2009 11:15*	*11/1/2009 6:15*	*2,033,750*	*46.71*	*17.77*	*3,428*
Base			*6*	*0.139*	*11/1/2009 6:15*	*11/3/2009 8:15*	*891,325*	*20.47*	*7.73*	*334*
*Base***			*6*	*0.139*	*11/3/2009 8:15*	*1/1/2010 0:00*	*15,203,700*	*349.21*	*131.93*	*5,695*
Storm Average			27	0.140						
Base Average			6	0.139						
All Average			23	0.135						
Total							**79,814,166**	**1,833**	**672**	**62,160**
Brown's Creek Major Subwatershed Total Acres							7,135			
Total TP/TSS(lb/ac/yr)									0.09	8.71
Total TP/TSS (kg/ha/yr)									0.11	9.76

*Italics indicate estimated concentrations based on average base and storm flow concentrations

**Interval volumes from 1/1/09 to 4/2/09 and 11/3/09 to 1/1/10 were estimated using base flow

Table 11. Brown's Creek at Highway 15 2009 Primary Chemistry Result Averages

Parameter	Storm Flow Average	Base Flow Average	Average (all samples)
TSS (mg/L)	27	6	23
VSS (mg/L)	37	3.5	13
TKN (mg/L)	1.06	0.458	0.854
TP (mg/L)	0.140	0.139	0.135
E. Coli (mpn/100 mL)	--	--	268

Table 12. Brown's Creek at Highway 15 2009 Field Measurement Results

Date	Transparency (cm)	Water Temperature (C)	Dissolved Oxygen (mg/L)	Conductivity (umhos/cm)	pH
3/17/2009 11:55	35	1.5	9.41	237	6.9
3/24/2009 8:50	70	3.5	8.77	256	6.8
4/23/2009 14:20		12.2	9.61	348	7.8
5/7/2009 13:56	>120	16.3	8.62	335	7.5
5/13/2009 8:27		11.6	6.70		7.4
5/22/2009 8:28	>100	10.8	7.48	384	8.2
5/28/2009 9:36	>100	10.5	8.40	480	7.9
6/4/2009 9:42	>100	12.3	7.74	405	8.1
6/10/2009 9:44	>100	11.7	7.30	360	7.9
6/12/2009 14:13	>100				
6/18/2009 9:11	>100	17.1	5.24	345	
6/24/2009 8:25	>100	19.6	5.01	393	7.8
6/25/2009 9:52	47	18.8	4.27	373	7.7
6/30/2009 8:19	>100	15.4	6.14	391	7.9
7/1/2009 13:50	>100	16.5	7.02	380	
7/6/2009 10:31	>100				
7/9/2009 10:56	>100				
7/13/2009 8:55	>120	15.6	6.68	380	
7/17/2009 9:32	>100	14.8	8.16	407	8.5
7/24/2009 9:53	79	16.9	5.95	382	7.9
7/29/2009 8:18	>100	14.6	7.10	408	8.2
7/31/2009 8:24	>100	14.4	7.33	409	8.4
8/6/2009 8:22	>100	14.8	5.81	418	8.1
8/10/2009 11:33	>100	20.0	6.36	365	7.8
8/13/2009 8:13	>100		6.34	424	7.9
8/17/2009 9:23	>100	17.6	5.67	350	7.57
8/21/2009 13:28	80	16.9	4.67	289	7.7
8/25/2009 14:35	51	19.3	4.78	297	7.5
8/27/2009 8:59	>120	14.8	5.10	324	7.7
8/27/2009 14:12	>100	18.6	6.70	336	7.8
9/8/2009 10:39	>100	14.5	7.82	411	8.0
9/10/2009 13:17	>100	18.3	9.59	404	8.3
9/24/2009 7:56	>100	13.9	6.91	419	7.9
9/29/2009 7:59	>100	9.4	7.58	422	8.1
10/7/2009 14:31	72				
10/9/2009 14:01		7.7	8.12	312	
10/28/2009 10:57	>100	4.8	9.34	353	8.1

Exceeds Water Quality Standard

Table 13: Brown's Creek at Highway 15 2009 Primary Chemistry Results

Sample Type	Start	End	TSS (mg/L)	VSS (mg/L)	TKN (mg/L)	TP (mg/L)	Dissolved P (mg/L)	E Coli (mpn/100 mL)	COD (mg/L)	TOC (mg/L)	TBOD (mg/L)	CBOD (mg/L)	Turbidity (NTU)
Snowmelt Grab	3/17/2009 12:00	3/17/2009 12:00	81	46	2	0.295	0.114		101		11	7.5	25
Storm Grab	3/24/2009 8:50	3/24/2009 8:50	12	7	1.4	0.095	0.057		44		4.7	2.9	8
Base Grab	5/13/2009 8:30	5/13/2009 8:30	5	3	0.4	0.055	~0.013		19		1.3	<1.0	3
E. Coli Grab	5/28/2009 9:40	5/28/2009 9:40						167					
Base Grab	6/24/2009 8:25	6/24/2009 8:25	12	8	0.72	0.17	0.079		33		1.7	<1.0	
E. Coli Grab	6/30/2009 8:30	6/30/2009 8:30						237					
Base Grab	7/13/2009 8:56	7/13/2009 8:56	5	3	0.35	0.095	<0.010		18		<1.0	<1.0	5
E. Coli Grab	7/29/2009 8:15	7/29/2009 8:15						596					
Base Grab	8/6/2009 8:22	8/6/2009 8:22	5	~3	0.35	0.35	~0.047		~12		<1.0	<1.0	4
Storm Composite	8/8/2009 10:45	8/10/2009 2:20	28	18	1.1	0.168	0.072		54				11
Storm Grab	8/17/2009 9:24	8/17/2009 9:24	9	6	0.63	0.121	0.087		37				
Storm Composite	8/19/2009 17:50	8/21/2009 10:34	36	22	1.5	0.195	0.069		70				
E. Coli Grab	8/27/2009 9:00	8/27/2009 9:00						219					
Base Grab	9/8/2009 10:39	9/8/2009 10:39	3	~2	0.32	0.061	0.062		~11		<1.0	<1.0	3
Base Grab	9/29/2009 7:59	9/29/2009 7:59	3	~2	0.61	0.104	0.089		~12		<1.0	<1.0	3
E. Coli Grab	9/30/2009 9:36	9/30/2009 9:36						120					
Storm Composite	10/1/2009 17:11	10/3/2009 6:31	24	14	0.9	0.153	0.058		62				
Storm Composite	10/6/2009 3:39	10/7/2009 7:40	53	30	0.82	0.106	~0.038		74				

Exceeds Water Quality Standard

Table 14: Brown's Creek at Highway 15 2009 Secondary Chemistry Results including Exceeded MPCA 7050 Water Quality Standards

Sample Type	Start Date	Start Time	Copper (mg/L)	Nickel (mg/L)	Lead (mg/L)	Zinc (mg/L)	Cadmium (mg/L)	Chromium (mg/L)	Chloride (mg/L)	Nitrite N (mg/L)	Nitrate N (mg/L)	Ammonia Nitrogen (mg/L)	Hardness (mg/L)
Snowmelt Grab	3/17/2009 12:00	3/17/2009 12:00	0.0026	0.0024	0.0013	0.0081	<0.0005	<0.005	14	<0.03	0.28	1.19	96
Storm Grab	3/24/2009 8:50	3/24/2009 8:50	0.0022	0.0021	0.0008	0.0074	<0.0005	<0.006	11	<0.03	0.39	0.29	116
Base Grab	5/13/2009 8:30	5/13/2009 8:30	<0.0005	0.0016	0.0001	<0.005	<0.0005	<0.005	15	<0.03	0.51	~0.05	176
E. Coli Grab	5/28/2009 9:40	5/28/2009 9:40											
Base Grab	6/24/2009 8:25	6/24/2009 8:25	0.0015	0.0018	0.0002	<0.005	<0.0005	<0.005	12	<0.03	0.27	0.08	232
E. Coli Grab	6/30/2009 8:30	6/30/2009 8:30											
Base Grab	7/13/2009 8:56	7/13/2009 8:56	<0.0005	0.0017	0.0002	<0.005	<0.0005	<0.005	13	<0.03	0.34	~0.05	208
E. Coli Grab	7/29/2009 8:15	7/29/2009 8:15											
Base Grab	8/6/2009 8:22	8/6/2009 8:22	<0.0005	0.0016	0.0001	<0.005	<0.0005	<0.005	13	<0.03	0.16	~0.03	232
Storm Composite	8/8/2009 10:45	8/10/2009 2:20	0.0027	0.0016	0.0007	0.0057	<0.0005	<0.005	12	<0.03	0.11	~0.02	194
Storm Grab	8/17/2009 9:24	8/17/2009 9:24	0.0005	0.0016	0.0002	<0.005	<0.0005	<0.005	12	<0.03	<0.05	~0.03	186
Storm Composite	8/19/2009 17:50	8/21/2009 10:34	0.0012	0.0025	0.0007	<0.005	<0.0005	<0.005	9	<0.03	<0.05	~0.02	146
E. Coli Grab	8/27/2009 9:00	8/27/2009 9:00											
Base Grab	9/8/2009 10:39	9/8/2009 10:39	<0.0005	0.0017	<0.0001	<0.005	<0.0005	<0.005	12	<0.03	0.15	<0.02	210
Base Grab	9/29/2009 7:59	9/29/2009 7:59	<0.0005	0.0018	0.0001	<0.005	<0.0005	<0.005	15	<0.03	0.27	~0.04	208
E. Coli Grab	9/30/2009 9:36	9/30/2009 9:36											
Storm Composite	10/1/2009 17:11	10/3/2009 6:31	0.0014	0.0027	0.0009	0.517	<0.0005	<0.005	13	<0.03	0.15	~0.02	142
Storm Composite	10/6/2009 3:39	10/7/2009 7:40	0.0013	0.0019	0.0009	0.122	<0.0005	<0.005	10	<0.03	0.15	<0.02	118

No Exceedance Determinable
Exceeds Chronic Standard
Exceeds Max Standard
Exceeds Final Acute Standard

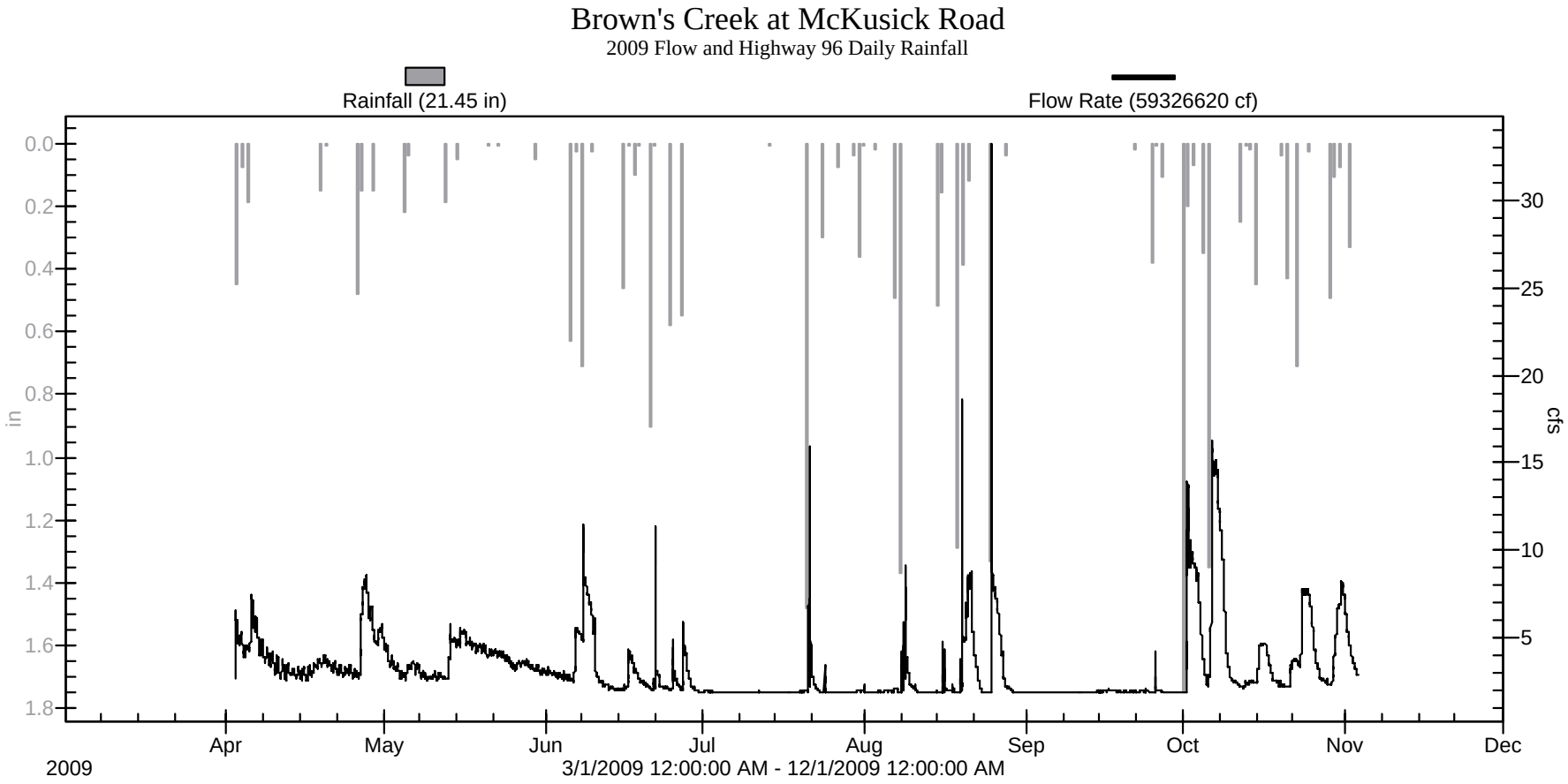


Figure 16. Brown' s Creek at McKusick Road 2009 Flow and Outlet Daily Rainfall

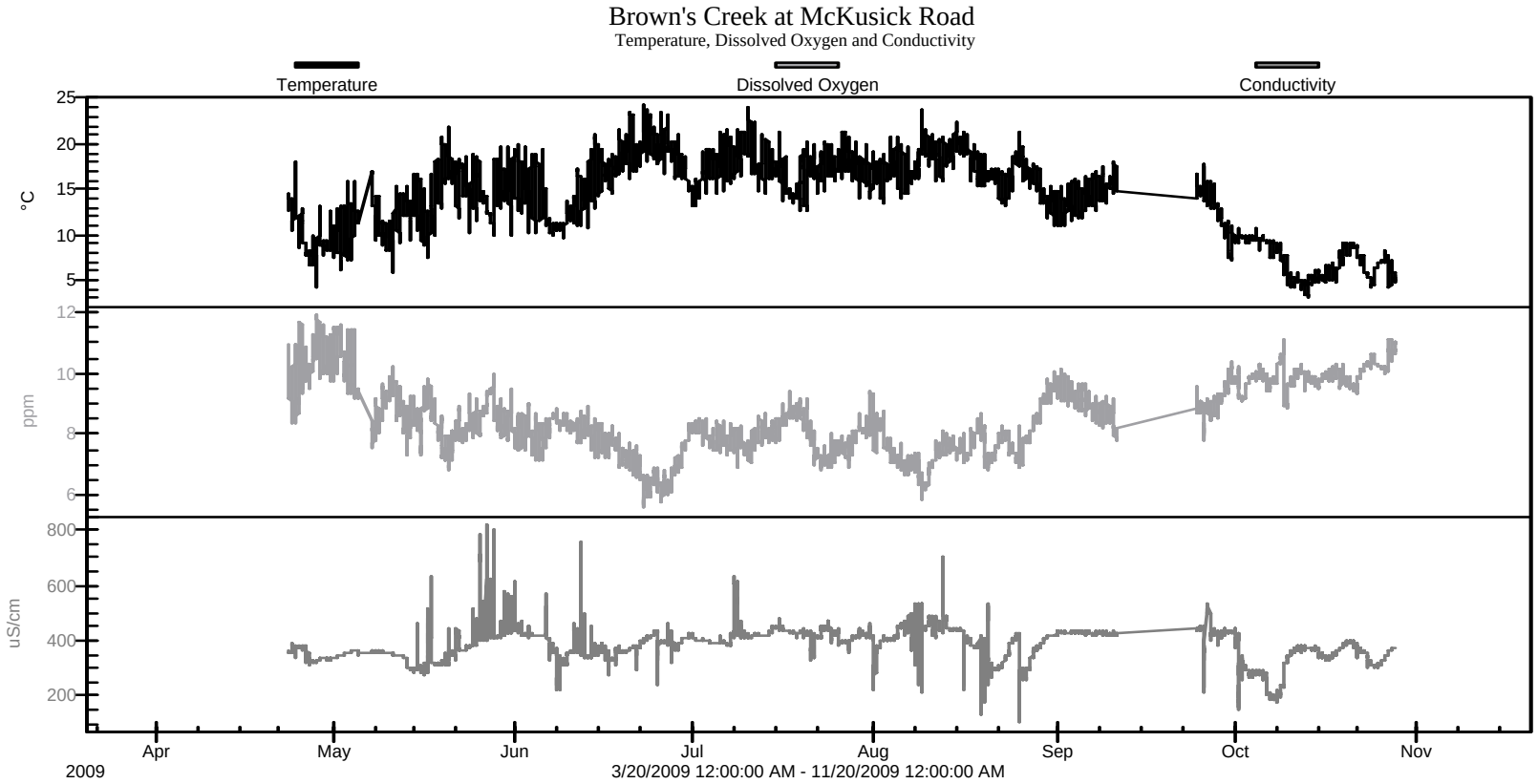


Figure 17. Brown's Creek at McKusick Road 2009 15-Minute Recorded Temperature, Dissolved Oxygen, and Conductivity

Table 15. Brown's Creek at McKusick Road 2009 Total Suspended Solids (TSS) and Total Phosphorus (TP) Loading

	Sample Collection Time				Loading Interval					
Sample Type	**Start**	**End**	**TSS (mg/L)**	**TP (mg/L)**	**Start**	**End**	**Interval Volume (cf)**	**Interval Volume (ac-ft)**	**Interval TP (lb)**	**Interval TSS (lb)**
*Base***			*12*	*0.12*	*1/1/2009 0:00*	*3/17/2009 6:00*	*13,003,200*	*298.67*	*97.4*	*9,741*
Snowmelt Grab**	3/17/09 11:40	3/17/09 11:40	67	0.44	3/17/2009 6:00	3/18/2009 0:00	421,200	9.67	11.5	1,762
*Base***			*12*	*0.12*	*3/18/2009 0:00*	*3/24/2009 6:00*	*1,620,000*	*37.21*	*12.1*	*1,214*
Storm Grab**	3/24/09 9:12	3/24/09 9:12	11	0.16	3/24/2009 6:00	3/26/2009 6:00	1,123,200	25.80	11.1	771
*Base***			*12*	*0.12*	3/26/2009 6:00	4/2/2009 13:00	2,205,000	50.65	16.5	1,652
Base			*12*	*0.12*	*4/2/2009 13:00*	*4/26/2009 10:00*	*7,580,794*	*174.12*	*56.8*	*5,679*
Storm			*194*	*0.41*	*4/26/2009 10:00*	*4/28/2009 21:00*	*1,461,605*	*33.57*	*37.4*	*17,701*
Base Grab	5/13/09 8:45	5/13/09 8:45	9	0.08	4/28/2009 21:00	6/6/2009 10:00	12,117,630	278.33	57.5	6,808
Storm			*194*	*0.41*	*6/6/2009 10:00*	6/9/2009 22:00	1,878,912	43.16	48.1	22,755
Base			*12*	*0.12*	*6/9/2009 22:00*	6/16/2009 16:00	1,491,653	*34.26*	11.2	1,117
Storm			*194*	*0.41*	*6/16/2009 16:00*	6/17/2009 23:00	410,236	*9.42*	10.5	4,968
Base			*12*	*0.12*	6/17/2009 23:00	6/21/2009 17:00	794,032	*18.24*	5.9	595
Storm			*194*	*0.41*	6/21/2009 17:00	6/22/2009 14:00	237,677	5.46	6.1	2,878
Base Grab	6/24/09 8:42	6/24/09 8:42	21	0.22	6/22/2009 14:00	6/25/2009 5:00	495,736	11.39	6.7	650
Storm			*194*	*0.41*	6/25/2009 5:00	6/25/2009 18:00	143,402	*3.29*	3.7	1,737
Base			*12*	*0.12*	*6/25/2009 18:00*	*6/27/2009 3:00*	*274,397*	*6.30*	*2.1*	206
Storm			*194*	*0.41*	*6/27/2009 3:00*	6/28/2009 2:00	320,050	*7.35*	8.2	3,876
Base Grab	7/13/09 9:30	7/13/09 9:30	14	0.13	6/28/2009 2:00	7/21/2009 7:00	3,843,023	88.27	30.9	3,359
Storm			*194*	*0.41*	7/21/2009 7:00	7/22/2009 2:00	278,292	6.39	7.1	3,370
Base			*12*	*0.12*	*7/22/2009 2:00*	*7/24/09 8:00*	*401,526*	*9.22*	*3.0*	*301*
Storm			*194*	*0.41*	7/24/2009 8:00	7/24/2009 13:00	40,695	0.93	1.0	493
Base			*12*	*0.12*	*7/24/2009 13:00*	*7/31/2009 22:00*	*1,204,603*	*27.67*	*9.0*	*902*
Storm			*194*	*0.41*	7/31/2009 22:00	8/1/2009 2:00	27,968	0.64	0.7	339
Base Grab	8/6/09 8:38	8/6/09 8:38	10	0.14	8/1/2009 2:00	8/7/2009 9:00	1,048,474	24.08	8.8	655
Storm Composite	8/7/09 14:47	8/9/09 7:37	286	0.42	8/7/2009 9:00	8/9/2009 9:00	478,094	10.98	12.4	8,536
Base			*12*	*0.12*	*8/9/2009 9:00*	*8/15/2009 22:00*	*1,110,007*	*25.50*	*8.3*	*832*
Storm			*194*	*0.41*	*8/15/2009 22:00*	*8/16/2009 11:00*	*104,980*	*2.41*	*2.7*	1,271
Base			*12*	*0.12*	*8/16/2009 11:00*	8/19/2009 3:00	460,085	*10.57*	3.4	345
Storm Composite	8/19/09 15:56	8/21/09 13:25	143	0.32	8/19/2009 3:00	8/21/2009 17:00	1,348,304	30.97	26.5	12,036
Base			*12*	*0.12*	*8/21/2009 17:00*	*8/25/2009 5:00*	*770,396*	*17.70*	*5.8*	*577*
Storm Composite***	8/25/09 6:30	8/25/09 7:31	1205	0.91	8/25/2009 5:00	8/26/2009 18:00	1,104,248	25.36	62.5	83,065
Base Grab	9/8/09 9:58	9/8/09 9:58	11	0.11	8/26/2009 18:00	9/10/2009 12:00	2,609,571	59.94	17.3	1,792
Base			*12*	*0.12*	*9/10/2009 12:00*	*9/25/2009 12:00*	*2,490,753*	*57.21*	*18.7*	*1,866*
Storm			*194*	*0.41*	*9/25/2009 12:00*	*9/25/2009 19:00*	*53,260*	*1.22*	*1.4*	*645*
Base Grab	9/29/09 8:17	9/29/09 8:17	6	0.07	9/25/2009 19:00	10/1/2009 15:00	950,057	21.82	4.2	356
Storm Composite	10/1/09 16:12	10/4/09 19:04	535	0.59	10/1/2009 15:00	10/4/2009 22:00	2,328,497	53.48	85.9	77,767
Base			*12*	*0.12*	*10/4/2009 22:00*	*10/5/2009 17:00*	*183,729*	*4.22*	*1.4*	*138*
Storm Grab	10/7/09 15:18	10/7/09 15:18	123	0.06	10/5/2009 17:00	10/8/2009 21:00	2,909,126	66.82	10.2	22,337
Base			*12*	*0.12*	*10/8/2009 21:00*	*10/15/2009 1:00*	*1,456,650*	*33.46*	*10.9*	*1,091*
Storm			*194*	*0.41*	10/15/2009 1:00	10/17/2009 11:00	871,074	20.01	22.3	10,549
Base			*12*	*0.12*	*10/17/2009 11:00*	10/21/2009 12:00	867,653	19.93	6.5	650
Storm			*194*	*0.41*	*10/21/2009 12:00*	*10/26/2009 5:00*	*2,171,202*	*49.87*	*55.6*	*26,295*
Base			*12*	*0.12*	*10/26/2009 5:00*	*10/29/2009 8:00*	*744,572*	*17.10*	*5.6*	*558*
Storm			*194*	*0.41*	*10/29/2009 8:00*	*11/1/2009 10:00*	*1,598,079*	*36.71*	*40.9*	*19,354*
Base			*12*	*0.12*	*11/1/2009 10:00*	*11/3/2009 10:00*	*665,586*	*15.29*	*5.0*	*499*
*Base***			*12*	*0.12*	*11/3/2009 10:00*	*1/1/2010 0:00*	*15,184,800*	*348.78*	*113.8*	*11,375*
Storm Average			194	0.41						
Base Average			12	0.12						
All Average			188	0.28						
Total							**92,884,028**	**2,133**	**985**	**375,461**
Brown's Creek Major Subwatershed Total Acres							8,064			
Total TP/TSS(lb/ac/yr)									0.12	46.56
Total TP/TSS (kg/ha/yr)									0.14	52.19

*Italics indicate estimated concentrations based on average base and storm flow concentrations

**Interval volumes were estimated using logged base and storm flow values

*** TSS Value ommited from average storm event

Table 16. Brown's Creek at McKusick Road 2009 Primary Chemistry Result Averages

Parameter	Storm Flow Average	Base Flow Average	Average (all samples)
TSS (mg/L)	194	12	188
VSS (mg/L)	86	6	45
TKN (mg/L)	1.93	0.538	1.43
TP (mg/L)	0.41	0.12	0.28
E. Coli (mpn/100 mL)	--	--	288

Table 17. Brown's Creek at McKusick Road 2009 Field Measurement Results

Date/Time	Transparency (cm)	Water Temperature (C)	Dissolved Oxygen (mg/L)	Conductivity (umhos/cm)	pH
3/17/2009 11:39	20	1.7	12.19	240	7.4
3/24/2009 9:12	61	3.8	12.01	271	7.4
4/23/2009 14:35		12.6	10.92	369	8.2
5/7/2009 14:32		17.00	8.45	360	8.1
5/13/2009 8:45		12.2	8.27		7.9
5/22/2009 9:13	34	12.3	8.81	417	8.0
5/28/2009 9:56	73	11.5	9.85	510	8.3
6/4/2009 10:36	87	13.1	8.45	418	8.7
6/12/2009 11:40	75				
6/18/2009 9:36	59	17.0	7.83	370	
6/24/2009 8:42	72	18.6	6.84	419	7.9
6/25/2009 9:18	21	18.1	6.26	382	7.9
6/30/2009 9:02	68	14.9	8.27	414	8.1
7/1/2009 14:21	83	15.7	8.32	400	
7/6/2009 11:05	51				
7/9/2009 10:07	83				
7/13/2009 9:30	75	15.4	8.64	420	
7/17/2009 9:57	>100	14.06	9.41	430	8.7
7/29/2009 9:43	>100	15.0	8.66	432	8.3
7/31/2009 8:51	>100	14.4	8.83	438	8.5
8/6/2009 8:38	96	14.6	7.20	434	8.5
8/10/2009 14:45	53	20.6	7.05	471	7.9
8/13/2009 8:48	75	17.6	8.02	441	8.1
8/21/2009 14:05	39	16.6	7.57	297	8.0
8/27/2009 7:30	65	15.2	8.01	310	
8/27/2009 14:42	71	17.5	8.10	345	7.7
9/8/2009 9:58	65	14.1	9.07	430	8.3
9/10/2009 13:50	>100	17.3	8.13	433	8.2
9/24/2009 8:55	83	13.9	8.81	443	8.2
9/29/2009 8:17	>100	9.6	9.47	438	8.5
10/7/2009 15:18	40				
10/9/2009 14:30		7.5	9.07	319	
10/28/2009 11:17	>100	5.5	10.94	376	8.2

Exceeds Water Quality Standard

Table 18: Brown's Creek at McKusick Road 2009 Primary Chemistry Results

Sample Type	Start	End	TSS (mg/L)	VSS (mg/L)	TKN (mg/L)	TP (mg/L)	Dissolved P (mg/L)	E Coli (mpn/100 mL)	COD (mg/L)	TOC (mg/L)	TBOD (mg/L)	CBOD (mg/L)	Turbidity (NTU)
Snowmelt Grab	3/17/2009 11:40	3/17/2009 11:40	67	32	3.8	0.438	0.12		94		12	8.5	28
Storm Grab	3/24/2009 9:12	3/24/2009 9:12	11	6	1.1	0.159	0.062		48		5.4	3.4	10
Base Grab	5/13/2009 8:45	5/13/2009 8:45	9	5	0.61	0.076	~0.022		22		1.3	<1.0	5
E. Coli Grab	5/28/2009 10:00	5/28/2009 10:00						199					
Base Grab	6/24/2009 8:42	6/24/2009 8:42	21	11	0.83	0.216	0.087		39		1.8	1.1	14
E. Coli Grab	6/30/2009 9:10	6/30/2009 9:10						488					
Base Grab	7/13/2009 9:30	7/13/2009 9:30	14	8	0.54	0.129	0.053		21		1.7	<1.0	10
E. Coli Grab	7/29/2009 9:45	7/29/2009 9:45						172					
Base Grab	8/6/2009 8:38	8/6/2009 8:38	10	5	0.52	0.135	~0.048		~14		<1.0	<1.0	8
Storm Composite	8/7/2009 14:47	8/9/2009 7:37	286	~56	2.3	0.415	0.072		83				45
Storm Composite	8/19/2009 15:56	8/21/2009 13:25	143	42	1.9	0.315	0.062		80				
Storm Composite	8/25/2009 6:30	8/25/2009 7:31	1250	230	4.9	0.907	0.092		217				
Base Grab	9/8/2009 9:58	9/8/2009 9:58	11	5	0.44	0.106	0.066		18		1.2	<1.0	7
Base Grab	9/29/2009 8:17	9/29/2009 8:17	6	3	0.29	0.071	0.054		~13		<1.0	<1.0	5
E. Coli Grab	9/30/2009 9:57	9/30/2009 9:57						291					
Storm Composite	10/1/2009 16:12	10/4/2009 19:04	535	161	0.98	0.591	0.087		243				
Storm Grab	10/7/2009 15:18	10/7/2009 15:18	123	20	0.39	0.056	~0.032		65				

Exceeds Water Quality Standard

Table 19: Brown's Creek at McKusick Road 2009 Secondary Chemistry Results including Exceeded MPCA 7050 Water Quality Standards

Sample Type	Start	End	Copper (mg/L)	Nickel (mg/L)	Lead (mg/L)	Zinc (mg/L)	Cadmium (mg/L)	Chromium (mg/L)	Chloride (mg/L)	Nitrite N (mg/L)	Nitrate N (mg/L)	Ammonia Nitrogen (mg/L)	Hardness (mg/L)
Snowmelt Grab	3/17/2009 11:40	3/17/2009 11:40	0.0031	0.0026	0.0012	0.0089	<0.0005	<0.005	16	<0.03	0.3	0.69	92
Storm Grab	3/24/2009 9:12	3/24/2009 9:12	0.0006	0.0014	0.0003	0.0027	<0.0005	<0.006	15	<0.03	0.4	0.31	114
Base Grab	5/13/2009 8:45	5/13/2009 8:45	0.0005	0.0018	0.0002	<0.005	<0.0005	<0.005	19	<0.03	0.44	~0.03	192
E. Coli Grab	5/28/2009 10:00	5/28/2009 10:00											
Base Grab	6/24/2009 8:42	6/24/2009 8:42	0.0008	0.002	0.0004	<0.005	<0.0005	<0.005	18	<0.03	0.35	~0.05	248
E. Coli Grab	6/30/2009 9:10	6/30/2009 9:10											
Base Grab	7/13/2009 9:30	7/13/2009 9:30	0.0009	0.002	0.0003	<0.005	<0.0005	<0.005	30	<0.03	0.32	~0.05	220
E. Coli Grab	7/29/2009 9:45	7/29/2009 9:45											
Base Grab	8/6/2009 8:38	8/6/2009 8:38	0.0006	0.0018	0.0002	<0.005	<0.0005	<0.005	19	<0.03	0.28	~0.03	
Storm Composite	8/7/2009 14:47	8/9/2009 7:37	0.0066	0.0032	0.0023	0.0171	<0.0005	<0.005	18	<0.03	0.35	~0.04	164
Storm Composite	8/19/2009 15:56	8/21/2009 13:25	0.0043	0.0036	0.0019	0.01	<0.0005	<0.005	15	<0.03	0.22	~0.02	152
Storm Composite	8/25/2009 6:30	8/25/2009 7:31	0.0106	0.0095	0.0103	0.0379	<0.0005	0.0141	6	<0.03	0.18	~0.05	68
Base Grab	9/8/2009 9:58	9/8/2009 9:58	0.0006	0.002	0.0002	<0.005	<0.0005	<0.005	18	<0.03	0.21	~0.03	220
Base Grab	9/29/2009 8:17	9/29/2009 8:17	0.0005	0.0019	0.0002	<0.005	<0.0005	<0.005	19	<0.03	0.25	~0.04	214
E. Coli Grab	9/30/2009 9:57	9/30/2009 9:57											
Storm Composite	10/1/2009 16:12	10/4/2009 19:04	0.0079	0.0061	0.0064	0.0255	<0.0005	0.0101	19	<0.03	0.18	~0.04	140
Storm Grab	10/7/2009 15:18	10/7/2009 15:18	0.0015	0.0019	0.0009	0.0056	<0.0005	<0.005	13	<0.03	0.06	<0.02	120

No Exceedance Determinable
Exceeds Chronic Standard
Exceeds Max Standard
Exceeds Final Acute Standard

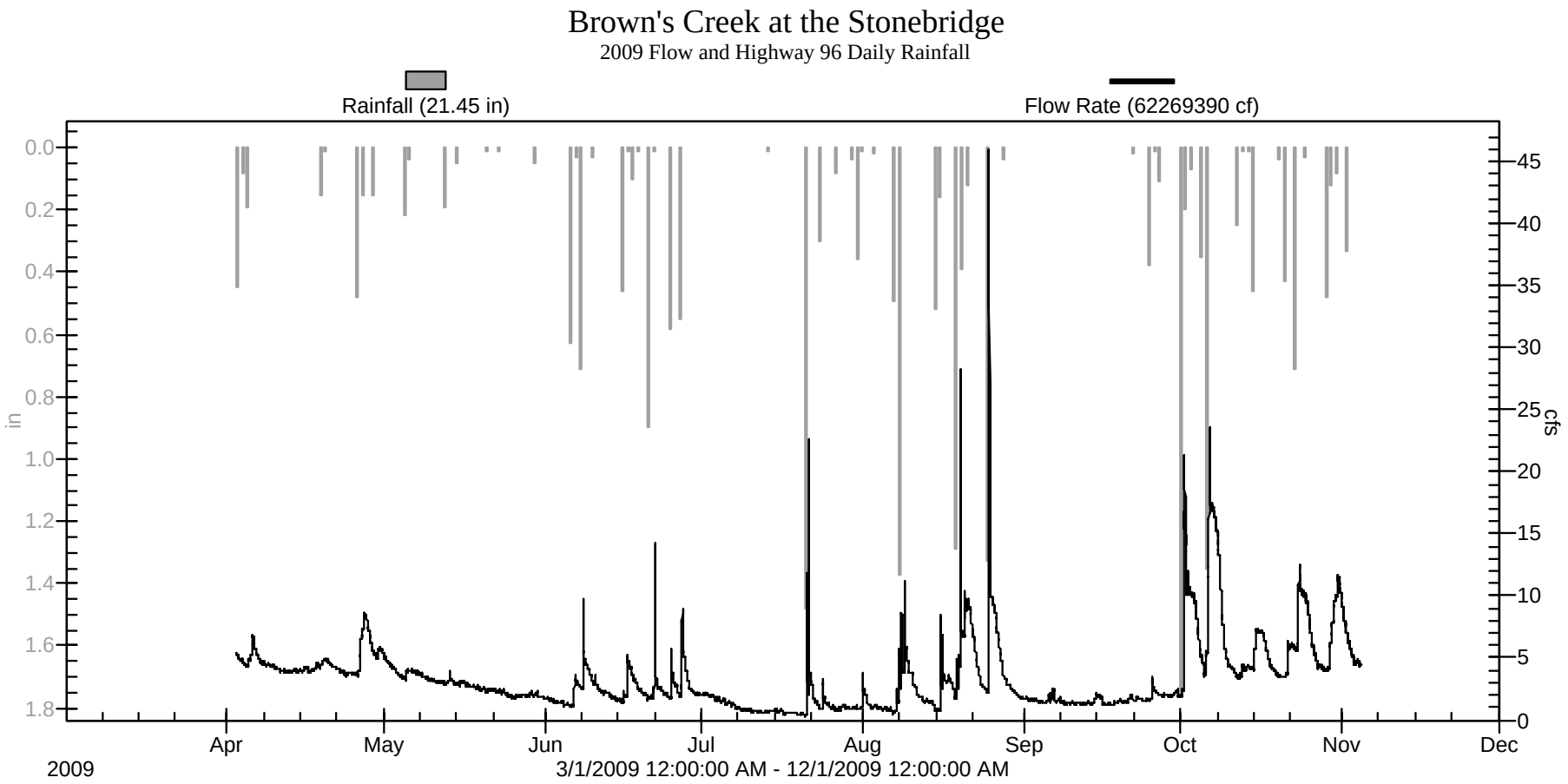


Figure 18: Brown's Creek at the Stonebridge 2009 Flow and Outlet Daily Rainfall

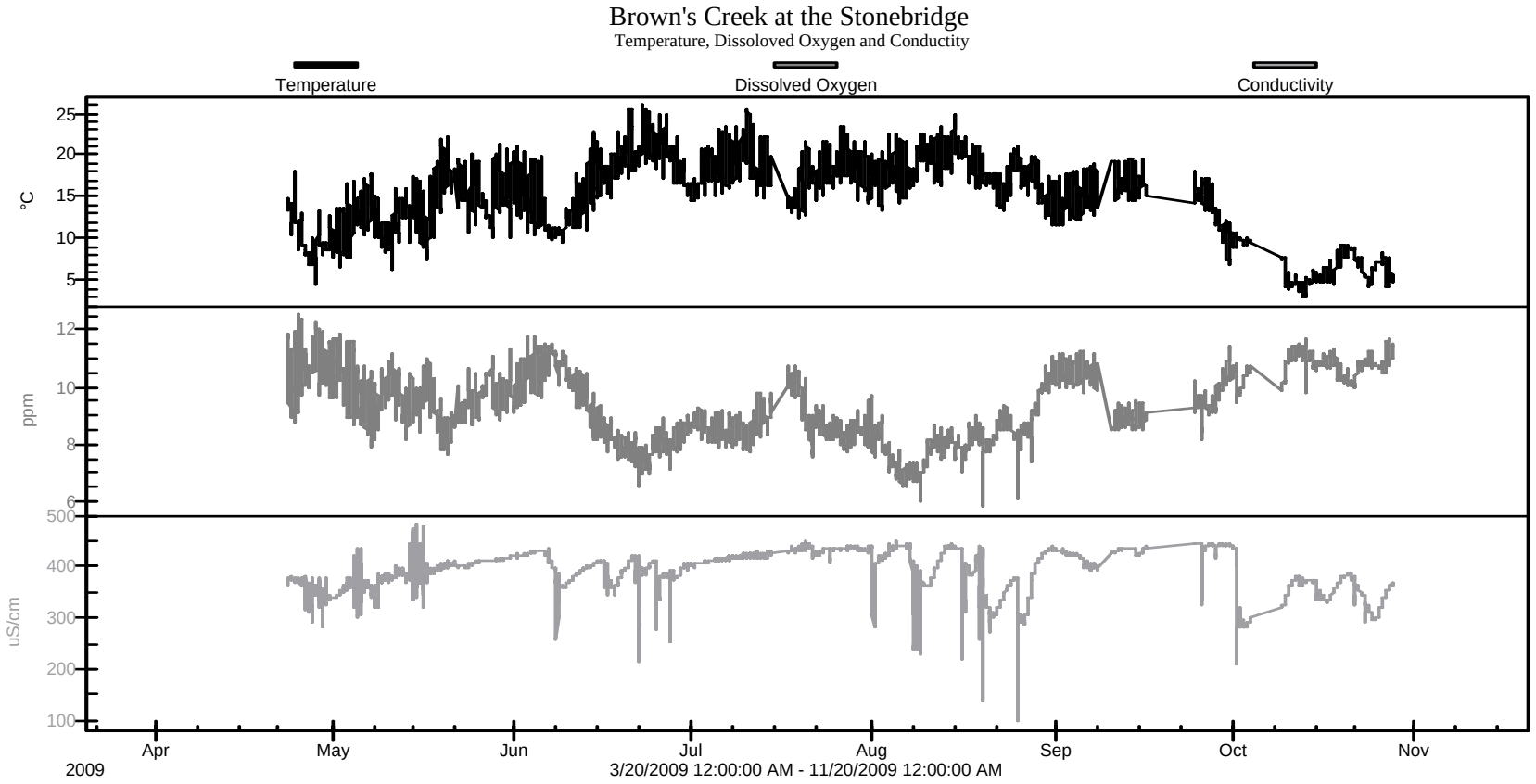


Figure 19: Brown's Creek at the Stonebridge 2009 15-minute Temperature, Dissolved Oxygen and Conductivity

Table 20: Brown's Creek at the Stonebridge 2009 Total Suspended Solids (TSS) and Total Phosphorus (TP) Loading

	Sample Collection Time				Loading Interval					
Sample Type	**Start**	**End**	**TSS (mg/L)**	**TP (mg/L)**	**Start**	**End**	**Interval Volume (cf)**	**Interval Volume (ac-ft)**	**Interval TP (lb)**	**Interval TSS (lb)**
*Base***			*5*	*0.122*	*1/1/2009 0:00*	*3/17/2009 7:00*	*30,899,700*	*709.73*	*235.33*	*9,645*
Snowmelt Grab**	3/17/09 11:30	3/17/09 11:30	97	0.35	3/17/2009 7:00	3/18/2009 7:00	518,400	11.91	11.29	3,139
*Base***			*5*	*0.122*	*3/18/2009 7:00*	*3/24/2009 0:00*	*2,342,700*	*53.81*	*17.84*	*731*
Storm Grab***	3/24/09 9:24	3/24/09 9:24	11	0.139	3/24/2009 0:00	3/25/2009 0:00	518,400	11.91	4.50	356
*Base***			*5*	*0.122*	*3/25/2009 0:00*	*4/2/2009 15:45*	*3,552,525*	*81.60*	*27.06*	*1,109*
Base			*5*	*0.122*	*4/2/2009 15:45*	*4/4/2009 20:45*	*919,812*	*21.13*	*7.01*	*287*
Storm			*187*	*0.523*	*4/4/2009 20:45*	*4/6/2009 9:45*	*740,030*	*17.00*	*24.16*	*8,639*
Base			*5*	*0.122*	*4/6/2009 9:45*	*4/26/2009 2:45*	*7,108,573*	*163.28*	*54.14*	*2,219*
Storm			*187*	*0.523*	*4/26/2009 2:45*	*4/28/2009 9:45*	*1,373,276*	*31.54*	*44.84*	*16,031*
Base			*5*	*0.122*	*4/28/2009 9:45*	*4/29/2009 18:45*	*664,055*	*15.25*	*5.06*	*207*
Storm			*187*	*0.523*	*4/29/2009 18:45*	*5/1/2009 3:45*	*651,063*	*14.95*	*21.26*	*7,600*
Base Grab	5/13/09 9:00	5/13/09 9:00	7	0.08	5/1/2009 3:45	6/6/2009 9:45	8,304,795	190.75	40.44	3,629
Storm			*187*	*0.523*	*6/6/2009 9:45*	*6/7/2009 6:45*	*201,416*	*4.63*	*6.58*	*2,351*
Base			*5*	*0.122*	*6/7/2009 6:45*	*6/8/2009 4:45*	*212,324*	*4.88*	*1.62*	*66*
Storm Composite	6/8/09 6:17	6/8/09 20:52	276	0.643	6/8/2009 4:45	6/8/2009 21:45	331,627	7.62	13.31	5,714
Base			*5*	*0.122*	*6/8/2009 21:45*	*6/16/2009 2:45*	*1,488,000*	*34.18*	*11.33*	*464*
Storm			*187*	*0.523*	*6/16/2009 2:45*	*6/17/2009 13:45*	*420,458*	*9.66*	*13.73*	*4,908*
Base			*5*	*0.122*	*6/17/2009 13:45*	*6/21/2009 13:45*	*842,009*	*19.34*	*6.41*	*263*
Storm Composite	6/22/09 0:25	6/22/09 13:14	416	1.050	6/21/2009 13:45	6/22/2009 7:45	231,678	5.32	15.19	6,017
Base Grab	6/24/09 8:59	6/24/09 8:59	7	0.150	6/22/2009 7:45	6/25/2009 4:45	569,244	13.07	5.33	249
Storm			*187*	*0.523*	*6/25/2009 4:45*	*6/25/2009 17:45*	*167,351*	*3.84*	*5.46*	*1,954*
Base			*5*	*0.122*	*6/25/2009 17:45*	*6/27/2009 2:45*	*286,408*	*6.58*	*2.18*	*89*
Storm			*187*	*0.523*	*6/27/2009 2:45*	*6/28/2009 4:45*	*433,330*	*9.95*	*14.15*	*5,059*
Base Grab	7/13/09 11:32	7/13/09 11:32	3	0.099	6/28/2009 4:45	7/21/2009 7:45	2,298,187	52.79	14.20	430
Storm Composite	7/21/09 9:33	7/21/09 17:27	334	0.78	7/21/2009 7:45	7/22/2009 4:45	378,204	8.69	18.49	7,886
Base			*5*	*0.122*	*7/22/2009 4:45*	*7/24/2009 7:45*	*259,963*	*5.97*	*1.98*	*81*
Storm			*187*	*0.523*	*7/24/2009 7:45*	*7/24/2009 17:45*	*68,596*	*1.58*	*2.24*	*801*
Base			*5*	*0.122*	*7/24/2009 17:45*	*7/31/2009 16:45*	*599,152*	*13.76*	*4.56*	*187*
Storm			*187*	*0.523*	*7/31/2009 16:45*	*8/1/2009 14:45*	*165,677*	*3.81*	*5.41*	*1,934*
Base Grab	8/6/09 8:55	8/6/09 8:55	4	0.114	8/1/2009 14:45	8/7/2009 2:45	463,606	10.65	3.30	116
Storm Composite	8/8/09 1:38	8/9/09 12:26	59	0.257	8/7/2009 2:45	8/9/2009 11:45	736,035	16.91	11.81	2,711
Base			*5*	*0.122*	*8/9/2009 11:45*	*8/15/2009 21:45*	*1,113,468*	*25.58*	*8.48*	*348*
Storm Composite	8/15/09 23:41	8/16/09 7:49	111	0.437	8/15/2009 21:45	8/16/2009 13:45	225,651	5.18	6.16	1,564
Base			*5*	*0.122*	*8/16/2009 13:45*	*8/19/2009 2:45*	*606,916*	*13.94*	*4.62*	*189*
Storm Composite	8/19/09 15:09	8/20/09 21:44	101	0.34	8/19/2009 2:45	8/20/2009 22:45	1,182,356	27.16	25.10	7,455
Base			*5*	*0.122*	*8/20/2009 22:45*	*8/25/2009 5:45*	*1,851,762*	*42.53*	*14.10*	*578*
Storm Composite	8/25/09 6:41	8/25/09 11:12	326	0.86	8/25/2009 5:45	8/26/2009 11:45	1,245,034	28.60	66.92	25,338
Base Grab	9/8/09 9:39	9/8/09 9:39	11	0.23	8/26/2009 11:45	9/25/2009 12:45	4,833,100	111.01	70.60	3,319
Storm			*187*	*0.523*	*9/25/2009 12:45*	*9/25/2009 18:45*	*60,138*	*1.38*	*1.96*	*702*
Base Grab	9/29/09 8:38	9/29/09 8:38	3	0.056	9/25/2009 18:45	10/1/2009 8:45	985,101	22.63	3.44	184
Storm Composite	10/1/09 17:13	10/3/09 3:26	76	0.271	10/1/2009 8:45	10/3/2009 4:45	1,610,143	36.98	27.24	7,639
Base			*5*	*0.122*	*10/3/2009 4:45*	*10/5/2009 16:45*	*1,507,119*	*34.62*	*11.48*	*470*
Storm Composite	10/6/09 7:20	10/7/09 20:43	74	0.24	10/5/2009 16:45	10/8/2009 10:45	3,294,393	75.67	48.53	15,219
Base			*5*	*0.122*	*10/8/2009 10:45*	*10/14/2009 23:45*	*2,766,086*	*63.53*	*21.07*	*863*
Storm			*187*	*0.523*	*10/14/2009 23:45*	*10/17/2009 9:45*	*1,374,309*	*31.57*	*44.87*	*16,043*
Base			*5*	*0.122*	*10/17/2009 9:45*	*10/21/2009 7:45*	*1,354,326*	*31.11*	*10.31*	*423*
Storm			*187*	*0.523*	*10/21/2009 7:45*	*10/25/2009 22:45*	*3,101,261*	*71.23*	*101.25*	*36,203*
Base			*5*	*0.122*	*10/25/2009 22:45*	*10/29/2009 7:45*	*1,383,095*	*31.77*	*10.53*	*432*
Storm			*187*	*0.523*	*10/29/2009 7:45*	*11/2/2009 1:45*	*2,760,886*	*63.41*	*90.14*	*32,230*
Base			*5*	*0.122*	*11/2/2009 1:45*	*11/4/2009 13:45*	*1,099,381*	*25.25*	*8.37*	*343*
*Base***			*5*	*0.122*	*11/4/2009 13:45*	*1/1/2010 0:00*	*23,568,075*	*541.33*	*179.49*	*7,356*
Storm Average			187	0.523						
Base Average			5	0.122						
All Average			119	0.37						
Total							**123,669,192**	**2,841**	**1,405**	**251,770**
Brown's Creek Major Subwatershed Total Acres							8,310			
Total TP/TSS(lb/ac/yr)									0.17	30.30
Total TP/TSS (kg/ha/yr)									0.19	33.96

*Italics indicate estimated concentrations based on average base and storm flow concentrations

**Interval volume between 1/1/09-4/2/09 and 11/4/09-1/1/10 were estimated based upon base flow

***Results ommited from averages

Table 21: Brown's Creek at the Stonebridge 2009 Primary Chemistry Result Averages

Parameter	Storm Flow Average	Base Flow Average	Average (all samples)
TSS (mg/L)	197	6	113
VSS (mg/L)	73	3	42
TKN (mg/L)	3.06	0.45	1.98
TP (mg/L)	0.542	0.122	0.36
E. Coli (mpn/100 mL)	--	--	1180

Table 22. Brown's Creek at the Stonebridge 2009 Field Measurement Results

Date	Transparency (cm)	Water Temperature (C)	Dissolved Oxygen (mg/L)	Conductivity (umhos/cm)	pH
3/24/2009 9:24	20	1.7	13.32	238	7.1
4/2/2009 15:55	71	4.0	12.92	268	8.3
5/1/2009 14:23		13.4	11.73	364	8.7
5/13/2009 9:03	>120	17.7	9.00	358	8.1
5/14/2009 14:23		12.4	9.10		7.9
5/28/2009 10:10	>100	13.2	9.72	415	8.2
5/29/2009 10:33	>100	11.9	10.44	514	8.3
6/10/2009 11:31	>100	13.9	11.42	430	8.4
6/12/2009 11:20	81	12.6	9.88	378	8.6
6/18/2009 10:10	70				
6/22/2009 14:06	68	17.5	8.30	365	
6/24/2009 8:59	76	24.1	7.55		
6/25/2009 9:02	>100	19.4	8.11	409	8.2
7/1/2009 14:49	29	19.4	6.46	844	7.9
7/6/2009 11:27	>100	16.7	8.92	400	
7/9/2009 9:33	>100				
7/13/2009 11:31	>100				
7/17/2009 10:26	>100	17.1	9.61	421	8.8
7/24/2009 12:12	>100	14.8	10.02	430	8.7
7/31/2009 9:23	>100	15.0	9.20	431	8.5
8/3/2009 11:26	>100	15.1	9.16	432	8.9
8/6/2009 8:55				440	
8/6/2009 14:35	>100	14.9	7.24	438	8.5
8/13/2009 9:15	>100	21.9	7.97	367	8.2
8/17/2009 13:36	>100	18.3	8.20	438	8.3
8/21/2009 14:38	>100	20	8.54	380	8.2
8/26/2009 14:00	41	17.2	8.27	306	8.0
8/27/2009 9:34		18.1	8.65	290	
8/27/2009 15:13	75	15.2	8.79	328	8.2
9/1/2009 11:35		18.5	8.79	340	8.3
9/10/2009 14:23	>100	14.1	9.81	434	8.4
9/24/2009 9:32	>100	19.2	8.46	427	8.5
9/29/2009 8:37	>100	14.3	9.24	443	8.3
9/30/2009 9:23	>100	9.5	10.28	444	8.4
10/9/2009 14:55	64	8.3	11.03	265	7.9
10/12/2009 12:04		7.7	9.86	321	
10/28/2009 14:49	>100	5.6	11.52	369	8.4

Exceeds Water Quality Standard

Table 23: Brown's Creek at the Stonebridge 2009 Primary Chemistry Results

Sample Type	Start	End	TSS (mg/L)	VSS (mg/L)	TKN (mg/L)	TP (mg/L)	Dissolved P (mg/L)	E Coli (mpn/100 mL)	COD (mg/L)	TOC (mg/L)	TBOD (mg/L)	CBOD (mg/L)	Turbidity (NTU)
Snowmelt Grab	3/17/2009 11:30	3/17/2009 11:30	97	42	2.3	0.349	0.124		97		12	8.4	33
Storm Grab	3/24/2009 9:24	3/24/2009 9:24	11	5	1	0.139	0.073		46		5.8	3.6	8
Base Grab	5/13/2009 9:00	5/13/2009 9:00	7	4	0.56	0.078	~0.021		22		1.5	<1.0	5
E. Coli Grab	5/28/2009 10:12	5/28/2009 10:12						>2420					
Storm Composite	6/8/2009 6:17	6/8/2009 20:52	276	90	3.5	0.643	~0.049		129				150
Storm Composite	6/22/2009 0:25	6/22/2009 13:14	416	172	6.7	1.05							
Base Grab	6/24/2009 8:59	6/24/2009 8:59	7	4	0.64	0.15	0.073		32		1.5	<1.0	
E. Coli Grab	6/25/2009 9:00	6/25/2009 9:00						>2420					
Base Grab	7/13/2009 11:32	7/13/2009 11:32	3	~1	0.5	0.099	<0.010		~11		<1.0	<1.0	5
Storm Composite	7/21/2009 9:33	7/21/2009 17:27	334	111	4.3	0.783	0.077		159				110
E. Coli Grab	7/29/2009 9:25	7/29/2009 9:25						210					
Base Grab	8/6/2009 8:55	8/6/2009 8:55	4	~2	0.33	0.114	0.051		~10				5
Storm Composite	8/8/2009 1:38	8/9/2009 12:26	59	26	1.5	0.257	0.062		56				
Storm Composite	8/15/2009 23:41	8/16/2009 7:49	111	45	2.3	0.437	~0.037		93				
Storm Composite	8/19/2009 15:09	8/20/2009 21:44	101	38	2	0.34	0.067		78				
Storm Composite	8/25/2009 6:41	8/25/2009 11:12	326	117	4.1	0.861	0.07		174				
E. Coli Grab	8/27/2009 9:35	8/27/2009 9:35						291					
Base Grab	9/8/2009 9:39	9/8/2009 9:39	11	4	0.43	0.234	0.082		19		1.1	<1.0	8
Base Grab	9/29/2009 8:38	9/29/2009 8:38	3	~2	0.22	0.056	~0.041		~11		<1.0	<1.0	4
E. Coli Grab	9/30/2009 9:23	9/30/2009 9:23						249					
Storm Composite	10/1/2009 17:13	10/3/2009 3:26	76	27	1.6	0.271	0.059		66				
Storm Composite	10/6/2009 7:20	10/7/2009 20:43	74	29	1.6	0.236	~0.033		71				

Exceeds Water Quality Standard

Table 24: Brown's Creek at the Stonebridge 2009 Secondary Chemistry Results

Sample Type	Start	End	Copper (mg/L)	Nickel (mg/L)	Lead (mg/L)	Zinc (mg/L)	Cadmium (mg/L)	Chromium (mg/L)	Chloride (mg/L)	Nitrite N (mg/L)	Nitrate N (mg/L)	Ammonia Nitrogen (mg/L)	Hardness (mg/L)
Snowmelt Grab	3/17/2009 11:30	3/17/2009 11:30	0.0033	0.0027	0.0014	0.0091	<0.0005	<0.005	16	<0.03	0.29	0.73	90
Storm Grab	3/24/2009 9:24	3/24/2009 9:24	0.001	0.0014	0.0003	0.0099	<0.0005	<0.006	15	<0.03	0.4	0.3	112
Base Grab	5/13/2009 9:00	5/13/2009 9:00	0.0006	0.0017	0.0001	0.0085	<0.0005	<0.005	19	<0.03	0.43	~0.04	246
E. Coli Grab	5/28/2009 10:12	5/28/2009 10:12											
Storm Composite	6/8/2009 6:17	6/8/2009 20:52	0.0075	0.0046	0.0037	0.0253	<0.0005	0.0069	31	<0.03	0.27	<0.02	152
Storm Composite	6/22/2009 0:25	6/22/2009 13:14	0.0093	0.0066	0.0065	0.0326	<0.0005	0.0111					
Base Grab	6/24/2009 8:59	6/24/2009 8:59	0.0017	0.0019	0.0002	<0.005	<0.0005	<0.005	18	<0.03	0.36	~0.03	200
E. Coli Grab	6/25/2009 9:00	6/25/2009 9:00											
Base Grab	7/13/2009 11:32	7/13/2009 11:32	<0.0005	0.0019	0.0001	<0.005	<0.0005	<0.005	19	<0.03	0.26	0.08	214
Storm Composite	7/21/2009 9:33	7/21/2009 17:27	0.0096	0.0055	0.0052	0.0352	<0.0005	0.0096	14	<0.03	0.3	0.08	100
E. Coli Grab	7/29/2009 9:25	7/29/2009 9:25											
Base Grab	8/6/2009 8:55	8/6/2009 8:55	0.0005	0.0017	0.0001	<0.005	<0.0005	<0.005	19	<0.03	0.29	~0.02	216
Storm Composite	8/8/2009 1:38	8/9/2009 12:26	0.0041	0.0022	0.0015	0.0109	<0.0005	<0.005	17	<0.03	0.23	~0.02	154
Storm Composite	8/15/2009 23:41	8/16/2009 7:49	0.0044	0.0031	0.0021	0.0131	<0.0005	<0.005		<0.03	<0.05		144
Storm Composite	8/19/2009 15:09	8/20/2009 21:44	0.0041	0.0042	0.0018	0.0126	<0.0005	<0.005	16	<0.03	0.1	<0.02	140
Storm Composite	8/25/2009 6:41	8/25/2009 11:12	0.0072	0.0064	0.0057	0.0235	<0.0005	0.0096	9	<0.03	0.32	~0.02	88
E. Coli Grab	8/27/2009 9:35	8/27/2009 9:35											
Base Grab	9/8/2009 9:39	9/8/2009 9:39	0.0006	0.002	0.0002	<0.005	<0.0005	<0.005	18	<0.03	0.24	~0.03	214
Base Grab	9/29/2009 8:38	9/29/2009 8:38	<0.0005	0.0019	<0.0001	<0.005	<0.0005	<0.005	19	<0.03	0.24	~0.04	220
E. Coli Grab	9/30/2009 9:23	9/30/2009 9:23											
Storm Composite	10/1/2009 17:13	10/3/2009 3:26	0.0032	0.0029	0.0014	0.273	<0.0005	<0.005	17	<0.03	0.31	~0.04	136
Storm Composite	10/6/2009 7:20	10/7/2009 20:43	0.0026	0.0024	0.0013	0.0101	<0.0005	<0.005	14	<0.03	0.15	<0.02	134

No Exceedance Determinable
Exceeds Chronic Standard
Exceeds Max Standard
Exceeds Final Acute Standard

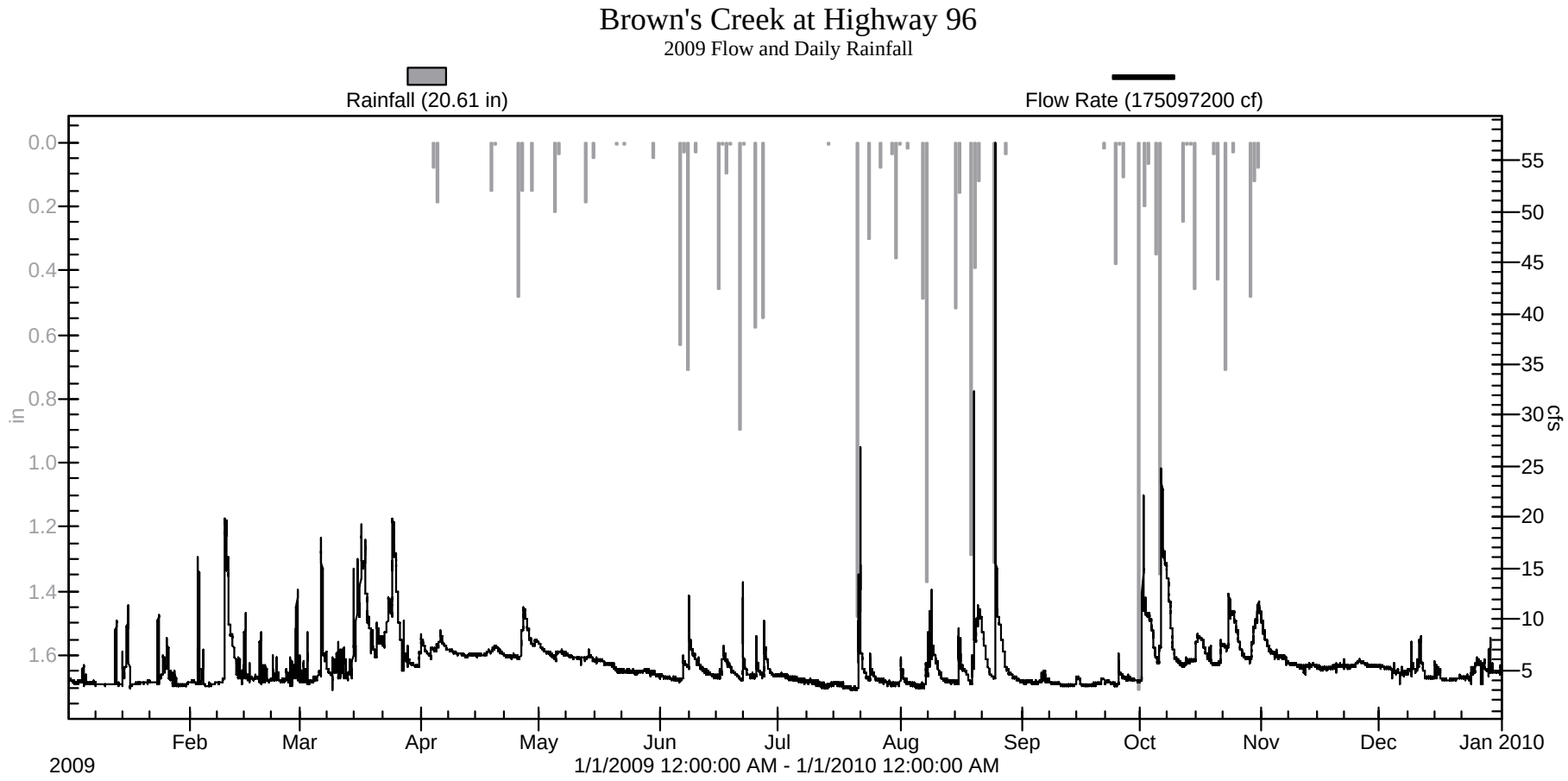


Figure 20. Brown's Creek Outlet at Hwy 96 2009 Flow and Daily Rainfall

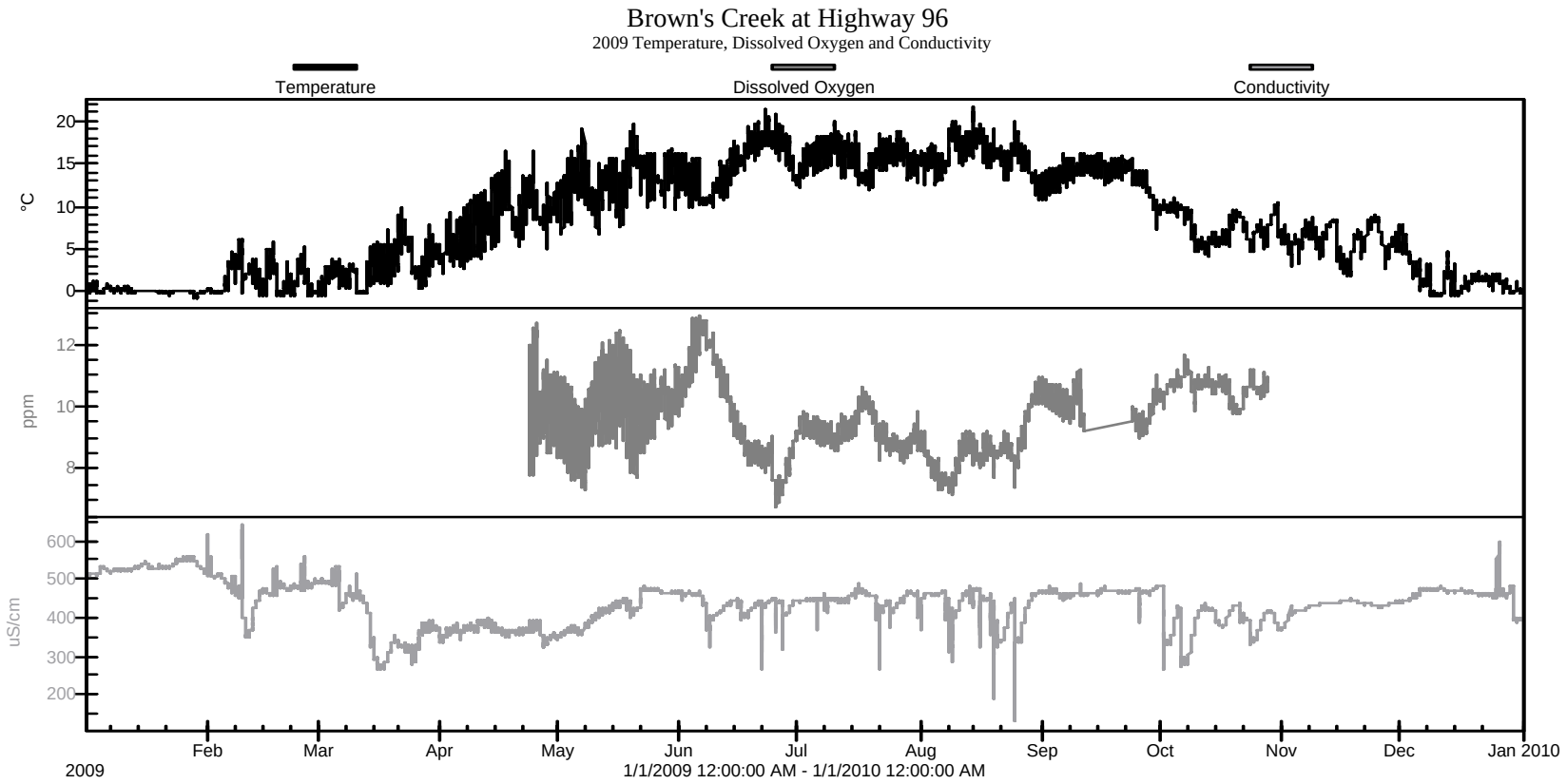


Figure 21: Brown's Creek Outlet at Highway 96 2009 15-minute Temperature, Dissolved Oxygen and Conductivity

Table 25. Brown's Creek Outlet at Highway 96 2009 Total Suspended Solids (TSS) and Total Phosphorus (TP) Loading

	Sample Collection Time				Loading Interval					
Sample Type	**Start**	**End**	**TSS (mg/L)**	**TP (mg/L)**	**Start**	**End**	**Interval Volume (cf)**	**Interval Volume (ac-ft)**	**Interval TSS (lb)**	**Interval TP (lb)**
Base			*5*	*0.074*	*1/1/2009 0:00*	*1/25/2009 0:00*	*8,439,545*	*193.85*	*2,634*	*38.99*
Base Grab	1/28/09 11:15	1/28/09 11:15	6	0.059	1/25/2009 0:00	2/9/2009 18:00	5,845,802	134.27	2,190	21.53
Snowmelt Grab	2/10/09 10:19	2/10/09 10:19	82	0.538	2/9/2009 18:00	2/12/2009 1:00	2,181,771	50.11	11,168	73.28
Base			*5*	*0.074*	*2/12/2009 1:00*	*3/14/2009 14:00*	*13,006,270*	*298.74*	*4,060*	*60.08*
Snowmelt Grab	3/17/09 10:59	3/17/09 10:59	57	0.216	3/14/2009 14:00	3/18/2009 7:00	3,999,397	91.86	14,231	53.93
Base			*5*	*0.074*	*3/18/2009 7:00*	*3/23/2009 9:00*	*3,580,699*	*82.24*	*1,118*	*16.54*
Storm Grab	3/24/09 9:34	3/24/09 9:34	22	0.106	3/23/2009 9:00	3/26/2009 6:00	3,254,372	74.75	4,469	21.53
Base			*5*	*0.074*	*3/26/2009 6:00*	*4/5/2009 15:00*	*5,985,287*	*137.48*	*1,868*	*27.65*
Storm			*618*	*1.113*	*4/5/2009 15:00*	*4/6/2009 16:00*	*736,065*	*16.91*	*28,397*	*51.14*
Base			*5*	*0.074*	*4/6/2009 16:00*	*4/26/2009 10:00*	*11,307,610*	*259.72*	*3,529*	*52.24*
Storm			*618*	*1.113*	*4/26/2009 10:00*	*5/1/2009 10:00*	*3,662,846*	*84.13*	*141,310*	*254.50*
Base Grab	5/13/09 9:40	5/13/09 9:40	6	0.075	5/1/2009 10:00	5/20/2009 10:00	10,241,030	235.22	3,836	47.95
Base			*5*	*0.074*	*5/20/2009 10:00*	*6/6/2009 10:00*	*6,750,742*	*155.06*	*2,107*	*31.19*
Storm			*618*	*1.113*	*6/6/2009 10:00*	*6/8/2009 5:00*	*839,748*	*19.29*	*32,397*	*58.35*
Storm			*618*	*1.113*	*6/8/2009 5:00*	*6/9/2009 12:00*	*827,231*	*19.00*	*31,914*	*57.48*
Base			*5*	*0.074*	*6/9/2009 12:00*	*6/16/2009 3:00*	*2,817,682*	*64.72*	*879*	*13.02*
Storm			*618*	*1.113*	*6/16/2009 3:00*	*6/18/2009 3:00*	*999,235*	*22.95*	*38,550*	*69.43*
Base			*5*	*0.074*	*6/18/2009 3:00*	*6/21/2009 18:00*	*1,461,813*	*33.58*	*456*	*6.75*
Storm			*618*	*1.113*	*6/21/2009 18:00*	*6/22/2009 12:00*	*397,649*	*9.13*	*15,341*	*27.63*
Base Grab	6/24/09 9:27	6/24/09 9:27	8	0.118	6/22/2009 12:00	6/25/2009 6:00	1,089,518	25.02	544	8.03
Storm			*618*	*1.113*	*6/25/2009 6:00*	*6/25/2009 18:00*	*263,042*	*6.04*	*10,148*	*18.28*
Base			*5*	*0.074*	*6/25/2009 18:00*	*6/27/2009 3:00*	*565,030*	*12.98*	*176*	*2.61*
Storm			*618*	*1.113*	*6/27/2009 3:00*	*6/28/2009 5:00*	*612,502*	*14.07*	*23,630*	*42.56*
Base Grab	7/13/09 8:39	7/13/09 8:39	4	0.069	6/28/2009 5:00	7/15/2009 5:00	5,939,428	136.42	1,483	25.58
Base			*5*	*0.074*	*7/15/2009 5:00*	*7/21/2009 7:00*	*1,786,700*	*41.04*	*558*	*8.25*
Storm Composite	7/21/09 9:58	7/21/09 18:47	1080	2.000	7/21/2009 7:00	7/22/2009 9:00	775,798	17.82	52,304	96.86
Base			*5*	*0.074*	*7/22/2009 9:00*	*7/24/2009 8:00*	*771,519*	*17.72*	*241*	*3.56*
Storm			*618*	*1.113*	*7/24/2009 8:00*	*7/24/2009 21:00*	*246,558*	*5.66*	*9,512*	*17.13*
Base			*5*	*0.074*	*7/24/2009 21:00*	*7/31/2009 22:00*	*2,330,534*	*53.53*	*727*	*10.77*
Storm			*618*	*1.113*	*7/31/2009 22:00*	*8/1/2009 15:00*	*315,152*	*7.24*	*12,158*	*21.90*
Base Grab	8/6/09 9:10	8/6/09 9:10	3	0.077	8/1/2009 15:00	8/7/2009 7:00	1,767,462	40.60	331	8.50
Base			*5*	*0.074*	*8/7/2009 7:00*	*8/8/2009 9:00*	*478,174*	*10.98*	*149*	*2.21*
Storm Composite	8/8/09 12:38	8/9/09 1:02	456	0.814	8/8/2009 9:00	8/9/2009 9:00	671,494	15.42	19,115	34.12
Base			*5*	*0.074*	*8/9/2009 9:00*	*8/15/2009 23:00*	*2,519,855*	*57.88*	*787*	*11.64*
Storm			*618*	*1.113*	*8/15/2009 23:00*	*8/16/2009 13:00*	*322,371*	*7.40*	*12,437*	*22.40*
Base			*5*	*0.074*	8/16/2009 13:00	8/19/2009 14:00	1,212,551	27.85	378	5.60
Storm Composite	8/19/09 16:00	8/19/09 16:22	1120	1.780	8/19/2009 14:00	8/19/2009 21:00	368,762	8.47	25,783	40.98
Base			*5*	*0.074*	*8/19/2009 21:00*	*8/20/2009 12:00*	*436,128*	*10.02*	*136*	*2.01*
Storm			*618*	*1.113*	*8/20/2009 12:00*	*8/21/2009 22:00*	*1,242,816*	*28.55*	*47,947*	*86.35*
Base			*5*	*0.074*	*8/21/2009 22:00*	*8/25/2009 6:00*	*1,615,793*	*37.11*	*504*	*7.46*
Storm Composite	8/25/09 6:58	8/25/09 9:32	950	1.810	8/25/2009 6:00	8/26/2009 11:00	1,384,219	31.79	*82,091*	*156.40*
Base Grab	9/8/09 9:28	9/8/09 9:28	4	0.069	8/26/2009 11:00	9/15/2009 11:00	7,188,896	165.12	1,795	30.97
Base			*5*	*0.074*	*9/15/2009 11:00*	*9/25/2009 13:00*	*3,184,343*	*73.14*	*994*	*14.71*
Storm			*618*	*1.113*	*9/25/2009 13:00*	*9/25/2009 20:00*	*134,891*	*3.10*	*5,204*	*9.37*
Base Grab	9/29/09 9:00	9/29/09 9:00	2	0.048	9/25/2009 20:00	10/1/2009 16:00	2,085,909	47.91	260	6.25
Storm			*618*	*1.113*	*10/1/2009 16:00*	*10/2/2009 15:00*	*1,097,432*	*25.21*	*42,338*	*76.25*
Base			*5*	*0.074*	*10/2/2009 15:00*	*10/5/2009 18:00*	*2,286,098*	*52.51*	*714*	*10.56*
Storm Composite	10/6/09 7:09	10/8/09 8:06	81	0.170	10/5/2009 18:00	10/8/2009 9:00	3,206,910	73.66	16,216	34.03
Base			*5*	*0.074*	*10/8/2009 9:00*	*10/15/2009 2:00*	*3,811,897*	*87.55*	*1,190*	*17.61*
Storm			*618*	*1.113*	*10/15/2009 2:00*	*10/17/2009 4:00*	*1,428,813*	*32.82*	*55,123*	*99.27*
Base			*5*	*0.074*	*10/17/2009 4:00*	*10/21/2009 8:00*	*2,186,518*	*50.22*	*682*	*10.10*
Storm			*618*	*1.113*	*10/21/2009 8:00*	*10/22/2009 4:00*	*507,317*	*11.65*	*19,572*	*35.25*
Base			*5*	*0.074*	*10/22/2009 4:00*	*10/23/2009 8:00*	*738,420*	*16.96*	*230*	*3.41*
Storm			*618*	*1.113*	*10/23/2009 8:00*	*10/25/2009 13:00*	*1,936,325*	*44.48*	*74,702*	*134.54*
Base			*5*	*0.074*	*10/25/2009 13:00*	*10/29/2009 0:00*	*2,066,255*	*47.46*	*645*	*9.55*
Storm			*618*	*1.113*	*10/29/2009 0:00*	*11/1/2009 23:00*	*3,091,504*	*71.01*	*119,268*	*214.80*
Base			*5*	*0.074*	*11/1/2009 23:00*	*1/1/2010 0:00*	*27,095,450*	*622.35*	*8,457*	*125.17*
Storm Average			618	1.113						
Base Average			5	0.074						
Snowmelt Average			70	0.377						
All Average			259	0.530						
Total							**175,097,177**	**4,022**	**988,987**	**2,448**
Brown's Creek Major Subwatershed Total Acres							9,051			
Total TP/TSS (lb/ac/yr)									109.27	0.27
Total TP/TSS (kg/ha/yr)									122.47	0.30

*Italics indicate estimated concentrations based on average base and storm flow concentrations.

Table 26. Brown's Creek Outlet at Highway 96 2009 Primary Chemistry Result Averages

Parameter	Storm Flow Average	Base Flow Average	Average (all samples)
TSS (mg/L)	618	5	259
VSS (mg/L)	170	2	63
TKN (mg/L)	5.04	0.23	2.13
TP (mg/L)	1.113	0.074	0.530
E. Coli (mpn/100 mL)	--	--	605

Table 27. Brown's Creek Outlet at Highway 96 2009 Field Measurement Results

Date/Time	Transparency (cm)	Water Temperature (C)	Dissolved Oxygen (mg/L)	Conductivity (umhos/cm)	pH
1/28/2009 11:14	>100	0.5	12.29	553	8.9
2/10/2009 10:19	25	1.3	12.21	397	9.7
3/17/2009 10:59	58	2.4	13.39	271	8.5
3/24/2009 9:34	63	4.9	13.36	310	8.1
4/23/2009 15:20		13.8	13.16	394	8.7
5/7/2009 15:19	>120	16.7	9.32	393	8.7
5/13/2009 9:39		12.1	9.7		8.2
5/22/2009 9:46	>100	12.4	10.6	446	8.6
5/28/2009 8:44	>100	10.5	10.96	564	8.4
6/4/2009 11:48	>100	13.5	11.5	462	8.7
6/18/2009 10:34	85	15.9	8.66	409	
6/22/2009 15:32	69	21.1	8.05		
6/24/2009 9:27	>100	17.4	8.87	445	8.6
6/25/2009 8:47	31	16.8	7.24	423	8.4
7/1/2009 15:12	>100	14.7	9.55	440	
7/9/2009 9:04	>100				
7/13/2009 8:39	>120	13.8	9.6	450	
7/17/2009 10:55	>100	13.1	10.36	469	8.7
7/24/2009 14:53	>100	17.9	8.78	408	8.2
7/29/2009 9:14	>100	13.8	9.04	466	8.6
7/31/2009 10:15	>100	14	9.76	470	8.6
8/6/2009 9:10	>100	13.6	7.79	465	8.6
8/10/2009 15:54	>100	18.9	8.6	403	8.6
8/13/2009 9:38	>100	16.5	9.19	471	8.5
8/24/2009 7:46	>100	14.2	8.64	430	8.1
8/26/2009 15:47	60	17.2	8.63	341	8
8/27/2009 10:07	81	14.7	9.33	394	8.2
8/27/2009 15:45	81	17.1	8.86		8.3
9/8/2009 9:28	>100	13.3	10.26	460	8.7
9/10/2009 15:02	>100	16.1	9.4	463	8.6
9/24/2009 10:13	>100	13.4	9.5	471	8.6
9/29/2009 9:00	>100	9.5	10.41	470	8.6
10/8/2009 8:09	62	8.5	11.49	295	8.5
10/9/2009 15:18		7.9	9.81	367	
10/28/2009 12:04	>100	6.7	10.75	415	8.6
11/23/2009 10:04		7.4	10.62	437	8.4
12/17/2009 8:54		1.7	15.45	469	9.2

Exceeds Water Quality Standard

Table 28: Brown's Creek Outlet at Hwy 96 2009 Primary Water Quality Results

Sample Type	Start	End	TSS (mg/L)	VSS (mg/L)	TKN (mg/L)	TP (mg/L)	Dissolved P (mg/L)	E Coli (mpn/100 mL)	COD (mg/L)	TOC (mg/L)	TBOD (mg/L)	Sulfate (mg/L)	Ortho P (mg/L)	Alkalinity (mg/L)	Turbidity (NTU)
Base Grab	1/28/2009 11:15	1/28/2009 11:15	6	~2	~0.03	0.059	~0.025		~5	2	<1	10.8	0.03	191	6
Snowmelt Grab	2/10/2009 10:19	2/10/2009 10:19	82	14	2.10	0.538	0.354		51	14.6	10	6.29	0.342	71	38
Snowmelt Grab	3/17/2009 10:59	3/17/2009 10:59	57	22	1.80	0.216	0.112		81	15.5	11	5.17	0.103	71	28
Storm Grab	3/24/2009 9:34	3/24/2009 9:34	22	4	1.00	0.106	0.06		39	10.1	4.1	6.6	0.059	103	14
Base Grab	5/13/2009 9:40	5/13/2009 9:40	6	3	0.41	0.075	<0.01		18	4.5	3	7.57	0.015	181	3
E. Coli Grab	5/28/2009 8:44	5/28/2009 8:44						111							
Base Grab	6/24/2009 9:27	6/24/2009 9:27	8	4	0.38	0.118	0.073		18	6.1	1.1	7.72	0.064	199	6
E. Coli Grab	6/25/2009 8:45	6/25/2009 8:45						2420							
Base Grab	7/13/2009 8:39	7/13/2009 8:39	4	~2	0.20	0.069	~0.031		~6	2.4	<1	9.33	0.045	215	5
Storm Composite	7/21/2009 9:58	7/21/2009 18:47	1080	272	9.30	2	0.072		276	7.6		8.14		108	280
E. Coli Grab	7/29/2009 9:15	7/29/2009 9:15						178							
Base Grab	8/6/2009 9:10	8/6/2009 9:10	3	~1	0.18	0.077	0.061		~6	3	<1	8.95	0.043	210	3
Storm Composite	8/8/2009 12:38	8/9/2009 1:02	456	113	3.70	0.814	0.077								120
Storm Composite	8/19/2009 16:00	8/19/2009 16:22	1120	295	7.40	1.78	0.089		268	6.7		6.24		80	
Storm Composite	8/25/2009 6:58	8/25/2009 9:32	950	310	8.10	1.81	0.072		314	8.9		4.87		59	
E. Coli Grab	8/27/2009 10:05	8/27/2009 10:05						238							
Base Grab	9/8/2009 9:28	9/8/2009 9:28	4	~2	0.24	0.069	~0.047		16	3.2	<1	8.8	0.04	194	4
Base Grab	9/29/2009 9:00	9/29/2009 9:00	~2	~1	0.10	~0.048	0.064		~5	3.2	<1	9.43	0.042	192	3
E. Coli Grab	9/30/2009 9:15	9/30/2009 9:15						78							
Storm Composite	10/6/2009 7:09	10/8/2009 8:06	81	28	0.71	0.170	0.08		63	11.1		1.65		105	
Base Grab	11/23/2009 10:00	11/23/2009 10:00	4	~2	0.29	~0.044	~0.043		~8	3.2	<1	7.94	0.03	179	5
Base Grab	12/17/2009 8:54	12/17/2009 8:54	5	3	0.28	0.051	~0.026		<5	2.1	<1	8.54	0.023	356	6

Exceeds Water Quality Standard

Table 29: Brown's Creek Outlet at Hwy 96 2009 Secondary Water Quality Results

Sample Type	Start	End	Copper (mg/L)	Nickel (mg/L)	Lead (mg/L)	Zinc (mg/L)	Cadmium (mg/L)	Chromium (mg/L)	Chloride (mg/L)	Nitrite N (mg/L)	Nitrate N (mg/L)	Ammonia Nitrogen (mg/L)	Hardness (mg/L)
Base Grab	1/28/2009 11:15	1/28/2009 11:15	0.0035	0.0017	0.0002	0.0045	<0.0005	<0.006	22	<0.03	1.42	~0.03	230
Snowmelt Grab	2/10/2009 10:19	2/10/2009 10:19	0.0038	0.0023	0.0012	0.0079	<0.0005	<0.005	60	<0.03	1.01	0.48	96
Snowmelt Grab	3/17/2009 10:59	3/17/2009 10:59	0.0033	0.0027	0.0011	0.0079	<0.0005	<0.005	18	<0.03	0.38	0.63	98
Storm Grab	3/24/2009 9:34	3/24/2009 9:34	0.001	0.0018	0.0003	0.0026	<0.0005	<0.006	17	<0.03	0.53	0.23	144
Base Grab	5/13/2009 9:40	5/13/2009 9:40	<0.0005	0.0018	<0.0001	<0.005	<0.0005	<0.005	23	<0.03	0.61	<0.02	208
E. Coli Grab	5/28/2009 8:44	5/28/2009 8:44											
Base Grab	6/24/2009 9:27	6/24/2009 9:27	0.0007	0.0019	0.0002	<0.005	<0.0005	<0.005	22	<0.03	0.71	<0.02	264
E. Coli Grab	6/25/2009 8:45	6/25/2009 8:45											
Base Grab	7/13/2009 8:39	7/13/2009 8:39	0.0005	0.0019	0.0001	<0.005	<0.0005	<0.005	24	<0.03	0.69	<0.02	440
Storm Composite	7/21/2009 9:58	7/21/2009 18:47	0.0205	0.0142	0.0154	0.0482	<0.0005	0.0273	17	<0.03	0.48	0.07	128
E. Coli Grab	7/29/2009 9:15	7/29/2009 9:15											
Base Grab	8/6/2009 9:10	8/6/2009 9:10	0.005	0.0016	<0.0001	<0.005	<0.0005	<0.005	24	<0.03	0.74	<0.02	240
Storm Composite	8/8/2009 12:38	8/9/2009 1:02	0.0109	0.0061	0.006	0.0225	<0.0005	0.0106	19				
Storm Composite	8/19/2009 16:00	8/19/2009 16:22	0.0203	0.0134	0.0144	0.0465	<0.0005	0.0239	11	<0.03	0.06	0.06	120
Storm Composite	8/25/2009 6:58	8/25/2009 9:32	0.0169	0.0117	0.0146	0.0445	0.0009	0.0217	9	<0.03	0.05	~0.05	104
E. Coli Grab	8/27/2009 10:05	8/27/2009 10:05											
Base Grab	9/8/2009 9:28	9/8/2009 9:28	0.0005	0.0018	<0.0001	<0.005	<0.0005	<0.005	23	<0.03	0.61	<0.02	252
Base Grab	9/29/2009 9:00	9/29/2009 9:00	<0.0005	0.0020	<0.0001	0.0073	<0.0005	<0.005	23	<0.03	0.58	~0.02	248
E. Coli Grab	9/30/2009 9:15	9/30/2009 9:15											
Storm Composite	10/6/2009 7:09	10/8/2009 8:06	0.0032	0.0026	0.00130	0.0092	<0.0005	<0.005	16	<0.03	0.29	<0.02	160
Base Grab	11/23/2009 10:00	11/23/2009 10:00	0.0005	0.0020	<0.0001	<0.005	<0.0005	<0.005	22	<0.03	0.66	<0.02	236
Base Grab	12/17/2009 8:54	12/17/2009 8:54	<0.0005	0.0022	0.0001	<0.005	<0.0005	<0.005	24	<0.03	1.14	~0.03	256

No Exceedance Determinable
Exceeds Chronic Standard
Exceeds Max Standard
Exceeds Final Acute Standard

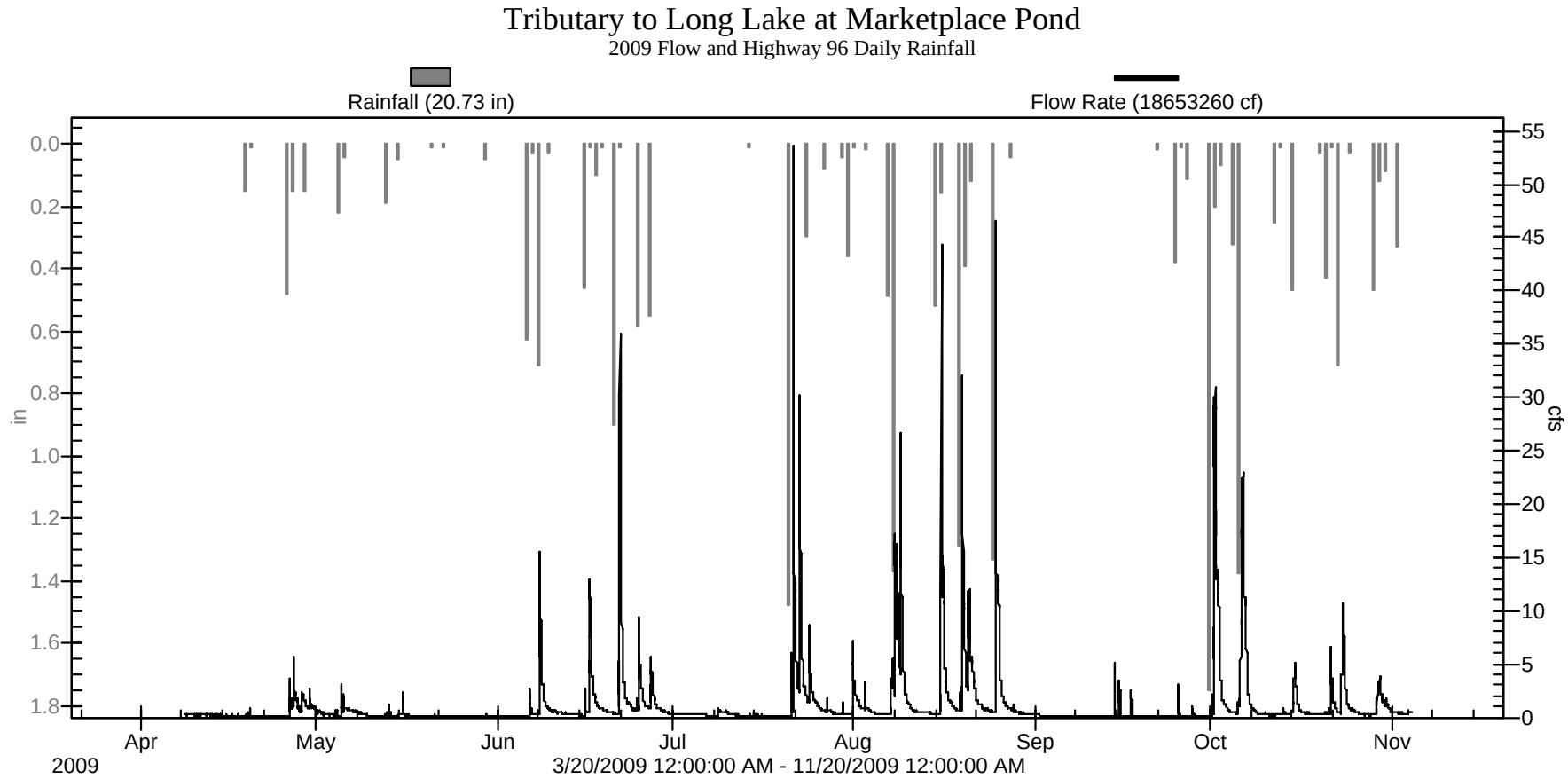


Figure 22. Tributary to Long Lake at Marketplace Pond 2009 Flow and Outlet Daily Rainfall

Table 30. Tributary to Long Lake at Marketplace Pond 2009 Total Suspended Solids (TSS) and Total Phosphorus (TP) Loading

	Sample Collection Time				Loading Interval					
Sample Type	Start	End	TSS (mg/L)	TP (mg/L)	Start	End	Interval Volume (cf)	Interval Volume (ac-ft)	Interval TP (lb)	Interval TSS (lb)
*Base**			*6*	*0.11*	*1/1/2009 0:00*	*2/10/2009 0:00*	*1,728,000*	*39.69*	*11.87*	*647*
Snowmelt Grab**	2/10/09 11:13	2/10/09 11:13	24	0.56	2/10/2009 0:00	2/12/2009 0:00	345,600	7.94	12.04	518
*Base**			*6*	*0.11*	*2/12/2009 0:00*	*4/8/2009 9:30*	*2,393,100*	*54.97*	*16.43*	*896*
Base			*6*	*0.11*	*4/8/2009 9:30*	*4/19/2009 2:30*	*181,104*	*4.16*	*1.24*	*68*
Storm			*17*	*0.09*	*4/19/2009 2:30*	*4/19/2009 18:30*	*16,185*	*0.37*	*0.09*	*17*
Base			*6*	*0.11*	*4/19/2009 18:30*	*4/26/2009 8:30*	*42,435*	*0.97*	*0.29*	*16*
Storm Composite	4/26/09 10:27	4/27/09 6:20	72	0.19	4/26/2009 8:30	4/27/2009 8:30	137,564	3.16	1.59	618
Base			*6*	*0.11*	*4/27/2009 8:30*	*4/28/2009 10:30*	*120,694*	*2.77*	*0.83*	*45*
Storm			*17*	*0.09*	*4/28/2009 10:30*	*4/29/2009 0:30*	*93,215*	*2.14*	*0.52*	*99*
Base			*6*	*0.11*	*4/29/2009 0:30*	*4/29/2009 20:30*	*75,769*	*1.74*	*0.52*	*28*
Storm			*17*	*0.09*	*4/29/2009 20:30*	*4/30/2009 1:30*	*24,318*	*0.56*	*0.14*	*26*
Base			*6*	*0.11*	*4/30/2009 1:30*	*5/5/2009 4:30*	*181,616*	*4.17*	*1.25*	*68*
Storm			*17*	*0.09*	*5/5/2009 4:30*	*5/5/2009 19:30*	*39,963*	*0.92*	*0.22*	*42*
Base			*6*	*0.11*	*5/5/2009 19:30*	*5/13/2009 2:30*	*206,066*	*4.73*	*1.42*	*77*
Storm			*17*	*0.09*	*5/13/2009 2:30*	*5/13/2009 17:30*	*11,818*	*0.27*	*0.07*	*13*
Base			*6*	*0.11*	*5/13/2009 17:30*	*5/15/2009 18:30*	*25,287*	*0.58*	*0.17*	*9*
Storm			*17*	*0.09*	*5/15/2009 18:30*	*5/16/2009 1:30*	*12,931*	*0.30*	*0.07*	*14*
Base Grab	5/18/09 8:45	5/18/09 8:45	5	0.10	5/16/2009 1:30	5/21/2009 6:30	50,591	1.16	0.33	16
Storm			*17*	*0.09*	*5/21/2009 6:30*	*5/21/2009 10:30*	*2,114*	*0.05*	*0.01*	*2*
Base			*6*	*0.11*	*5/21/2009 10:30*	*5/29/2009 23:30*	*49,817*	*1.14*	*0.34*	*19*
Storm			*17*	*0.09*	*5/29/2009 23:30*	*5/30/2009 10:30*	*6,516*	*0.15*	*0.04*	*7*
Base			*6*	*0.11*	*5/30/2009 10:30*	*6/6/2009 2:30*	*25,743*	*0.59*	*0.18*	*10*
Storm Composite	6/6/09 12:15	6/9/09 13:47	30	0.12	6/6/2009 2:30	6/9/2009 15:30	531,701	12.21	3.92	996
Base			*6*	*0.11*	*6/9/2009 15:30*	*6/16/2009 2:30*	*201,231*	*4.62*	*1.38*	*75*
Storm Composite	6/16/09 3:42	6/17/09 14:30	18	0.13	6/16/2009 2:30	6/17/2009 21:30	523,583	12.03	4.09	588
Base			*6*	*0.11*	*6/17/2009 21:30*	*6/21/2009 17:30*	*203,264*	*4.67*	*1.40*	*76*
Storm Composite	6/21/09 18:09	6/22/09 19:17	29	0.10	6/21/2009 17:30	6/22/2009 21:30	740,418	17.01	4.62	1,340
Base			*6*	*0.11*	*6/22/2009 21:30*	*6/25/2009 5:30*	*208,800*	*4.80*	*1.43*	*78*
Storm			*17*	*0.09*	*6/25/2009 5:30*	*6/25/2009 19:30*	*194,424*	*4.47*	*1.09*	*206*
Base			*6*	*0.11*	*6/25/2009 19:30*	*6/27/2009 2:30*	*133,105*	*3.06*	*0.75*	*141*
Storm			*17*	*0.09*	6/27/2009 2:30	6/27/2009 20:30	176,011	4.04	1.21	66
Base			*6*	*0.11*	*6/27/2009 20:30*	*7/21/2009 6:30*	*531,546*	*12.21*	*3.65*	*199*
Storm			*17*	*0.09*	*7/21/2009 6:30*	*7/25/2009 21:30*	*2,138,090*	*49.11*	*12.01*	*2,269*
Base			*6*	*0.11*	*7/25/2009 21:30*	*7/31/2009 22:30*	*235,093*	*5.40*	*1.61*	*88*
Storm			*17*	*0.09*	*7/31/2009 22:30*	*8/1/2009 7:30*	*108,390*	*2.49*	*0.61*	*115*
Base Grab	8/5/09 10:42	8/5/09 10:42	6	0.11	8/1/2009 7:30	8/7/2009 9:30	*327,326*	*7.52*	2.31	123
Storm Composite	8/8/09 0:52	8/9/09 7:15	17	0.08	8/7/2009 9:30	8/9/2009 7:30	1,363,621	31.32	6.64	1,447
Base			*6*	*0.11*	*8/9/2009 7:30*	*8/15/2009 21:30*	*495,778*	*11.39*	*3.40*	*186*
Storm Composite	8/15/09 22:58	8/16/09 12:17	25	0.10	8/15/2009 21:30	8/16/2009 13:30	743,004	17.07	4.45	1,160
Base			*6*	*0.11*	8/16/2009 13:30	8/19/2009 11:30	*358,992*	*8.25*	2.47	134
Storm Composite	8/19/09 14:42	8/20/09 10:36	9	0.09	8/19/2009 11:30	8/21/2009 13:30	1,308,057	30.04	7.10	735
Base			*6*	*0.11*	*8/21/2009 13:30*	*8/25/2009 5:30*	*324,521*	*7.45*	*2.23*	*122*
Storm Composite	8/25/09 6:14	8/25/09 14:51	19	0.07	8/25/2009 5:30	8/25/2009 20:30	853,047	19.59	3.62	1,012
Base			*6*	*0.11*	*8/25/2009 20:30*	*9/25/2009 12:30*	*718,922*	*16.51*	*4.94*	*269*
Storm			*17*	*0.09*	*9/25/2009 12:30*	*9/25/2009 18:30*	*19,478*	*0.45*	*0.11*	*21*
Base			*6*	*0.11*	*9/25/2009 18:30*	*9/27/2009 17:30*	*17,845*	*0.41*	*0.12*	*7*
Storm			*17*	*0.09*	*9/27/2009 17:30*	*9/28/2009 1:30*	*8,573*	*0.20*	*0.05*	*9*
Base			*6*	*0.11*	*9/28/2009 1:30*	*10/1/2009 7:30*	*28,172*	*0.65*	*0.19*	*11*
Storm Composite	10/1/09 16:21	10/2/09 14:26	10	0.05	10/1/2009 7:30	10/2/2009 16:30	1,323,178	30.39	3.80	826
Base			*6*	*0.11*	*10/2/2009 16:30*	*10/5/2009 16:30*	*267,100*	*6.13*	*1.83*	*100*
Storm Composite	10/6/09 0:07	10/7/09 7:26	5	0.07	10/5/2009 16:30	10/7/2009 7:30	1,227,752	28.20	5.21	383
Base			*6*	*0.11*	*10/7/2009 7:30*	*10/14/2009 23:30*	*317,580*	*7.29*	*2.18*	*119*
Storm Composite	10/15/09 7:13	10/15/09 19:41	5	0.06	10/14/2009 23:30	10/15/2009 20:30	196,370	4.51	0.74	61
Base			*6*	*0.11*	*10/15/2009 20:30*	*10/21/2009 6:30*	*181,153*	*4.16*	*1.24*	*68*
Storm			*17*	*0.09*	*10/21/2009 6:30*	*10/22/2009 2:30*	*187,061*	*4.30*	*1.05*	*199*
Base			*6*	*0.11*	*10/22/2009 2:30*	*10/23/2009 7:30*	*75,614*	*1.74*	*0.52*	*28*
Storm			*17*	*0.09*	*10/23/2009 7:30*	*10/24/2009 3:30*	*362,950*	*8.34*	*2.04*	*385*
Base			*6*	*0.11*	*10/24/2009 3:30*	*10/29/2009 8:30*	*225,142*	*5.17*	*1.55*	*84*
Storm			*17*	*0.09*	*10/29/2009 8:30*	*10/31/2009 8:30*	*320,986*	*7.37*	*1.80*	*341*
Base			*6*	*0.11*	*10/31/2009 8:30*	*11/4/2009 15:30*	*171,245*	*3.93*	*1.18*	*64*
*Base**			*6*	*0.11*	*11/4/2009 15:30*	*1/1/2010 0:00*	*2,477,700*	*56.91*	*17.01*	*928*
Storm Average			17	0.09						
Base Average			6	0.11						
All Average			16	0.10						
Total							**25,597,268**	**588**	**165**	**18,315**
Brown's Creek Major Subwatershed Total Acres							448			
Total TP/TSS(lb/ac/yr)									0.37	40.88
Total TP/TSS (kg/ha/yr)									0.41	45.82

*Italics indicate estimated concentrations based on average base and storm flow concentrations

**Interval volume between 1/1/09-4/8/09 and 11/4/09-1/1/10 were estimated using recorded base flow

Table 31. Tributary to Long Lake at Marketplace Pond 2009 Primary Chemistry Result Averages

Parameter	Storm Flow Average	Base Flow Average	Average (all samples)
TSS (mg/L)	17	6	16
VSS (mg/L)	8	3	8
TKN (mg/L)	1.55	1.38	1.82
TP (mg/L)	0.09	0.11	0.10
E. Coli (mpn/100 mL)	--	--	860

Table 32: Tributary to Long Lake at Marketplace Pond 2009 Primary Water Quality Results

Sample Type	Start	End	TSS (mg/L)	VSS (mg/L)	TKN (mg/L)	TP (mg/L)	Dissolved TP (mg/L)	E Coli (mpn/100 mL)
Snowmelt Grab	2/10/2009 11:13	2/10/2009 11:13	24	11	5.7	0.558	0.449	
Storm Composite	4/26/2009 10:27	4/27/2009 6:20	72	30	3.4	0.185	<0.010	
Base Grab	5/18/2009 8:45	5/18/2009 8:45	5	~2	2	0.104	~0.019	
Storm Composite	6/6/2009 12:15	6/9/2009 13:47	30	10	2.5	0.118	0.09	
Storm Composite	6/16/2009 3:42	6/17/2009 14:30	18	8	4	0.125	~0.032	
Storm Composite	6/21/2009 18:09	6/22/2009 19:17	29	9	2.4	0.1	<0.010	
E. Coli Grab	6/25/2009 10:11	6/25/2009 10:11						>2420
E. Coli Grab	7/29/2009 9:40	7/29/2009 9:40						100
Base Grab	8/5/2009 10:42	8/5/2009 10:42	6	4	0.75	0.113	~0.027	
Storm Composite	8/8/2009 0:52	8/9/2009 7:15	17	6	0.87	0.078	<0.010	
Storm Composite	8/15/2009 22:58	8/16/2009 12:17	25	9	1	0.096	<0.010	
Storm Composite	8/19/2009 14:42	8/20/2009 10:36	9	5	0.73	0.087	<0.010	
Storm Composite	8/25/2009 6:14	8/25/2009 14:51	19	~6	0.33	0.068	<0.010	
E. Coli Grab	8/27/2009 0:00	8/27/2009 0:00						61
Storm Composite	10/1/2009 16:21	10/2/2009 14:26	10	4	0.46	~0.046	~0.016	
Storm Composite	10/6/2009 0:07	10/7/2009 7:26	5	~2	0.8	0.068	0.064	
Storm Composite	10/15/2009 7:13	10/15/2009 19:41	5	~2	0.59	0.06	<0.010	

Exceeds Water Quality Standard

Table 33: Tributary to Long Lake at Marketplace Pond 2009 Secondary Water Quality Results

Sample Type	Start	End	Copper (mg/L)	Nickel (mg/L)	Lead (mg/L)	Zinc (mg/L)	Cadmium (mg/L)	Chromium (mg/L)	Hardness (mg/L)	Chloride (mg/L)	Nitrite N (mg/L)	Nitrate N (mg/L)	Ammonia Nitrogen (mg/L)
Snowmelt Grab	2/10/2009 11:13	2/10/2009 11:13	0.017	0.0037	0.0022	0.0474	<0.0005	<0.005	80	516	0.05	0.53	1.11
Storm Composite	4/26/2009 10:27	4/27/2009 6:20	0.0157	0.0034	0.0028	0.046	<0.0005	<0.008	68	328	<0.03	0.19	0.12
Base Grab	5/18/2009 8:45	5/18/2009 8:45	0.0116	0.0025	0.0003	0.0097	<0.0005	<0.005	98	570	<0.03	0.31	0.12
Storm Composite	6/6/2009 12:15	6/9/2009 13:47	0.0097	0.004	0.0016	0.0234	<0.0005	0.009	48	260	<0.03	0.12	0.13
Storm Composite	6/16/2009 3:42	6/17/2009 14:30	0.0067	0.0017	0.001	0.0164	<0.0005	<0.005	52	168	<0.03	0.22	0.15
Storm Composite	6/21/2009 18:09	6/22/2009 19:17	0.0092	0.0019	0.0012	0.0191	<0.0005	<0.005	56	124	<0.03	0.08	0.07
E. Coli Grab	6/25/2009 10:11	6/25/2009 10:11											
E. Coli Grab	7/29/2009 9:40	7/29/2009 9:40											
Base Grab	8/5/2009 10:42	8/5/2009 10:42	0.0023	0.0013	0.0002	<0.005	<0.0005	<0.005	68	78	<0.03	0.08	~0.03
Storm Composite	8/8/2009 0:52	8/9/2009 7:15	0.0045	0.0013	0.0006	0.0114	<0.0005	<0.005	34	46	<0.03	0.19	0.01
Storm Composite	8/15/2009 22:58	8/16/2009 12:17	0.0046	0.0016	0.007	0.0131	<0.0005	<0.005	40	33	<0.03	<0.05	~0.02
Storm Composite	8/19/2009 14:42	8/20/2009 10:36	0.0036	0.0011	0.0005	0.0093	<0.0005	<0.005	30	23	<0.03	0.07	~0.04
Storm Composite	8/25/2009 6:14	8/25/2009 14:51	0.0034	0.0012	0.0007	0.0132	<0.0005	<0.005	32	13	<0.03	0.11	~0.02
E. Coli Grab	8/27/2009 0:00	8/27/2009 0:00											
Storm Composite	10/1/2009 16:21	10/2/2009 14:26	0.0035	0.0012	0.0005	0.0102	<0.0005	<0.005	24	13	<0.03	0.27	0.12
Storm Composite	10/6/2009 0:07	10/7/2009 7:26	0.0034	0.0011	0.0004	0.0088	<0.0005	<0.005	44	9	<0.03	0.11	0.08
Storm Composite	10/15/2009 7:13	10/15/2009 19:41	0.0037	0.0013	0.0004	0.0093	<0.0005	<0.005		15	<0.03	0.13	0.07

No Exceedance Determinable
Exceeds Chronic Standard
Exceeds Max Standard
Exceeds Final Acute Standard

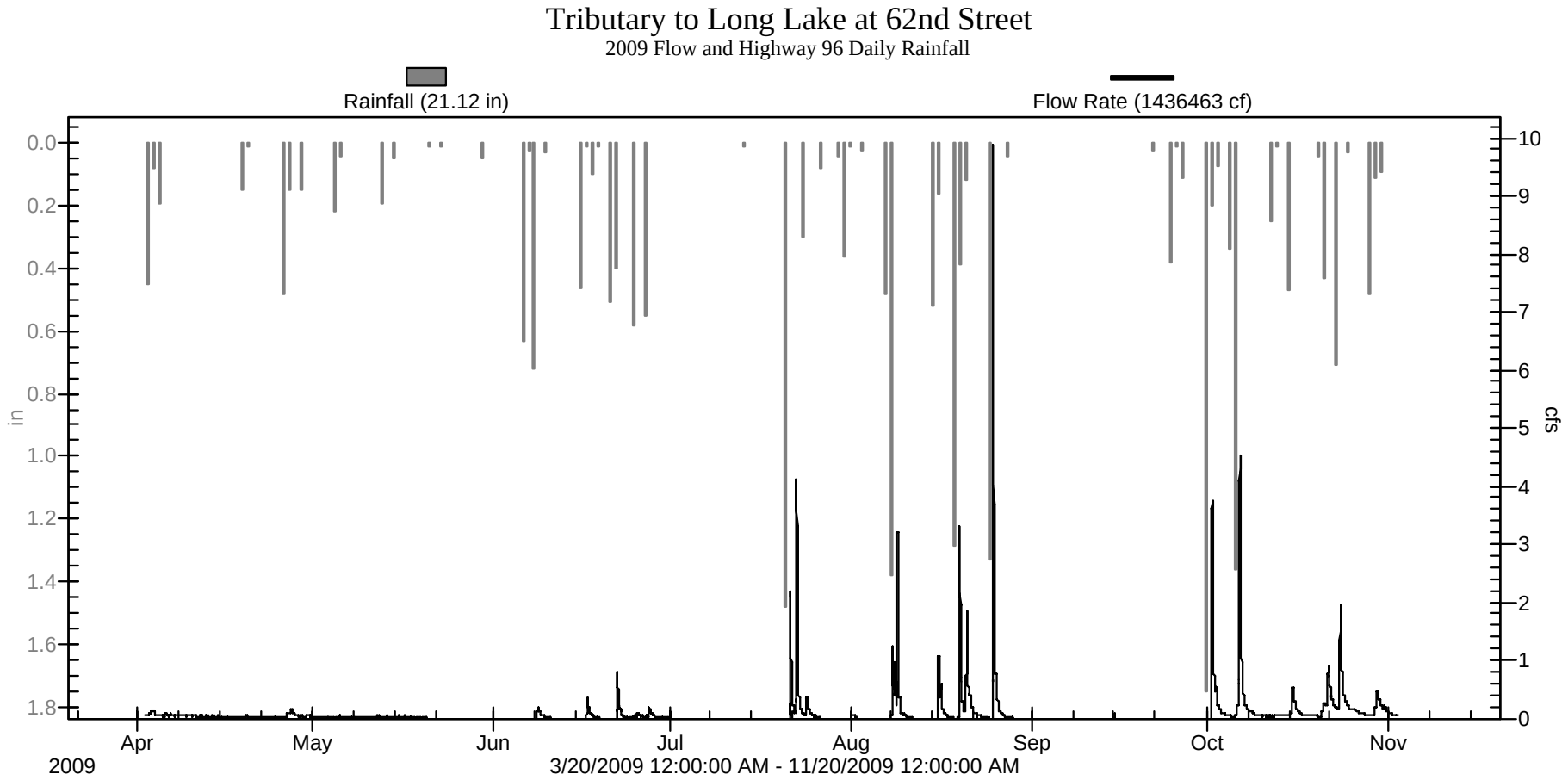


Figure 23. Tributary to Long Lake at 62nd St. 2009 Flow and Outlet Daily Rainfall

Table 34. Tributary to Long Lake at 62nd St. 2009 Total Suspended Solids (TSS) and Total Phosphorus (TP) Loading

	Sample Collection Time				Loading Interval					
Sample Type	**Start**	**End**	**TSS (mg/L)**	**TP (mg/L)**	**Start**	**End**	**Interval Volume (cf)**	**Interval Volume (ac-ft)**	**Interval TP (lb)**	**Interval TSS (lb)**
*Base***			*12*	*0.406*	*1/1/2009 0:00*	*3/17/2009 5:00*	*6,498*	*0.15*	*0.16*	*5*
Snowmelt Grab**	3/17/2009 11:00	3/17/2009 11:00	12	0.406	3/17/2009 5:00	3/19/2009 5:00	34,560	0.79	0.88	26
*Base***			*12*	*0.406*	*3/19/2009 5:00*	*4/2/2009 11:00*	*49,248*	*1.13*	*1.25*	*37*
Base			*12*	*0.406*	*4/2/2009 11:00*	*4/26/2009 10:00*	*72,650*	*1.67*	*1.84*	*54*
Storm			*81*	*0.474*	*4/26/2009 10:00*	*4/28/2009 0:00*	*12,995*	*0.30*	*0.38*	*66*
Base			*12*	*0.406*	*4/28/2009 0:00*	*5/21/2009 20:00*	*39,328*	*0.90*	*1.00*	*29*
No Flow			*0*	*0.000*	*5/21/2009 20:00*	*6/8/2009 5:00*	*0*	*0.00*	*0.00*	*0*
Storm			*81*	*0.474*	*6/8/2009 5:00*	*6/9/2009 17:00*	*9,505*	*0.22*	*0.28*	*48*
Base			*12*	*0.406*	*6/9/2009 17:00*	*6/12/2009 22:00*	*836*	*0.02*	*0.02*	*1*
No Flow			*0*	*0.000*	*6/12/2009 22:00*	*6/16/2009 17:00*	*0*	*0.00*	*0.00*	*0*
Storm			*81*	*0.474*	*6/16/2009 17:00*	*6/18/2009 16:00*	*15,167*	*0.35*	*0.45*	*77*
Base			*12*	*0.406*	*6/18/2009 16:00*	*6/20/2009 15:00*	*15*	*0.00*	*0.00*	*0*
No Flow			*0*	*0.000*	*6/20/2009 15:00*	*6/21/2009 23:00*	*0*	*0.00*	*0.00*	*0*
Storm Composite	6/22/2009 2:47	6/22/2009 11:49	*81*	0.514	6/21/2009 23:00	6/22/2009 20:00	21,029	0.48	0.67	106
Base			*12*	*0.406*	*6/22/2009 20:00*	*6/27/2009 11:00*	*9,033*	*0.21*	*0.23*	*7*
Storm			*81*	*0.474*	*6/27/2009 11:00*	*6/28/2009 0:00*	*5,494*	*0.13*	*0.16*	*28*
Base			*12*	*0.406*	*6/28/2009 0:00*	*7/2/2009 4:00*	*3,883*	*0.09*	*0.10*	*3*
No Flow			*0*	*0.000*	*7/2/2009 4:00*	*7/21/2009 15:00*	*0*	*0.00*	*0.00*	*0*
Storm Composite	7/21/2009 16:47	7/22/2009 13:21	125	0.639	7/21/2009 15:00	7/22/2009 17:00	42,818	0.98	1.71	334
Storm Composite	7/22/2009 18:30	7/23/2009 6:46	118	0.508	7/22/2009 17:00	7/25/2009 10:00	90,440	2.08	2.87	666
Base			*12*	*0.406*	*7/25/2009 10:00*	*7/28/2009 9:00*	*3,002*	*0.07*	*0.08*	*2*
No Flow			*0*	*0.000*	*7/28/2009 9:00*	*8/1/2009 4:00*	*0*	*0.00*	*0.00*	*0*
Storm			*81*	*0.474*	*8/1/2009 4:00*	*8/3/2009 0:00*	*2,393*	*0.05*	*0.07*	*12*
Base			*12*	*0.406*	*8/3/2009 0:00*	*8/3/2009 12:00*	*0*	*0.00*	*0.00*	*0*
No Flow			*0*	*0.000*	*8/3/2009 12:00*	*8/7/2009 17:00*	*0*	*0.00*	*0.00*	*0*
Storm Composite	8/8/2009 1:45	8/9/2009 12:14	51	0.386	8/7/2009 17:00	8/9/2009 18:00	101,318	2.33	2.44	323
Base			*12*	*0.406*	*8/9/2009 18:00*	*8/13/2009 7:00*	*5,237*	*0.12*	*0.13*	*4*
No Flow			*0*	*0.000*	*8/13/2009 7:00*	*8/15/2009 23:00*	*0*	*0.00*	*0.00*	*0.00*
Storm Composite	8/16/2009 1:15	8/16/2009 22:58	61	0.483	8/15/2009 23:00	8/17/2009 5:00	35,423	0.81	1.07	135
Base			*12*	*0.406*	*8/17/2009 5:00*	*8/19/2009 12:00*	*2,865*	*0.07*	*0.07*	*2*
Storm Composite	8/19/2009 16:04	8/21/2009 10:37	33	0.340	8/19/2009 12:00	8/22/2009 0:00	125,419	2.88	2.66	258
Base			*12*	*0.406*	*8/22/2009 0:00*	*8/25/2009 6:00*	*8,404*	*0.19*	*0.21*	*6*
Storm Composite	8/25/2009 6:25	8/25/2009 13:43	104	0.454	8/25/2009 6:00	8/26/2009 12:00	204,703	4.70	5.80	1,329
Base			*12*	*0.406*	*8/26/2009 12:00*	*9/1/2009 20:00*	*7,575*	*0.17*	*0.19*	*6*
No Flow			*0*	*0.000*	*9/1/2009 20:00*	*10/1/2009 17:00*	*0*	*0.00*	*0.00*	*0*
Storm Composite	10/1/2009 20:05	10/1/2009 22:58	109	0.480	10/1/2009 17:00	10/2/2009 22:00	100,494	2.31	3.011	683.81
Base			*12*	*0.406*	*10/2/2009 22:00*	*10/5/2009 22:00*	*17,295*	*0.40*	*0.44*	*13*
Storm Composite	10/6/2009 7:03	10/7/2009 3:30	37	0.376	10/5/2009 22:00	10/7/2009 4:00	138,632	3.18	3.25	320
Base			*12*	*0.406*	*10/7/2009 4:00*	*10/15/2009 7:00*	*52,542*	*1.21*	*1.33*	*39*
Storm Composite	10/15/2009 14:06	10/16/2009 1:02	88	0.561	10/15/2009 7:00	10/16/2009 22:00	33,972	0.78	1.19	187
Base			*12*	*0.406*	*10/16/2009 22:00*	*10/20/2009 14:00*	*14,313*	*0.33*	*0.36*	*11*
Storm			*81*	*0.474*	*10/20/2009 14:00*	*10/24/2009 21:00*	*157,767*	*3.62*	*4.67*	*798*
Base			*12*	*0.406*	*10/24/2009 21:00*	*10/29/2009 14:00*	*43,979*	*1.01*	*1.11*	*33*
Storm			*81*	*0.474*	*10/29/2009 14:00*	*11/1/2009 1:00*	*48,071*	*1.10*	*1.42*	*243*
Base			*12*	*0.406*	*11/1/2009 1:00*	*11/2/2009 16:00*	*9,388*	*0.22*	*0.24*	*7*
*Base***			*12*	*0.406*	*11/2/2009 16:00*	*1/1/2010 0:00*	*0*	*0.00*	*0.00*	*0*
Storm Average			81	0.474						
Base/Snowmelt Average			12	0.406						
All Average			74	0.468						
Total							**1,526,291**	**35**	**42**	**5,898**
Brown's Creek Major Subwatershed Total Acres							561			
Total TP/TSS(lb/ac/yr)									0.07	10.51
Total TP/TSS (kg/ha/yr)									0.08	11.78

*Italics indicate estimated concentrations based on average base and storm flow concentrations

**Interval volumes from 1/1/09 to 4/2/09 and 11/2/09 to 1/1/10 were estimated using base flow

Table 35. Tributary to Long Lake at 62nd St. 2009 Primary Chemistry Result Averages

Parameter	Storm Flow Average	Base Flow Average	Average (all samples)
TSS (mg/L)	81	12	74
VSS (mg/L)	15	6	14
TKN (mg/L)	1.24	2.2	1.33
TP (mg/L)	0.474	0.406	0.468
E. Coli (mpn/100 mL)	--	--	387

Table 36: Tributary to Long Lake at 62nd St. 2009 Primary Water Quality Results

Sample Type	Start	End	TSS (mg/L)	VSS (mg/L)	TKN (mg/L)	TP (mg/L)	Dissolved P (mg/L)	E Coli (mpn/100 mL)
Snowmelt Grab	3/17/2009 11:00	3/17/2009 11:00	12	6	2.2	0.406	0.219	
Storm Composite	6/22/2009 2:47	6/22/2009 11:49			1.7	0.514	0.102	
Storm Composite	7/21/2009 16:47	7/22/2009 13:21	125	~19	1.4	0.639	0.271	
Storm Composite	7/22/2009 18:30	7/23/2009 6:46	118	~16	1.2	0.508	0.258	
Storm Composite	8/8/2009 1:45	8/9/2009 12:14	51	~10	1.3	0.386	0.196	
Storm Composite	8/16/2009 1:15	8/16/2009 22:58	61	~12	0.99	0.483	0.214	
Storm Composite	8/19/2009 16:04	8/21/2009 10:37	33	~7	1.5	0.34	0.201	
Storm Composite	8/25/2009 6:25	8/25/2009 13:43	104	~18	1.4	0.454	0.249	
E. Coli Grab	8/27/2009 8:40	8/27/2009 8:40						387
Storm Composite	10/1/2009 20:05	10/1/2009 22:58	109	24	0.61	0.48	0.396	
Storm Composite	10/6/2009 7:03	10/7/2009 3:30	37	~10	0.97	0.376	0.314	
Storm Composite	10/15/2009 14:06	10/16/2009 1:02	88	21	1.3	0.561	0.129	

Exceeds Water Quality Standard

Exceeds Water Quality Standard for Turbidity(TSS Value used to calculate)

Table 37: Tributary to Long Lake at 62nd St. 2009 Secondary Water Quality Results

Sample Type	Start	End	Copper (mg/L)	Nickel (mg/L)	Lead (mg/L)	Zinc (mg/L)	Cadmium (mg/L)	Chromium (mg/L)	Chloride (mg/L)	Hardness (mg/L)	Nitrite mg/L)	Nitrate mg/L)	Ammonia Nitrogen mg/L)
Snowmelt Grab	3/17/2009 11:00	3/17/2009 11:00	0.0056	0.0038	0.0007	0.0245	<0.0005	<0.005	87	80	<0.03	0.1	0.23
Storm Composite	6/22/2009 2:47	6/22/2009 11:49	0.0075	0.004	0.0024	0.0208	<0.0005	<0.005	41	96	<0.03	<0.05	~0.02
Storm Composite	7/21/2009 16:47	7/22/2009 13:21	0.0111	0.0062	0.0048	0.0355	0.0012	0.008	20	32	<0.03	0.31	0.11
Storm Composite	7/22/2009 18:30	7/23/2009 6:46	0.0141	0.0088	0.0063	0.0436	<0.0005	0.0109	16	32	0.04	0.35	0.07
Storm Composite	8/8/2009 1:45	8/9/2009 12:14	0.0101	0.0046	0.0036	0.0251	<0.0005	<0.005	26	38	0.08	0.17	0.07
Storm Composite	8/16/2009 1:15	8/16/2009 22:58	0.0083	0.0039	0.0026	0.0263	<0.0005	<0.005	23	42	<0.03	0.05	~0.03
Storm Composite	8/19/2009 16:04	8/21/2009 10:37	0.0093	0.0047	0.0037	0.0236	<0.0005	<0.005	42	58	<0.03	<0.05	~0.04
Storm Composite	8/25/2009 6:25	8/25/2009 13:43	0.0093	0.0068	0.0062	0.0319	<0.0005	0.0068	18	40	<0.03	<0.05	~0.05
E. Coli Grab	8/27/2009 8:40	8/27/2009 8:40											
Storm Composite	10/1/2009 20:05	10/1/2009 22:58							14				
Storm Composite	10/6/2009 7:03	10/7/2009 3:30	0.01	0.0048	0.0068	0.0364	<0.0005	<0.005	47	74	0.06	0.11	0.12
Storm Composite	10/15/2009 14:06	10/16/2009 1:02	0.0078	0.0042	0.0031	0.0359	<0.0005	<0.005					

No Exceedance Determinable

Exceeds Chronic Standard

Exceeds Max Standard

Exceeds Final Acute Standard

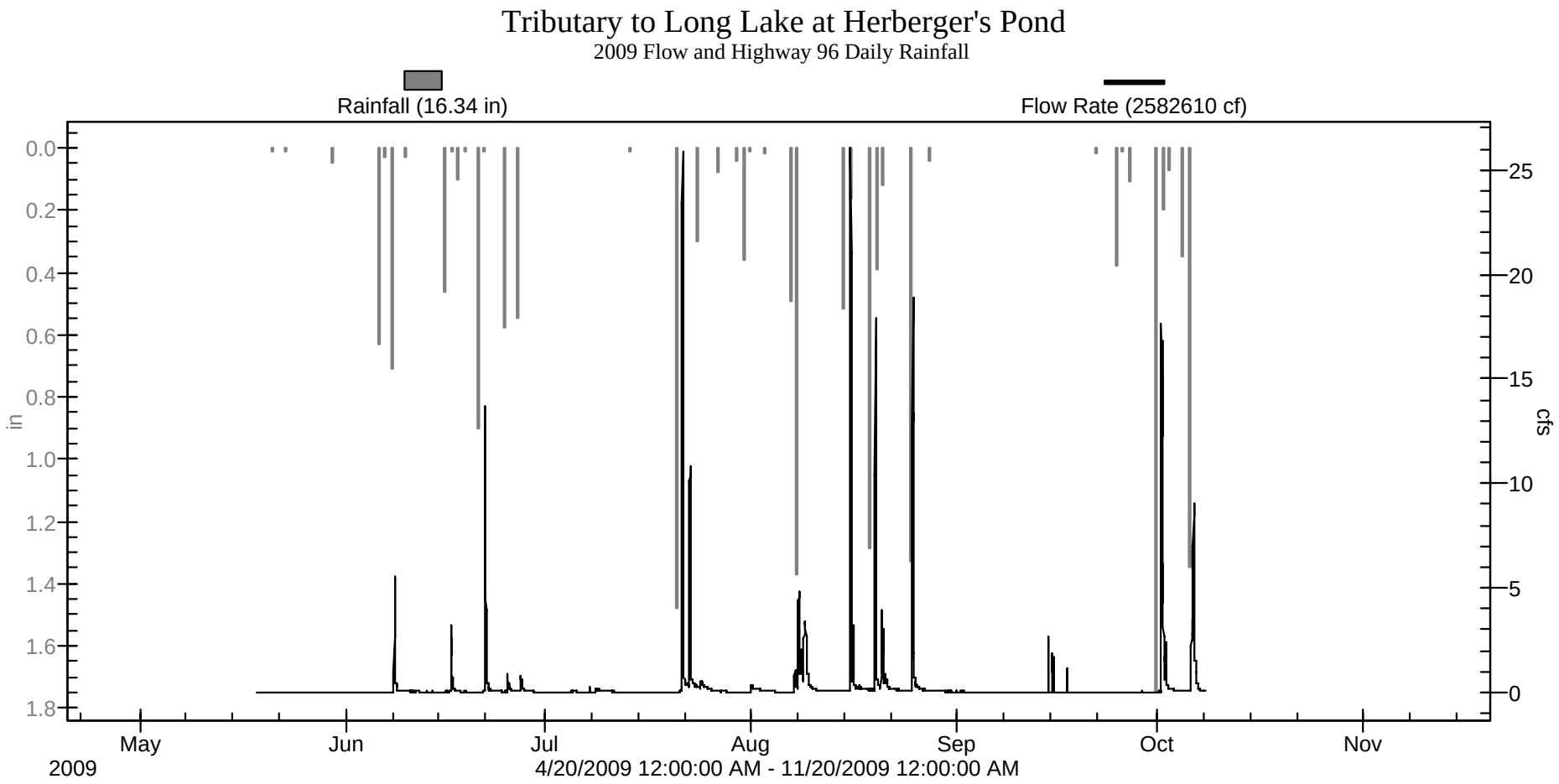


Figure 24: Tributary to Long Lake at Herberger's Pond 2009 Flow and Outlet Daily Rainfall

Table 38: Tributary to Long Lake at Herberger's Pond 2009 Total Suspended Solids (TSS) and Total Phosphorus (TP) Loading

	Sample Collection Time				Loading Interval					
Sample Type	**Start**	**End**	**TSS (mg/L)**	**TP (mg/L)**	**Start**	**End**	**Interval Volume (cf)**	**Interval Volume (ac-ft)**	**Interval TP (lb)**	**Interval TSS (lb)**
*Base***			*8*	*0.14*	*1/1/2009 0:00*	*3/15/2009 0:00*	*63,072*	*1.45*	*0.6*	*31*
*Base***			*19*	*0.09*	*3/15/2009 0:00*	*4/25/2009 0:00*	*1,771,200*	*40.68*	*10.0*	*2,101*
*Base***			*19*	*0.09*	*4/25/2009 0:00*	*5/18/2009 15:00*	*20,412*	*0.47*	*0.1*	*24*
Base			*8*	*0.14*	*5/18/2009 15:00*	*6/8/2009 5:00*	*0*	*0.00*	*0.0*	*0*
Storm Composite	6/8/2009 7:13	6/8/2009 9:50	23	0.06	6/8/2009 5:00	6/8/2009 21:00	54,982	1.26	0.2	79
Base			*8*	*0.14*	*6/8/2009 21:00*	*6/16/2009 3:00*	*18,106*	*0.42*	*0.2*	*9*
Storm			*23*	*0.07*	*6/16/2009 3:00*	*6/17/2009 10:00*	*50,923*	*1.17*	*0.2*	*73*
Base			*8*	*0.14*	6/17/2009 10:00	6/21/2009 17:00	12,354	0.28	0.1	6
Storm Composite	6/21/2009 23:47	6/22/2009 6:43	30	0.11	6/21/2009 17:00	6/22/2009 17:00	118,498	2.72	0.8	222
Base			*8*	*0.14*	*6/22/2009 17:00*	*6/25/2009 5:00*	*11,656*	*0.27*	*0.1*	*6*
Storm			*23*	*0.07*	*6/25/2009 5:00*	*6/25/2009 21:00*	*19,431*	*0.45*	*0.1*	*28*
Base			*8*	*0.14*	*6/25/2009 21:00*	*6/27/2009 4:00*	*7,196*	*0.17*	*0.1*	*4*
Storm			*23*	*0.07*	*6/27/2009 4:00*	*6/27/2009 16:00*	*15,375*	*0.35*	*0.1*	*22*
Base Grab	7/16/2009 15:15	7/16/2009 15:15	5	0.12	6/27/2009 16:00	7/21/2009 8:00	64,692	1.49	0.5	20
Storm Composite	7/21/2009 15:15	7/21/2009 18:11	46	0.11	7/21/2009 8:00	7/22/2009 9:00	225,201	5.17	1.5	647
Storm Composite	7/22/2009 18:02	7/22/2009 21:51	18	0.06	7/22/2009 9:00	7/23/2009 2:00	135,982	3.12	0.5	153
Base			*8*	*0.14*	*7/23/2009 2:00*	*7/24/2009 8:00*	*35,303*	*0.81*	*0.3*	*18*
Storm			*23*	*0.07*	7/24/2009 8:00	7/24/2009 17:00	13,545	0.31	0.1	19
Base			*8*	*0.14*	*7/24/2009 17:00*	*7/31/2009 22:00*	*43,138*	*0.99*	*0.4*	*22*
Storm			*23*	*0.07*	7/31/2009 22:00	8/1/2009 11:00	10,684	0.25	0.0	15
Base			*8*	*0.14*	*8/1/2009 11:00*	*8/7/2009 11:00*	*32,644*	*0.75*	*0.3*	*16*
Storm Composite	8/8/2009 1:04	8/9/2009 7:02	13	0.06	8/7/2009 11:00	8/9/2009 15:00	271,275	6.23	1.1	220
Base			*8*	*0.14*	8/9/2009 15:00	8/15/2009 23:00	49,758	1.14	0.4	25
Storm Composite	8/15/2009 23:06	8/16/2009 6:58	29	0.07	8/15/2009 23:00	8/16/2009 11:00	150,314	3.45	0.6	272
Base			*8*	*0.14*	*8/16/2009 11:00*	*8/19/2009 14:00*	*50,888*	*1.17*	*0.4*	*25*
Storm Composite	8/19/2009 15:01	8/20/2009 21:18	12	0.05	8/19/2009 14:00	8/19/2009 23:00	107,693	2.47	0.4	81
Base			*8*	*0.14*	*8/19/2009 23:00*	*8/20/2009 11:00*	*15,162*	*0.35*	*0.1*	*8*
Storm			*23*	*0.07*	8/20/2009 11:00	8/21/2009 11:00	102,018	2.34	0.4	146
Base			*8*	*0.14*	8/21/2009 11:00	8/25/2009 6:00	44,172	1.01	0.4	22
Storm Composite	8/25/2009 6:25	8/25/2009 10:14	14	0.05	8/25/2009 6:00	8/25/2009 15:00	166,596	3.83	0.5	146
Base Grab	9/8/2009 11:18	9/8/2009 11:18	6	0.09	8/25/2009 15:00	9/15/2009 15:00	106,737	2.45	0.6	40
Base Grab	9/28/2009 13:44	9/28/2009 13:44	13	0.21	9/15/2009 15:00	10/1/2009 16:00	18,455	0.42	0.2	15
Storm			*23*	*0.07*	*10/1/2009 16:00*	*10/2/2009 15:00*	*315,284*	*7.24*	*1.4*	*453*
Base			*8*	*0.14*	*10/2/2009 15:00*	*10/5/2009 23:00*	*31,909*	*0.73*	*0.3*	*16*
Storm			*23*	*0.07*	10/5/2009 23:00	10/7/2009 6:00	273,456	6.28	1.2	393
Base			*8*	*0.14*	*10/7/2009 6:00*	*10/8/2009 10:00*	*9,134*	*0.21*	*0.1*	*5*
*Base***			*8*	*0.14*	*10/8/2009 10:00*	*12/8/2009 0:00*	*523,440*	*12.02*	*4.6*	*261*
*Base***			*8*	*0.14*	*12/8/2009 0:00*	*1/1/2010 0:00*	*20,736*	*0.48*	*0.2*	*10*
Storm Average			23	0.07						
Base Average			8	0.14						
All Average			19	0.09						
Total							**4,981,420**	**114**	**29**	**5,653**
Brown's Creek Major Subwatershed Total Acres							111			
Total TP/TSS(lb/ac/yr)									0.26	50.92
Total TP/TSS (kg/ha/yr)									0.29	57.08

*Italics indicate estimated concentrations based on average base and storm flow concentrations

** Interval volumes from 1/1/09 to 5/18/09 and 10/8/09 to 1/1/10 were estimated using base flow

Table 39. Tributary to Long Lake at Herberger's Pond 2009 Primary Chemistry Result Averages

Parameter	Storm Flow Average	Base Flow Average	Average (all samples)
TSS (mg/L)	23	8	19
VSS (mg/L)	6	3	14
TKN (mg/L)	1.57	1.30	1.50
TP (mg/L)	0.07	0.14	0.09
E. Coli (mpn/100 mL)	--	--	N/A

Table 40. Tributary to Long Lake at Herberger's Pond 2009 Primary Water Quality Results

Sample Type	Start	End	TSS (mg/L)	VSS (mg/L)	TKN (mg/L)	TP (mg/L)	Dissolved P (mg/L)
Storm Composite	6/8/09 7:13	6/8/09 9:50	23	8	1.4	0.059	<0.010
Storm Composite	6/21/09 23:47	6/22/09 6:43	30	8	0.91	0.106	~0.013
Base Grab	7/16/09 15:15	7/16/09 15:15	5	~1	1.6	0.124	0.086
Storm Composite	7/21/09 15:15	7/21/09 18:11	46	11	0.91	0.106	<0.010
Storm Composite	7/22/09 18:02	7/22/09 21:51	18	5	0.51	0.058	<0.010
Storm Composite	8/8/09 1:04	8/9/09 7:02	13	~5	1.3	0.064	<0.010
Storm Composite	8/15/09 23:06	8/16/09 6:58	29	8	0.64	0.065	~0.017
Storm Composite	8/19/09 15:01	8/20/09 21:18	12	~5	0.4	0.054	<0.010
Storm Composite	8/25/09 6:25	8/25/09 10:14	14	~4	0.29	~0.047	~0.038
Base Grab	9/8/09 11:18	9/8/09 11:18	6	~2	0.51	0.089	~0.034
Base Grab	9/28/09 13:44	9/28/09 13:44	13	7	1.8	0.210	~0.030
Storm Composite	10/1/09 17:04	10/2/09 10:11	16	5	0.49	0.127	<0.010
Storm Composite	10/6/09 4:49	10/7/09 0:04	6	~2	8.8	0.196	0.056

Exceeds Water Quality Standard

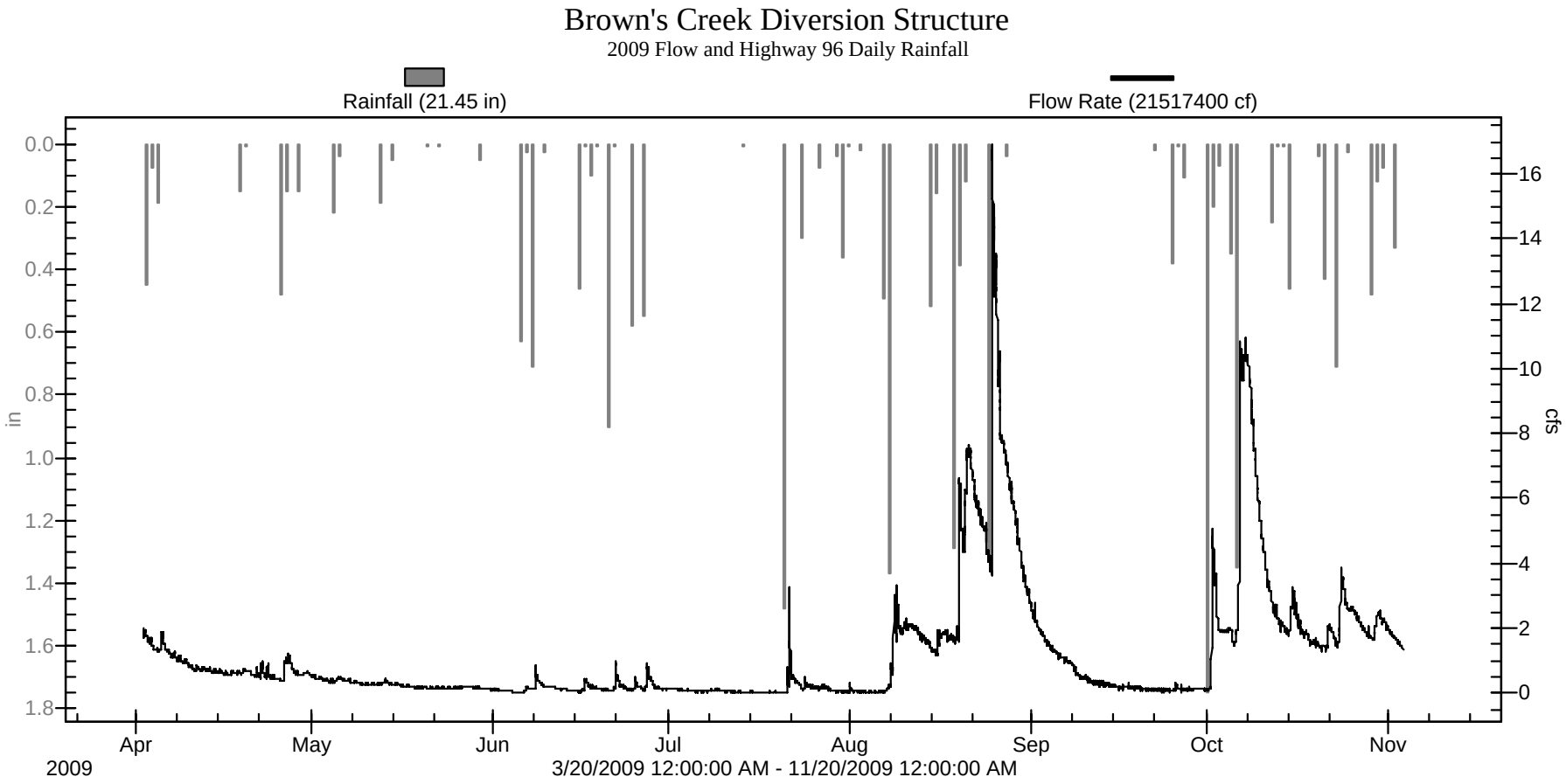


Figure 25. Brown's Creek Diversion Structure Drainage 2009 Flow and Outlet Daily Rainfall

Table 41. Brown's Creek Diversion Structure Drainage 2009 Total Suspended Solids (TSS) and Total Phosphorus (TP) Loading

	Sample Collection Time				Loading Interval					
Sample Type	**Start**	**End**	**TSS (mg/L)**	**TP (mg/L)**	**Start**	**End**	**Interval Volume (cf)**	**Interval Volume (ac-ft)**	**Interval TP (lb)**	**Interval TSS (lb)**
*Base***			*11*	*0.126*	*1/1/2009 0:00*	*3/17/2009 5:00*	*2,534,220*	*58.21*	*19.93*	*1,740*
Snowmelt Grab**	3/17/09 10:40	3/17/09 10:40	52	0.317	3/17/2009 5:00	3/19/2009 5:00	276,480	*6.35*	*5.47*	*897*
*Base***			*11*	*0.126*	*3/19/2009 5:00*	*3/24/2009 5:00*	*548,640*	*12.60*	*4.32*	*377*
Storm Grab**	3/24/09 9:03	3/24/09 9:03	44	0.145	*3/24/2009 5:00*	3/26/2009 5:00	276,480	*6.35*	*2.50*	*759*
*Base***			*11*	*0.126*	*3/26/2009 5:00*	*4/2/2009 12:15*	*801,234*	*18.40*	*6.30*	*550*
Base			*11*	*0.126*	*4/2/2009 12:15*	4/3/2009 13:15	155,363	3.57	1.22	107
Storm			*435*	*0.754*	*4/3/2009 13:15*	*4/4/2009 0:15*	*63,063*	*1.45*	*2.97*	*1,712*
Base			*11*	*0.126*	*4/4/2009 0:15*	4/5/2009 10:15	163,922	3.77	1.29	113
Storm			*435*	*0.754*	*4/5/2009 10:15*	*4/6/2009 3:15*	*96,747*	*2.22*	*4.55*	*2,627*
Base			*11*	*0.126*	*4/6/2009 3:15*	*4/26/2009 10:15*	*1,255,536*	*28.84*	*9.88*	*862*
Storm			*435*	*0.754*	*4/26/2009 10:15*	*4/28/2009 1:15*	*128,376*	*2.95*	*6.04*	*3,486*
Base Grab	5/18/09 13:30	5/18/09 13:30	3	0.071	4/28/2009 1:15	5/21/2009 1:15	691,789	15.89	3.07	130
Base Grab	6/4/09 13:00	6/4/09 13:00	8	0.131	5/21/2009 1:15	6/6/2009 10:15	172,006	3.95	1.41	86
Storm			*435*	*0.754*	*6/6/2009 10:15*	*6/7/2009 0:15*	*6,744*	*0.15*	*0.32*	*183*
Base			*11*	*0.126*	*6/7/2009 0:15*	*6/8/2009 5:15*	*14,592*	*0.34*	*0.11*	*10*
Storm			*435*	*0.754*	*6/8/2009 5:15*	*6/8/2009 23:15*	*32,362*	*0.74*	*1.52*	*879*
Base			*11*	*0.126*	*6/8/2009 23:15*	*6/16/2009 16:15*	*90,737*	*2.08*	*0.71*	*62*
Storm			*435*	*0.754*	*6/16/2009 16:15*	*6/17/2009 8:15*	*17,610*	*0.40*	*0.83*	*478*
Base			*11*	*0.126*	*6/17/2009 8:15*	6/21/2009 17:15	49,285	1.13	0.39	34
Storm Grab	6/22/09 8:50	6/22/09 8:50	36	0.188	6/21/2009 17:15	6/22/2009 17:15	32,411	0.74	0.38	73
Base			*11*	*0.126*	*6/22/2009 17:15*	*6/27/2009 3:15*	*64,266*	*1.48*	*0.51*	*44*
Storm			*435*	*0.754*	*6/27/2009 3:15*	*6/28/2009 11:15*	*52,446*	*1.20*	*2.47*	*1,424*
Base Grab	7/13/09 9:12	7/13/09 9:12	33	0.184	6/28/2009 11:15	7/21/2009 7:15	124,641	2.86	1.43	257
Storm Composite	7/21/09 9:44	7/21/09 21:10	416	0.936	7/21/2009 7:15	7/21/2009 23:15	51,988	1.19	3.04	1,350
Base Grab	7/27/09 8:41	7/27/09 8:41	13	0.148	7/21/2009 23:15	7/31/2009 22:15	151,933	3.49	1.40	123
Base Grab	8/5/09 15:24	8/5/09 15:24	18	0.177	7/31/2009 22:15	8/7/2009 10:15	29,452	0.68	0.33	33
Storm Composite	8/8/09 11:06	8/10/09 13:44	448	0.693	8/7/2009 10:15	8/10/2009 15:15	444,783	10.22	19.24	12,439
Base			*11*	*0.126*	*8/10/2009 15:15*	*8/19/2009 11:15*	*1,320,725*	*30.34*	*10.39*	*907*
Storm Composite	8/19/09 15:23	8/20/09 20:17	1090	1.910	8/19/2009 11:15	8/20/2009 22:15	639,608	*14.69*	*76.26*	*43,522*
Base			*11*	*0.126*	*8/20/2009 22:15*	*8/25/2009 5:15*	*2,114,050*	*48.56*	*16.63*	*1,452*
Storm Composite	8/25/09 6:34	8/25/09 9:34	1130	1.830	8/25/2009 5:15	8/26/2009 6:15	1,148,531	*26.38*	*131.21*	*81,019*
Base			*11*	*0.126*	*8/26/2009 6:15*	*9/5/2009 6:15*	*3,435,438*	*78.91*	*27.02*	*2,359*
Base Grab	9/8/09 10:17	9/8/09 10:17	5	0.078	9/5/2009 6:15	9/15/2009 6:15	504,339	*11.58*	*2.46*	*157*
Base Grab	9/18/09 8:15	9/18/09 8:15	2	0.118	9/15/2009 6:15	9/25/2009 12:15	123,956	*2.85*	*0.91*	*15*
Storm			*435*	*0.754*	*9/25/2009 12:15*	*9/25/2009 21:15*	*6,899*	*0.16*	*0.32*	*187*
Base Grab	9/28/09 14:25	9/28/09 14:25	4	0.099	9/25/2009 21:15	10/1/2009 16:15	61,111	*1.40*	*0.38*	*15*
Storm Composite	10/1/09 17:47	10/5/09 7:40	630	0.909	10/1/2009 16:15	10/2/2009 3:15	141,884	*3.26*	*8.05*	*5,580*
Storm Grab	10/2/09 9:49	10/2/09 9:49	30	0.205	10/2/2009 3:15	10/2/2009 17:15	160,910	*3.70*	*2.06*	*301*
Base			*11*	*0.126*	*10/2/2009 17:15*	*10/6/2009 10:15*	*619,012*	*14.22*	*4.87*	*425*
Storm Composite	10/6/09 9:41	10/7/09 14:46	524	0.606	10/6/2009 10:15	10/7/2009 9:15	802,051	*18.42*	*30.34*	*26,236*
Storm Grab	10/7/09 9:45	10/7/09 9:45	2	0.113	10/7/2009 9:15	10/8/2009 18:15	1,161,273	*26.67*	*8.19*	*145*
Base			*11*	*0.126*	*10/8/2009 18:15*	*10/15/2009 0:15*	*1,991,966*	*45.75*	*15.67*	*1,368*
Storm			*435*	*0.754*	*10/15/2009 0:15*	*10/16/2009 7:15*	*300,486*	*6.90*	*14.14*	*8,160*
Base			*11*	*0.126*	*10/16/2009 7:15*	*10/21/2009 11:15*	*750,056*	*17.23*	*5.90*	*515*
Storm			*435*	*0.754*	*10/21/2009 11:15*	*10/22/2009 10:15*	*158,552*	*3.64*	*7.46*	*4,306*
Base			*11*	*0.126*	*10/22/2009 10:15*	*10/23/2009 10:15*	*139,103*	*3.20*	*1.09*	*96*
Storm			*435*	*0.754*	*10/23/2009 10:15*	*10/24/2009 14:15*	*305,944*	*7.03*	*14.40*	*8,308*
Base			*11*	*0.126*	*10/24/2009 14:15*	*10/29/2009 11:15*	*919,982*	*21.13*	*7.24*	*632*
Storm			*435*	*0.754*	*10/29/2009 11:15*	*10/30/2009 18:15*	*252,648*	*5.80*	*11.89*	*6,861*
Base			*11*	*0.126*	*10/30/2009 18:15*	*11/3/2009 9:15*	*568,825*	*13.07*	*4.47*	*391*
*Base***			*11*	*0.126*	*11/3/2009 9:15*	*12/2/2009 0:00*	*3,708,450*	*85.18*	*29.17*	*2,547*
*Base***			*11*	*0.126*	*12/2/2009 0:00*	*1/1/2010 0:00*	*1,503,360*	*34.53*	*11.82*	*1,032*
Storm Average			435	0.754						
Base Average			11	0.126						
All Average			236	0.466						
Total							**31,166,264**	**716**	**544**	**227,372**
Brown's Creek Major Subwatershed Total Acres							3,837			
Total TP/TSS(lb/ac/yr)									0.14	59.26
Total TP/TSS (kg/ha/yr)									0.16	66.42

*Italics indicate estimated concentrations based on average base and storm flow concentrations

**Interval volumes from 1/1/09 to 4/2/09 and 11/3/09 to 1/1/10 were estimated using recorded base flow

Table 42. Brown's Creek Diversion Structure Drainage 2009 Primary Chemistry Result Averages

Parameter	Storm Flow Average	Base Flow Average	Average (all samples)
TSS (mg/L)	435	11	236
VSS (mg/L)	206	5	114
TKN (mg/L)	5.94	0.59	3.68
TP (mg/L)	0.754	0.124	0.466
E. Coli (mpn/100 mL)	--	--	474

Table 43. Brown's Creek Diversion Structure Drainage 2009 Field Measurement Results

Date	Transparency (cm)	Water Temperature (C)	Dissolved Oxygen (mg/L)	Conductivity (umhos/cm)	pH
3/24/2009 9:03	41	4.1	12.11	344	7.7
5/18/2009 13:29	>100	16.5	13.35		
5/28/2009 9:51	>100	9.6	10.46	645	7.9
6/10/2009 10:59	75				
6/12/2009 13:47	46				
6/22/2009 8:40	35	15.4	7.48		
6/25/2009 9:36	16	15.4	6.66	404	7.7
6/30/2009 8:39	29	13	8.94	513	8.3
7/6/2009 10:49	31				
7/9/2009 10:36	28.4				
7/13/2009 9:12	20	12	8.23	490	
7/24/2009 10:26	23	14.3	8.17	413	8
7/29/2009 9:57	30	12.2	9.26	526	8.2
8/5/2009 15:24	26	16.9	8.1	526	8.2
8/10/2009 13:53	40	23.9	6.3	432	7.6
8/24/2009 8:15	>100	20.7	5.69	489	7.5
8/26/2009 16:05	88	22.4	5.94	462	7.7
8/27/2009 9:11	>100	20.7	6.06	491	7.3
9/8/2009 10:17	>100	18	7.82	531	8
9/24/2009 8:34	46	11.4	9.34	534	8.1
9/28/2009 14:25	39	11.7	9.57	523	8.5
10/7/2009 14:57	52				

Exceeds Water Quality Standard

Table 44: Brown's Creek Diversion Structure Drainage 2009 Primary Water Quality Results

Sample Type	Start	End	TSS (mg/L)	VSS (mg/L)	TKN (mg/L)	TP (mg/L)	Dissolved P (mg/L)	E Coli (mpn/100mL)	COD (mg/L)	CBOD (mg/L)	TBOD (mg/L)	Turbidity
Snowmelt Grab	3/17/2009 10:30	3/17/2009 10:30	53	18	3.00	0.371	0.108		67	5.2	7.5	26
Snowmelt Grab	3/17/2009 10:40	3/17/2009 10:40	52			0.317						
Storm Grab	3/24/2009 9:03	3/24/2009 9:03	44	17	0.97	0.145	0.056					
Base Grab	5/18/2009 13:30	5/18/2009 13:30	3	~2	0.37	0.071	~0.011					
E. Coli Grab	5/28/2009 9:51	5/28/2009 9:51						23				
Base Grab	6/4/2009 13:00	6/4/2009 13:00	8			0.131						
Storm Grab	6/22/2009 8:50	6/22/2009 8:50	36			0.188						
E. Coli Grab	6/30/2009 8:50	6/30/2009 8:50						180				
Base Grab	7/13/2009 9:12	7/13/2009 9:12	33	14	0.91	0.184	0.078					
Storm Composite	7/21/2009 9:44	7/21/2009 21:10	416	148	5.9	0.936	0.077					
Base Grab	7/27/2009 8:41	7/27/2009 8:41	13			0.148						
E. Coli Grab	7/29/2009 10:00	7/29/2009 10:00						1046				
Base Grab	8/5/2009 15:24	8/5/2009 15:24	18	7	0.6	0.177	0.07					
Storm Composite	8/8/2009 11:06	8/10/2009 13:44	448	212	7.30	0.693	0.069					
Storm Grab	8/20/2009 8:44	8/20/2009 8:44	25			0.148						
Storm Composite	8/19/2009 15:23	8/20/2009 20:17	1090	350	11	1.91	0.073					
Storm Composite	8/25/2009 6:34	8/25/2009 9:34	1130	~280	6.5	1.83	0.087					
E. Coli Grab	8/27/2009 9:15	8/27/2009 9:15						74				
Base Grab	9/8/2009 10:17	9/8/2009 10:17	5	~2	1.2	0.078	~0.049					
Base Grab	9/18/2009 8:15	9/18/2009 8:15	<2			0.118						
Base Grab	9/28/2009 14:25	9/28/2009 14:25	4	~2	0.2	0.099	0.069					
E. Coli Grab	9/30/2009 9:47	9/30/2009 9:47						1046				
Storm Grab	10/2/2009 9:49	10/2/2009 9:49	30			0.205						
Storm Composite	10/1/2009 17:47	10/5/2009 7:40	630	288	8.2	0.909	~0.035					
Storm Composite	10/6/2009 9:41	10/7/2009 14:46	524	146	1.7	0.606	0.082					
Storm Grab	10/7/2009 9:45	10/7/2009 9:45	<2			0.113						

Exceeds Water Quality Standard

Exceeds Water Quality Standard for Turbidity(TSS Value used to calculate)

Table 45: Brown's Creek Diversion Structure Drainage 2009 Secondary Water Quality Results

Sample Type	Start Date	Start Time	Copper (mg/L)	Nickel (mg/L)	Lead (mg/L)	Zinc (mg/L)	Cadmium (mg/L)	Chromium (mg/L)	Chloride (mg/L)	Hardness (mg/L)	Nitrite (mg/L)	Nitrate mg/L)	Ammonia Nitrogen (mg/L)
Snowmelt Grab	3/17/2009 10:30	3/17/2009 10:30	0.0177	0.0029	0.0012	0.008	<0.0005	<0.005	71	62	<0.03	0.21	0.35
Snowmelt Grab	3/17/2009 10:40	3/17/2009 10:40											
Storm Grab	3/24/2009 9:03	3/24/2009 9:03	0.0021	0.002	0.0008	0.0063	<0.0005	<0.006	65	88	<0.03	0.18	0.08
Base Grab	5/18/2009 13:30	5/18/2009 13:30	0.0007	0.0022	<0.0001	<0.005	<0.0005	<0.005	40	218	<0.03	0.59	<0.02
E. Coli Grab	5/28/2009 9:51	5/28/2009 9:51											
Base Grab	6/4/2009 13:00	6/4/2009 13:00											
Storm Grab	6/22/2009 8:50	6/22/2009 8:50											
E. Coli Grab	6/30/2009 8:50	6/30/2009 8:50											
Base Grab	7/13/2009 9:12	7/13/2009 9:12	0.0014	0.0029	0.0009	0.0085	<0.0005	<0.005	41	244	<0.03	1.2	0.09
Storm Composite	7/21/2009 9:44	7/21/2009 21:10	0.0095	0.009	0.0065	0.0291	<0.0005	0.0099	27	130	<0.03	0.61	~0.05
Base Grab	7/27/2009 8:41	7/27/2009 8:41											
E. Coli Grab	7/29/2009 10:00	7/29/2009 10:00											
Base Grab	8/5/2009 15:24	8/5/2009 15:24	0.0011	0.0024	0.0005	<0.005	<0.0005	<0.005	44		<0.03	1.28	0.07
Storm Composite	8/8/2009 11:06	8/10/2009 13:44	0.0101	0.0092	0.0052	0.0314	<0.0005	0.0069	75	112	0.03	0.17	0.16
Storm Grab	8/20/2009 8:44	8/20/2009 8:44											
Storm Composite	8/19/2009 15:23	8/20/2009 20:17	0.0195	0.0198	0.021	0.0848	<0.0005	<0.005	74	88	<0.03	0.05	~0.05
Storm Composite	8/25/2009 6:34	8/25/2009 9:34	0.012	0.0139	0.015	0.044	<0.0005	0.0153	56	80	<0.03	<0.05	~0.04
E. Coli Grab	8/27/2009 9:15	8/27/2009 9:15											
Base Grab	9/8/2009 10:17	9/8/2009 10:17	0.0015	0.0012	0.0001	<0.005	<0.0005	<0.005	97	86	<0.03	0.21	~0.04
Base Grab	9/18/2009 8:15	9/18/2009 8:15											
Base Grab	9/28/2009 14:25	9/28/2009 14:25	0.0007	0.0023	0.0001	<0.005	<0.0005	<0.005	38	240	<0.03	0.95	~0.05
E. Coli Grab	9/30/2009 9:47	9/30/2009 9:47											
Storm Grab	10/2/2009 9:49	10/2/2009 9:49											
Storm Composite	10/1/2009 17:47	10/5/2009 7:40	0.0102	0.0111	0.0078	0.0368	<0.0005	0.0127	67	106	<0.03	0.23	0.09
Storm Composite	10/6/2009 9:41	10/7/2009 14:46	0.0077	0.0077	0.0074	0.0283	<0.0005	0.0078	65	136	<0.03	0.19	~0.02
Storm Grab	10/7/2009 9:45	10/7/2009 9:45											

No Exceedance Determinable

Exceeds Chronic Standard

Exceeds Max Standard

Exceeds Final Acute Standard

Table 46: Long Lake-Brown's Creek Diversion Drainage 2009 Water Quality Results

Site	Sample Type	Date	TSS (mg/L)	TP (mg/L)	Flow (cfs)	TP lb/day	TSS lb/day
Long Lake Outlet	Snowmelt Grab	3/17/2009	Dry	Dry	Dry		
Long Lake Outlet	Base Grab	6/4/2009	Dry	Dry	Dry		
Long Lake Outlet	Storm Grab	6/22/09 10:10	9	0.057	0.06	**0.02**	**3.15**
Long Lake Outlet	Base Grab	7/27/09 10:15	3	0.048	0.61	**0.16**	**9.82**
Long Lake Outlet	Storm Grab	8/20/09 13:30	3	0.044	6.73	**1.60**	**108.98**
Long Lake Outlet	Base Grab	9/18/09 10:10	<2	0.03	0.27	**0.04**	**2.91**
Long Lake Outlet	Storm Grab	10/2/09 11:36	3	0.037	1.11	**0.22**	**17.88**
Long Lake Outlet	Storm Grab	10/7/09 11:40	2	0.039	7.33	**1.54**	**79.08**
Jackson WMA	Snowmelt Grab	3/17/09 14:36	6	0.084	1.73	**0.78**	**55.99**
Jackson WMA	Base Grab	6/4/2009	Dry	Dry	Dry		
Jackson WMA	Storm Grab	6/22/2009	Dry	Dry	Dry		
Jackson WMA	Base Grab	7/27/2009	Dry	Dry	Dry		
Jackson WMA	Storm Grab	8/20/09 10:50	<2	0.040	2.64	**0.57**	**14.23**
Jackson WMA	Base Grab	9/18/09 9:50	<2	0.036	0.11	**0.02**	**0.61**
Jackson WMA	Storm Grab	10/2/09 11:17	<2	0.036	0.52	**0.10**	**2.79**
Jackson WMA	Storm Grab	10/7/09 11:24	<2	0.027	5.32	**0.77**	**28.69**
Boutwell Rd.	Snowmelt Grab	3/17/09 12:00	13	0.151	1.62	**1.32**	**113.60**
Boutwell Rd.	Base Grab	6/4/2009	Dry	Dry	Dry		
Boutwell Rd.	Storm Grab	6/22/2009	Dry	Dry	Dry		
Boutwell Rd.	Base Grab	7/27/2009	Dry	Dry	Dry		
Boutwell Rd.	Storm Grab	8/20/09 10:20	<2	0.079	3.16	**1.35**	**17.06**
Boutwell Rd.	Base Grab	9/18/09 9:30	<2	0.135	0.07	**0.05**	**0.38**
Boutwell Rd.	Storm Grab	10/2/09 11:00	7	0.151	0.67	**0.55**	**25.30**
Boutwell Rd.	Storm Grab	10/7/09 11:06	3	0.063	8.99	**3.05**	**145.45**
South Branch	Snowmelt Grab	3/17/09 11:15	41	0.234	1.79	**2.26**	**395.89**
South Branch	Base Grab	6/4/09 13:15	13	0.168	0.02	**0.02**	**1.23**
South Branch	Storm Grab	6/22/09 9:00	37	0.177	0.04	**0.04**	**8.48**
South Branch	Base Grab	7/27/09 9:00	59	0.226	0.01	**0.01**	**3.18**
South Branch	Storm Grab	8/20/09 9:00	36	0.100	4.39	**2.37**	**852.81**
South Branch	Base Grab	9/18/09 8:40	6	0.125	0.08	**0.06**	**2.74**
South Branch	Storm Grab	10/2/09 10:03	38	0.176	0.49	**0.46**	**99.52**
South Branch	Storm Grab	10/7/09 10:00	45	0.090	6.55	**3.18**	**1590.41**
West Branch 2	Snowmelt Grab	3/17/09 11:45	16	0.414	0.89	**1.99**	**76.82**
West Branch 2	Base Grab	6/4/09 14:00	2	0.06	0.02	**0.01**	**0.19**
West Branch 2	Storm Grab	6/22/09 9:50	3	0.109	0.18	**0.11**	**2.96**
West Branch 2	Base Grab	7/27/09 9:45	4	0.108	0.02	**0.01**	**0.44**
West Branch 2	Storm Grab	8/20/09 10:00	7	0.171	0.93	**0.85**	**35.00**
West Branch 2	Base Grab	9/18/09 9:20	7	0.225	0.03	**0.03**	**1.02**
West Branch 2	Storm Grab	10/2/09 10:48	7	0.172	1.42	**1.31**	**53.51**
West Branch 2	Storm Grab	10/7/09 10:51	2	0.124	1.97	**1.32**	**21.26**
West Branch 1	Snowmelt Grab	3/17/09 11:20	44	0.388	1.11	**2.32**	**263.46**
West Branch 1	Base Grab	6/4/09 13:45	15	0.104	0.09	**0.05**	**7.16**
West Branch 1	Storm Grab	6/22/09 9:30	32	0.198	0.25	**0.26**	**42.67**
West Branch 1	Base Grab	7/27/09 9:30	18	0.137	0.05	**0.04**	**5.08**
West Branch 1	Storm Grab	8/20/09 9:30	32	0.232	1.35	**1.69**	**232.95**
West Branch 1	Base Grab	9/18/09 9:00	11	0.119	0.04	**0.03**	**2.49**
West Branch 1	Storm Grab	10/2/09 10:30	32	0.231	1.92	**2.39**	**331.25**
West Branch 1	Storm Grab	10/7/09 10:28	11	0.152	2.98	**2.44**	**176.53**
North Branch	Snowmelt Grab	3/17/2009	No Sample	No Sample	No Measurement		
North Branch	Base Grab	6/4/09 13:30	21	0.125	0.02	**0.01**	**2.49**
North Branch	Storm Grab	6/22/09 9:20	109*	0.308*	0.01	**0.01**	**2.94**
North Branch	Base Grab	7/27/09 9:15	155*	0.408*	0.03	**0.07**	**26.76**
North Branch	Storm Grab	8/20/09 9:20	80	0.253	0.02	**0.03**	**10.69**
North Branch	Base Grab	9/18/09 8:50	106*	0.218*	0.003	**0.004**	**1.72**
North Branch	Storm Grab	10/2/09 10:17	24	0.192	0.13	**0.14**	**16.96**
North Branch	Storm Grab	10/7/09 10:14	13	0.125	0.15	**0.10**	**10.66**
Browns Creek Diversion	Snowmelt Grab	3/17/09 10:40	52	0.317	2.70	**4.62**	**757.36**
Browns Creek Diversion	Base Grab	6/4/09 13:00	8	0.131	0.16	**0.11**	**6.90**
Browns Creek Diversion	Storm Grab	6/22/09 8:50	36	0.188	0.41	**0.42**	**80.01**
Browns Creek Diversion	Base Grab	7/27/09 8:41	13	0.148	0.25	**0.20**	**17.53**
Browns Creek Diversion	Storm Grab	8/20/09 8:44	25	0.148	4.61	**3.68**	**621.70**
Browns Creek Diversion	Base Grab	9/18/09 8:15	<2	0.118	1.69	**1.08**	**9.12**
Browns Creek Diversion	Storm Grab	10/2/09 9:49	30	0.205	3.67	**4.06**	**593.91**
Browns Creek Diversion	Storm Grab	10/7/09 9:45	<2	0.113	9.58	**5.84**	**51.68**

* High result possibly due to bottom sediment in sample

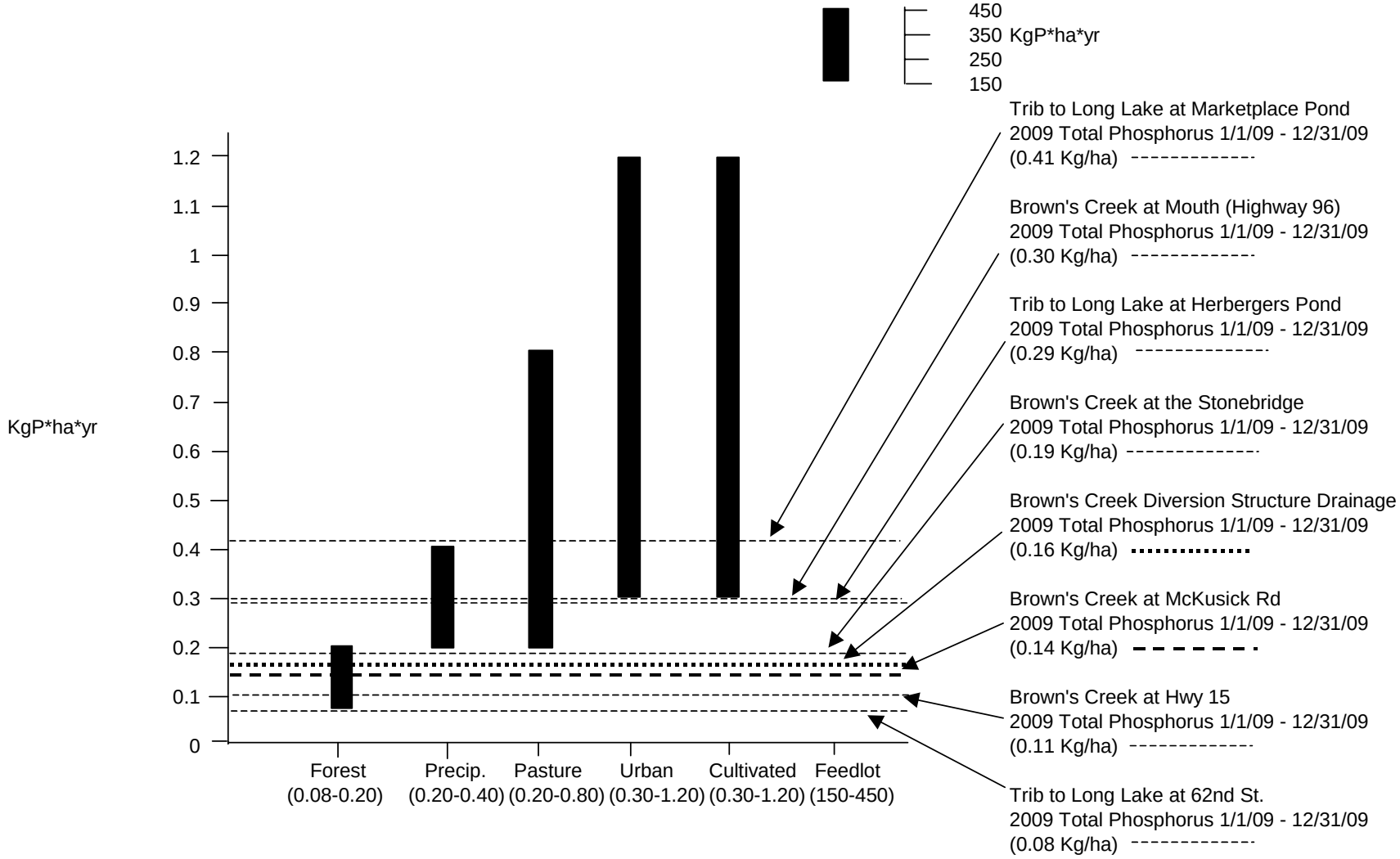


Figure 26: Total Phosphorus Export Coefficients: Brown's Creek and Estimated Range by Land Use

2. TEMPERATURE DATA

Temperature in Brown's Creek has been monitored by several organizations since 1998 and a portion of this data is summarized in a report by the Minnesota Department of Natural Resources as well as in this report. Temperatures are recorded in Brown's Creek to monitor existing conditions and to identify areas where warming or cooling may occur. Water temperatures less than 18°C are considered preferred, between 18 and 20°C are low impact, 20 to 25°C have a moderate impact, and greater than 25°C is considered high impact to trout. Temperature relations in trout streams are complex and depend on exposure time, conditions leading up to the exposure, the availability of refugia (small pockets of colder water), and other factors that are not easily identified. The same impact levels are used in the BCWD H&H study. Temperature data prior to 2001 comes from a Report on Water Temperatures for 1998 and 1999 in Brown's Creek, Washington County, Minnesota, by Jason Moeckel, MN DNR.

Sustained periods of increased water temperatures can be stressful and even lethal to trout, particularly smaller fish. Warm temperatures affect small fish more easily than larger ones. Water temperatures in a stream go up and down throughout the day. They are usually coolest in the early morning hours (about sunrise) and warmest in the late afternoon (about 5pm). Even during the warmest days, the cooler water during the night can serve as somewhat of a refuge for trout. At one time in its history, Brown's Creek was diverted into McKusick Lake, which supplied water to Stillwater residents. By 1955 fisheries managers recognized that warm lake water was putting a strain on the trout population in Brown's Creek. In an effort to reduce water temperatures for the benefit of trout, a dike was constructed to separate the stream from the lake and return the flow back to Brown's Creek. The dike still exists today.

Efforts to improve habitat and water quality in Brown's Creek continue. With the goal of further reducing water temperatures and improving trout habitat, the city of Stillwater and the Minnesota DNR collaborated to construct a new stream channel along the Minnesota Zephyr rail line and the Oak Glen Golf Course in 1999. This project created a new section of stream, 2,000 feet long (Figure 27), which replaces a 5,130-foot long section that flowed through the wetland just north of McKusick Lake and across the golf course (Figure 28). Water now moves through the new channel in about 30 minutes, compared with the 10 hours it took to flow through the wetland. This translates to cooler water, since it doesn't sit in the hot sun and warm up as it flows downstream. In addition, fish and insect habitat in the new channel is much better than in the old channel. The habitat is so much better that brown trout have been found farther upstream than ever before. Limiting high temperature inputs to Brown's Creek made additional improvements.

During 2003, a project to divert suburban stormwater from Brown's Creek was completed. An approximately 2,000 acre area of Stillwater now is diverted into McKusick Lake and eventually to the St. Croix. This appears to have enhanced the thermal regime of the creek even more. Warming is still likely to occur in the area downstream of the realigned channel due to lack of shade and runoff from the golf course, but work is being done to address this issue. In previous years, the DNR and Trout Unlimited have worked with the golf course to improve trout habitat in what has been some of the poorest quality habitat for a number of years. Brown's Creek is probably at its thermal maximum for a cold-water stream, but continued efforts to improve shade through the middle and upper reaches will likely improve temperature conditions.

Figure 27: New channel along the golf course. This photo shows the much-improved habitat, with many native shrubs and trees growing along the banks.

Figure 28: Old channel through golf course. Note lack of shade, and wide shallow channel.

Trout in Brown's Creek were exposed to much warmer water in 2001 and 2002 when compared to 2003 through 2009, even during the night and early morning hours when water temperatures are usually coolest. Both 2001 and 2002 had several days in which the maximum daily water temperatures exceeded 25 degrees Celsius (77º F) at both McKusick Rd and the Outlet. The minimum daily temperature at McKusick Road and the Outlet reached and exceeded 20 degrees in 2001 and 2002, but was never above 20 degrees Celsius in 2003 and 2004, but briefly exceeds it again in 2005 and 2006 (Figure 30 and Figure 32). This decrease is likely due to a number of factors, including the relatively dry periods during the mid-late summers and falls as well as an effect from the Brown's Creek diversion structure diverting warm water away from the stream towards McKusick Lake.

Water temperatures in a stream are influenced by a number of factors, but two of the most prominent are air temperature and the amount of solar radiation or direct sunlight that reaches the water. In general, days in which air temperatures meet or exceed 90º F are typically the days when water temperatures are highest. The more days with air temperature at 90º F or above, the more stressful the conditions in the stream for trout. Based on the past 30 years of records, the average number of days at or above 90º F in Twin Cities is about 17.6 days a year. Figure 29-Figure 32 show the correlation between the number of warm days and warm stream temperatures at the four sites where trout are known to exist or could possibly exist under the right conditions. The newest site, Stonebridge, was added to the monitoring regiment in 2008 and has limited historical data. No days where the minimum temperature exceeded 20 degrees Celsius were recorded at any site in 2009. The years 2001, 2002, and 2003 had a significant amount of above average number of these "hot days", while 2004 had significantly less "hot days", 2005 and 2006 were close to average, 2007 was also below average, 2008 and 2009 had the lowest number recorded in the last 10 years (Figure 33). The daily minimum temperature is described as the coldest the water was during a given 24-hour period.

In the past, daily maximum, mean, and minimum water temperatures had been thought to generally decrease in the downstream direction of Brown's Creek in the summer months due to increased groundwater inputs in the downstream reaches. Recent data from the Brown's Creek TMDL monitoring, as well as from the BCWD baseline-monitoring program that have implemented monitoring at upper watershed locations, have proven to show otherwise. Figure 34-Figure 46 show the temperature differences between each of the sites on Brown's Creek as well as daily maximum, average, and minimum temperatures at each site.

With respect to trout survival, the comparisons made by the following discussion will focus mainly on the summer months of data collection (June, July, August, September) since these months have the most potential to affect trout survival because of warmer air and subsequently warmer water temperatures.

The Hwy 15 site shows maximum daily and average daily temperatures that were slightly warmer than the McKusick Road site, but the daily minimum temperatures were slightly cooler. Daily average temperatures hovered around the 20º C range for the warmest portions of the summer, but the daily minimum temperatures never exceeded 20º C. The fact that the daily maximum temperatures were warmer and the daily minimum temperatures were approximately the same at Hwy 15 compared to McKusick Road may indicate that the more channelized stream

and increased riparian shade as well as some possible groundwater contribution is affecting the diurnal temperature variation between these two sites. However, the site at McKusick Road experienced slightly higher daily minimum temperatures. This is most likely due to the pooling affect caused by the remnants of a beaver dam just upstream of the monitoring station, rather than the result of any subwatershed impacts. Dissolved oxygen concentrations at the Hwy 15 site hover near the 7 mg/L threshold (usually around 6 mg/L), but when heavy precipitation events occur, the concentration drops dramatically (Figure 15). This is likely due to the increased sedimentation loading that occurs during a storm event. The morphology of this site is fairly suitable for trout, but the temperatures and changes in dissolved oxygen may prevent trout from inhabiting this reach. With further BMP efforts specifically designed to improve trout habitat, this reach may be able to obtain future trout conditions, but based on data shown here, locations upstream of this site would still inhibit trout survival.

The McKusick Road site shows maximum and average daily temperatures about 1º-2º C cooler, and daily minimum temperatures nearly the same as the Stonebridge site during the warmest portions of the summer. This seems counterintuitive because of the increased riparian shade and more naturalized channel present at the Stonebridge site. However, downstream of the site at McKusick Road, much of the channel runs through the open golf course. This lack of shading allows direct sunlight to increase the water temperature. Additionally, a wetland connected to a nearby neighborhood has its storm runoff empty into this reach of the creek. Of note for 2009 is that the average difference in temperature between the McKusick and Stonebridge sites was much smaller when compared to 2008 (Figure 35). It is not known what caused this, however one possibility is that below average rainfall amounts prevented the wetland downstream of the site from discharging into the creek. Daily maximum temperatures were near 25º C in the early part of the summer and not suitable for trout, but daily average and daily minimum temperatures were near or below 20º C and considered more suitable. A beaver dam was found in the channel in the spring and early summer. After repeated efforts were made last year to remove both the dam and beaver, the beavers were successfully removed this year. A volunteer was able to remove the dam in mid May, and it was not rebuilt for the remainder of the season. It is interesting to note that the average temperatures at this site were slightly cooler in 2009 compared to 2008. This is likely due to the dam being removed and not allowing water to sit in the sun just upstream of the datalogger and warm up. Significant increases in sedimentation occurred while the dam was in place, as well as when it was removed, leading to slight drops in the dissolved oxygen readings. The impact, however, was not nearly as pronounced as it was in 2008. Due to the large amount of sediment that accumulated in that area of stream, even without the dam in place, there was a slight pooling effect observed where it had been. When the ram was removed the release of the sediments and nutrients, as well as the biological decay, caused a decrease in available oxygen. Dissolved oxygen at this location was near the 7 mg/L threshold for much of the year, but rarely dropped below (Figure 17). Although a riparian restoration project was implemented near this location in the past, additional plantings that would shade the stream in this reach (possibly trees that would hover over the stream) would help in reducing temperatures even more and would potentially increase dissolved oxygen concentrations.

The Stonebridge site shows average daily temperatures that rarely exceeded 20° C, and minimum temperatures near 15° C during the warmest parts of the summer. Daily maximum

temperatures were at or near 25° C during the warmest periods of the summer, likely due to the lack of shade upstream from the site. In 2009, temperatures were about 2-4° C warmer than those recorded at the Outlet site during the warmest parts of the summer. This is consistent with what was observed in 2008 (Figure 34). Dissolved oxygen was near or above 7 mg/L during the summer months, only dipping below this threshold briefly in August (Figure 19). These temperature and dissolved oxygen results indicate suitable trout habitat. Likewise, the morphology of the site lends itself well for trout suitability.

The Brown's Creek Outlet site continues to show that groundwater contribution, increased riparian shade, and shade from the ravine, is maintaining much cooler maximum, average, and daily temperatures than any upstream monitoring location. Daily maximum, average, and minimum temperatures were near or below 20º C during the warmest portions of the summer. Based on 15-minute data from the site, temperatures never exceeded 25º C the entire year. Dissolved oxygen readings only went below the 7 mg/L threshold for an approximately 12 hour period in late June (Figure 21).

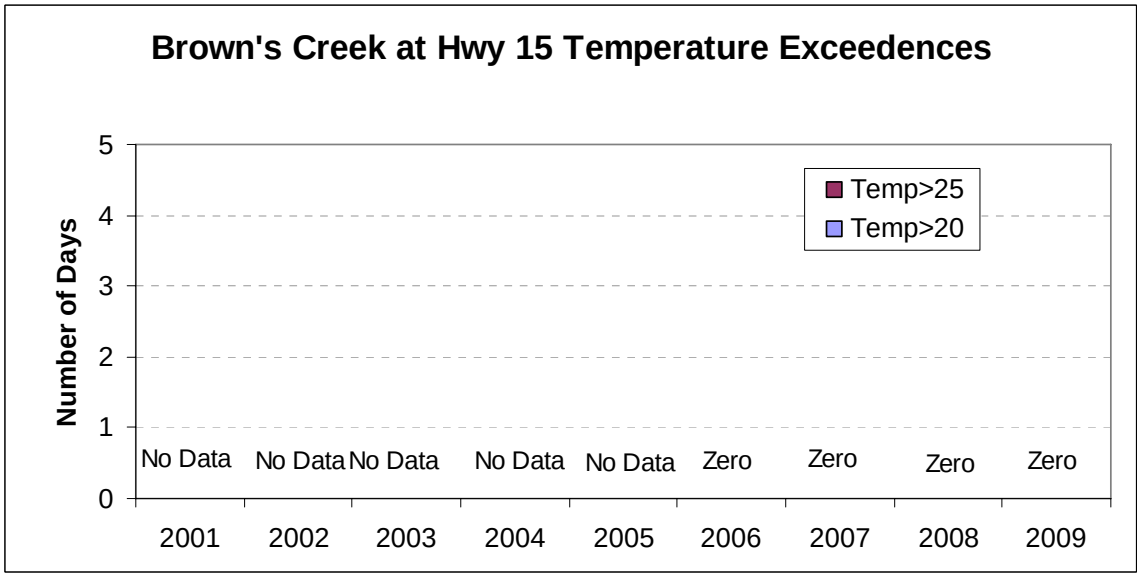


Figure 29: Occurrences of Brown's Creek Daily Minimum Water Temperature Greater than 20 and 25 degrees Celsius at Hwy 15

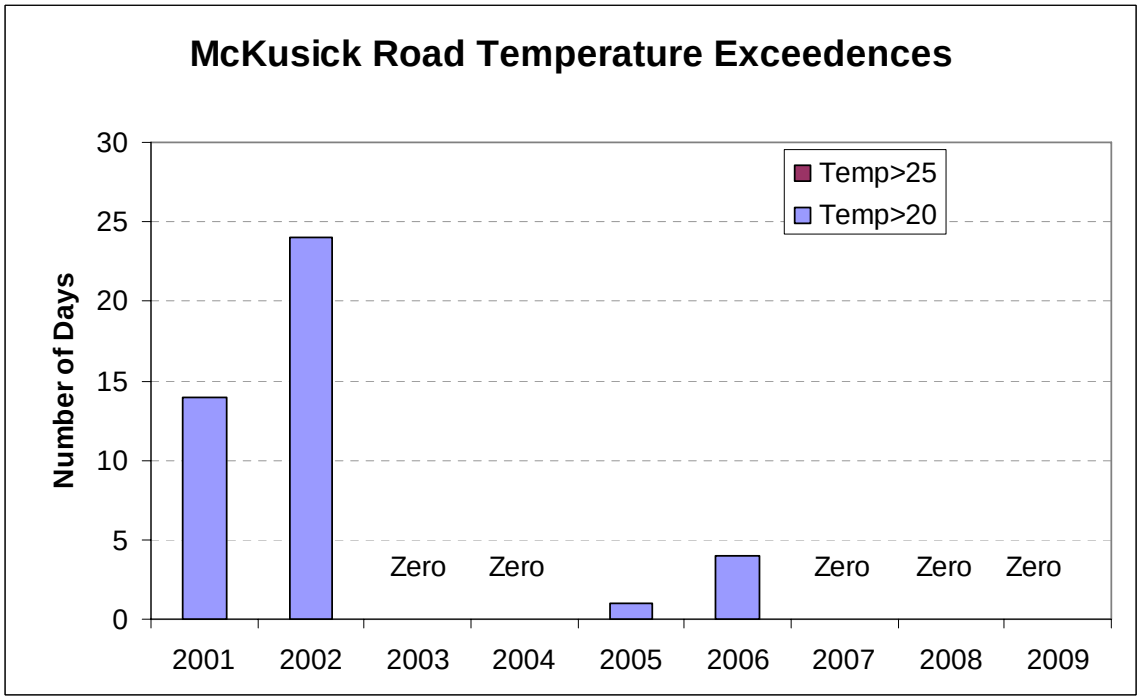


Figure 30: Occurrences of Brown's Creek Daily Minimum Water Temperature Greater than 20 and 25 degrees Celsius at McKusick Road

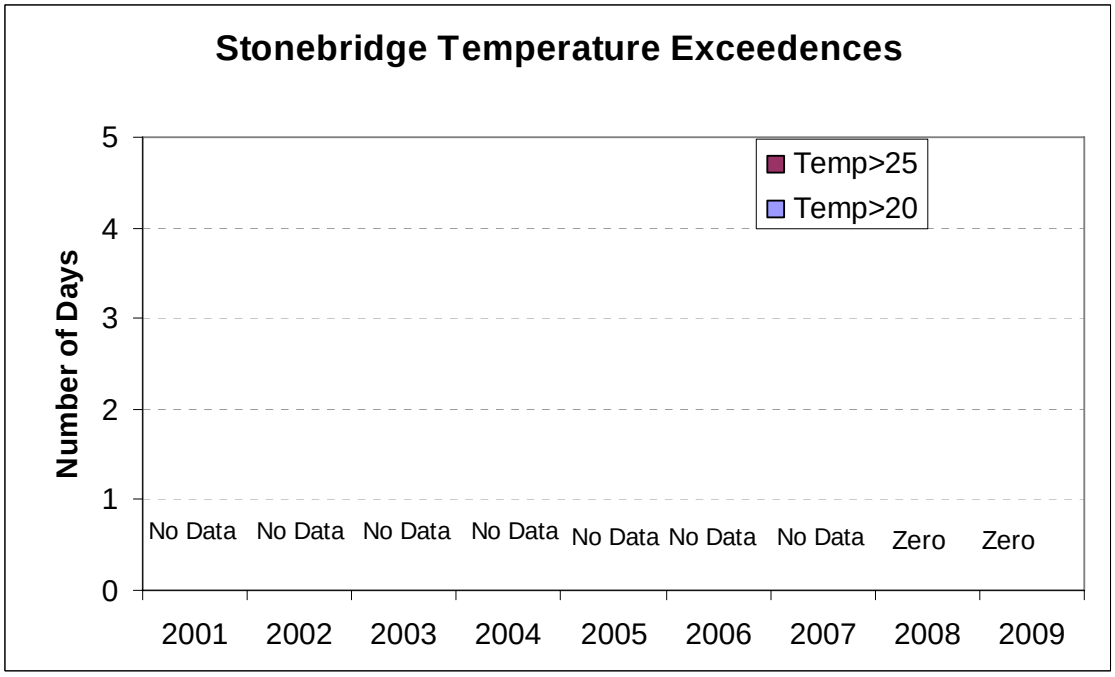


Figure 31. Occurrences of Brown's Creek Daily Minimum Water Temperature Greater than 20 and 25 degrees Celsius at the Stonebridge

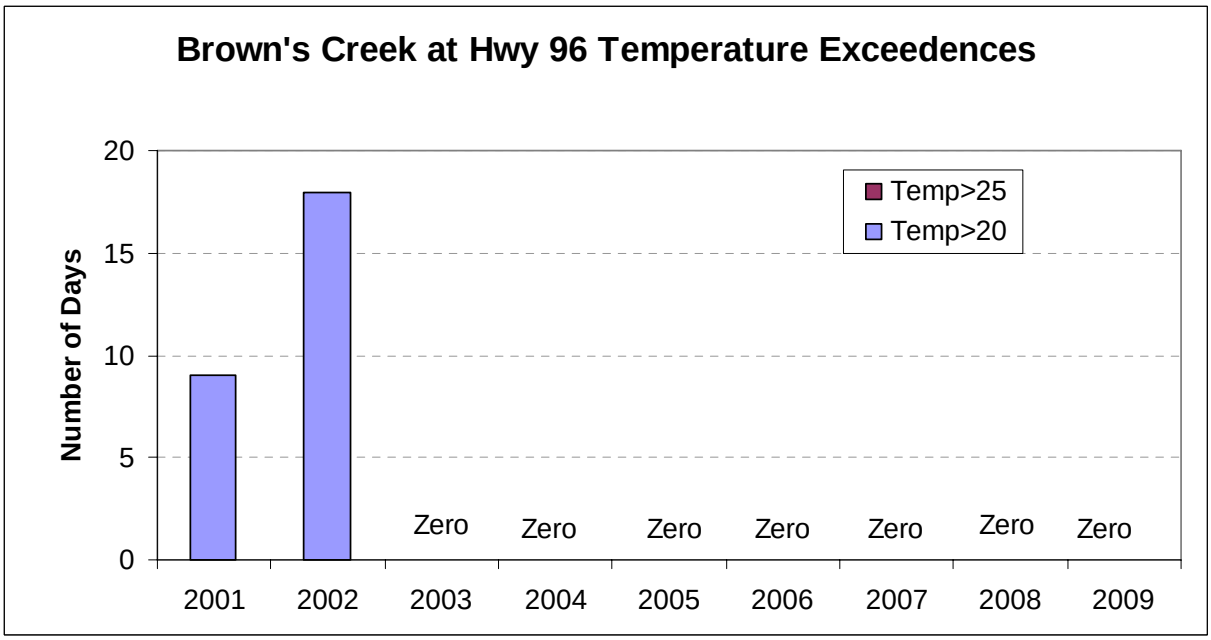


Figure 32: Occurrences of Brown's Creek Daily Minimum Water Temperature Greater than 20 and 25 degrees Celsius at Brown's Creek Outlet

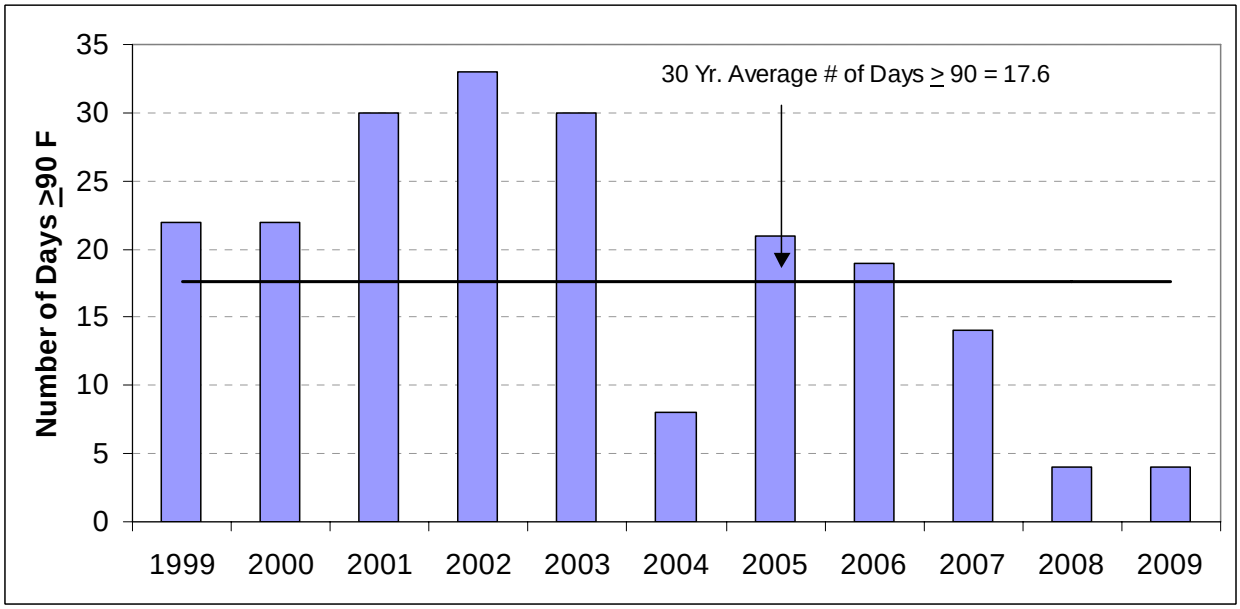


Figure 33. Days With Air Temperatures Over 90 Degrees Fahrenheit, Stillwater, MN (Source: National Weather Service {Stillwater 30N, 20W, S34})

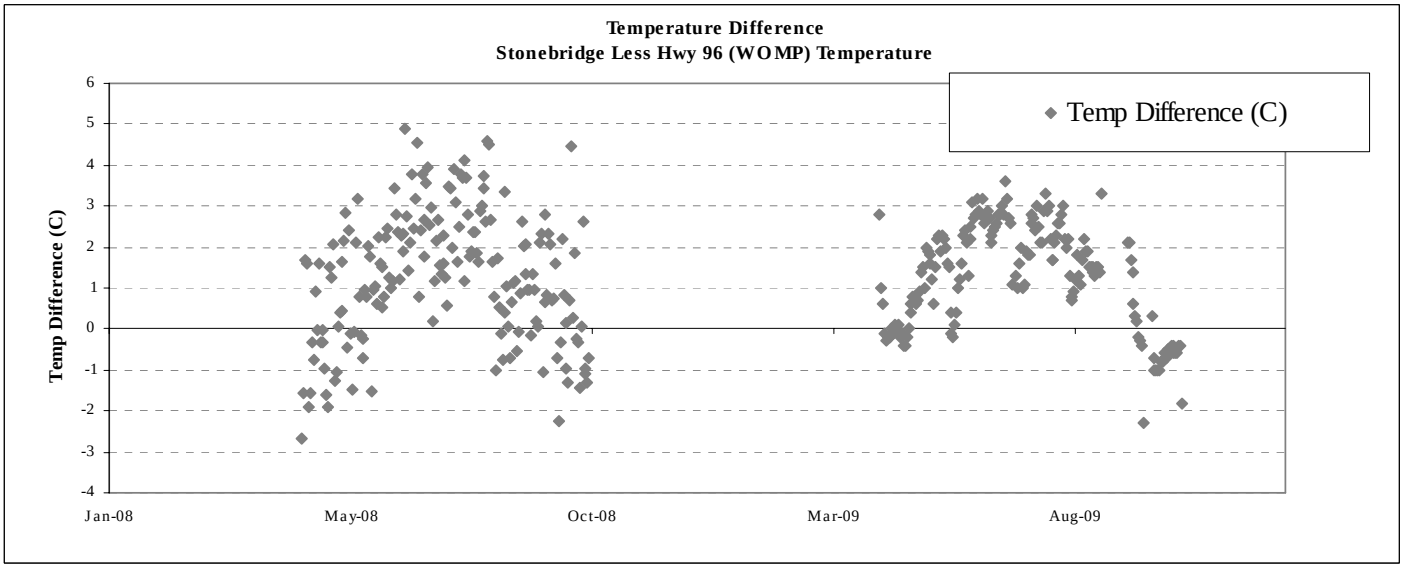


Figure 34: Temperature Differences Between Stonebridge & Outlet Sites

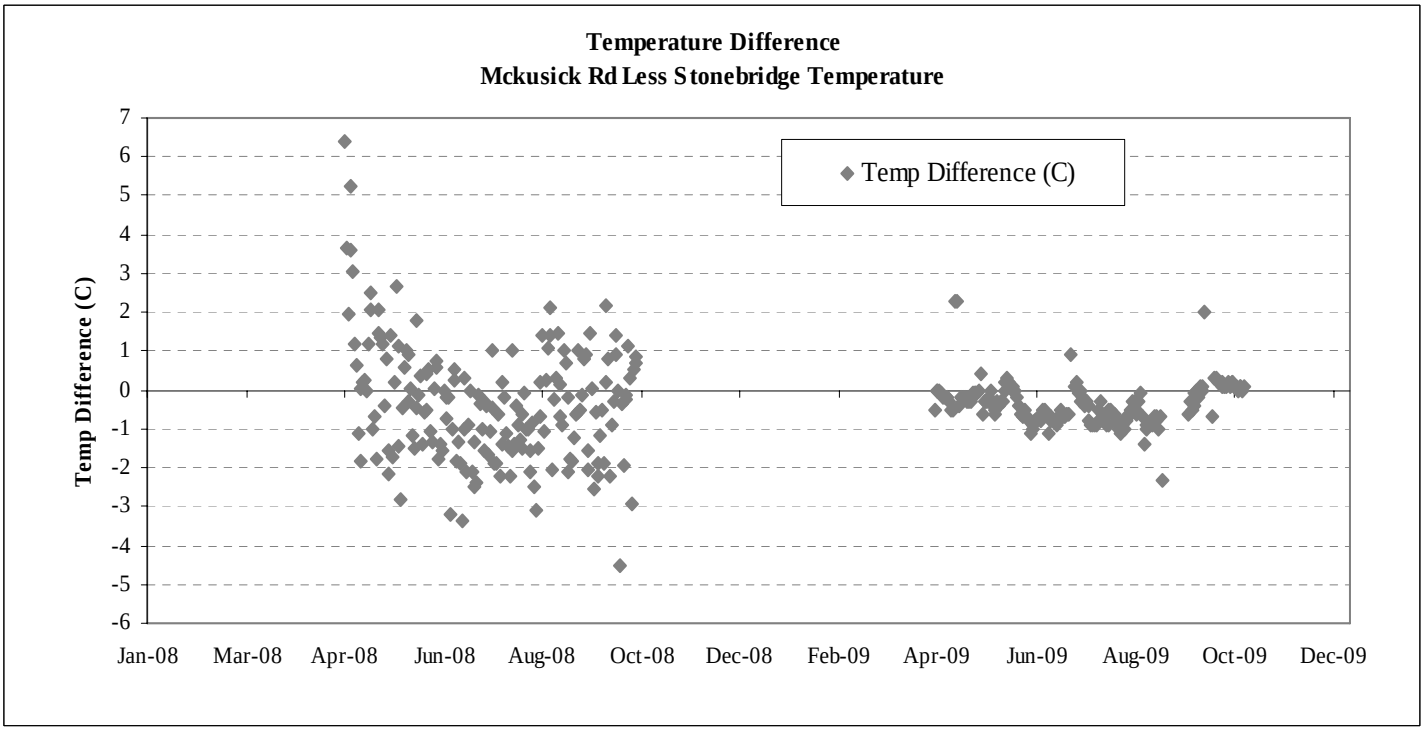


Figure 35: Temperature Differences Between Stonebridge & McKusick Sites

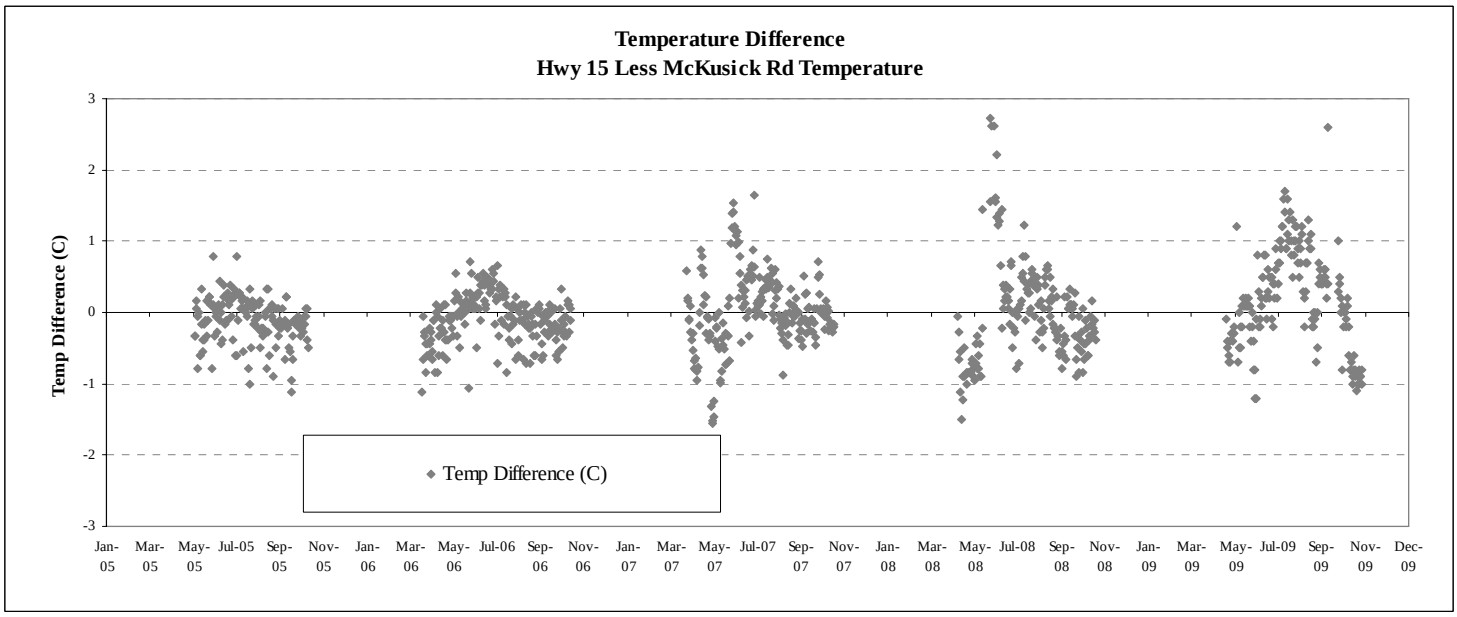


Figure 36: Temperature Differences Between McKusick Rd & Highway 15 Sites

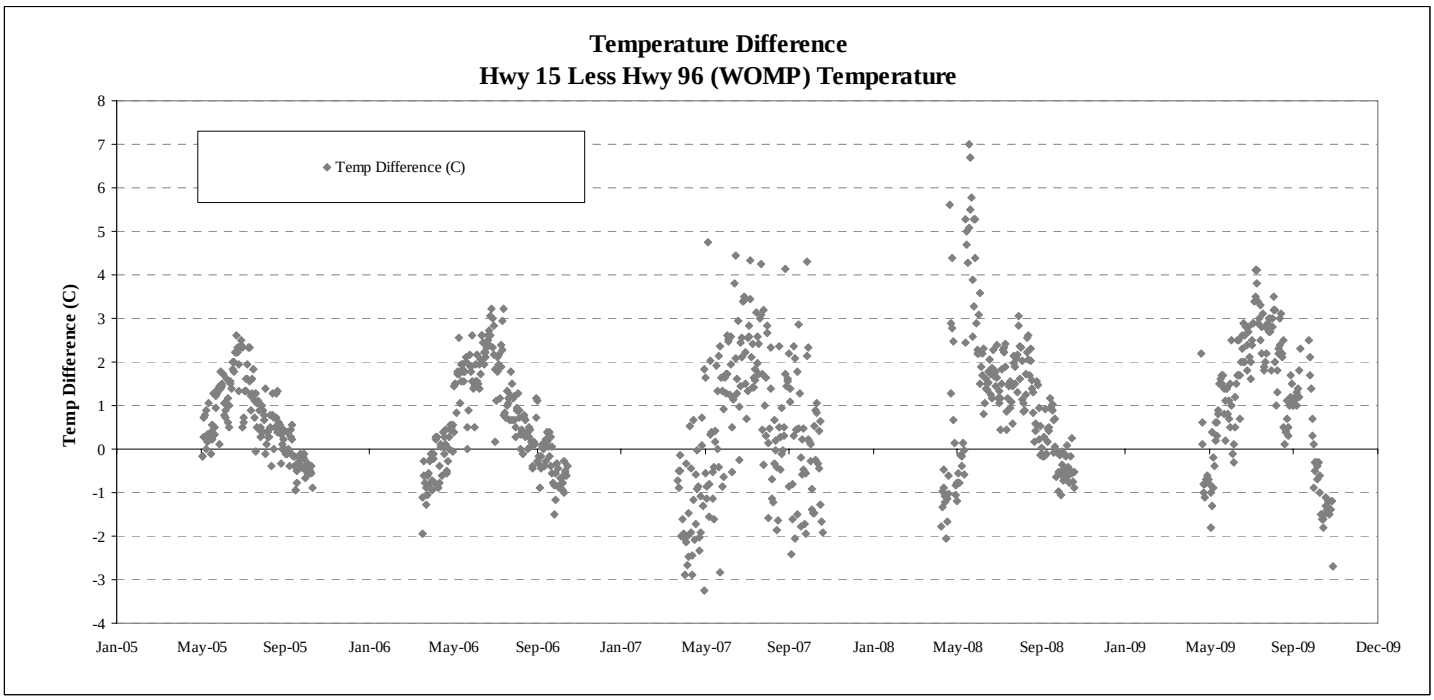


Figure 37: Temperature Differences Between Highway 15 & WOMP Sites

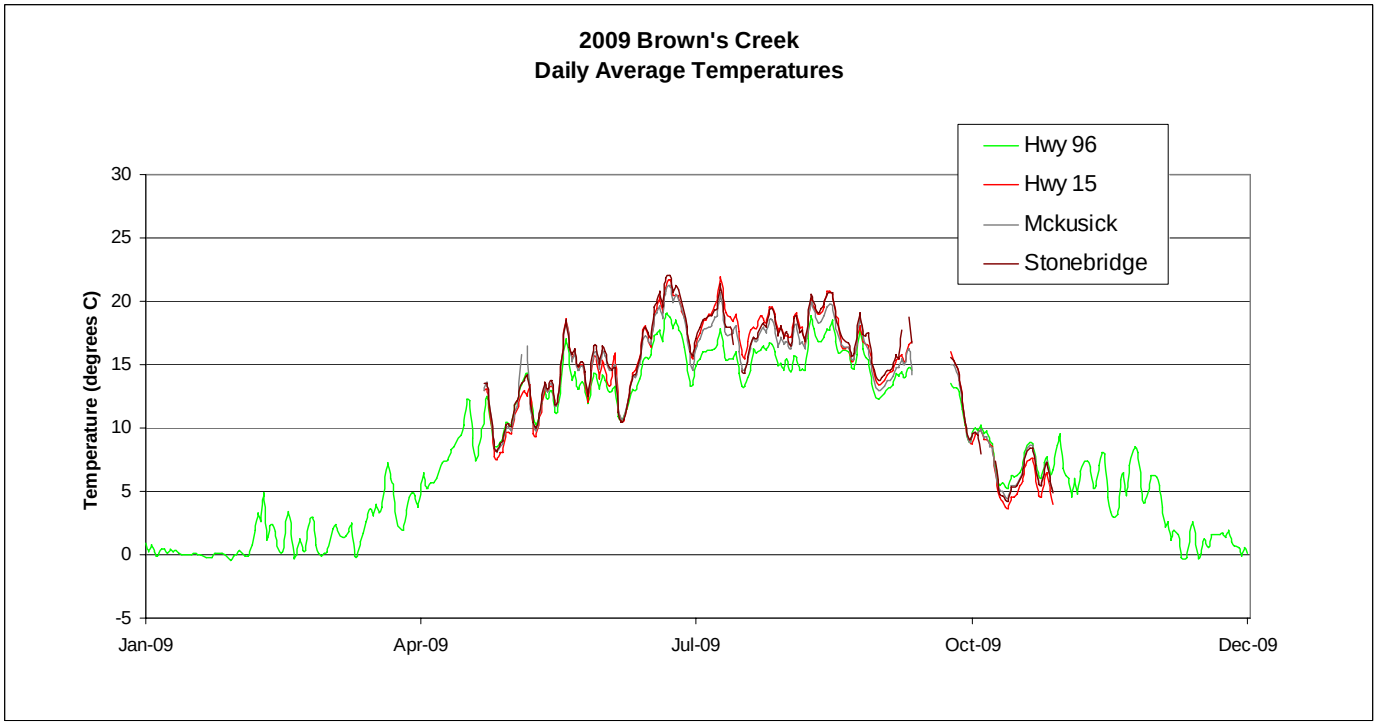


Figure 38: 2009 Daily Average Temperatures

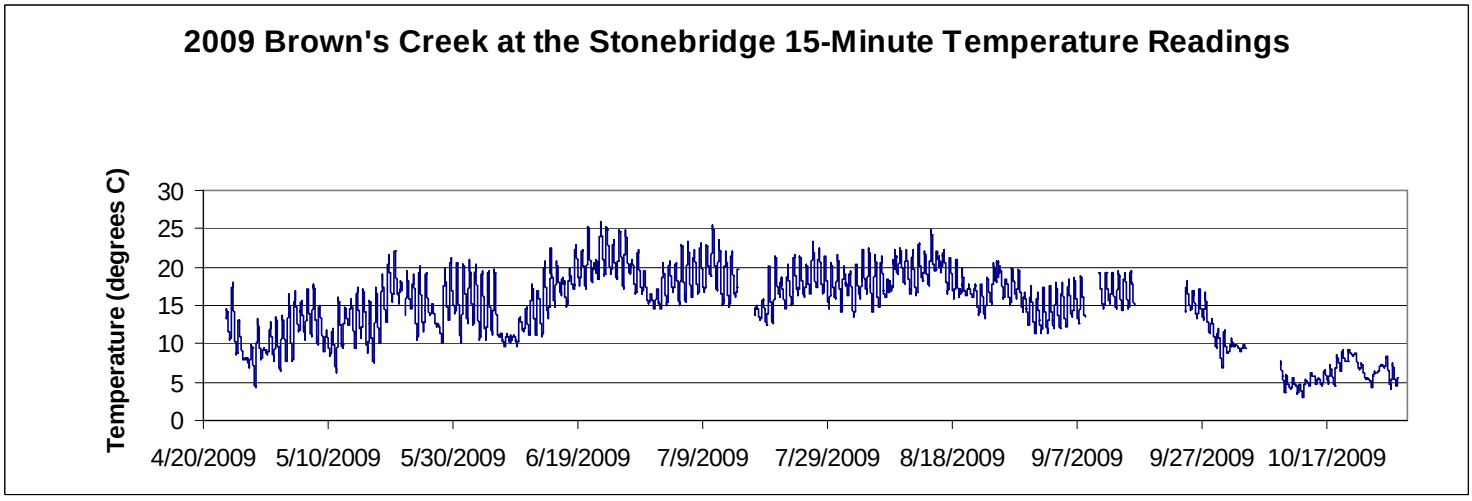


Figure 39: 2009 Brown's Creek at the Stonebridge Temperatures

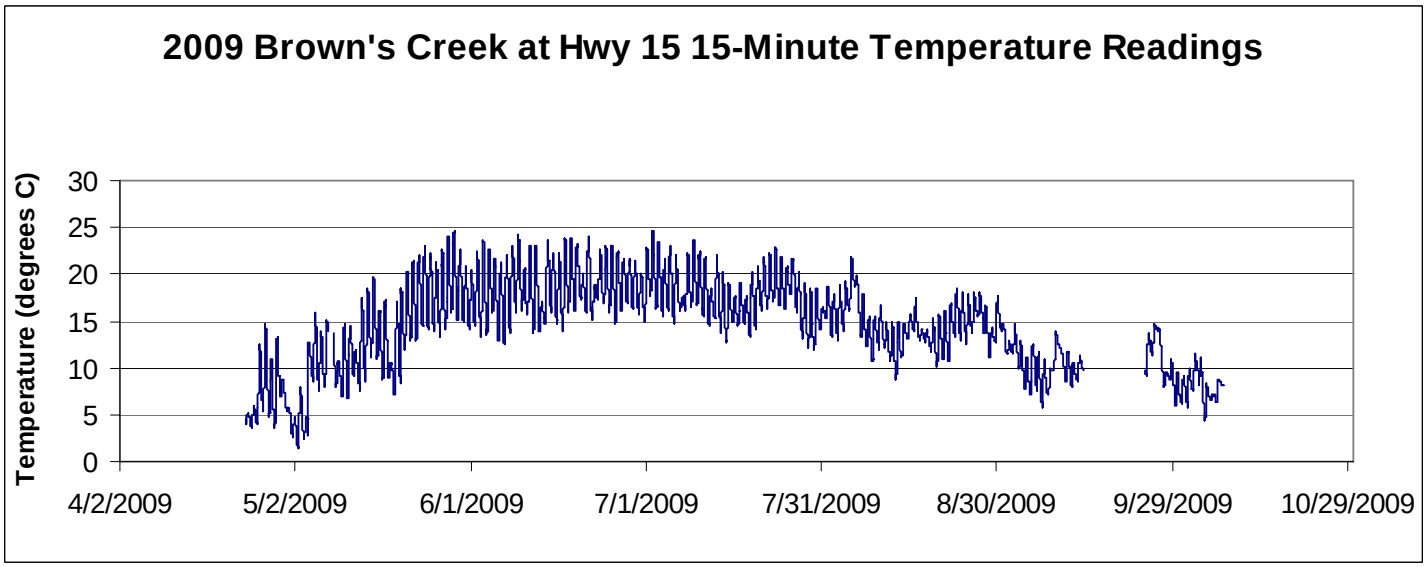


Figure 40: 2009 Brown's Creek at Hwy 15 Temperatures

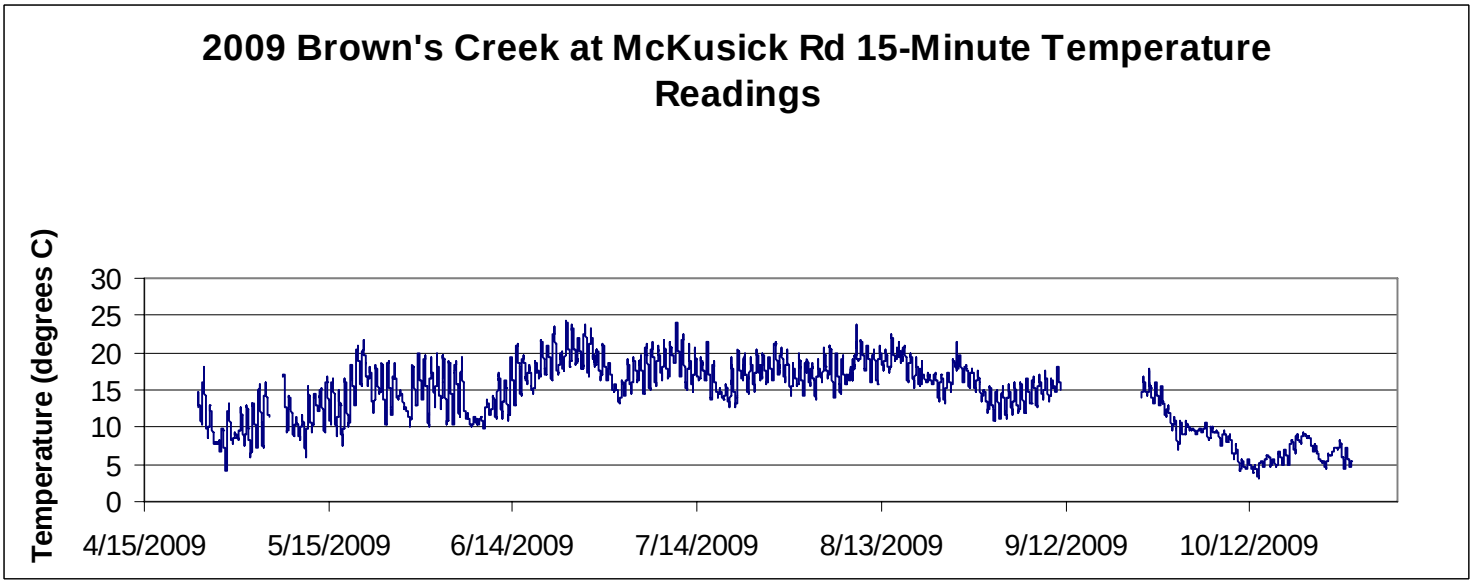


Figure 41: **2009 Brown's Creek at McKusick Road Temperature**

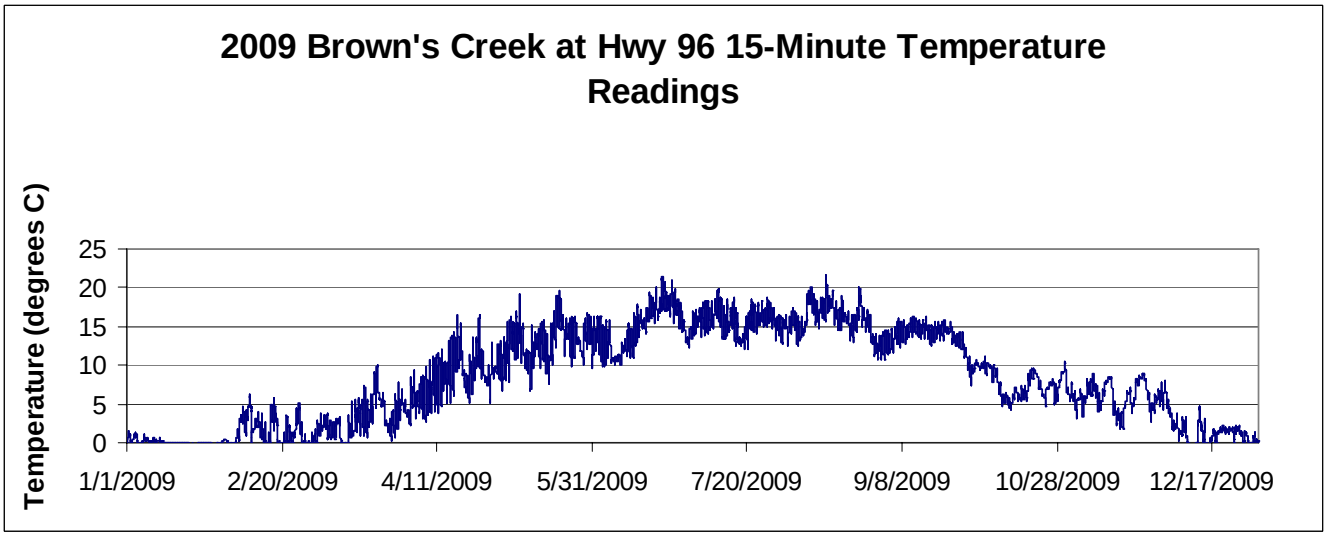


Figure 42: 2009 Brown's Creek Outlet Temperatures

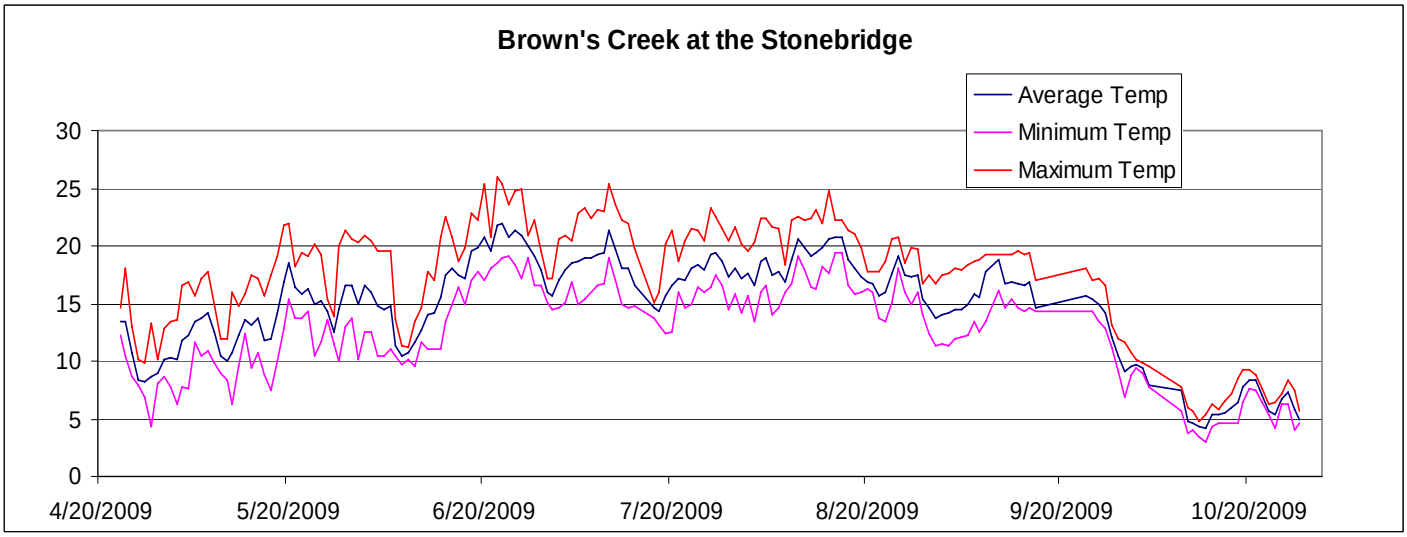


Figure 43: 2009 Brown's Creek at the Stonebridge Daily Average, Minimum, and Maximum Temperatures

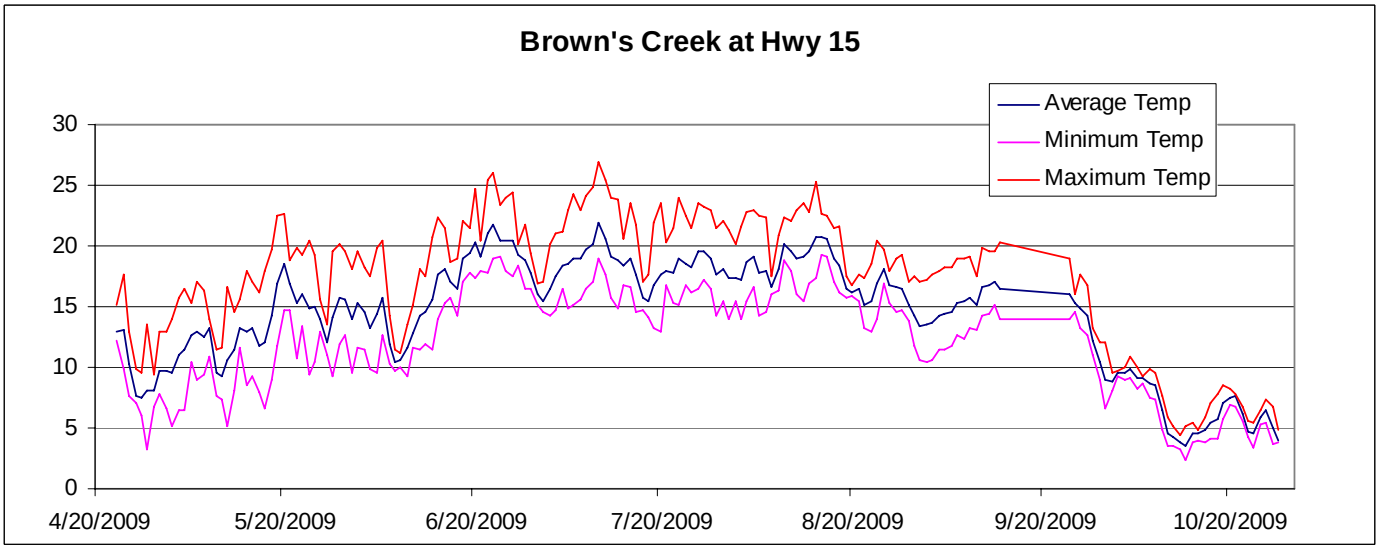


Figure 44: 2009 Brown's Creek at Hwy 15 Daily Average, Minimum, and Maximum Temperatures

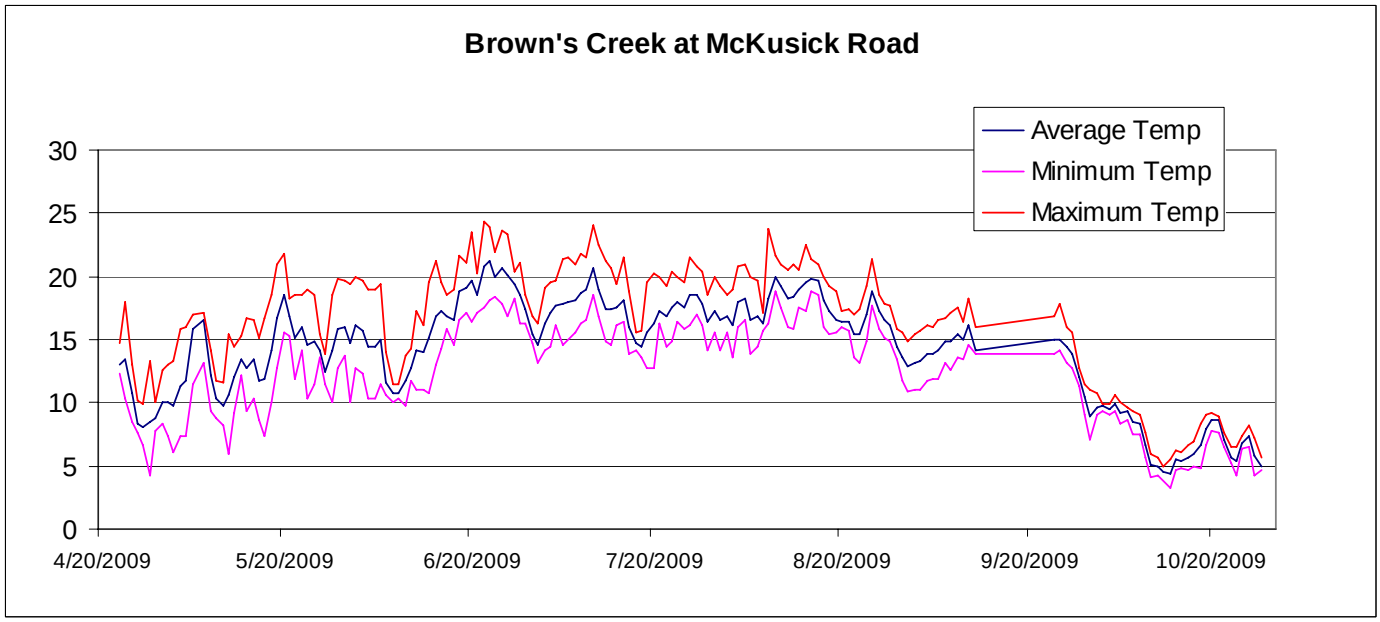


Figure 45. 2009 Brown's Creek at McKusick Road Daily Average, Minimum, and Maximum Temperatures

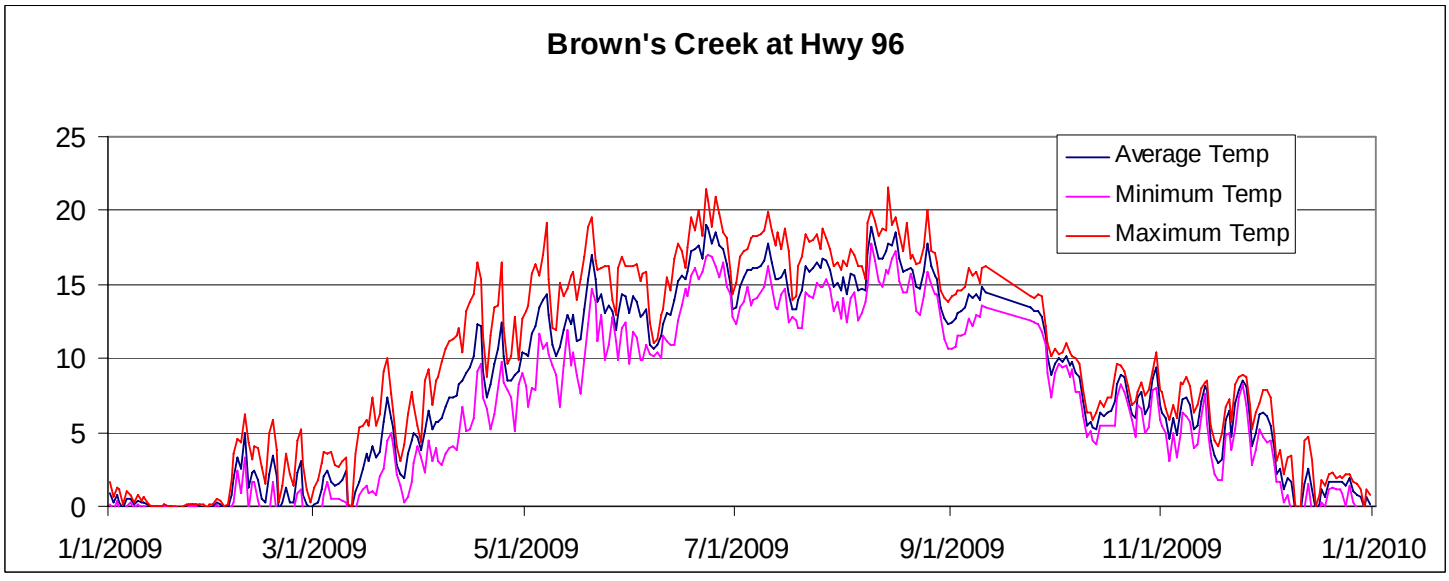


Figure 46. 2009 Brown's Creek Outlet Daily Average, Minimum, and Maximum Temperatures

B. CONCLUSIONS

The stream monitoring sites on Brown's Creek are producing valuable baseline water quality information that will be a helpful tool in determining a healthy balance of resources as the watershed continues to experience growth and changes in land use. To determine the health of the stream, discharge (base and storm), chemical, physical and biological parameters are compared on a year-to-year basis and with other streams in the region.

Base flow at the outlet of the stream consistently averages around 7 cubic feet per second (cfs). The 2002 monitoring season had the highest base flow of 10 cfs within the past seven years. For 2009, stream flow averaged 5.6 cfs. This is the lowest average annual flow during recorded data. While the base flow may fluctuate with climatic cycles, it provides a good point of reference for overall groundwater recharge to the stream. A drop in base flow during periods of normal or high precipitation may suggest a loss of groundwater recharge in the watershed. This may have been seen slightly in 2004 when compared to 2003 and in 2006 when compared to 2005.

In 2007 there were three large peak discharge events at the mouth: 92 cfs on August 14th, 58 cfs on March 13th, and 55 cfs on August 28th. High discharge rates from August were the result of high magnitude rainfall events and discharge rates from the March 13th event were the result of snowmelt. In 2008 peak discharge did not get as high as in 2009. The largest event of 47 cfs occurred on May 2, due to earlier rainfall events. 2009 showed further evidence of a string of dry summers. Again, there was only one large discharge event for the season, 59 cfs on August 25th. As in 2008, Brown's Creek was at base flow levels for the majority of the year.

While phosphorous has not been identified as a problem nutrient at the mouth or within other reaches of the stream, it is a common nutrient associated with lake eutrophication and is therefore routinely monitored in streams throughout the state. Total loading and loading per unit area are additional tools to help assess the health of the stream. During 2009, Brown's Creek Outlet exhibited annual loading rates per unit area (Kg/ha) similar to loading found between the natural atmospheric deposition range and the pasture, urban and cultivated land use ranges (Figure 26). The average total phosphorus concentration in the stream at the Outlet was 0.53 mg/L in 2009. This is consistent with the high impact range according to the H&H study (Table 47). The Stonebridge site exhibited annual loading rates per unit area (Kg/ha) similar to loading found in pasture land use areas. In 2009 both the Hwy 15 and McKusick Road sites exhibited annual loading rates per unit area (Kg/ha), which were less than the outlet station (0.11 Kg/ha and 0.14 Kg/ha respectively) and both were within the forest land use range. The Brown's Creek Diversion Structure site, although not completely connected with Brown's Creek as it was historically, exhibited a loading rate per unit area of 0.16 Kg/ha. This is consistent with a loading in the natural atmospheric deposition range and the pasture land use range. The total phosphorus load from Brown's Creek to the St. Croix River in 2009 was **2,448 lbs (0.27 lbs per acre of watershed land)**, determined by the Outlet station results.

The tributaries to Long Lake, at 62nd St. and at Marketplace Pond, exhibited loadings per unit area within the forest land use range, and within the deposition by precipitation and urban land use ranges, respectively. The tributary to Long Lake at the Herberger's Pond Outlet exhibited loading consistent with natural atmospheric and urban land use. From these loadings it is quite obvious that the Marketplace Pond subwatershed is draining either much more impervious areas without adequate treatment prior to this site or is draining a subwatershed that has a lot of erosion and sediment control problems. Although there is some construction activity in that subwatershed, the untreated drainage from impervious surfaces seems to be the more likely explanation. One factor that needs to be considered is that a series of settling ponds exists between Marketplace Pond and Long Lake to provide further treatment, whereas the 62nd St. site has no further treatment prior to discharging to Long Lake.

Total suspended solids (TSS) concentration is a good measure of the particulate matter in the stream and can be correlated to disturbances within the watershed. The average TSS in 2009 at the Brown's Creek Outlet was 259 mg/L. This is within the high impact modeled condition for the Outlet site from the H&H Study. All sites on Brown's Creek had average TSS concentrations less than the average concentration found at the Outlet. The Brown's Creek Diversion Structure site had an average concentration of 236 mg/L. One storm grab sample from the Stonebridge site was collected with an extremely low TSS value and one storm composite sample was collected at McKusick Road with an extremely high TSS value. These were left out of average calculations based on our professional judgment. At the Diversion site, base flow concentrations are relatively low, but storm concentrations are much higher and may indicate that impervious surfaces, stormwater runoff from development, or remaining agricultural lands in this subwatershed may be contributing to these higher concentrations.

The Long Lake drainage sites at 62nd St. and Marketplace Pond had average concentrations of 74 mg/L and 16 mg/L, respectively. The drainage site at Herberger's Pond Outlet had an average TSS concentration of 19 mg/L. The value for 62nd St. was lower in 2009 compared to 2008, likely due in part to less overall precipitation and storm events. The value from the Marketplace pond is consistent with the previous year. It is recommended that monitoring continue at these sites in order to generate conclusions and long-term trends.

Turbidity or suspended solids should continue to be monitored in Brown's Creek. Average TSS values for the Brown's Creek Diversion Structure drainage (236 mg/L), Stonebridge (113 mg/L), McKusick Road (188 mg/L) and the Outlet drainage (259 mg/L) were in the high water quality impact range of modeled conditions (Table 47). TSS values at Highway 15 were within the low impact range. The TSS value for the 62nd St. site (74 mg/L) was within the high impact range, and the Marketplace and Herberger's Pond Outlet drainages (16 mg/L and 19 mg\L) were within the low impact range. Based on the Brown's Creek Impaired Biota TMDL, the average TSS load at the Outlet was 236 mg\L above the targeted goal of 23 mg\L (Table 48). This translates to 2,025 pounds of daily discharge over the low flow condition threshold allowed within the TMDL framework.

Sampling was conducted at seven additional sites along the diversion drainage from March through October. Groundwater inflow is most likely present between Boutwell Rd. and the S. Branch, upstream from the N. Branch, upstream from the W. Branch 1 and the W. Branch 2, and potentially between the Diversion Structure and the confluence of the N., S., and W. Branches. Looking at the results, there appears to be some additional contribution of TSS and TP between W. Branch 2 and W. Branch 1, and between Boutwell Rd, and S. Branch. When comparing TSS at S. Branch and W. Branch 1, all sample results, except the 7/27/09 samples, were similar. The groundwater present at S. Branch, W. Branch 2, W. Branch 1, N. Branch, and the Diversion Structure has some affect on the water quality and flows as well. The higher results from the 6/22/09, 7/27/09 and 9/18/09 samples at N. Branch may have been due to bottom sediment contaminating the sample. This channel is very shallow, narrow, incised, and covered with vegetation making it very difficult to collect a representative sample. Additional monitoring in 2010 should make more precise identification of what is occurring in this drainage possible. Again, further BMP's may need to be investigated for the Diversion Structure drainage.

Table 47: Issues Matrix: Water Quality

	Total Phosphorus (mg/L)	Total Suspended Solids (mg/L)
Low Impact	0-0.15	0-30
Moderate Impact	0.15-0.25	30-100
High Impact	>0.250	>100

Brown's Creek Watershed District Hydrologic/Hydraulic Study, November 1999

Table 48. TSS Loading Capacity

Flow Range	Flow Range Midpoint (cfs)	TSS TMDL (lbs/day) @ 23 mg/L
High	25.0	3,105
Moist	11.7	1,456
Mid	8.5	1,049
Dry	6.8	839
Low	5.5	684

Brown's Creek Impaired Biota TMDL, November 2009

Temperatures in Brown's Creek are at the thermal maximum for a cold-water stream. Maximum temperatures for young of the year Brown trout were regularly exceeded during the 2000-2002 seasons at both the outlet and at McKusick Road. However, in 2003 cooler temperatures and little stormwater runoff contributed no exceedance of the maximum temperature thresholds. In 2005 and 2006, one day and four days respectively exceeded the 20° C daily minimum temperature threshold at the McKusick Road site. In 2007 there were no days that exceeded the 20° C threshold at McKusick Road. The Hwy 15 site and the Outlet site did not exceed the 20° daily minimum temperature threshold in 2007 either. At the Gateway Bike Trail, no daily minimum temperatures exceeded 20°, but at the Headwaters site, the temperature exceeded this value 3 times throughout the season. In 2008 and 2009 all monitored sites had daily minimum temperatures below 20°C, including the Stonebridge site. Continued efforts to improve shade throughout critical areas as well as in areas upstream of where trout are known to live will likely improve temperature conditions for trout throughout the stream. In 2001 and 2002 stream temperatures reached levels above ideal conditions for trout habitat but showed no direct negative correlation to natural reproduction rates.

C. RECOMMENDATIONS

- Continue phosphorus loading and total suspended solid analysis on Brown's Creek Outlet at Hwy 96, McKusick Road, Hwy 15, Stonebridge, and Diversion Structure, and at Long Lake tributaries at 62nd St., Herberger's Pond and Marketplace Pond to monitor any potential trends.
- Install secondary monitoring station at Herberger's Pond to assess the performance of the EcoStorm Plus system.
- Begin implementation of TMDLs on waters currently listed on the 303d impaired water's list (Goggin's Lake, Long Lake, Lynch Lake, and South School Section Lake) as well as staging implementation on waters that will be listed based on water quality data with a small period of record.
- Begin monitoring the second (deeper) basin of Lynch Lake to confirm impairment status and compare the two basins.
- Continue implementation of activities to de-list Brown's Creek from the MPCA's impaired waters list.
- Continue to gather baseline water quality data at all sites on Brown's Creek as BCWD continues to become more developed.
- Support continued biological monitoring of Brown's Creek through the volunteer efforts of Stillwater Area High School.
- Assist the City of Stillwater and Middle St. Croix Water Management Organization in reduction of nutrient and sediment loads from the Brown's Creek Diversion Structure Drainage to McKusick Lake.
- Investigate if stream temperatures in Brown's Creek upstream of Hwy 15 can be reduced during the warmest hours of the day using practices to promote further shading to provide more tolerable conditions for trout survival. In either locations they do not exist or for downstream trout tolerance benefits.
- Begin to track BMP effectiveness according to the Monitoring Plan in the BC Biotic TMDL.

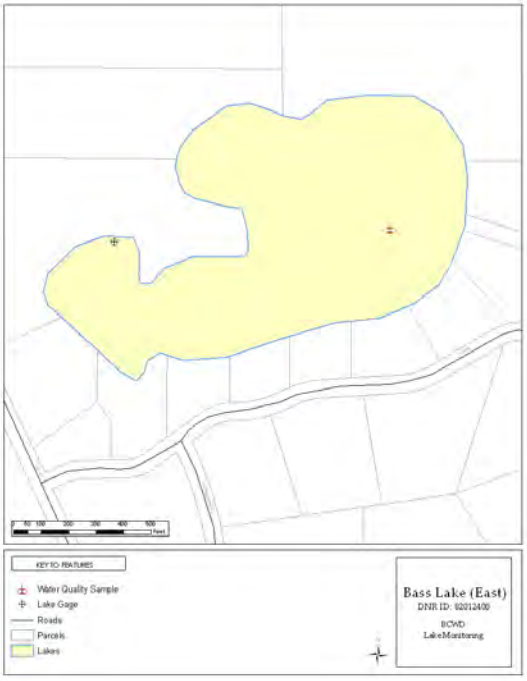
APPENDIX A - WATER QUALITY DATA – BY LAKE

Brown's Creek Watershed Lakes: Bass East, Bass West, Benz, Goggin's, July Avenue, Kismet, Long, Lynch, Masterman, Pat, Plaisted, South School Section, and Wood Pile

Bass Lake (East)

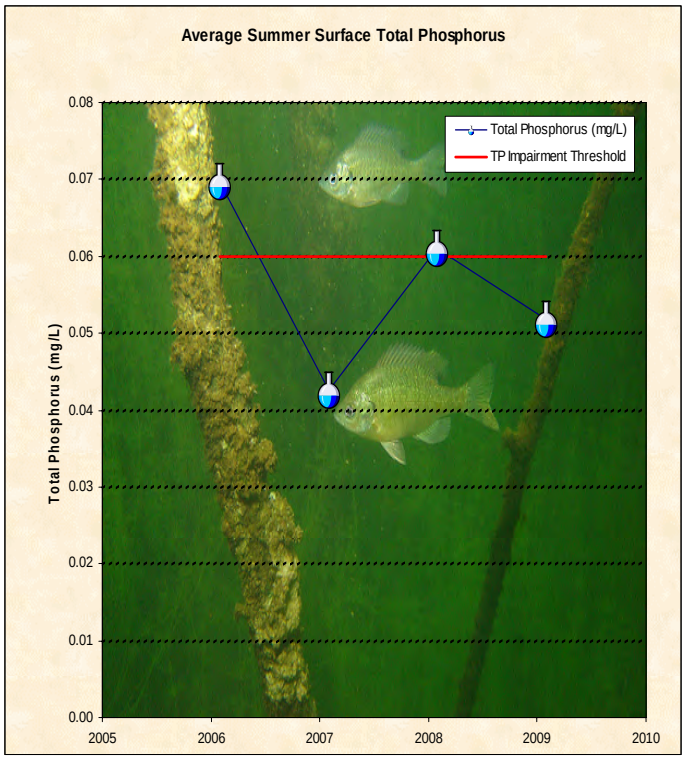
2009 Lake Grade: B-

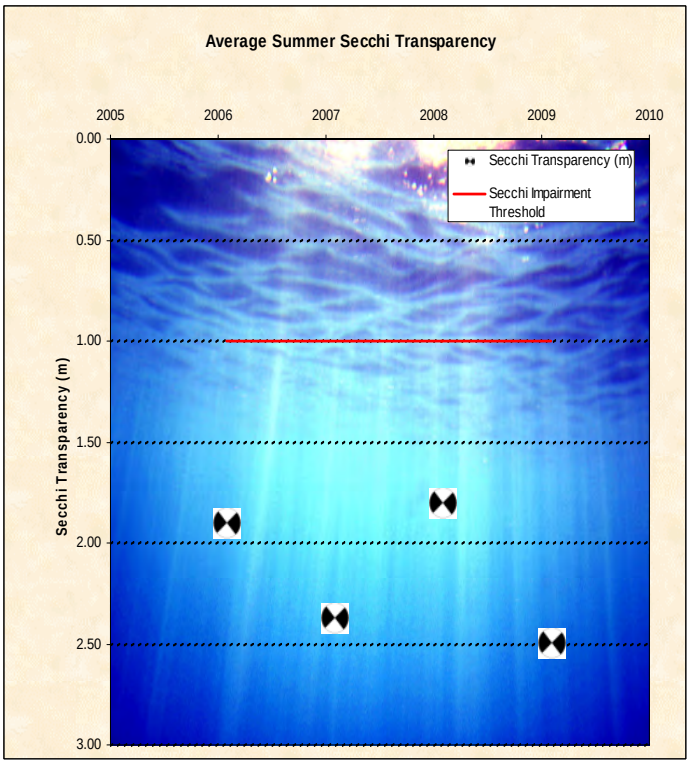
- DNR ID #: 820124
- Municipality: City of Grant
- Location: Section 10, T30N-R21W
- Lake Size: 29 Acres
- Maximum Depth: 14 ft
- Ordinary High Water Mark: 960.20 ft
- 100-Year High Water Level: 960.40 ft
- 100% Littoral
  Note: Littoral area is the portion of the lake <15 ft and dominated by aquatic vegetation.



Summary Points

- Bass Lake (East) was considered a mesotrophic lake in 2009, based on the Carlson Trophic State Index.
- At this time there are not enough years of data to determine a statistically significant overall water quality trend.
- The major land use is rural/agricultural.
- The lake did not stratify in 2009.





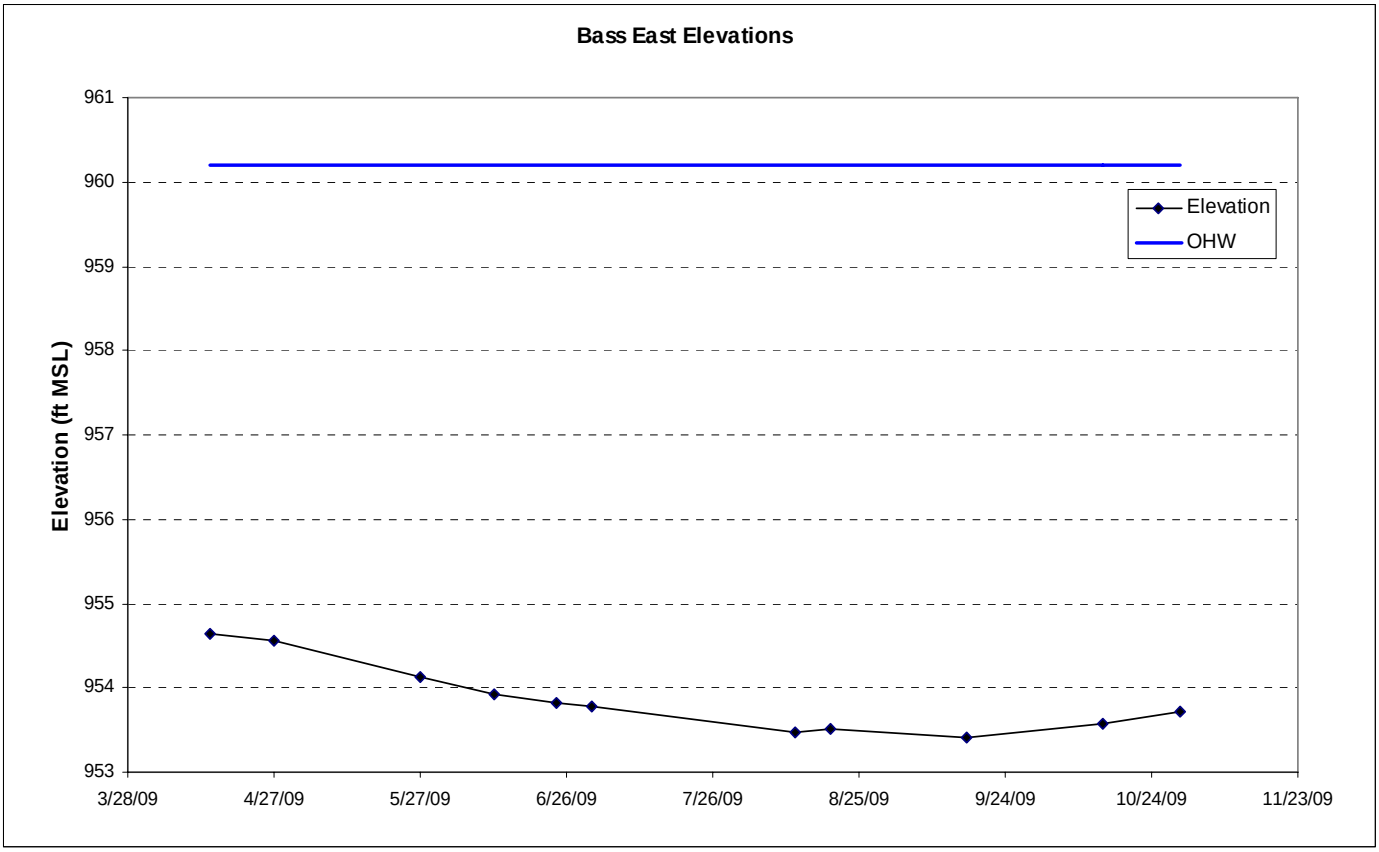
Date	Total Phosphorus (mg/L)	Chlorophyll-a (ug/L)	Total Kjeldahl Nitrogen (mg/L)	Secchi Disk Depths (m)	Surface Dissolved Oxygen Levels (mg/L)	Surface Temperature Levels (Celsius)
4/27/2009	0.031	9	1.00	3.20	9.95	13.0
5/27/2009	0.041	9	0.95	3.20	8.58	19.0
6/24/2009	0.051	7	1.10	2.90	9.14	26.6
7/23/2009	0.039	8	1.10	2.59	10.53	22.5
8/19/2009	0.071	9	1.20	1.83	6.42	23.0
9/16/2009	0.057	18	1.10	1.98	7.50	22.6
10/14/2009	0.018	7	0.76	3.35	12.47	6.4
2009 Average	0.044	9	1.03	2.72	9.23	19.0
2009 Summer Average	0.052	10	1.09	2.50	8.43	22.7

Water quality thresholds are 0.04 mg/L TP, 14 µg/L CL-a, 1.4 m Secchi depth*

Shallow lake water quality thresholds are 0.06 mg/L TP, 20 µg/L CL-a, 1.0 m Secchi depth*

	High	High Date	Low	Low Date	Average
2009 Elevation (ft)	954.65	4/14/2009	953.41	9/16/2009	953.87

*MPCA description of Imparied Lake's Listing criteria: "At a minimum, a decision that a given lake is impaired for the 303(d) list due to excessive nutrients will be supported by data for both causal and response factors. Data requirements for 303(d) listing consist of 12 or more TP measurements collected from June through September over the most recent 10-year period. Ideally this should represent 12 separate visits to the lake over the course of two summers; however it might also reflect four monthly samples over the course of three years (a typical sampling regimen for many lake monitoring programs). In addition to exceeding the TP guideline thresholds, lakes to be considered for 303(d) listing should have at least 12 Secchi measurements and 12 chlorophyll-a measurements. This amount of data will allow for at least one season (preferably more) for paired TP, chlorophyll-a, and Secchi disk data and provide a basis for evaluating their interrelationships and hence the trophic status of the lake."



Lake Water Quality Summary	Trophic Status	Summertime Lake Grades									
	2009	2009	2008	2007	2006	2005	2004	2003	2002	2001	2000
Total Phosphorus (mg/l)	Eutrophic	C	C	C	D	NA	NA	NA	NA	NA	NA
Chlorophyll-*a* (ug/l)	Mesotrophic	B	C	B	B	NA	NA	NA	NA	NA	NA
Secchi disk (ft)	Mesotrophic	B	C	B	C	NA	NA	NA	NA	NA	NA
Overall	Mesotrophic	B-	C	B-	C	NA	NA	NA	NA	NA	NA

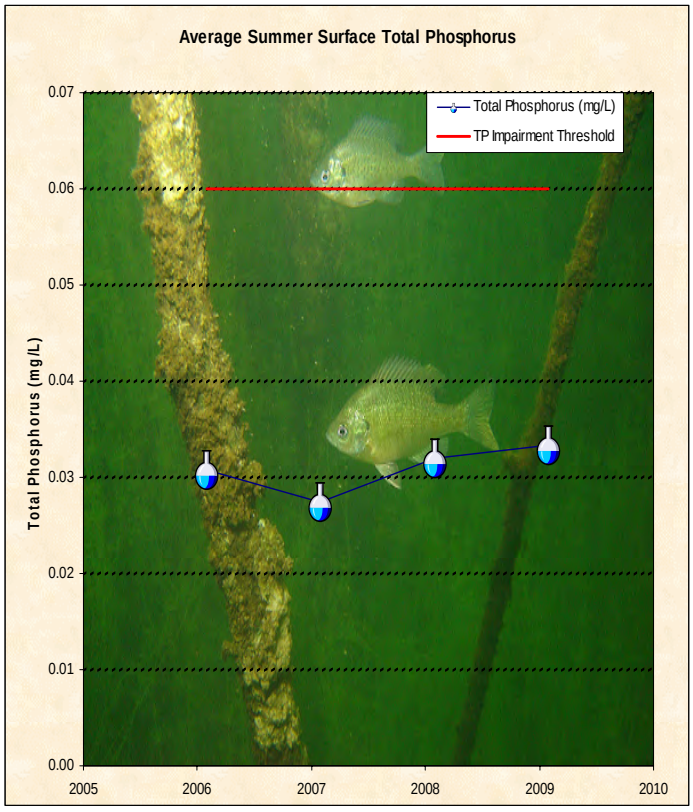
Bass Lake (West)

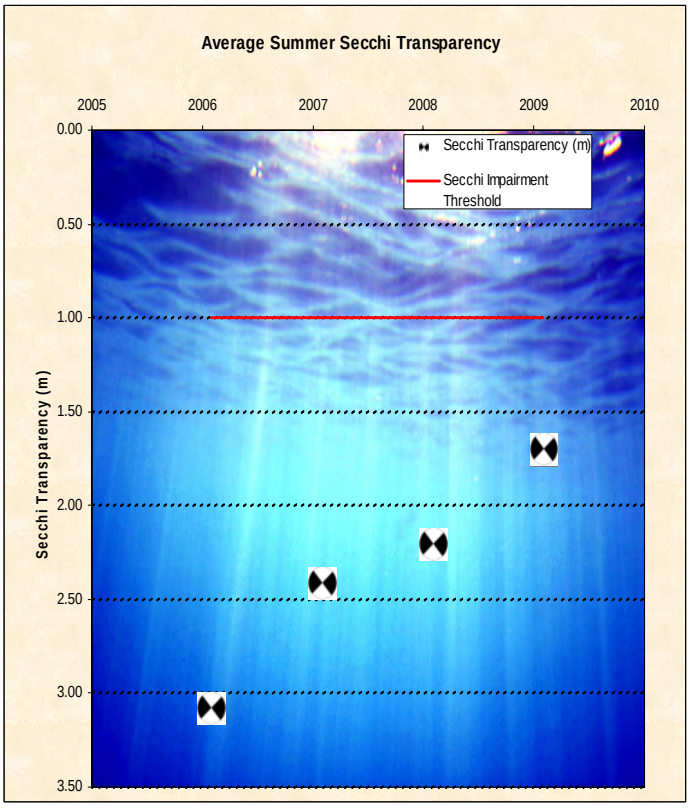
2009 Lake Grade: C+

- DNR ID #: 820123
- Municipality: City of Grant
- Location: Section 10, T30N-R21W
- Lake Size: 72 Acres
- Maximum Depth: 15 ft
- Ordinary High Water Mark: 952.60 ft
- 100-Year High Water Level: 955.90 ft
- 100% Littoral
  Note: Littoral area is the portion of the lake <15 ft and dominated by aquatic vegetation.

Summary Points

- Bass Lake (West) was considered a eutrophic lake in 2009, based on the Carlson Trophic State Index.
- At this time there are not enough years of data to determine a statistically significant overall water quality trend.
- The major land use is rural/agricultural.
- The lake did not stratify in 2009.





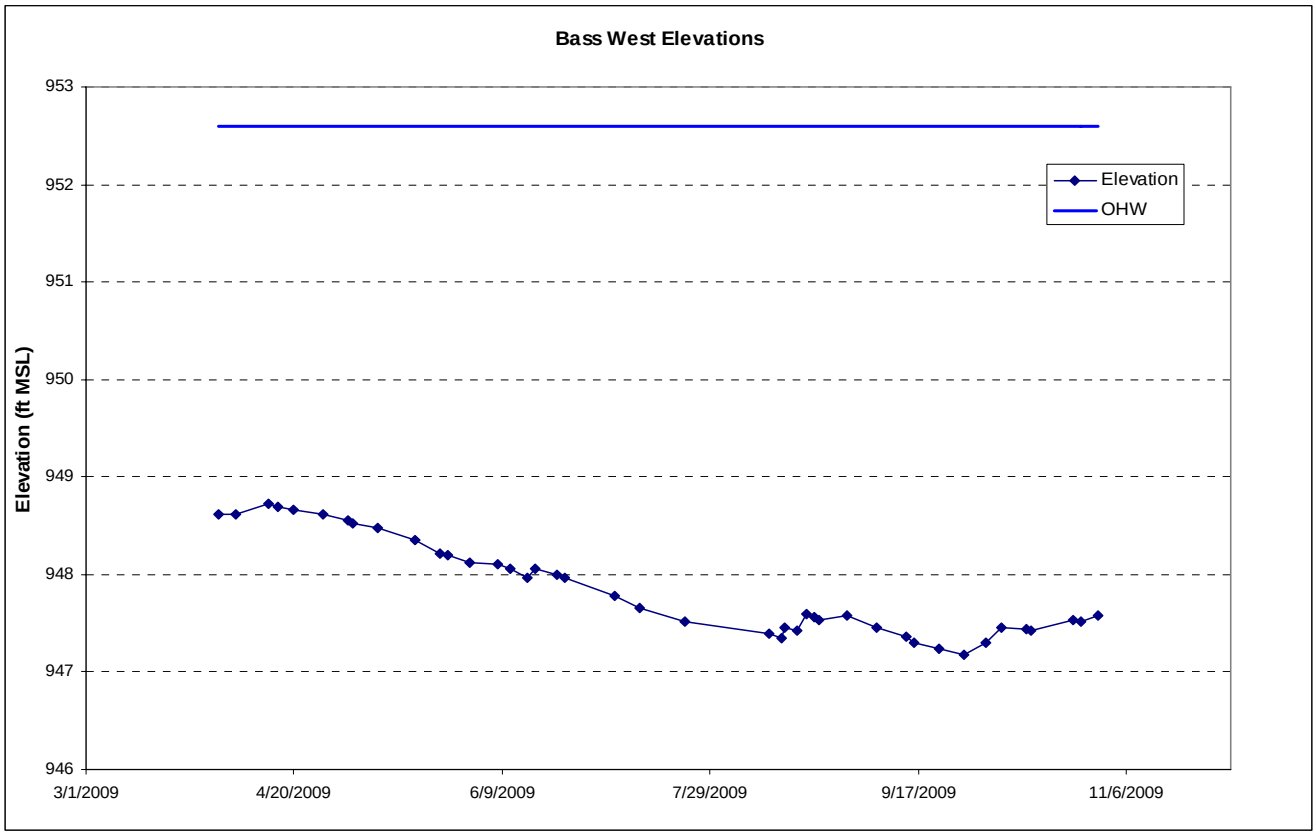
Date	Total Phosphorus (mg/L)	Chlorophyll-a (ug/L)	Total Kjeldahl Nitrogen (mg/L)	Secchi Disk Depths (m)	Surface Dissolved Oxygen Levels (mg/L)	Surface Temperature Levels (Celsius)
4/27/2009	0.031	6	0.84	1.52	9.45	12.0
5/27/2009	0.027	8	0.84	1.83	6.98	18.5
6/24/2009	0.025	6	0.99	2.13	8.44	26.6
7/23/2009	0.021	8	0.98	1.83	10.60	22.3
8/19/2009	0.034	32	1.10	1.37	7.04	23.3
9/16/2009	0.060	8	0.88	1.37	7.46	22.7
10/14/2009	0.017	3	0.70	1.22	12.35	6.0
2009 Average	0.031	10	0.90	1.61	8.90	18.8
2009 Summer Average	0.033	12	0.96	1.71	8.10	22.7

Water quality thresholds are 0.04 mg/L TP, 14 µg/L CL-a, 1.4 m Secchi depth*

Shallow lake water quality thresholds are 0.06 mg/L TP, 20 µg/L CL-a, 1.0 m Secchi depth*

	High	High Date	Low	Low Date	Average
2009 Elevation (ft)	948.72	4/14/2009	947.18	9/28/2009	947.86

*MPCA description of Imparied Lake's Listing criteria: "At a minimum, a decision that a given lake is impaired for the 303(d) list due to excessive nutrients will be supported by data for both causal and response factors. Data requirements for 303(d) listing consist of 12 or more TP measurements collected from June through September over the most recent 10-year period. Ideally this should represent 12 separate visits to the lake over the course of two summers; however it might also reflect four monthly samples over the course of three years (a typical sampling regimen for many lake monitoring programs). In addition to exceeding the TP guideline thresholds, lakes to be considered for 303(d) listing should have at least 12 Secchi measurements and 12 chlorophyll-a measurements. This amount of data will allow for at least one season (preferably more) for paired TP, chlorophyll-a, and Secchi disk data and provide a basis for evaluating their interrelationships and hence the trophic status of the lake."



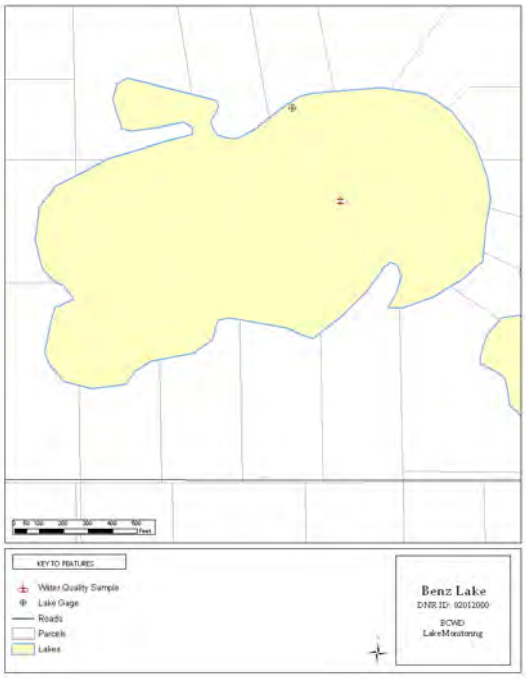
Lake Water Quality Summary

	Trophic Status	Summertime Lake Grades									
	2009	2009	2008	2007	2006	2005	2004	2003	2002	2001	2000
Total Phosphorus (mg/l)	Eutrophic	C	B	B	B	NA	NA	NA	NA	NA	NA
Chlorophyll-*a* (ug/l)	Eutrophic	B	B	B	A	NA	NA	NA	NA	NA	NA
Secchi disk (ft)	Eutrophic	C	B	B	A	NA	NA	NA	NA	NA	NA
Overall	Eutrophic	C+	B	B	A-	NA	NA	NA	NA	NA	NA

Benz Lake

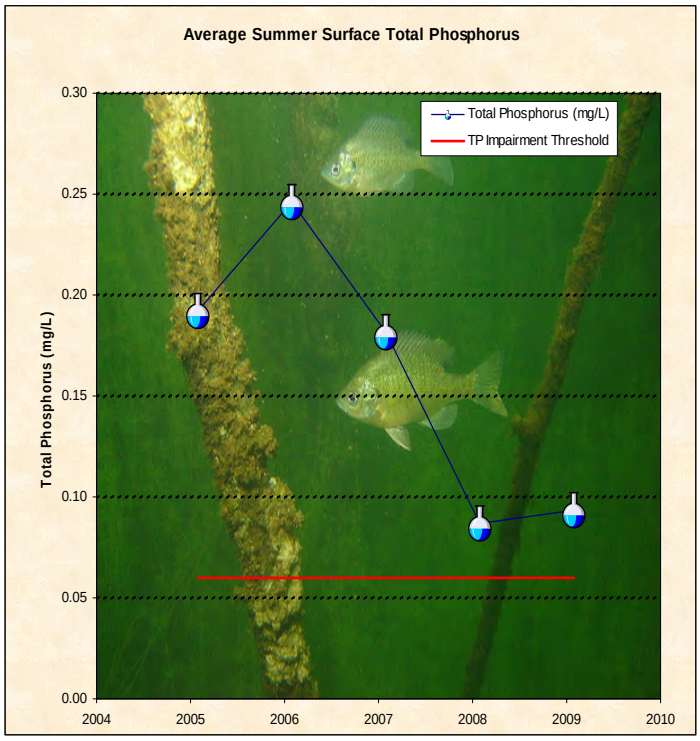
2009 Lake Grade: D+

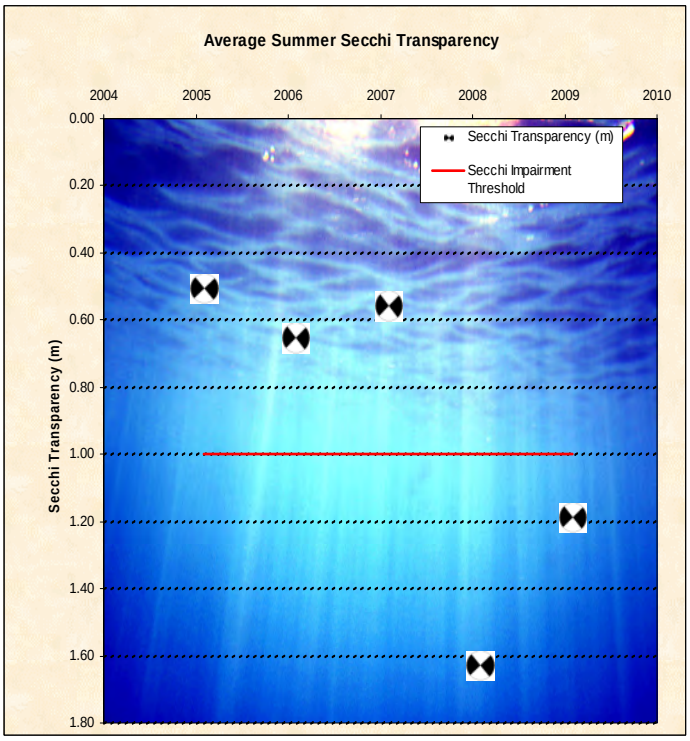
- DNR ID #: 820120
- Municipality: City of Grant
- Location: $SE^{1/4}$ Section 2, T30N-R21W
- Lake Size: 40 Acres
- Maximum Depth: 8 ft
- Ordinary High Water Mark: 954.07 ft*
- 100-Year High Water Level: 955.30 ft
- 100% Littoral
  Note: Littoral area is the portion of the lake <15 ft and dominated by aquatic vegetation.
  **Reduced by 4.84 feet due to benchmark error*



Summary Points

- Benz Lake was considered a eutrophic lake in 2009, based on the Carlson Trophic State Index.
- At this time there are not enough years of data to determine a statistically significant overall water quality trend.
- The major land use is rural/agricultural.
- The lake did not stratify in 2009.





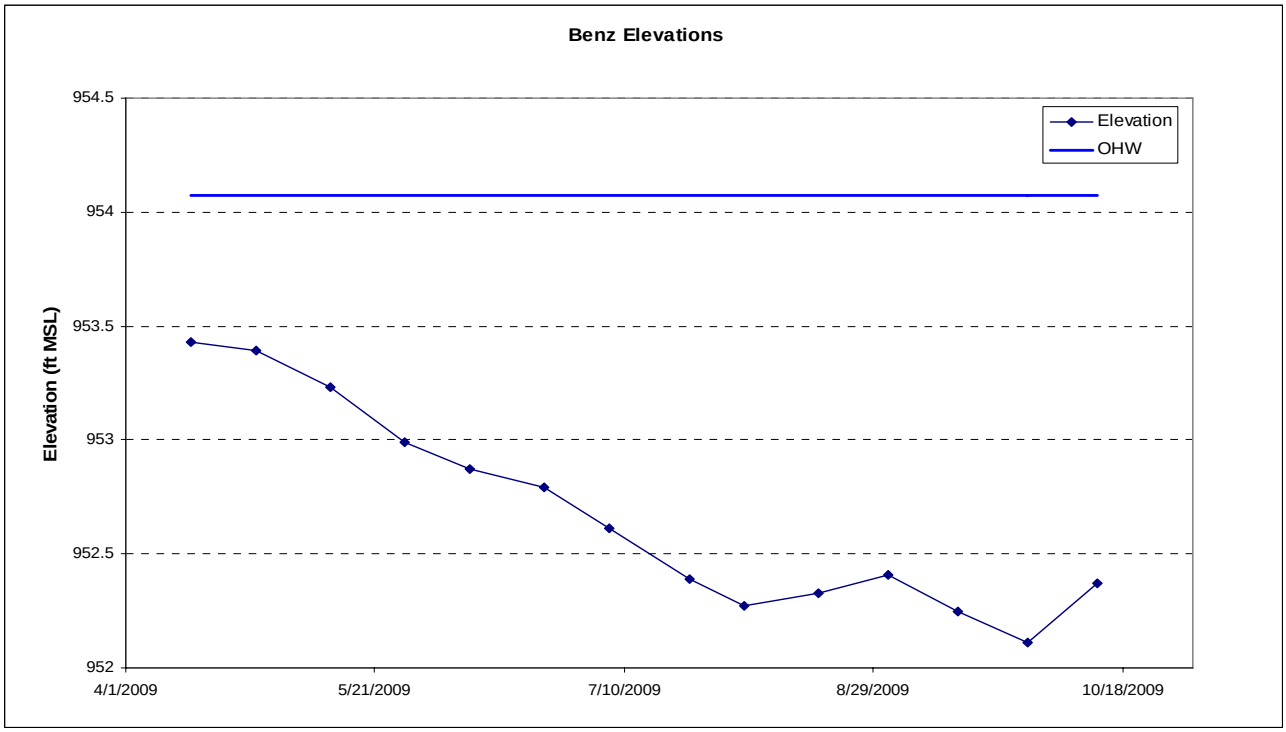
Date	Total Phosphorus (mg/L)	Chlorophyll-a (ug/L)	Total Kjeldahl Nitrogen (mg/L)	Secchi Disk Depths (m)	Surface Dissolved Oxygen Levels (mg/L)	Surface Temperature Levels (Celsius)
4/14/2009	0.057	15	1.70	1.98	11.70	13.1
4/27/2009	0.068	44	1.60	1.37	10.91	12.8
5/12/2009	0.072	30	1.60	1.07	10.01	15.6
5/27/2009	0.088	19	1.80	1.22	7.44	19.1
6/9/2009	0.083	2	1.90	1.52	7.35	16.5
6/24/2009	0.114	35	1.80	1.68	7.35	27.5
7/7/2009	0.075	12	1.50	1.52	10.73	24.7
7/23/2009	0.087	25	1.90	1.22	11.91	23.3
8/3/2009	0.111	36	2.00	0.91	10.52	24.8
8/18/2009	0.130	60	2.10	0.61	7.12	23.7
9/1/2009	0.085	20	1.90	0.91	9.53	22.2
9/15/2009	0.065	17	1.60	0.91	7.61	23.9
9/30/2009	0.098	16	1.60	1.37	10.04	13.6
10/13/2009	0.047	12	1.40	1.83	12.24	7.0
2009 Average	0.084	25	1.74	1.30	9.60	19.1
2009 Summer Average	0.094	24	1.81	1.19	8.96	21.9

Water quality thresholds are 0.04 mg/L TP, 14 µg/L CL-a, 1.4 m Secchi depth*

Shallow lake water quality thresholds are 0.06 mg/L TP, 20 µg/L CL-a, 1.0 m Secchi depth*

	High	High Date	Low	Low Date	Average
2009 Elevation (ft)	953.43	4/14/2009	952.11	9/29/2009	952.67

*MPCA description of Imparied Lake's Listing criteria: "At a minimum, a decision that a given lake is impaired for the 303(d) list due to excessive nutrients will be supported by data for both causal and response factors. Data requirements for 303(d) listing consist of 12 or more TP measurements collected from June through September over the most recent 10-year period. Ideally this should represent 12 separate visits to the lake over the course of two summers; however it might also reflect four monthly samples over the course of three years (a typical sampling regimen for many lake monitoring programs). In addition to exceeding the TP guideline thresholds, lakes to be considered for 303(d) listing should have at least 12 Secchi measurements and 12 chlorophyll-a measurements. This amount of data will allow for at least one season (preferably more) for paired TP, chlorophyll-a, and Secchi disk data and provide a basis for evaluating their interrelationships and hence the trophic status of the lake."



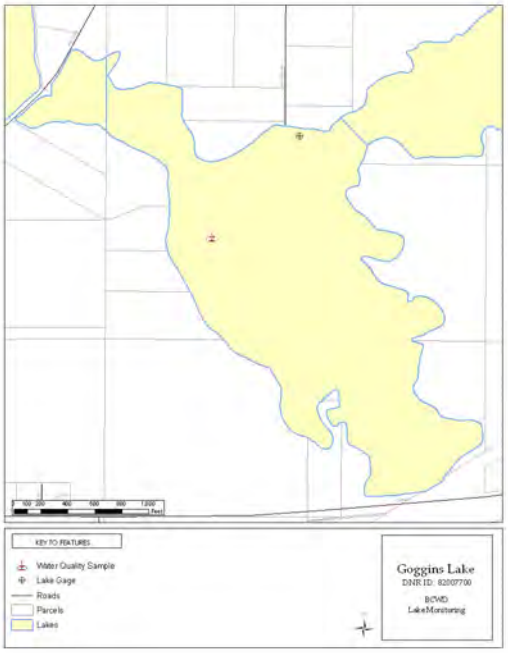
Lake Water Quality Summary

	Trophic Status	Summertime Lake Grades							
	2009	2009	2008	2007	2006	2005	2004	2003	2002
Total Phosphorus (mg/l)	Hypereutrophic	D	D	F	F	F	NA	NA	NA
Chlorophyll-*a* (ug/l)	Eutrophic	C	C	F	D	F	NA	NA	NA
Secchi disk (ft)	Eutrophic	D	C	F	F	F	NA	NA	NA
Overall	Eutrophic	D+	C-	F	F+	F	NA	NA	NA

Goggin's Lake

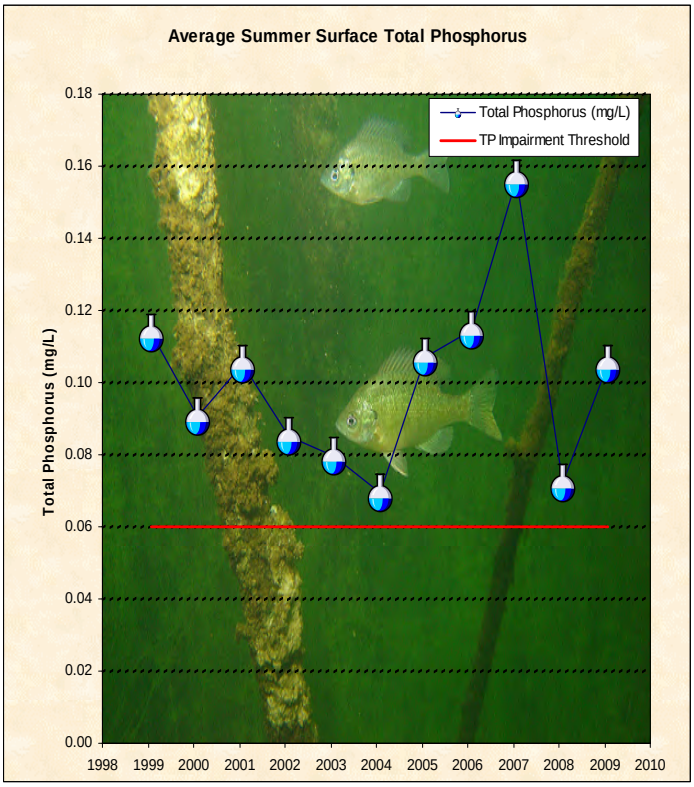
2009 Lake Grade: D+

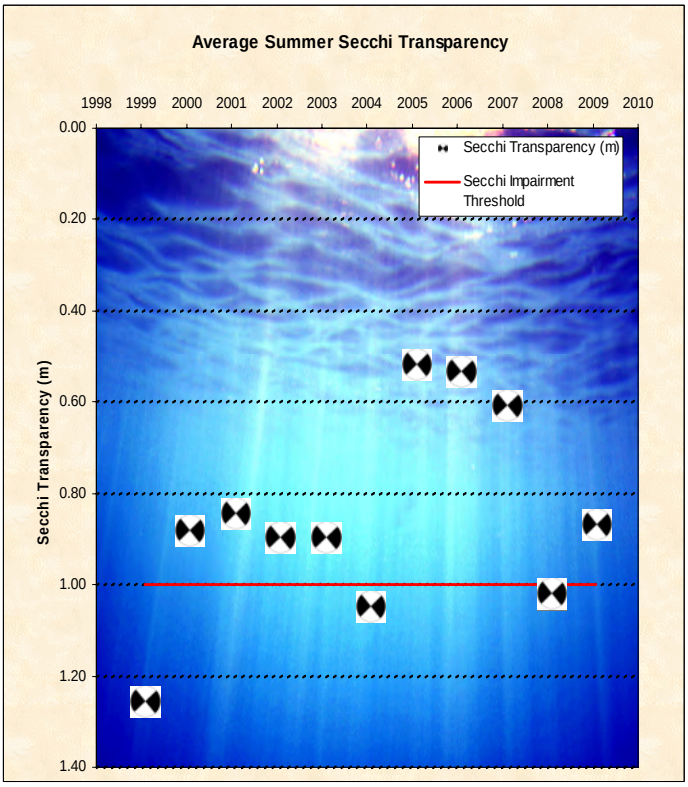
- DNR ID #: 820077
- Municipality: May Township
- Location: NW$^{1/4}$ Section 31, T31N-R20W
- Lake Size: 85 Acres
- Maximum Depth: 15 ft
- Ordinary High Water Mark: 966.50 ft
- 100-Year High Water Level: 972.20 ft
- 100% Littoral
  Note: Littoral area is the portion of the lake <15 ft and dominated by aquatic vegetation.



Summary Points

- Goggin's Lake was considered a hypereutrophic lake in 2009, based on the Carlson Trophic State Index.
- There is a statistically significant **declining trend** for average Secchi transparency and no trend can be determined for average total phosphorus.
- The major land use is rural/agricultural.
- The lake did not stratify in 2009.
- Goggin's Lake is listed as impaired for nutrients on the Minnesota Pollution Control Agency's Impaired Waters List.





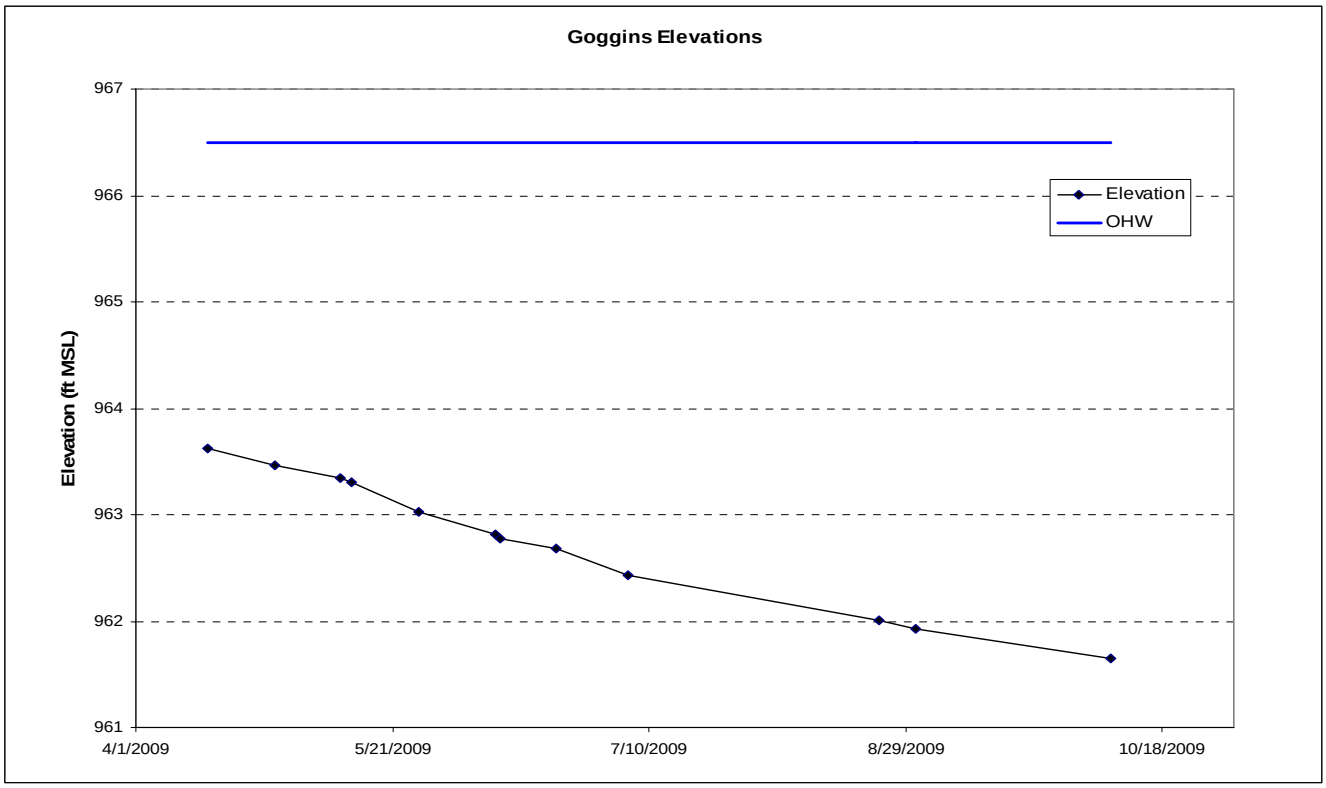
Date	Total Phosphorus (mg/L)	Chlorophyll-a (ug/L)	Total Kjeldahl Nitrogen (mg/L)	Total Phosphorus (mg/L) (Hypolimnion)	Total Ortho-P (mg/L) (Hypolimnion)	Total Kjeldahl Nitrogen (mg/L) (Hypolimnion)	Secchi Disk Depths (m)	Surface Dissolved Oxygen Levels (mg/L)	Surface Temperature Levels (Celsius)
4/13/2009	0.073	30	2.30	0.09	0.01	1.7	1.37	12.85	9.3
4/28/2009	0.066	23	1.60	0.061	0.01	1.6	1.37	10.78	11.9
5/11/2009	0.059	9.7	1.70	0.081	0.01	1.6	2.59	8.87	14.7
5/26/2009	0.081	27	1.90	0.069	0.01	1.6	1.22	8.98	19.1
6/10/2009	0.106	30	2.50	0.117	0.01	2.2	1.07	8.07	16.5
6/22/2009	0.091	31	2.50		0.01		1.22	9.92	24.0
7/6/2009	0.114	60	2.60	0.11	0.01	2.6	0.91	13.04	23.4
7/20/2009	0.152	87	3.70	0.141	0.03	2.3	0.46	12.86	20.2
8/4/2009	0.126	36	2.90	0.128	0.01	2.6	0.46	8.92	22.8
8/17/2009	0.106	23	2.40	0.133	0.01	2.5	0.91	6.01	24.1
8/31/2009	0.107	37	2.10	0.103	0.01	1.9	0.76	7.53	19.9
9/14/2009	0.068	28	2.00	0.111	0.01	2.2	1.07	8.66	23.2
9/29/2009	0.099	66	2.20	0.091	0.01	2.2	0.61	7.36	15.0
10/14/2009	0.058	32	1.80	0.048	0.15	1.7	1.22	12.96	7.0
2009 Average	0.093	37	2.30	0.10	0.02	2.05	1.09	9.77	17.9
2009 Summer Average	0.105	43	2.48	0.11	0.01	2.23	0.87	9.14	20.8

Water quality thresholds are 0.04 mg/L TP, 14 µg/L CL-a, 1.4 m Secchi depth*

Shallow lake water quality thresholds are 0.06 mg/L TP, 20 µg/L CL-a, 1.0 m Secchi depth*

	High	High Date	Low	Low Date	Average
2009 Elevation (ft)	963.62	4/15/200/	961.65	10/8/2009	962.75

*MPCA description of Imparied Lake's Listing criteria: "At a minimum, a decision that a given lake is impaired for the 303(d) list due to excessive nutrients will be supported by data for both causal and response factors. Data requirements for 303(d) listing consist of 12 or more TP measurements collected from June through September over the most recent 10-year period. Ideally this should represent 12 separate visits to the lake over the course of two summers; however it might also reflect four monthly samples over the course of three years (a typical sampling regimen for many lake monitoring programs). In addition to exceeding the TP guideline thresholds, lakes to be considered for 303(d) listing should have at least 12 Secchi measurements and 12 chlorophyll-a measurements. This amount of data will allow for at least one season (preferably more) for paired TP, chlorophyll-a, and Secchi disk data and provide a basis for evaluating their interrelationships and hence the trophic status of the lake."



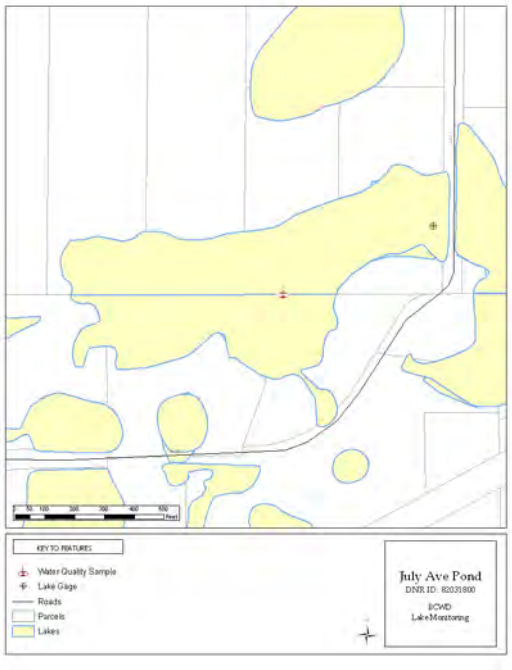
Lake Water Quality Summary

	Trophic Status	Summertime Lake Grades									
	2009	2009	2008	2007	2006	2005	2004	2003	2002	2001	2000
Total Phosphorus (mg/l)	Hypereutrophic	D	D	F	D	D	D+	D+	D	D	D
Chlorophyll-*a* (ug/l)	Hypereutrophic	C	C	F	C	D+	C	C	C	C	C
Secchi disk (ft)	Eutrophic	D	D	F	F	D	D	D	D	D	D
Overall	Hypereutrophic	D+	D+	F	D	D	D+	D+	D+	D+	D+

July Ave Pond

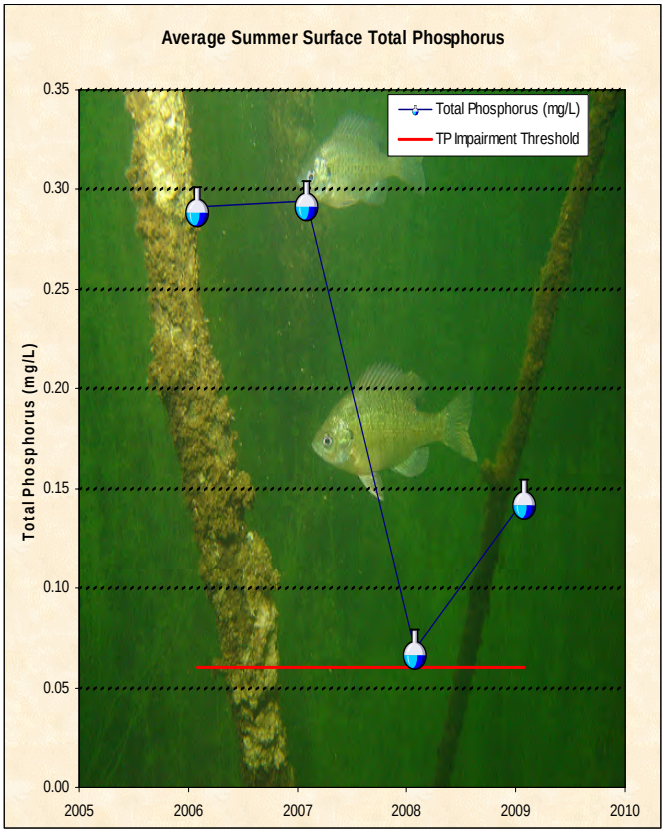
2009 Lake Grade: D-

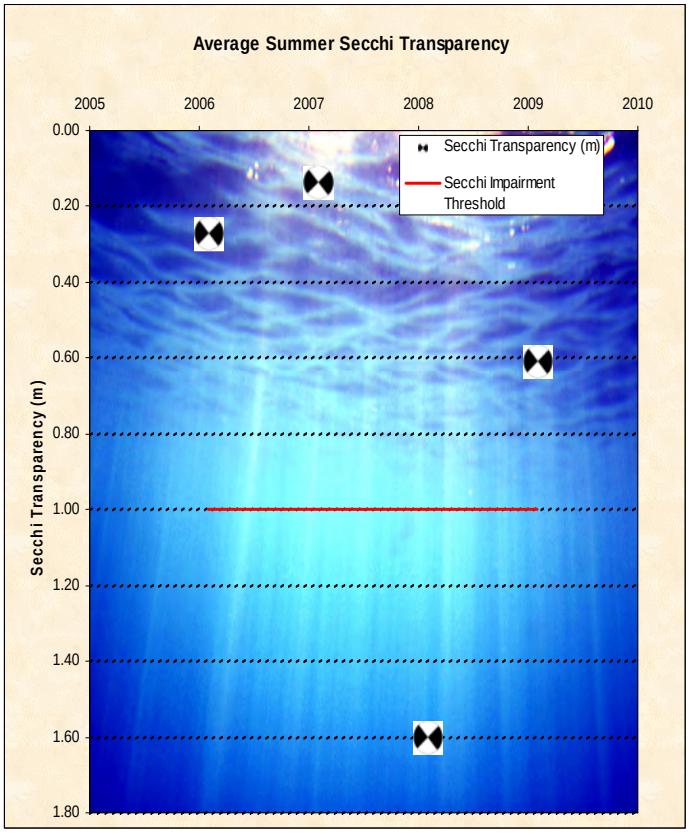
- DNR ID #: 820318
- Municipality: City of Grant
- Location: Section 3, T30N-R21W
- Lake Size: 12 Acres
- Maximum Depth: 7.50 ft
- Ordinary High Water Mark: NA
- 100-Year High Water Level: 979.20 ft
- 100% Littoral
  Note: Littoral area is the portion of the lake <15 ft and dominated by aquatic vegetation.



Summary Points

- July Ave Pond was considered a hypereutrophic lake in 2009, based on the Carlson Trophic State Index.
- At this time there are not enough years of data to determine a statistically significant overall water quality trend.
- The major land use is rural/agricultural.
- The lake did not stratify in 2009.





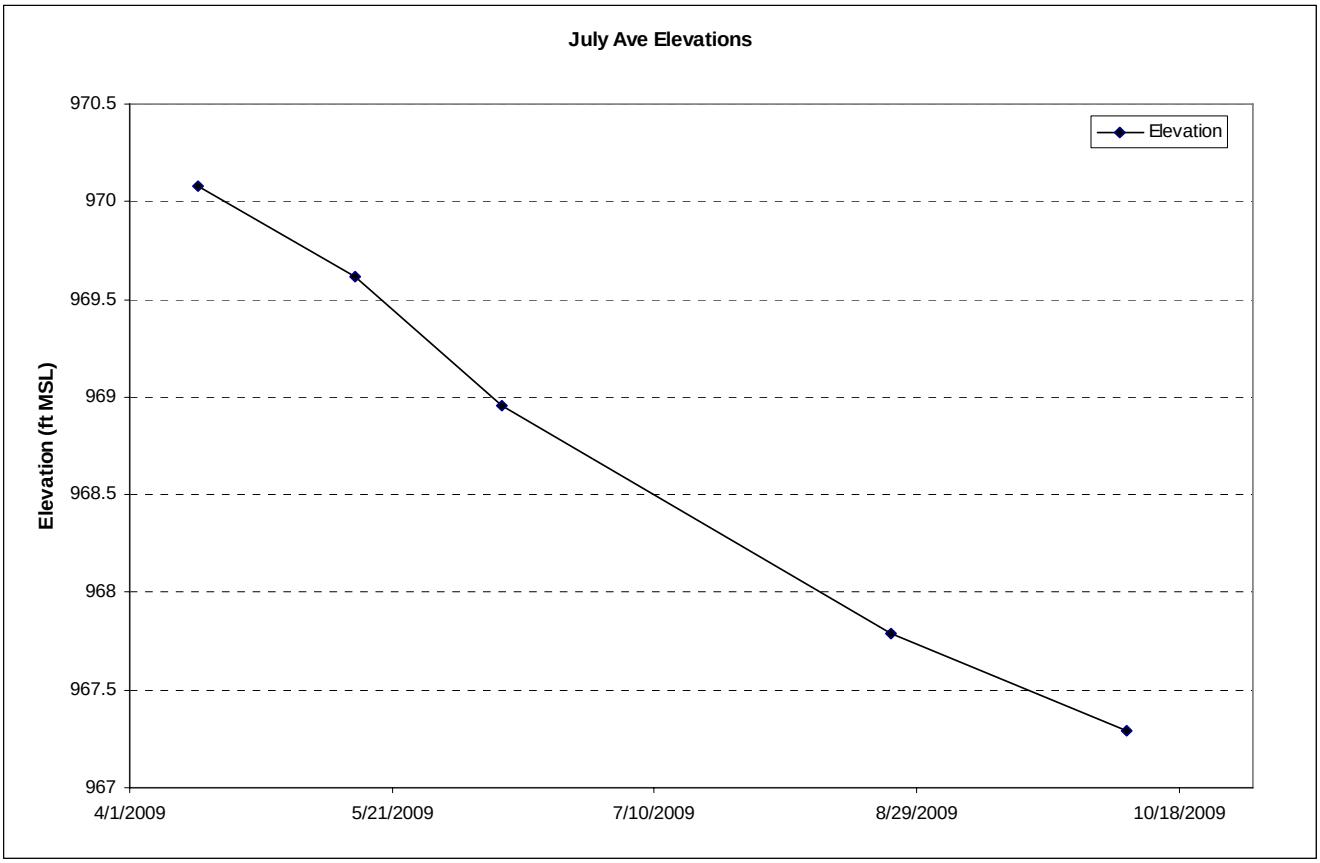
Date	Total Phosphorus (mg/L)	Chlorophyll-a (ug/L)	Total Kjeldahl Nitrogen (mg/L)	Secchi Disk Depths (m)	Surface Dissolved Oxygen Levels (mg/L)	Surface Temperature Levels (Celsius)
4/13/2009	0.026	12	0.89	1.37	12.13	11.0
5/14/2009	0.047	14	1.20	1.22	8.6	13.8
6/10/2009	0.085	15	1.50	0.91	9.76	16.7
7/7/2009	0.152	41	3.00	0.76	7.79	24.5
9/2/2009	0.197	110	3.50	0.15	8.48	18.2
2009 Average	0.101	38	2.02	0.88	9.35	16.8
2009 Summer Average	0.145	55	2.67	0.61	8.68	19.8

Water quality thresholds are 0.04 mg/L TP, 14 µg/L CL-a, 1.4 m Secchi depth*

Shallow lake water quality thresholds are 0.06 mg/L TP, 20 µg/L CL-a, 1.0 m Secchi depth*

	High	High Date	Low	Low Date	Average
2009 Elevation (ft)	970.08	4/14/2009	967.29	10/8/2009	968.75

*MPCA description of Imparied Lake's Listing criteria: "At a minimum, a decision that a given lake is impaired for the 303(d) list due to excessive nutrients will be supported by data for both causal and response factors. Data requirements for 303(d) listing consist of 12 or more TP measurements collected from June through September over the most recent 10-year period. Ideally this should represent 12 separate visits to the lake over the course of two summers; however it might also reflect four monthly samples over the course of three years (a typical sampling regimen for many lake monitoring programs). In addition to exceeding the TP guideline thresholds, lakes to be considered for 303(d) listing should have at least 12 Secchi measurements and 12 chlorophyll-a measurements. This amount of data will allow for at least one season (preferably more) for paired TP, chlorophyll-a, and Secchi disk data and provide a basis for evaluating their interrelationships and hence the trophic status of the lake."



Lake Water Quality Summary											
	Trophic Status	Summertime Lake Grades									
	2009	2009	2008	2007	2006	2005	2004	2003	2002	2001	2000
Total Phosphorus (mg/l)	Hypereutrophic	D	D	F	F	NA	NA	NA	NA	NA	NA
Chlorophyll-*a* (ug/l)	Hypereutrophic	D	B	F	F	NA	NA	NA	NA	NA	NA
Secchi disk (ft)	Hypereutrophic	F	C	F	F	NA	NA	NA	NA	NA	NA
Overall	Hypereutrophic	D-	C	F	F	NA	NA	NA	NA	NA	NA

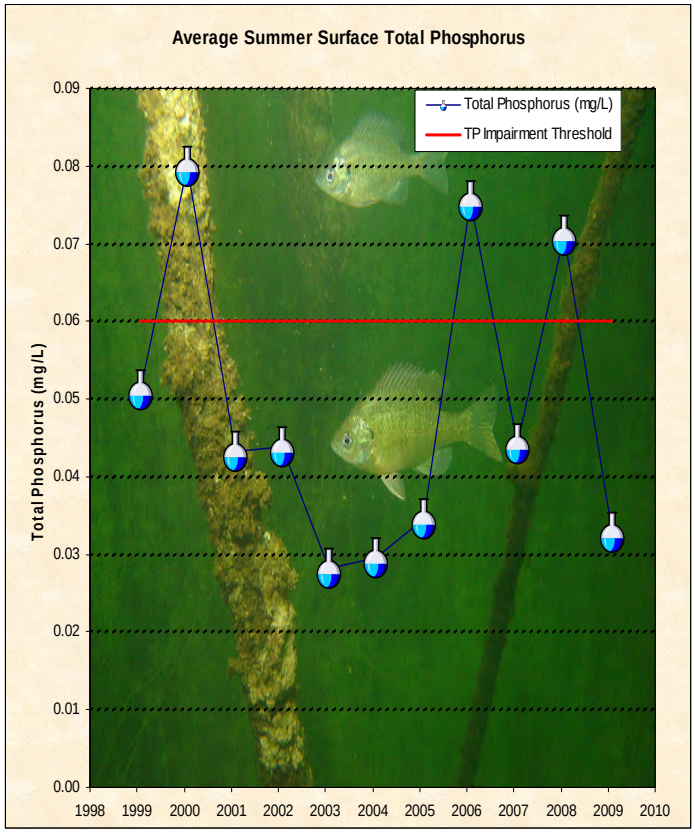
Kismet Basin

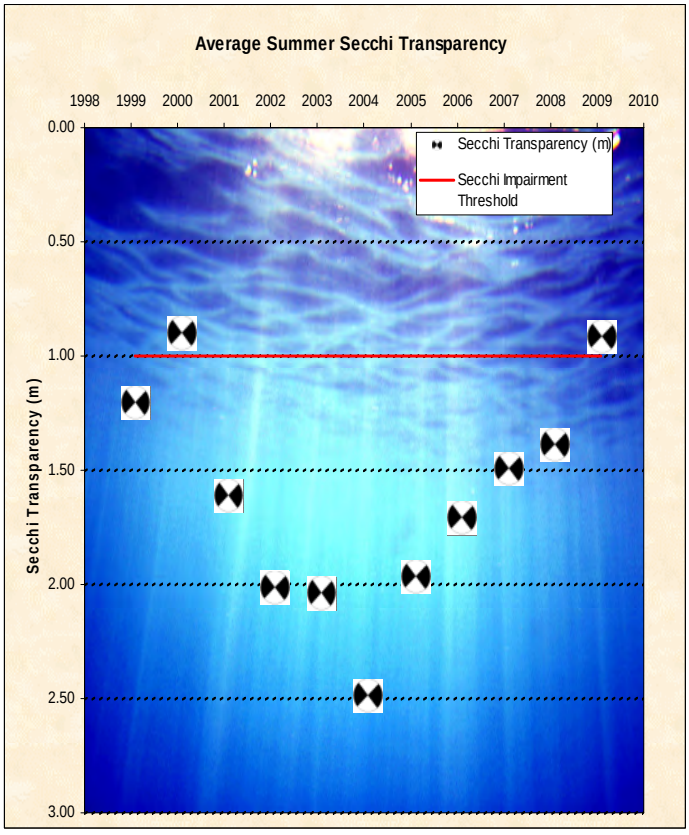
2009 Lake Grade: C

- DNR ID #: 820334
- Municipality: City of Grant
- Location: $S^{1/2}$ Section 11, T30N-R21W
- Lake Size: 70 Acres
- Maximum Depth: 12 ft
- Ordinary High Water Mark: 943.50 ft
- 100-Year High Water Level: 944.90 ft
- 100% Littoral
  Note: Littoral area is the portion of the lake <15 ft and dominated by aquatic vegetation.

Summary Points

- Kismet Basin was considered a eutrophic lake in 2009, based on the Carlson Trophic State Index.
- At this time no statistically significant trend can be determined for water quality.
- The major land use is rural/agricultural.
- The lake did not stratify in 2009.





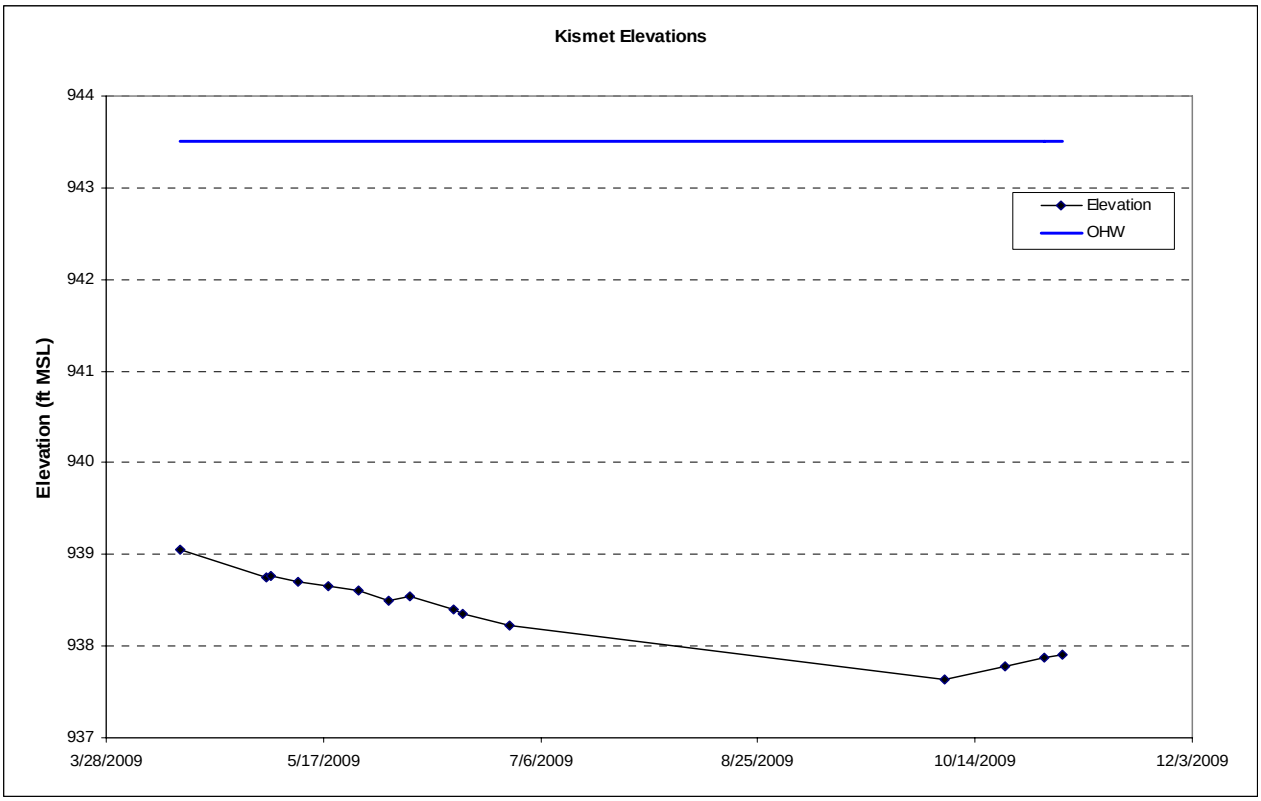
Date	Total Phosphorus (mg/L)	Chlorophyll-a (ug/L)	Total Kjeldahl Nitrogen (mg/L)	Secchi Disk Depths (m)	Surface Dissolved Oxygen Levels (mg/L)	Surface Temperature Levels (Celsius)
4/15/2009	0.028	9	0.86	1.37	10.95	13.0
4/27/2009	0.032	11	0.86	1.37	9.96	12.0
5/12/2009	0.038	4	1.00	1.68	10.57	15.3
5/27/2009	0.016	5	0.77	1.52	8.48	18.0
6/10/2009	0.044	5	0.97	0.91	7.49	15.8
6/24/2009	0.041	6	1.10	1.07	4.28	26.6
7/7/2009	0.033	5	1.10	0.91	8.05	24.5
7/23/2009	0.028	7	0.85	1.07	9.93	22.2
8/3/2009	0.034	7	0.92	0.76	9.32	25.7
8/18/2009	0.040	12	1.10	0.61	5.28	21.9
9/2/2009	0.040	9	0.84	0.91	7.98	18.7
9/15/2009	0.034	16	0.84	0.76	7.58	22.0
9/30/2009	0.018	5	0.83	0.61	8.18	11.7
10/13/2009	0.012	6	0.68	0.91	11.25	6.5
2009 Average	0.031	8	0.91	1.03	8.52	18.1
2009 Summer Average	0.033	8	0.94	0.91	7.66	20.7

Water quality thresholds are 0.04 mg/L TP, 14 µg/L CL-a, 1.4 m Secchi depth*

Shallow lake water quality thresholds are 0.06 mg/L TP, 20 µg/L CL-a, 1.0 m Secchi depth*

	High	High Date	Low	Low Date	Average
2009 Elevation (ft)	939.05	4/14/2009	937.63	10/7/2009	938.38

*MPCA description of Imparied Lake's Listing criteria: "At a minimum, a decision that a given lake is impaired for the 303(d) list due to excessive nutrients will be supported by data for both causal and response factors. Data requirements for 303(d) listing consist of 12 or more TP measurements collected from June through September over the most recent 10-year period. Ideally this should represent 12 separate visits to the lake over the course of two summers; however it might also reflect four monthly samples over the course of three years (a typical sampling regimen for many lake monitoring programs). In addition to exceeding the TP guideline thresholds, lakes to be considered for 303(d) listing should have at least 12 Secchi measurements and 12 chlorophyll-a measurements. This amount of data will allow for at least one season (preferably more) for paired TP, chlorophyll-a, and Secchi disk data and provide a basis for evaluating their interrelationships and



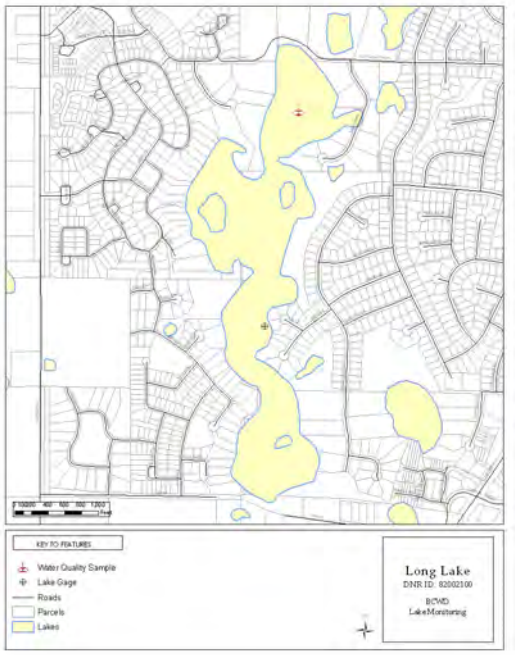
Lake Water Quality Summary

	Trophic Status	Summertime Lake Grades														
	2009	2009	2008	2007	2006	2005	2004	2003	2002	2001	2000	1999	1998	1997	1996	1995
Total Phosphorus (mg/l)	Eutrophic	C	D	C	D	C+	B+	B	C	C	D	C-	C	NA	NA	NA
Chlorophyll-*a* (ug/l)	Mesotrophic	A	D	C	C	C+	A-	B	B-	C	F	C-	C	NA	NA	NA
Secchi disk (ft)	Eutrophic	D	C	C	C	C+	B	C+	C+	C	D	C	C-	NA	NA	NA
Overall	Eutrophic	C	D+	C	C-	C+	B+	B-	C+	C	D-	C-	C	NA	NA	NA

Long Lake

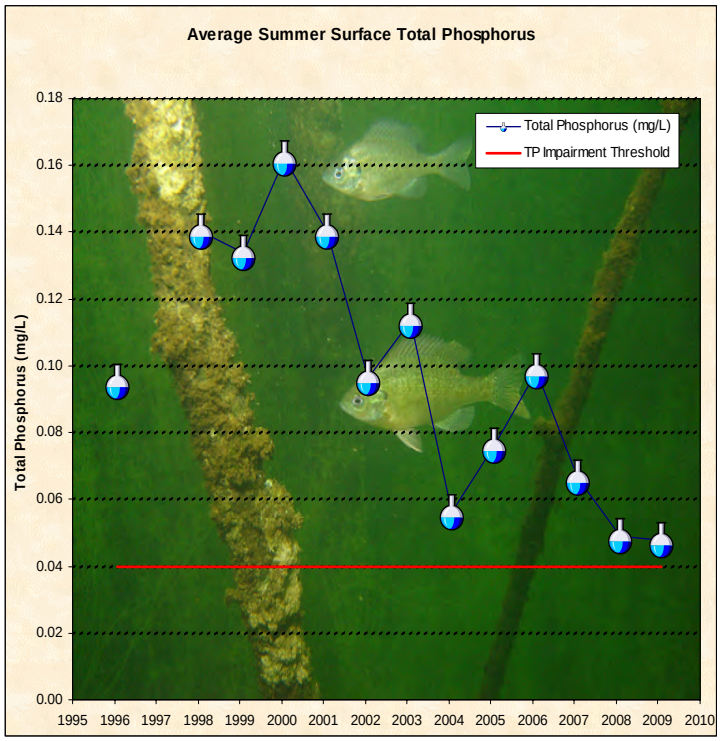
2009 Lake Grade: C+

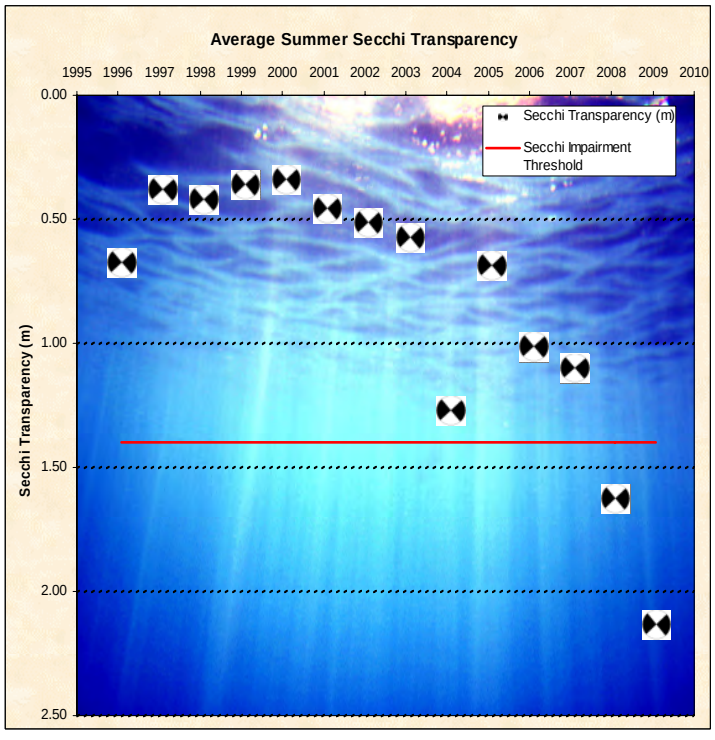
- DNR ID #: 820021
- Municipality: City of Stillwater
- Location: Section 30, T30N-R20W
- Lake Size: 110 Acres
- Maximum Depth: 22 ft
- Ordinary High Water Mark: 891.50 ft
- 100-Year High Water Level: 893.20 ft
- 95% Littoral
  Note: Littoral area is the portion of the lake <15 ft and dominated by aquatic vegetation.



Summary Points

- Long Lake was considered a eutrophic lake in 2009, based on the Carlson Trophic State Index.
- There is a statistically significant **improving trend** for average Secchi transparency and a statistically significant **improving trend** for average total phosphorus.
- The major land use is urban/residential.
- The lake did stratify with the thermocline varying between 3 to 5 meters.
- Long Lake is listed as impaired for nutrients on the Minnesota Pollution Control Agency's Impaired Waters List.





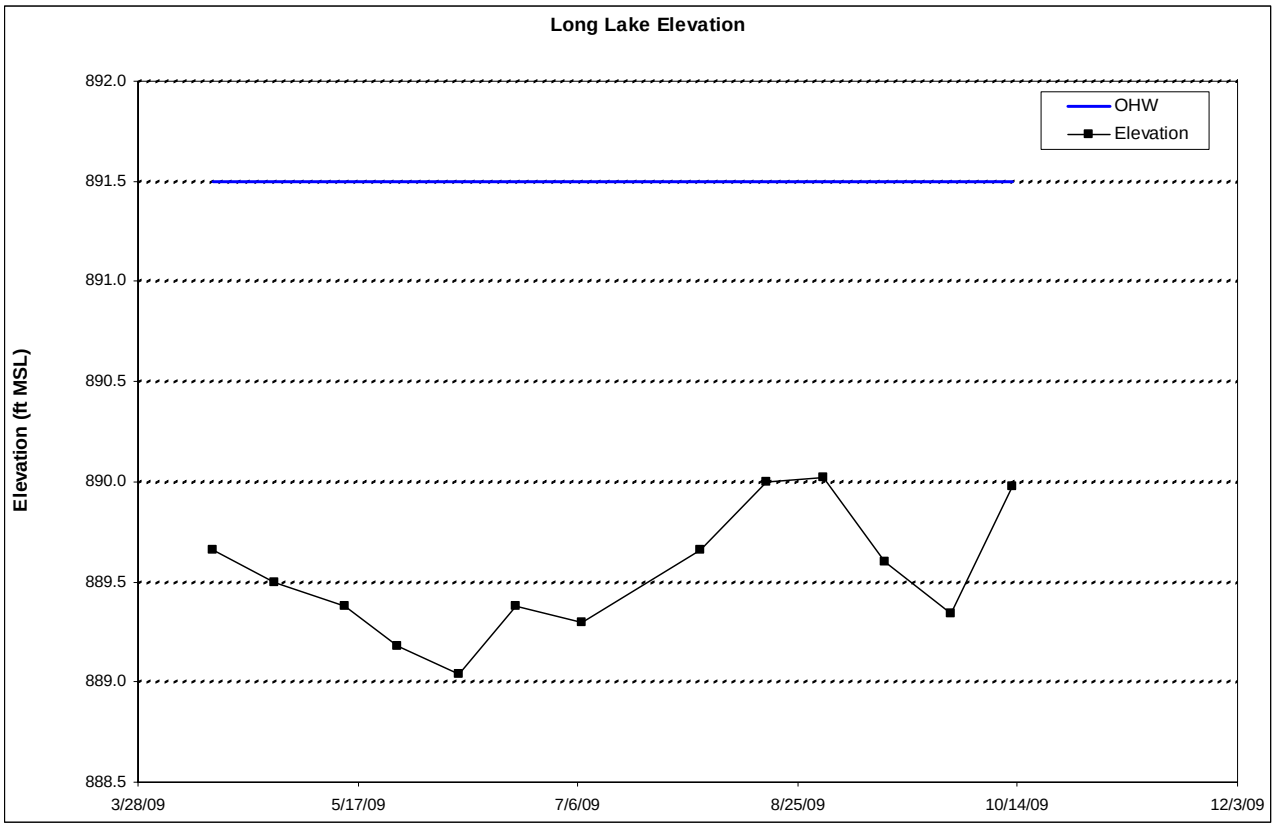
Date	Total Phosphorus (mg/L)	Chlorophyll-a (ug/L)	Total Kjeldahl Nitrogen (mg/L)	Secchi Disk Depths (m)	Surface Dissolved Oxygen Levels (mg/L)	Surface Temperature Levels (Celsius)
4/15/2009	0.057	13	1.5	1.83	11.21	12.1
4/28/2009	0.133	20	1.9	1.37	9.76	13.3
5/14/2009	0.057	8	1.5	2.29	8.24	15.0
5/26/2009	0.052	17	1.9	1.98	8.2	20.3
6/9/2009	0.053	17	1.7	1.83	6.84	17.0
6/22/2009	0.047	7	1.3	2.59	10.04	26.6
7/7/2009	0.044	9	1.4	1.98	11.51	26.1
7/21/2009	0.061	47	2	0.76	12.72	23.3
8/3/2009	0.037	21	0.98	1.52	9	23.8
8/18/2009	0.039	11	1.2	2.29	6.89	25.0
8/31/2009	0.033	9	0.98	3.05	7.19	21.7
9/14/2009	0.023	15	0.91	3.20	9.37	24.7
9/30/2009	0.09	8	1.5	2.13	5.74	15.9
10/13/2009	0.024	10	1.1	3.05	9.69	8.9
2009 Average	0.054	15	1.42	2.13	9.03	19.6
2009 Summer Average	0.048	16	1.39	2.13	8.75	22.4

Water quality thresholds are 0.04 mg/L TP, 14 µg/L CL-a, 1.4 m Secchi depth*

Shallow lake water quality thresholds are 0.06 mg/L TP, 20 µg/L CL-a, 1.0 m Secchi depth*

	High	High Date	Low	Low Date	Average
2009 Elevation (ft)	890.02	8/31/2009	889.04	6/9/2009	889.54

*MPCA description of Imparied Lake's Listing criteria: "At a minimum, a decision that a given lake is impaired for the 303(d) list due to excessive nutrients will be supported by data for both causal and response factors. Data requirements for 303(d) listing consist of 12 or more TP measurements collected from June through September over the most recent 10-year period. Ideally this should represent 12 separate visits to the lake over the course of two summers; however it might also reflect four monthly samples over the course of three years (a typical sampling regimen for many lake monitoring programs). In addition to exceeding the TP guideline thresholds, lakes to be considered for 303(d) listing should have at least 12 Secchi measurements and 12 chlorophyll-a measurements. This amount of data will allow for at least one season (preferably more) for paired TP, chlorophyll-a, and Secchi disk data and provide a basis for evaluating their interrelationships and hence the trophic status of the lake."



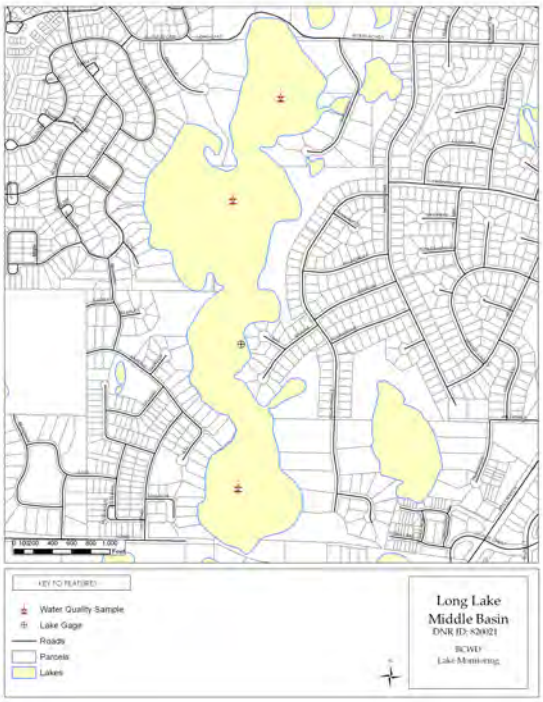
Lake Water Quality Summary

	Trophic Status	Summertime Lake Grades													
	2009	2009	2008	2007	2006	2005	2004	2003	2002	2001	2000	1999	1998	1997	1996	1995
Total Phosphorus (mg/l)	Eutrophic	C	C	C	D	D	D	D	D	D-	F	D	D	NA	D	D
Chlorophyll-*a* (ug/l)	Eutrophic	B	B	C	C	D	C	D-	F+	F	F	F	F	NA	D	D
Secchi disk (ft)	Mesotrophic	C	C	D	D	F	C-	F	F	F	F	F	F	F	F+	F+
Overall	Eutrophic	C+	C+	C-	D+	D-	C-	D-	F	F	F	F	F	F	D-	D-

Long Lake – Middle Basin

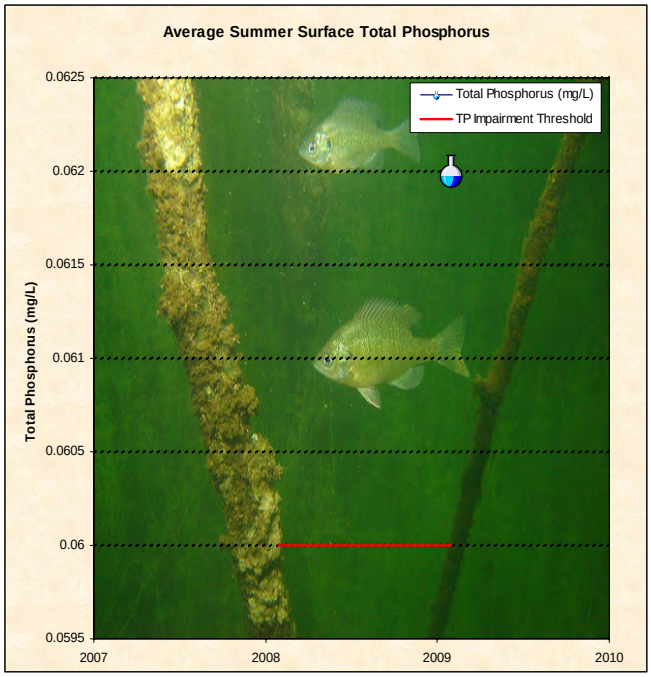
2009 Lake Grade: C

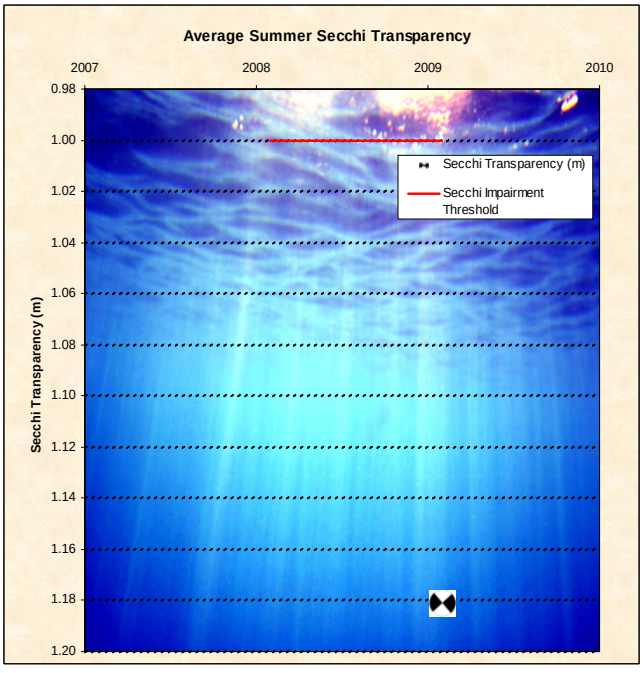
- DNR ID #: 820021
- Municipality: City of Stillwater
- Location: Section 30, T30N-R20W
- Lake Size: 110 Acres
- Maximum Depth: 22 ft
- Ordinary High Water Mark: 891.50 ft
- 100-Year High Water Level: 893.20 ft
- 95% Littoral
  Note: Littoral area is the portion of the lake <15 ft and dominated by aquatic vegetation.



Summary Points

- Long Lake – Middle Basin was considered a eutrophic lake in 2009, based on the Carlson Trophic State Index.
- At this time there are not enough years of data to determine a statistically significant overall water quality trend.
- The major land use is urban/residential.
- Long Lake is listed as impaired for nutrients on the Minnesota Pollution Control Agency's Impaired Waters List.



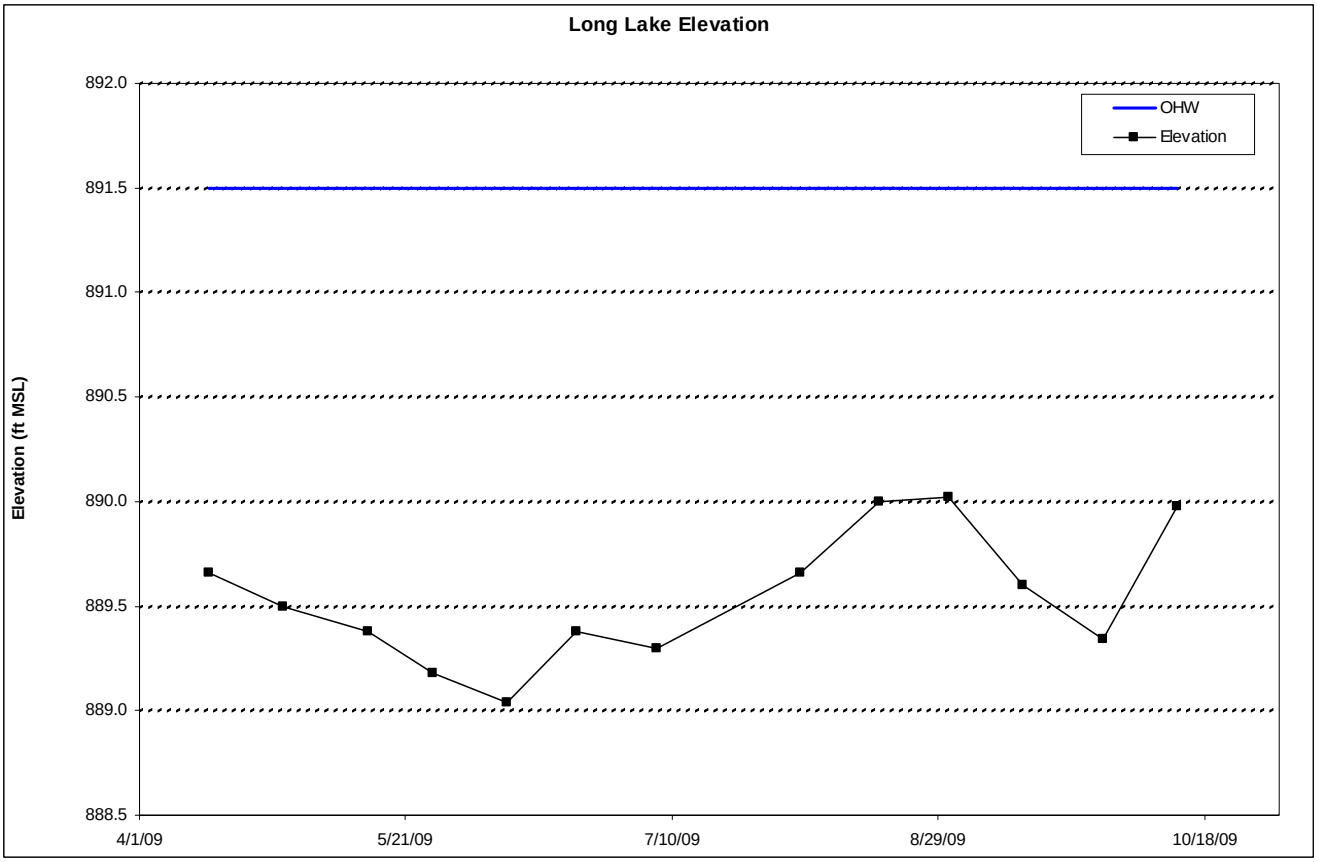


Date	Total Phosphorus (mg/L)	Chlorophyll-a (ug/L)	Total Kjeldahl Nitrogen (mg/L)	Secchi Disk Depths (m)	Surface Dissolved Oxygen Levels (mg/L)	Surface Temperature Levels (Celsius)
6/22/2009	0.056	3.6	1.2	1.52	10.43	27.7
7/21/2009	0.031	3.8	0.75	1.22	11	21.9
8/18/2009	0.073	9.5	1.2	0.91	5.29	24.5
9/14/2009	0.088	12	1	1.07	8.03	25.2
2009 Average	0.062	7	1.04	1.18	8.69	24.8
2009 Summer Average	0.062	7	1.04	1.18	8.69	24.8

Water quality thresholds are 0.04 mg/L TP, 14 µg/L CL-a, 1.4 m Secchi depth*
Shallow lake water quality thresholds are 0.06 mg/L TP, 20 µg/L CL-a, 1.0 m Secchi depth*

	High	High Date	Low	Low Date	Average
2009 Elevation (ft)	890.02	8/31/2009	889.04	6/9/2009	889.54

*MPCA description of Imparied Lake's Listing criteria: "At a minimum, a decision that a given lake is impaired for the 303(d) list due to excessive nutrients will be supported by data for both causal and response factors. Data requirements for 303(d) listing consist of 12 or more TP measurements collected from June through September over the most recent 10-year period. Ideally this should represent 12 separate visits to the lake over the course of two summers; however it might also reflect four monthly samples over the course of three years (a typical sampling regimen for many lake monitoring programs). In addition to exceeding the TP guideline thresholds, lakes to be considered for 303(d) listing should have at least 12 Secchi measurements and 12 chlorophyll-a measurements. This amount of data will allow for at least one season (preferably more) for paired TP, chlorophyll-a, and Secchi disk data and provide a basis for evaluating their interrelationships and hence the trophic status of the lake."



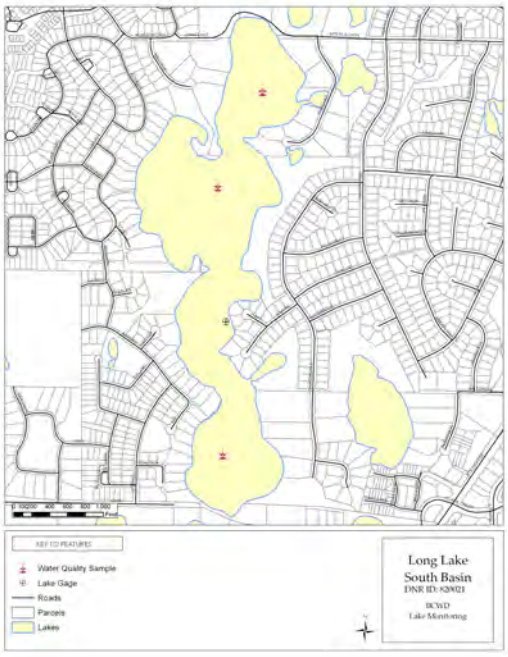
Lake Water Quality Summary

	Trophic Status	Summertime Lake Grades									
	2009	2009	2008	2007	2006	2005	2004	2003	2002	2001	2000
Total Phosphorus (mg/l)	Hypereutrophic	C	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chlorophyll-*a* (ug/l)	Mesotrophic	A	NA	NA	NA	NA	NA	NA	NA	NA	NA
Secchi disk (ft)	Eutrophic	D	NA	NA	NA	NA	NA	NA	NA	NA	NA
Overall	Eutrophic	C	NA	NA	NA	NA	NA	NA	NA	NA	NA

Long Lake – South Basin

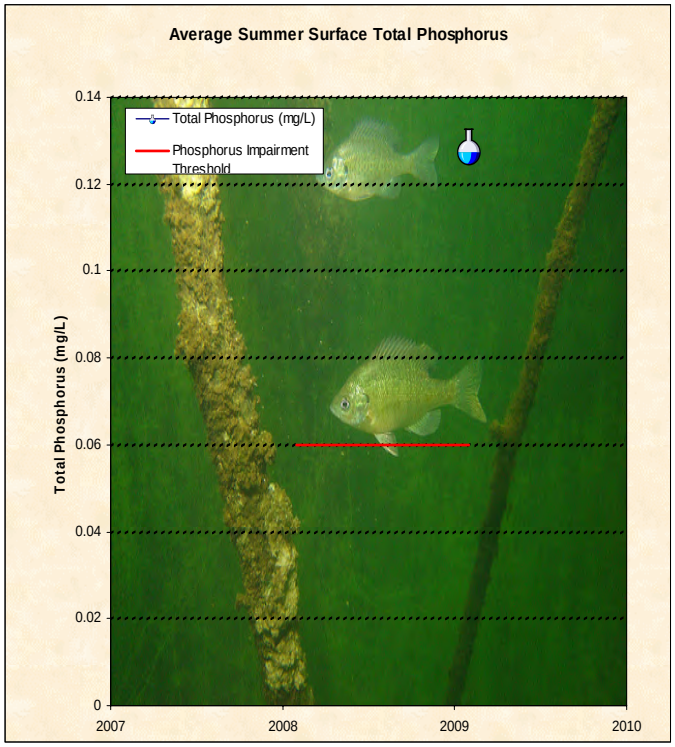
2009 Lake Grade: D+

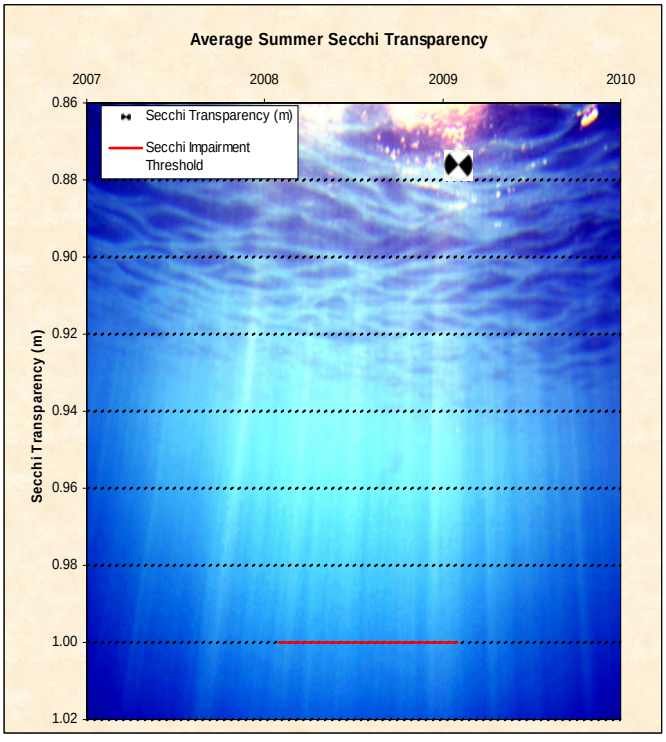
- DNR ID #: 820021
- Municipality: City of Stillwater
- Location: Section 30, T30N-R20W
- Lake Size: 110 Acres
- Maximum Depth: 22 ft
- Ordinary High Water Mark: 891.50 ft
- 100-Year High Water Level: 893.20 ft
- 95% Littoral
  Note: Littoral area is the portion of the lake <15 ft and dominated by aquatic vegetation.



Summary Points

- Long Lake – South Basin was considered a eutrophic lake in 2009, based on the Carlson Trophic State Index.
- At this time there are not enough years of data to determine a statistically significant overall water quality trend.
- The major land use is urban/residential.
- Long Lake is listed as impaired for nutrients on the Minnesota Pollution Control Agency's Impaired Waters List.





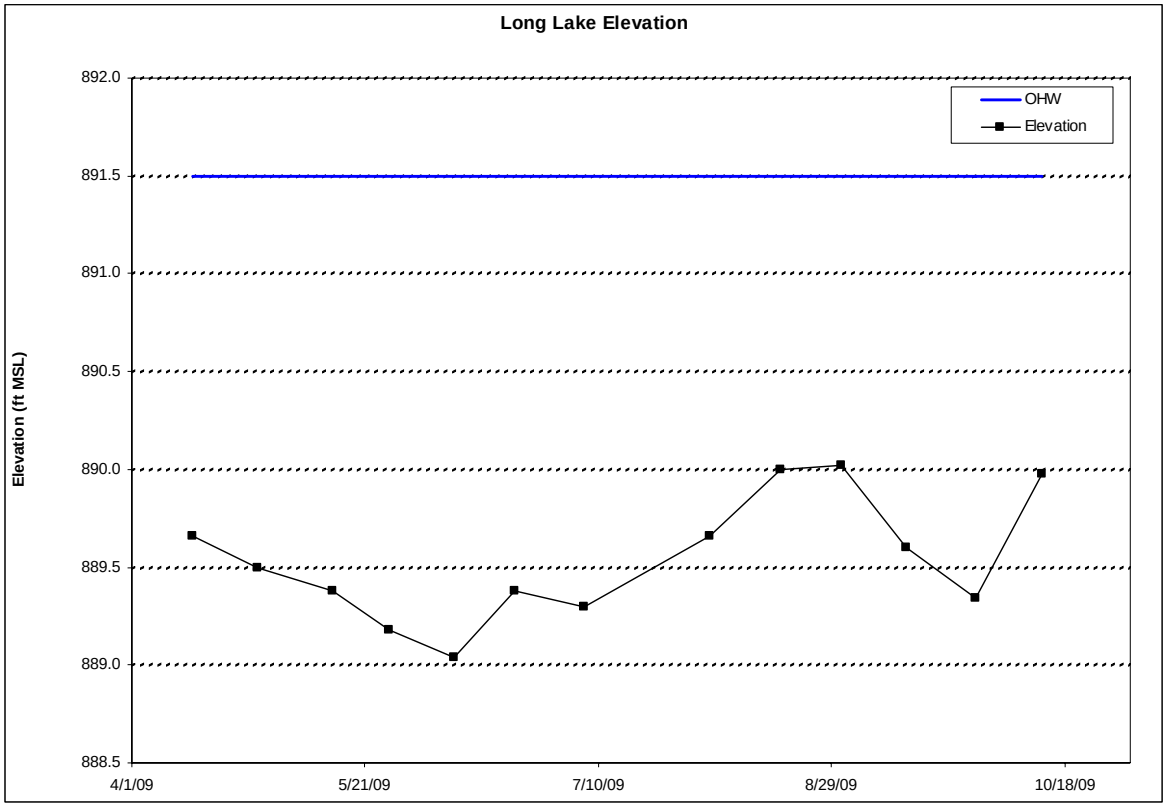
Date	Total Phosphorus (mg/L)	Chlorophyll-a (ug/L)	Total Kjeldahl Nitrogen (mg/L)	Secchi Disk Depths (m)	Surface Dissolved Oxygen Levels (mg/L)	Surface Temperature Levels (Celsius)
6/22/2009	0.16	6.7	1.5	1.22	8.15	27.3
7/21/2009	0.102	16	1.4	0.91	10.05	21.4
8/18/2009	0.123	21	1.3	0.61	4.61	24.2
9/14/2009	0.129	6.7	0.81	0.76	8.99	24.6
2009 Average	0.129	13	1.25	0.88	7.95	24.4
2009 Summer Average	0.129	13	1.25	0.88	7.95	24.4

Water quality thresholds are 0.04 mg/L TP, 14 µg/L CL-a, 1.4 m Secchi depth*

Shallow lake water quality thresholds are 0.06 mg/L TP, 20 µg/L CL-a, 1.0 m Secchi depth*

	High	High Date	Low	Low Date	Average
2009 Elevation (ft)	890.02	8/31/2009	889.04	6/9/2009	889.54

*MPCA description of Imparied Lake's Listing criteria: "At a minimum, a decision that a given lake is impaired for the 303(d) list due to excessive nutrients will be supported by data for both causal and response factors. Data requirements for 303(d) listing consist of 12 or more TP measurements collected from June through September over the most recent 10-year period. Ideally this should represent 12 separate visits to the lake over the course of two summers; however it might also reflect four monthly samples over the course of three years (a typical sampling regimen for many lake monitoring programs). In addition to exceeding the TP guideline thresholds, lakes to be considered for 303(d) listing should have at least 12 Secchi measurements and 12 chlorophyll-a measurements. This amount of data will allow for at least one season (preferably more) for paired TP, chlorophyll-a, and Secchi disk data and provide a basis for evaluating their interrelationships and hence the trophic status of the lake."



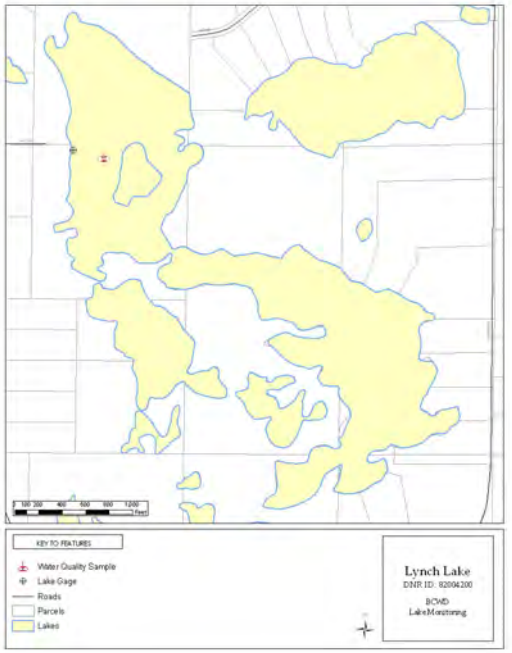
Lake Water Quality Summary

	Trophic Status	Summertime Lake Grades									
	2009	2009	2008	2007	2006	2005	2004	2003	2002	2001	2000
Total Phosphorus (mg/l)	Hypereutrophic	D	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chlorophyll-*a* (ug/l)	Eutrophic	B	NA	NA	NA	NA	NA	NA	NA	NA	NA
Secchi disk (ft)	Eutrophic	D	NA	NA	NA	NA	NA	NA	NA	NA	NA
Overall	Eutrophic	D+	NA	NA	NA	NA	NA	NA	NA	NA	NA

Lynch Lake

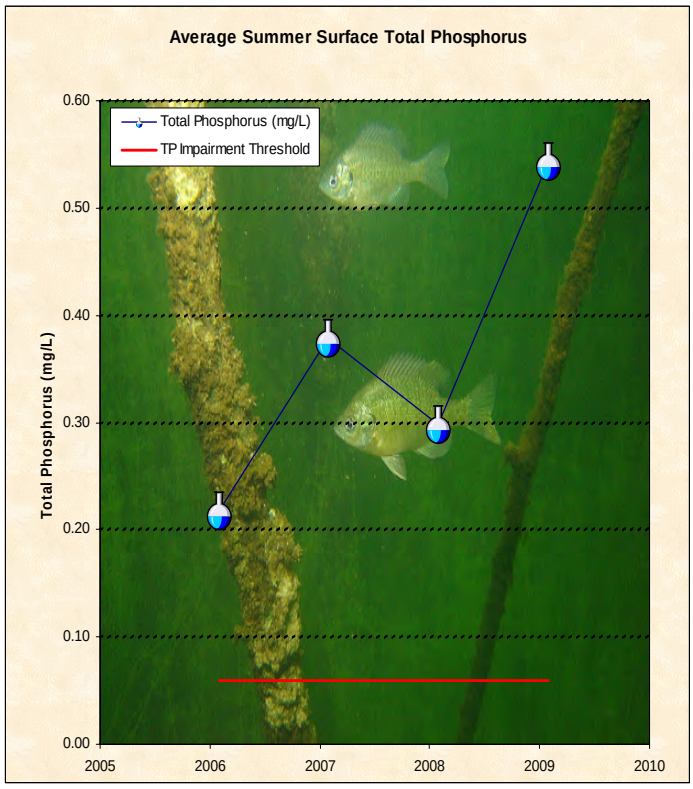
2009 Lake Grade: F

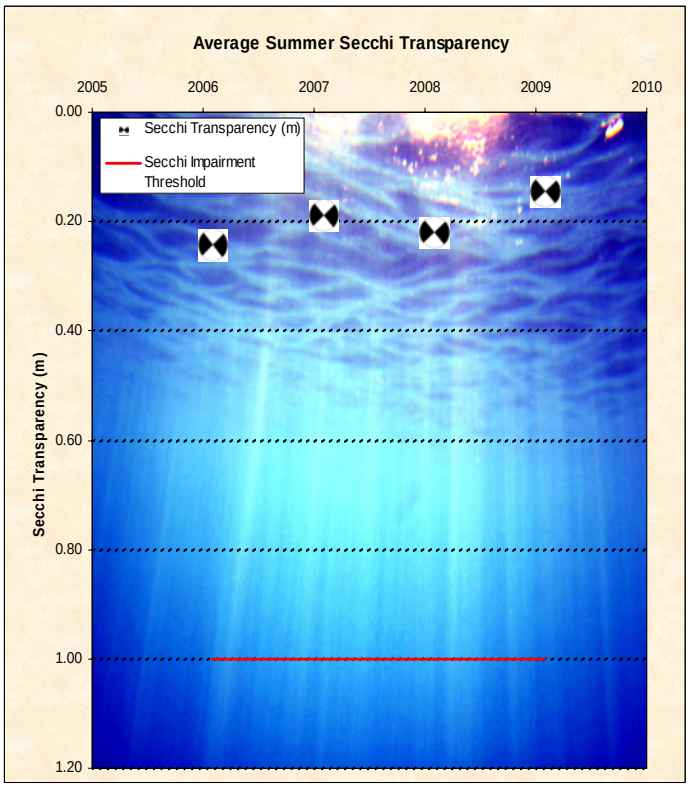
- DNR ID #: 820042
- Municipality: May Township
- Location: Section 30, T31N-R20W
- Lake Size: 87 Acres
- Maximum Depth: 6 ft
- Ordinary High Water Mark: 1005.30 ft
- 100-Year High Water Level: 1008.10 ft
- 100% Littoral
  Note: Littoral area is the portion of the lake <15 ft and dominated by aquatic vegetation.



Summary Points

- Lynch Lake was considered a hypereutrophic lake in 2009, based on the Carlson Trophic State Index.
- At this time there are not enough years of data to determine a statistically significant overall water quality trend.
- The major land use is rural/agricultural.
- The lake did not stratify in 2009.





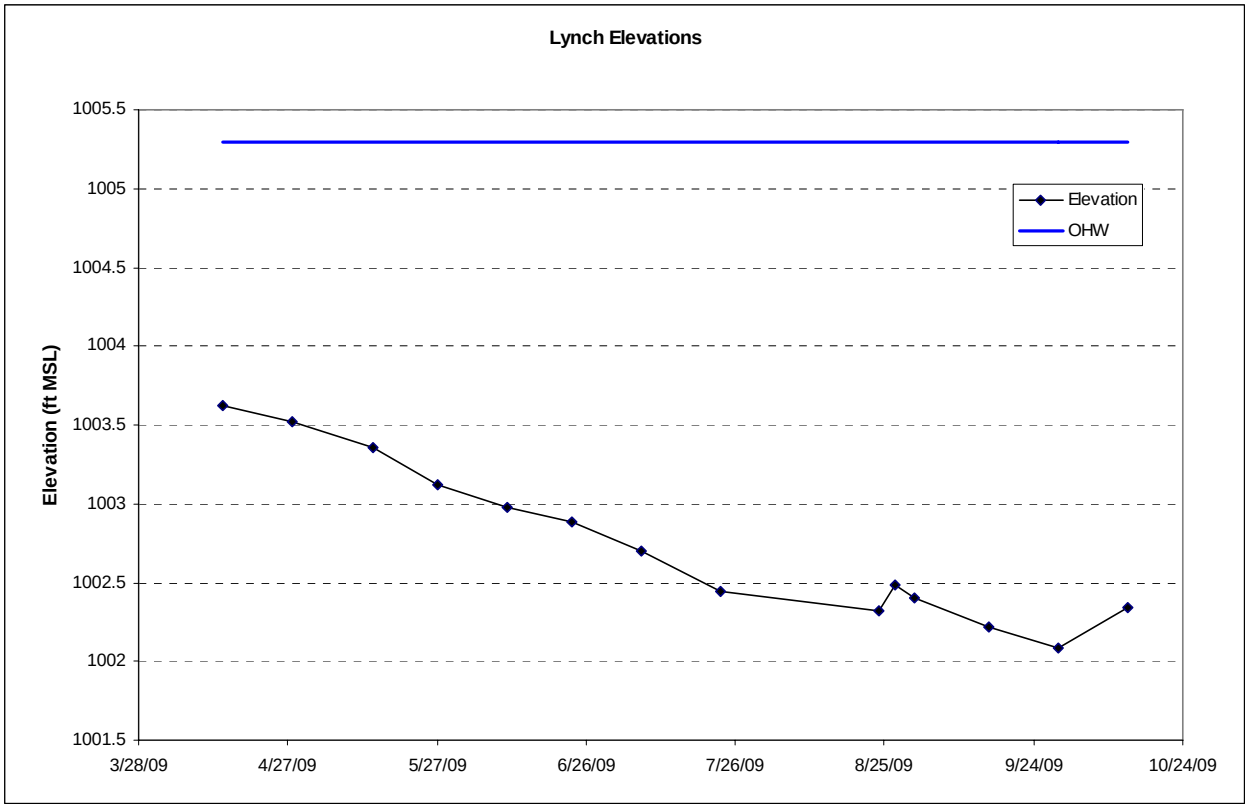
Date	Total Phosphorus (mg/L)	Chlorophyll-a (ug/L)	Total Kjeldahl Nitrogen (mg/L)	Secchi Disk Depths (m)	Surface Dissolved Oxygen Levels (mg/L)	Surface Temperature Levels (Celsius)
4/14/2009	0.140	48	3.40	0.91	11.68	12.9
4/28/2009	0.213	120	4.50	0.30	12.37	12.0
5/14/2009	0.256	140	5.10	0.30	8.83	13.8
5/27/2009	0.147	210	3.00	0.30	8.26	17.1
6/10/2009	0.322	170	6.50	0.30	7.73	16.0
6/23/2009	0.324	330	7.30	0.15	11.98	28.9
7/7/2009	0.527	540	9.40	0.15	8.43	23.9
7/23/2009	0.574	600	11.00	0.15	10.98	22.4
8/4/2009	0.664	680	13.00	0.08	11.88	25.0
8/18/2009	0.781	950	14.00	0.08	8.99	21.5
8/31/2009	0.695	790	13.00	0.08	13.56	21.7
9/15/2009	0.653	750	13.00	0.08	12.23	23.4
9/30/2009	0.752	810	15.00	0.08	11.13	10.2
10/13/2009	0.400	560	10.00	0.08	11.68	5.3
2009 Average	0.461	478	9.16	0.22	10.70	18.2
2009 Summer Average	0.544	583	10.52	0.14	10.52	21.0

Water quality thresholds are 0.04 mg/L TP, 14 µg/L CL-a, 1.4 m Secchi depth*

Shallow lake water quality thresholds are 0.06 mg/L TP, 20 µg/L CL-a, 1.0 m Secchi depth*

	High	High Date	Low	Low Date	Average
2009 Elevation (ft)	1003.62	4/14/2009	1002.08	9/29/2009	1002.75

*MPCA description of Imparied Lake's Listing criteria: "At a minimum, a decision that a given lake is impaired for the 303(d) list due to excessive nutrients will be supported by data for both causal and response factors. Data requirements for 303(d) listing consist of 12 or more TP measurements collected from June through September over the most recent 10-year period. Ideally this should represent 12 separate visits to the lake over the course of two summers; however it might also reflect four monthly samples over the course of three years (a typical sampling regimen for many lake monitoring programs). In addition to exceeding the TP guideline thresholds, lakes to be considered for 303(d) listing should have at least 12 Secchi measurements and 12 chlorophyll-a measurements. This amount of data will allow for at least one season (preferably more) for paired TP, chlorophyll-a, and Secchi disk data and provide a basis for evaluating their interrelationships and hence the trophic status of the lake."



Lake Water Quality Summary

	Trophic Status	Summertime Lake Grades									
	2009	2009	2008	2007	2006	2005	2004	2003	2002	2001	2000
Total Phosphorus (mg/l)	Hypereutrophic	F	F	F	F	NA	NA	NA	NA	NA	NA
Chlorophyll-*a* (ug/l)	Hypereutrophic	F	F	F	F	NA	NA	NA	NA	NA	NA
Secchi disk (ft)	Hypereutrophic	F	F	F	F	NA	NA	NA	NA	NA	NA
Overall	Hypereutrophic	F	F	F	F	NA	NA	NA	NA	NA	NA

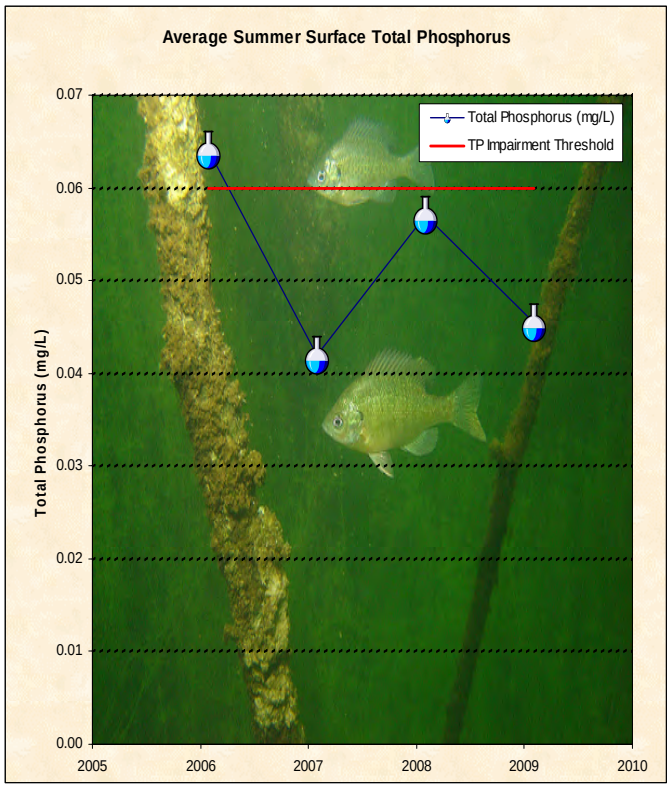
Masterman Lake

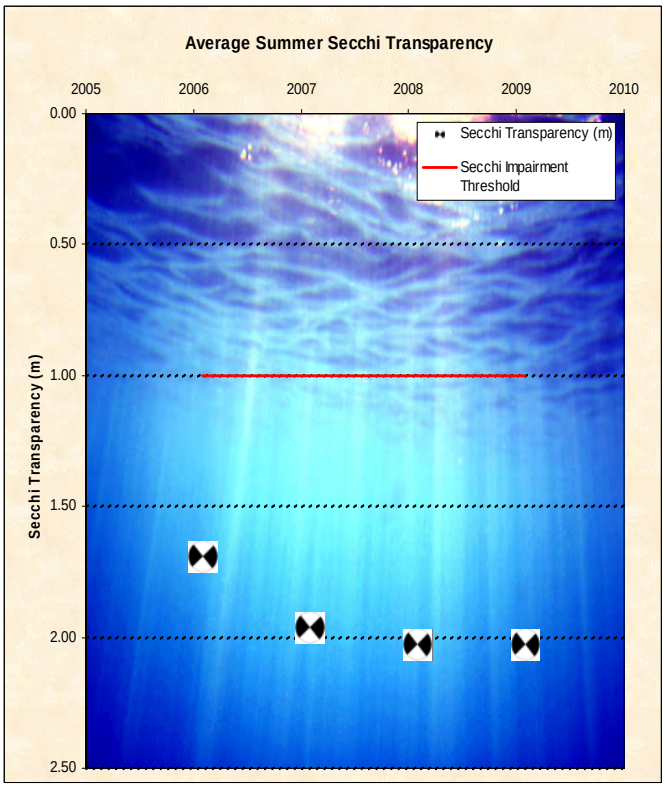
2009 Lake Grade: C+

- DNR ID #: 820126
- Municipality: City of Grant
- Location: Section 23, T30N-R21W
- Lake Size: 40 Acres
- Maximum Depth: 11 ft
- Ordinary High Water Mark: 955.70 ft
- 100-Year High Water Level: 955.90 ft
- 100% Littoral
  Note: Littoral area is the portion of the lake <15 ft and dominated by aquatic vegetation.

Summary Points

- Masterman Lake was considered a eutrophic lake in 2009, based on the Carlson Trophic State Index.
- At this time no statistically significant trend can be determined for overall water quality.
- The major land use is rural/agricultural.
- The lake did not stratify in 2009.





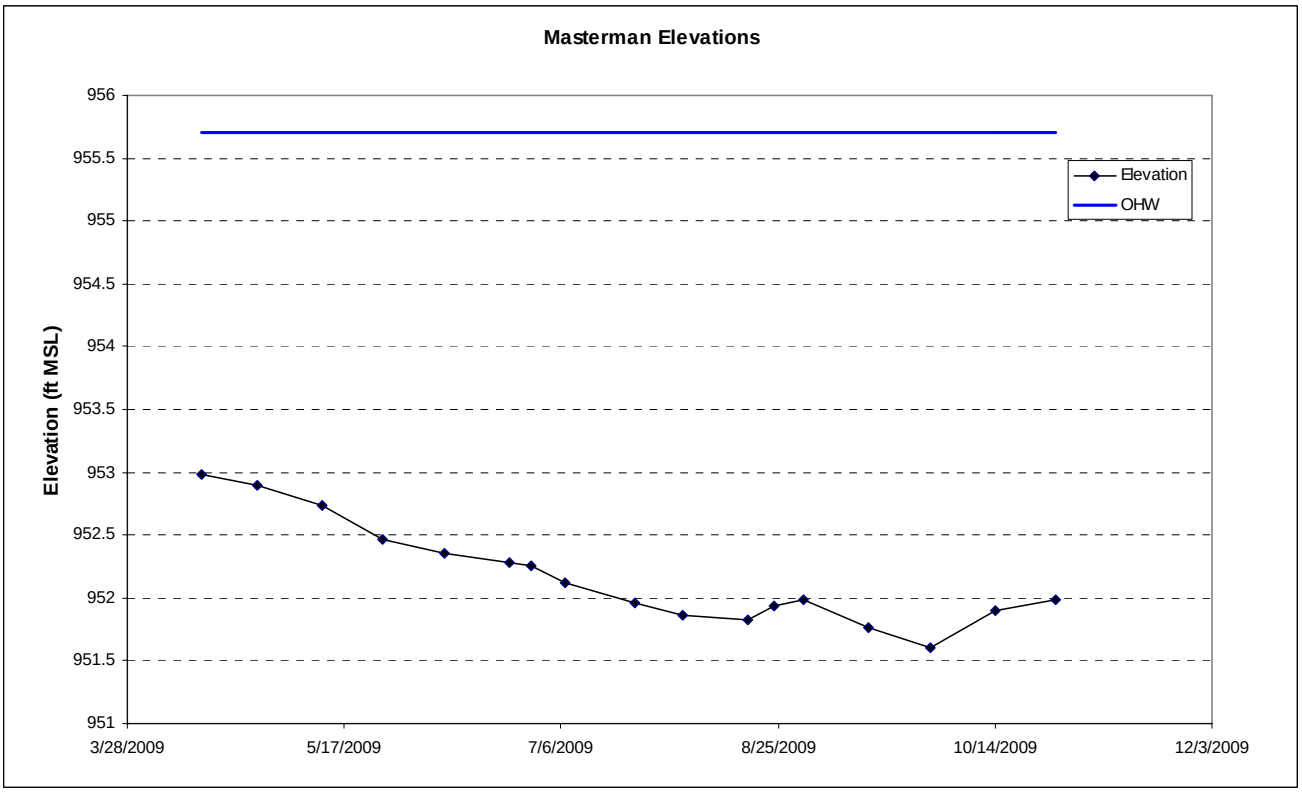
Date	Total Phosphorus (mg/L)	Chlorophyll-a (ug/L)	Total Kjeldahl Nitrogen (mg/L)	Secchi Disk Depths (m)	Surface Dissolved Oxygen Levels (mg/L)	Surface Temperature Levels (Celsius)
4/15/2009	0.052	7	2.00	2.29	10.97	12.1
4/27/2009	0.035	6	0.92	1.68	9.35	12.8
5/12/2009	0.031	8	0.96	2.13	9.21	16.1
5/26/2009	0.035	14	1.10	2.13	8.33	20.6
6/9/2009	0.047	9	0.99	2.29	5.04	15.9
6/24/2009	0.031	7	0.98	2.13	7.3	27.4
7/7/2009	0.041	7	1.20	2.13	7.98	24.5
7/23/2009	0.052	6	1.30	2.13	7.61	22.6
8/3/2009	0.049	11	1.20	1.83	7.27	24.2
8/18/2009	0.042	10	1.00	1.83	4.1	23.8
8/31/2009	0.070	16	1.10	2.13	5.87	21.8
9/15/2009	0.043	14	1.00	1.83	6.77	25.4
9/30/2009	0.044	14	1.00	1.83	6.68	13.8
10/14/2009	0.027	2	0.80	2.13	10.19	6.3
2009 Average	0.043	9	1.11	2.04	7.62	19.1
2009 Summer Average	0.045	11	1.09	2.03	6.70	22.0

Water quality thresholds are 0.04 mg/L TP, 14 µg/L CL-a, 1.4 m Secchi depth*

Shallow lake water quality thresholds are 0.06 mg/L TP, 20 µg/L CL-a, 1.0 m Secchi depth*

	High	High Date	Low	Low Date	Average
2009 Elevation (ft)	952.98	4/14/2009	951.60	9/29/2009	952.17

*MPCA description of Imparied Lake's Listing criteria: "At a minimum, a decision that a given lake is impaired for the 303(d) list due to excessive nutrients will be supported by data for both causal and response factors. Data requirements for 303(d) listing consist of 12 or more TP measurements collected from June through September over the most recent 10-year period. Ideally this should represent 12 separate visits to the lake over the course of two summers; however it might also reflect four monthly samples over the course of three years (a typical sampling regimen for many lake monitoring programs). In addition to exceeding the TP guideline thresholds, lakes to be considered for 303(d) listing should have at least 12 Secchi measurements and 12 chlorophyll-a measurements. This amount of data will allow for at least one season (preferably more) for paired TP, chlorophyll-a, and Secchi disk data and provide a basis for evaluating their interrelationships and hence the trophic status of the lake."



Lake Water Quality Summary

	Trophic Status	Summertime Lake Grades									
	2009	2009	2008	2007	2006	2005	2004	2003	2002	2001	2000
Total Phosphorus (mg/l)	Eutrophic	C	C	C	D	NA	NA	NA	NA	NA	NA
Chlorophyll-*a* (ug/l)	Eutrophic	B	C	B	C	NA	NA	NA	NA	NA	NA
Secchi disk (ft)	Mesotrophic	C	C	C	C	NA	NA	NA	NA	NA	NA
Overall	Eutrophic	C+	C	C+	C-	NA	NA	NA	NA	NA	NA

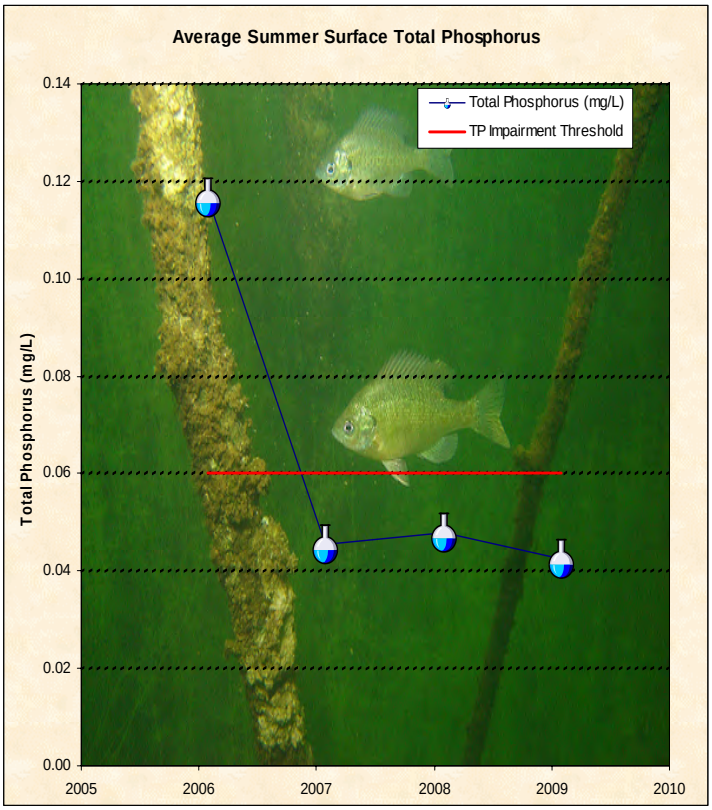
Pat Lake

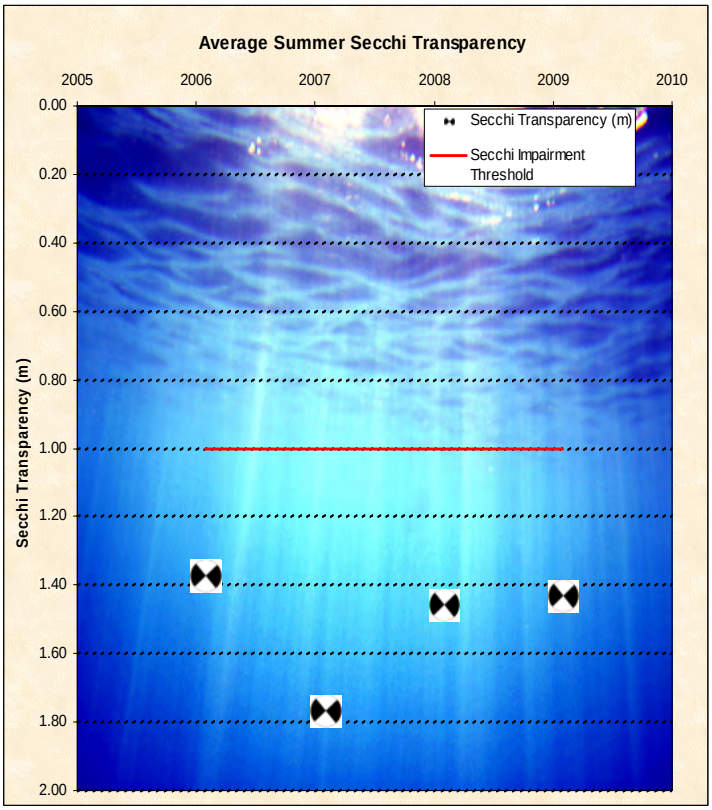
2009 Lake Grade: C+

- DNR ID #: 820125
- Municipality: City of Grant
- Location: Section 11, T30N-R21W
- Lake Size: 20 Acres
- Maximum Depth: 16 ft
- Ordinary High Water Mark: 941.80 ft
- 100-Year High Water Level: 949.10 ft
- % Littoral: NA
  Note: Littoral area is the portion of the lake <15 ft and dominated by aquatic vegetation.

Summary Points

- Pat Lake was considered a eutrophic lake in 2009, based on the Carlson Trophic State Index.
- At this time there are not enough years of data to determine a statistically significant overall water quality trend.
- The major land use is rural/agricultural.
- The lake did not stratify in 2009.





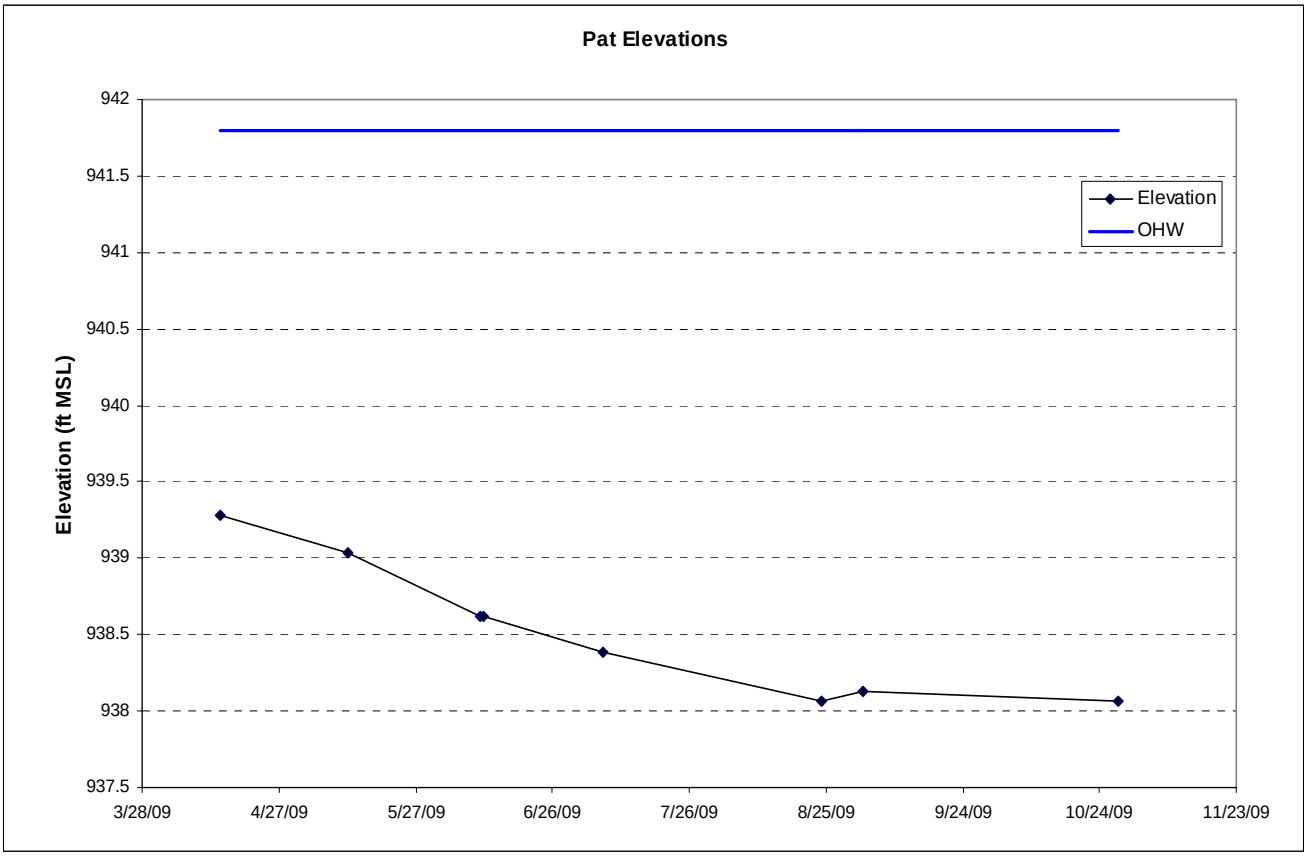
Date	Total Phosphorus (mg/L)	Chlorophyll-a (ug/L)	Total Kjeldahl Nitrogen (mg/L)	Secchi Disk Depths (m)	Surface Dissolved Oxygen Levels (mg/L)	Surface Temperature Levels (Celsius)
4/15/2009	0.035	6	0.93	2.13	10.87	12.5
5/12/2009	0.036	6	0.75	1.68	9.88	15.7
6/10/2009	0.087	20	1.10	1.68	9.04	16.5
7/7/2009	0.048	19	1.10	1.52	11.31	25.3
8/3/2009	0.030	6	1.10	1.22	10.08	24.5
9/2/2009	0.024	5	0.85	1.52	9.11	20.1
9/30/2009	0.023	4	0.81	1.22	10.41	12.1
2009 Average	0.040	10	0.95	1.57	10.10	18.1
2009 Summer Average	0.042	11	0.99	1.43	9.99	19.7

Water quality thresholds are 0.04 mg/L TP, 14 µg/L CL-a, 1.4 m Secchi depth*

Shallow lake water quality thresholds are 0.06 mg/L TP, 20 µg/L CL-a, 1.0 m Secchi depth*

	High	High Date	Low	Low Date	Average
2009 Elevation (ft)	939.28	4/14/2009	938.07	8/24/2009	938.53

*MPCA description of Imparied Lake's Listing criteria: "At a minimum, a decision that a given lake is impaired for the 303(d) list due to excessive nutrients will be supported by data for both causal and response factors. Data requirements for 303(d) listing consist of 12 or more TP measurements collected from June through September over the most recent 10-year period. Ideally this should represent 12 separate visits to the lake over the course of two summers; however it might also reflect four monthly samples over the course of three years (a typical sampling regimen for many lake monitoring programs). In addition to exceeding the TP guideline thresholds, lakes to be considered for 303(d) listing should have at least 12 Secchi measurements and 12 chlorophyll-a measurements. This amount of data will allow for at least one season (preferably more) for paired TP, chlorophyll-a, and Secchi disk data and provide a basis for evaluating their interrelationships and hence the trophic status of the lake."

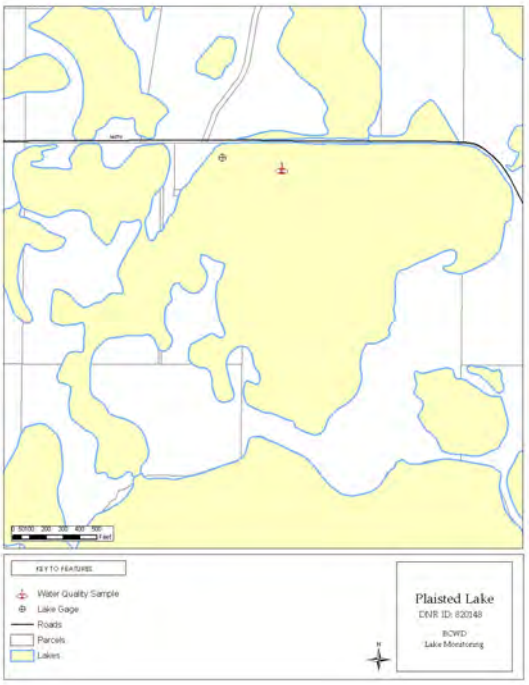


Lake Water Quality Summary	Trophic Status	Summertime Lake Grades									
	2009	2009	2008	2007	2006	2005	2004	2003	2002	2001	2000
Total Phosphorus (mg/l)	Eutrophic	C	C	C	D	NA	NA	NA	NA	NA	NA
Chlorophyll-*a* (ug/l)	Eutrophic	B	C	B	C	NA	NA	NA	NA	NA	NA
Secchi disk (ft)	Eutrophic	C	C	C	C	NA	NA	NA	NA	NA	NA
Overall	Eutrophic	C+	C	C+	C-	NA	NA	NA	NA	NA	NA

Plaisted Lake

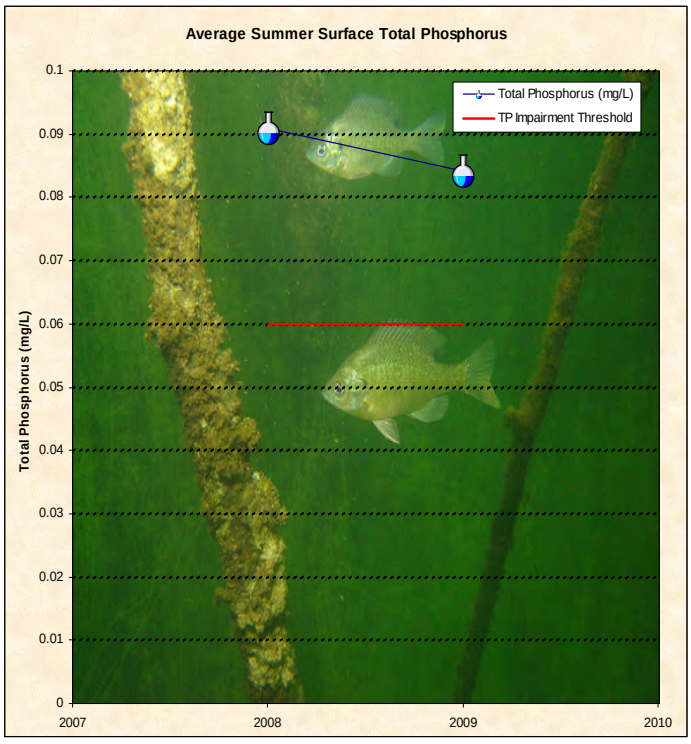
2009 Lake Grade: D+

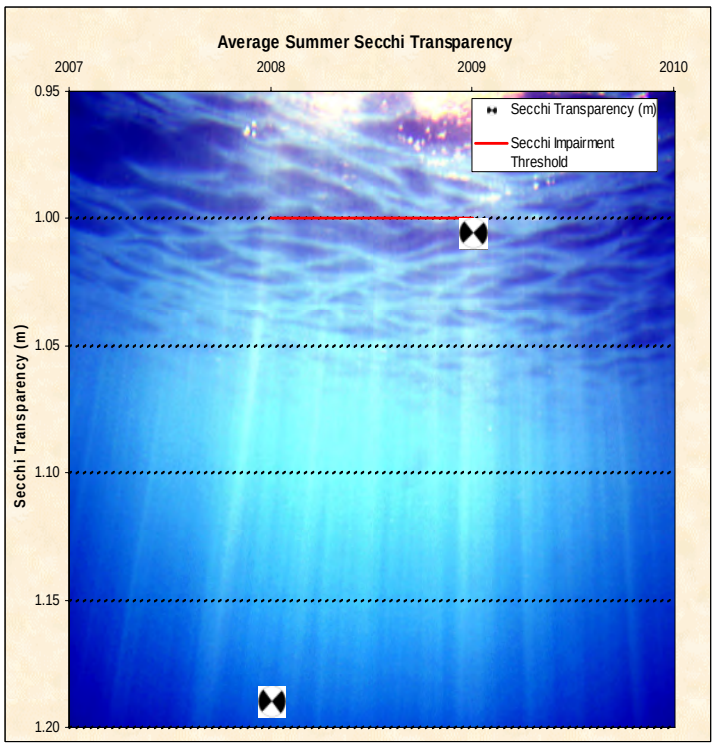
- DNR ID #: 820148
- Municipality: City of Hugo
- Location: Section 25, T31N-R21W
- Lake Size: 70 Acres
- Maximum Depth: 11 ft
- Ordinary High Water Mark: 966.00 ft
- 100-Year High Water Level: NA
- 100% Littoral
  Note: Littoral area is the portion of the lake <15 ft and dominated by aquatic vegetation.



Summary Points

- Plaisted Lake was considered a hypereutrophic lake in 2009, based on the Carlson Trophic State Index.
- At this time there are not enough years of data to determine a statistically significant overall water quality trend.
- The major land use is rural/agricultural.
- The lake did not stratify in 2009.





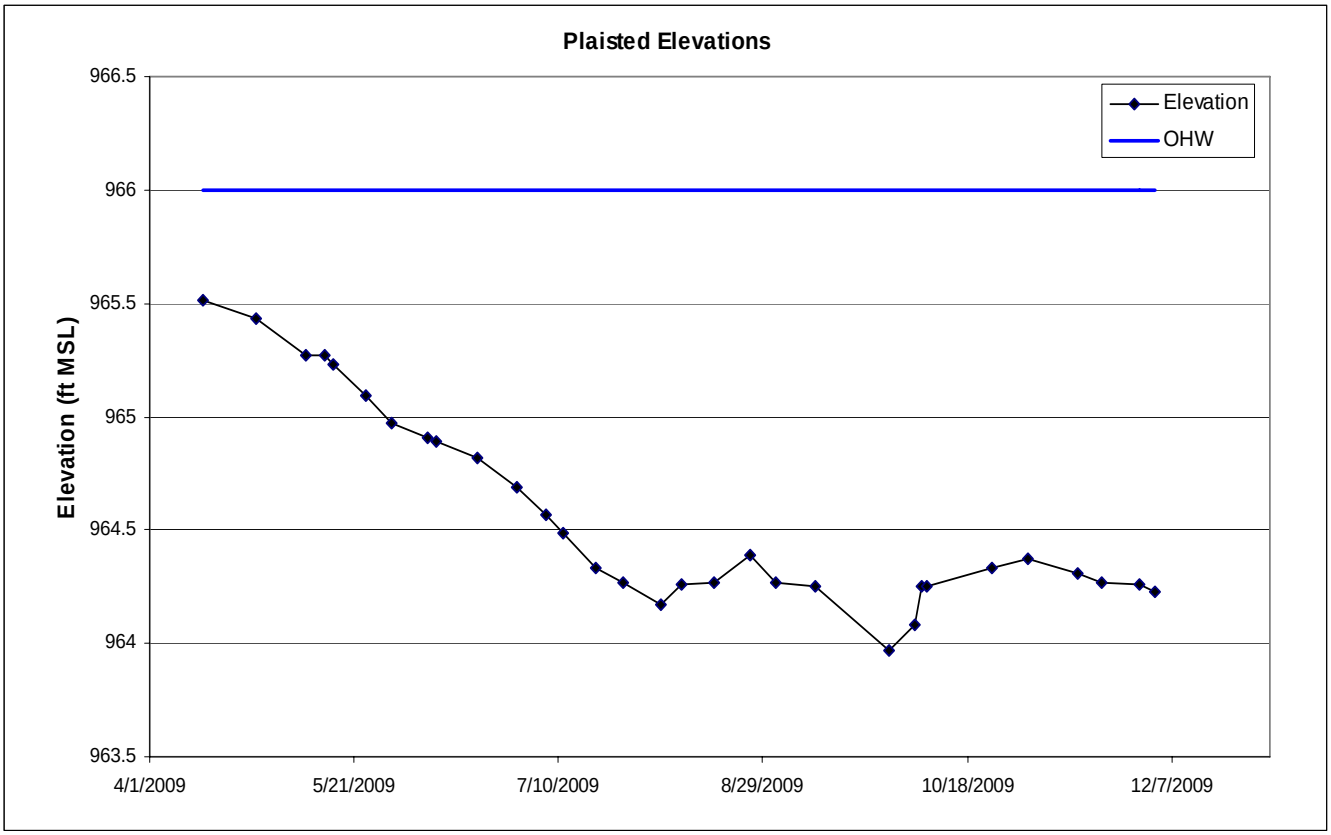
Date	Total Phosphorus (mg/L)	Chlorophyll-a (ug/L)	Total Kjeldahl Nitrogen (mg/L)	Secchi Disk Depths (m)	Surface Dissolved Oxygen Levels (mg/L)	Surface Temperature Levels (Celsius)
4/14/2009	0.038	5	1.5	3.05	11.7	12.3
5/14/2009	0.024	6	1.2	2.44	10.27	15.1
6/10/2009	0.065	4	1.4	2.44	7.42	17.1
7/7/2009	0.131	97	2.8	0.61	13.77	24.2
8/4/2009	0.087	57	2.7	0.46	10.82	25.3
9/1/2009	0.079	44	2.0	0.61	9.45	22.2
9/30/2009	0.059	37	2.1	0.91	8.3	14.2
2009 Average	0.069	36	1.96	1.50	10.25	18.63
2009 Summer Average	0.084	48	2.20	1.01	9.95	20.60

Water quality thresholds are 0.04 mg/L TP, 14 µg/L CL-a, 1.4 m Secchi depth*

Shallow lake water quality thresholds are 0.06 mg/L TP, 20 µg/L CL-a, 1.0 m Secchi depth*

	High	High Date	Low	Low Date	Average
2009 Elevation (ft)	965.51	4/14/2009	963.97	9/29/2009	964.57

*MPCA description of Imparied Lake's Listing criteria: "At a minimum, a decision that a given lake is impaired for the 303(d) list due to excessive nutrients will be supported by data for both causal and response factors. Data requirements for 303(d) listing consist of 12 or more TP measurements collected from June through September over the most recent 10-year period. Ideally this should represent 12 separate visits to the lake over the course of two summers; however it might also reflect four monthly samples over the course of three years (a typical sampling regimen for many lake monitoring programs). In addition to exceeding the TP guideline thresholds, lakes to be considered for 303(d) listing should have at least 12 Secchi measurements and 12 chlorophyll-a measurements. This amount of data will allow for at least one season (preferably more) for paired TP, chlorophyll-a, and Secchi disk data and provide a basis for evaluating their interrelationships and hence the trophic status of the lake."

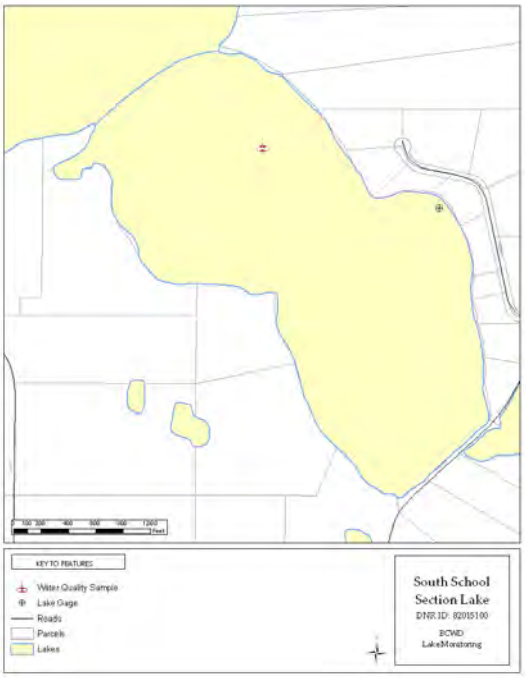


Lake Water Quality Summary	Trophic Status	Summertime Lake Grades									
	2009	2009	2008	2007	2006	2005	2004	2003	2002	2001	2000
Total Phosphorus (mg/l)	Hypereutrophic	D	D	NA	NA	NA	NA	NA	NA	NA	NA
Chlorophyll-*a* (ug/l)	Hypereutrophic	C	D	NA	NA	NA	NA	NA	NA	NA	NA
Secchi disk (ft)	Eutrophic	D	C	NA	NA	NA	NA	NA	NA	NA	NA
Overall	Hypereutrophic	D+	D+	NA	NA	NA	NA	NA	NA	NA	NA

South School Section Lake

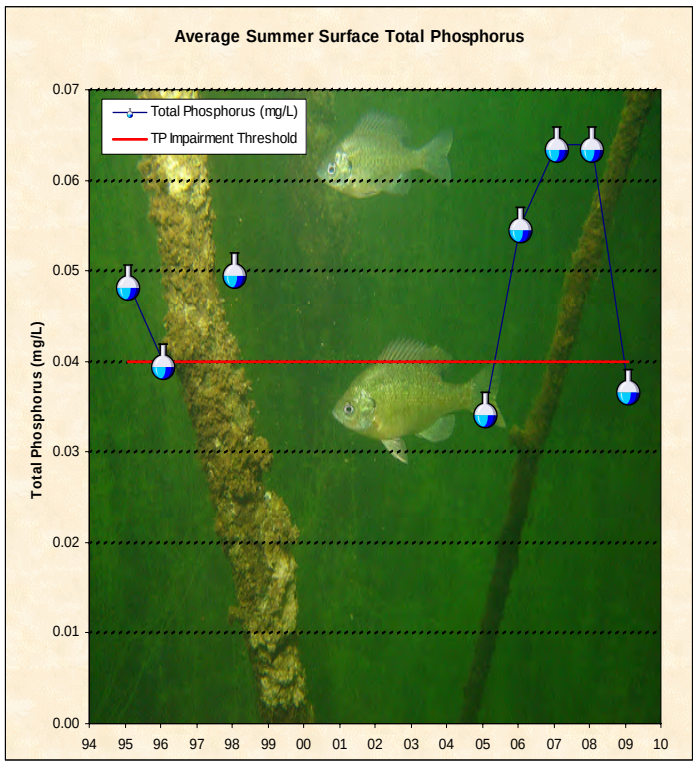
2009 Lake Grade: B-

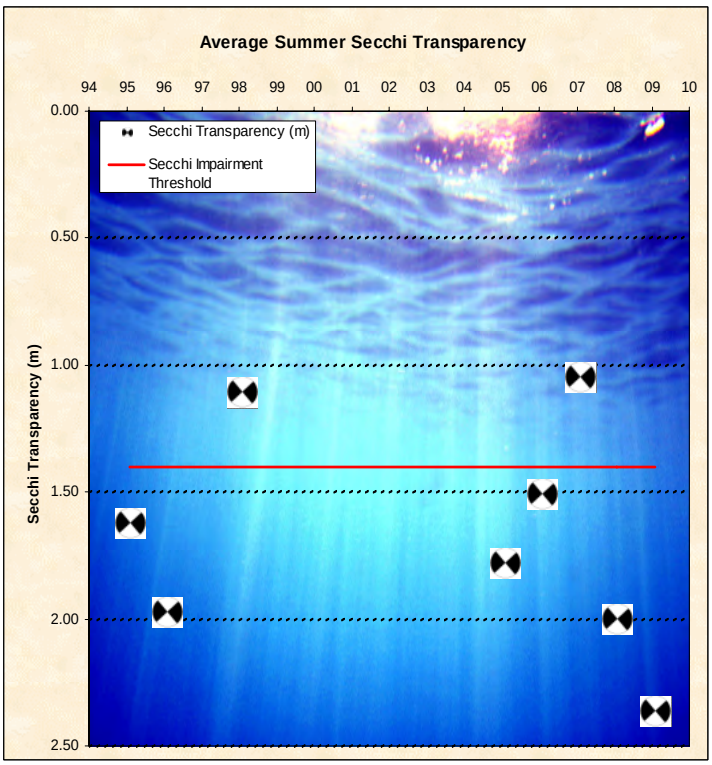
- DNR ID #: 820151
- Municipality: City of Hugo
- Location: S ½ Section 25, T31N-R21W
- Lake Size: 115 Acres
- Maximum Depth: 26 ft
- Ordinary High Water Mark: 965.30 ft
- 100-Year High Water Level: 972.20 ft
- 41% Littoral
  Note: Littoral area is the portion of the lake <15 ft and dominated by aquatic vegetation.



Summary Points

- South School Section Lake was considered a eutrophic lake in 2009, based on the Carlson Trophic State Index.
- At this time no statistically significant trend can be determined for overall water quality.
- The major land use is rural/agricultural.
- The lake did not stratify in 2009.
- South School Section Lake is listed as impaired for nutrients on the Minnesota Pollution Control Agency's Impaired Waters List.





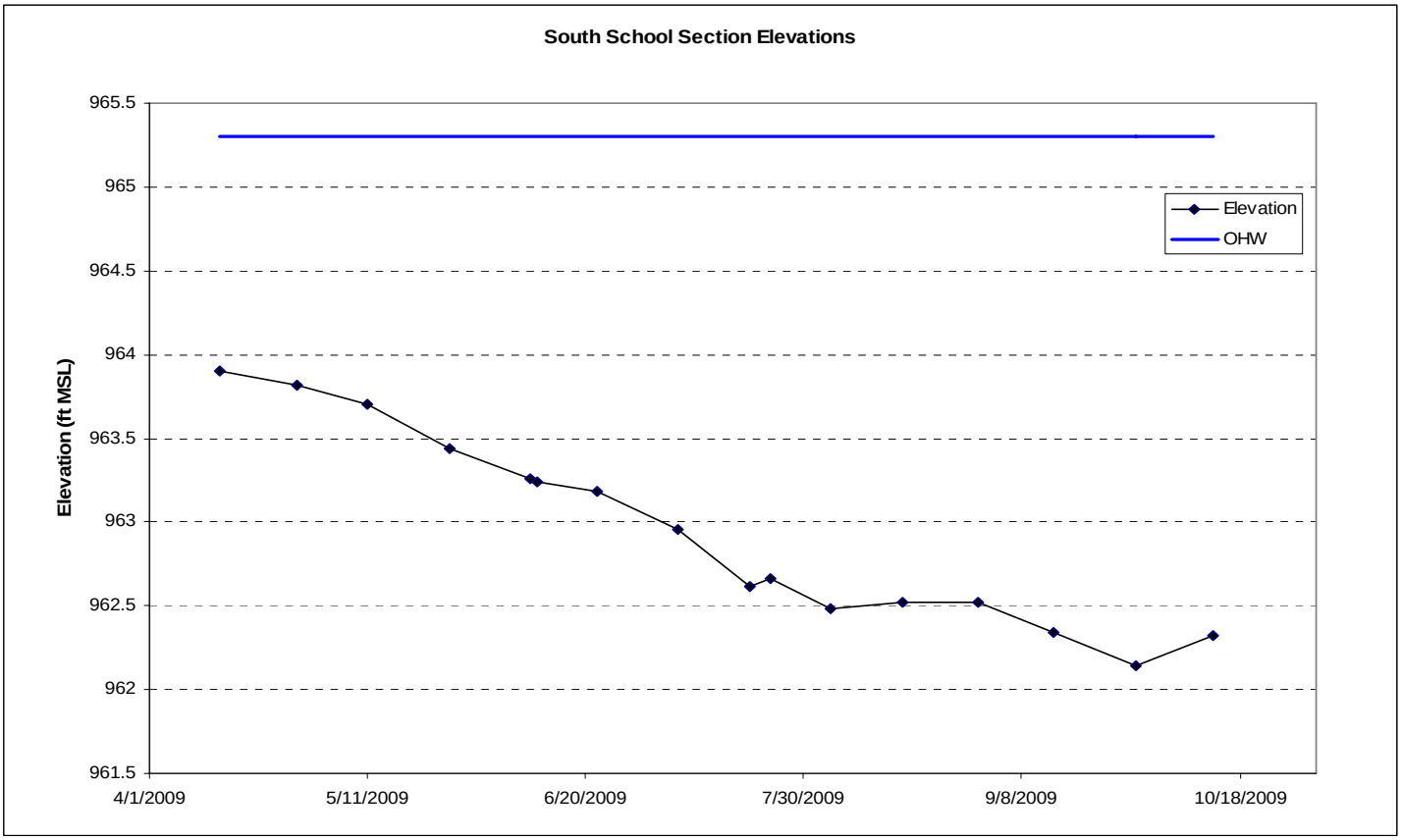
Date	Total Phosphorus (mg/L)	Chlorophyll-a (ug/L)	Total Kjeldahl Nitrogen (mg/L)	Total Phosphorus (mg/L) (Hypolimnion)	Total Ortho-P (mg/L) (Hypolimnion)	Total Kjeldahl Nitrogen (mg/L) (Hypolimnion)	Secchi Disk Depths (m)	Surface Dissolved Oxygen Levels (mg/L)	Surface Temperature Levels (Celsius)
4/13/2009	0.035	4	1.70	0.07	0.01	1.00	2.74	11.54	7.9
4/28/2009	0.032	4	1.10	0.03	0.01	0.70	3.81	9.85	11.6
5/11/2009	0.027	3	1.1	0.025	0.01	0.73	4.57	8.58	14.3
5/26/2009	0.021	4	0.81	0.02	0.01	0.71	3.51	7.81	18.7
6/10/2009	0.033	9	0.92	0.024	0.01	0.68	3.20	8.45	17.2
6/22/2009	0.035	5	1.00	0.042	0.01	0.92	3.81	9.32	23.6
7/6/2009	0.034	8	1.10	0.057	0.01	0.91	2.90	9.69	22.9
7/20/2009	0.045	15	1.30	0.044	0.01	0.88	1.68	8.86	20.5
8/4/2009	0.038	13	0.98	0.039	0.005	0.83	1.37	8.94	22.5
8/17/2009	0.034	16	1.00	0.065	0.005	0.87	1.83	7.65	24.1
8/31/2009	0.046	14	0.88	0.051	0.008	0.85	1.83	5.52	20.5
9/14/2009	0.032	16	0.94	0.093	0.011	0.92	1.83	9.98	23.0
9/29/2009	0.053	19	1.10	0.042	0.005	0.88	1.68	6.46	16.6
10/13/2009	0.051	10	0.88	0.032	0.005	0.85	2.90	10.51	8.1
2009 Average	0.037	10	1.06	0.05	0.01	0.84	2.69	8.80	18.0
2009 Summer Average	0.037	12	1.00	0.05	0.01	0.85	2.36	8.27	21.4

Water quality thresholds are 0.04 mg/L TP, 14 µg/L CL-a, 1.4 m Secchi depth*

Shallow lake water quality thresholds are 0.06 mg/L TP, 20 µg/L CL-a, 1.0 m Secchi depth*

	High	High Date	Low	Low Date	Average
2009 Elevation (ft)	963.90	4/14/2009	962.14	9/29/2009	962.91

*MPCA description of Imparied Lake's Listing criteria: "At a minimum, a decision that a given lake is impaired for the 303(d) list due to excessive nutrients will be supported by data for both causal and response factors. Data requirements for 303(d) listing consist of 12 or more TP measurements collected from June through September over the most recent 10-year period. Ideally this should represent 12 separate visits to the lake over the course of two summers; however it might also reflect four monthly samples over the course of three years (a typical sampling regimen for many lake monitoring programs). In addition to exceeding the TP guideline thresholds, lakes to be considered for 303(d) listing should have at least 12 Secchi measurements and 12 chlorophyll-a measurements. This amount of data will allow for at least one season (preferably more) for paired TP, chlorophyll-a, and Secchi disk data and provide a basis for evaluating their interrelationships and hence the trophic status of the lake."



Lake Water Quality Summary

	Trophic Status	Summertime Lake Grades														
	2009	2009	2008	2007	2006	2005	2004	2003	2002	2001	2000	1999	1998	1997	1996	1995
Total Phosphorus (mg/l)	Eutrophic	C	C	C	C	C	NA	NA	NA	NA	NA	NA	D+	NA	C	C
Chlorophyll-*a* (ug/l)	Eutrophic	B	C	D	C	C+	NA	NA	NA	NA	NA	NA	D+	NA	C	C
Secchi disk (ft)	Mesotrophic	B	C	D	C	C	NA	NA	NA	NA	NA	NA	C	NA	C	C
Overall	Eutrophic	B-	C	D+	C	C	NA	NA	NA	NA	NA	NA	C-	NA	C	C

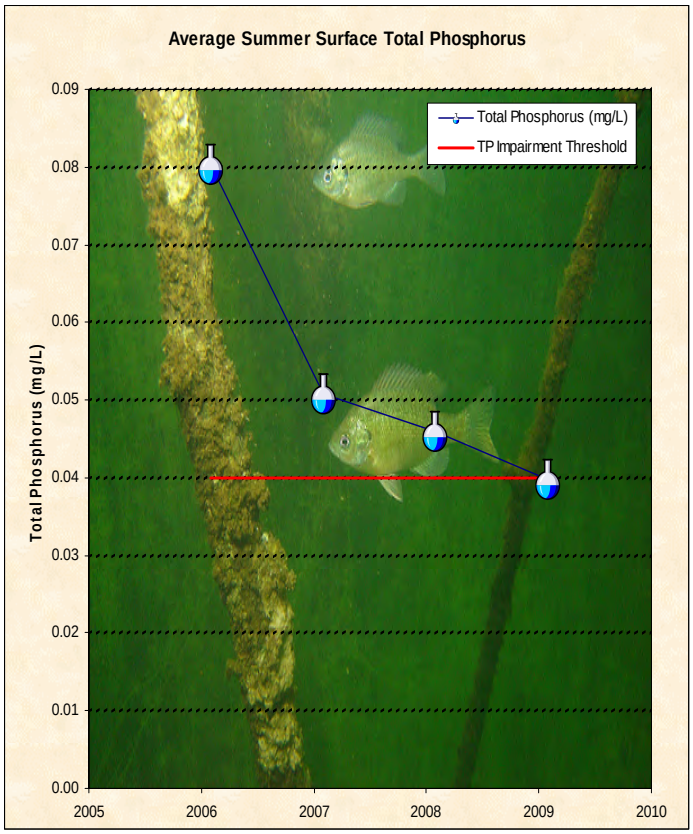
Woodpile Lake

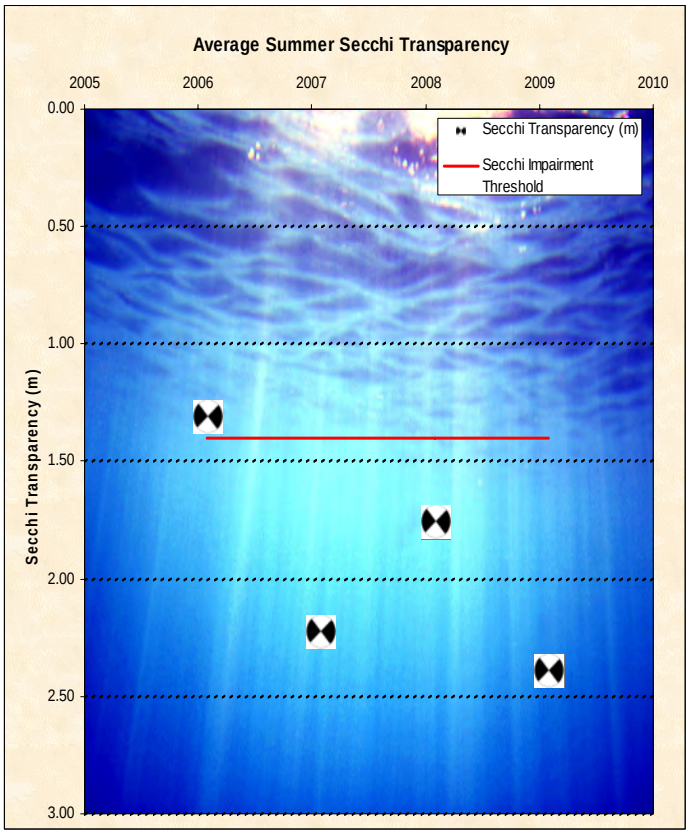
2009 Lake Grade: B-

- DNR ID #: 820132
- Municipality: City of Grant
- Location: Section 23, T30N-R21W
- Lake Size: 15 Acres
- Maximum Depth: 27 ft
- Ordinary High Water Mark: 968.50 ft
- 100-Year High Water Level: 971.00 ft
- 8% Littoral
  Note: Littoral area is the portion of the lake <15 ft and dominated by aquatic vegetation.

Summary Points

- Woodpile Lake was considered a eutrophic lake in 2009, based on the Carlson Trophic State Index.
- At this time there are not enough years of data to determine a statistically significant overall water quality trend.
- The major land use is rural/agricultural.
- The lake did stratify with the thermocline varying between 4 to 6 meters.





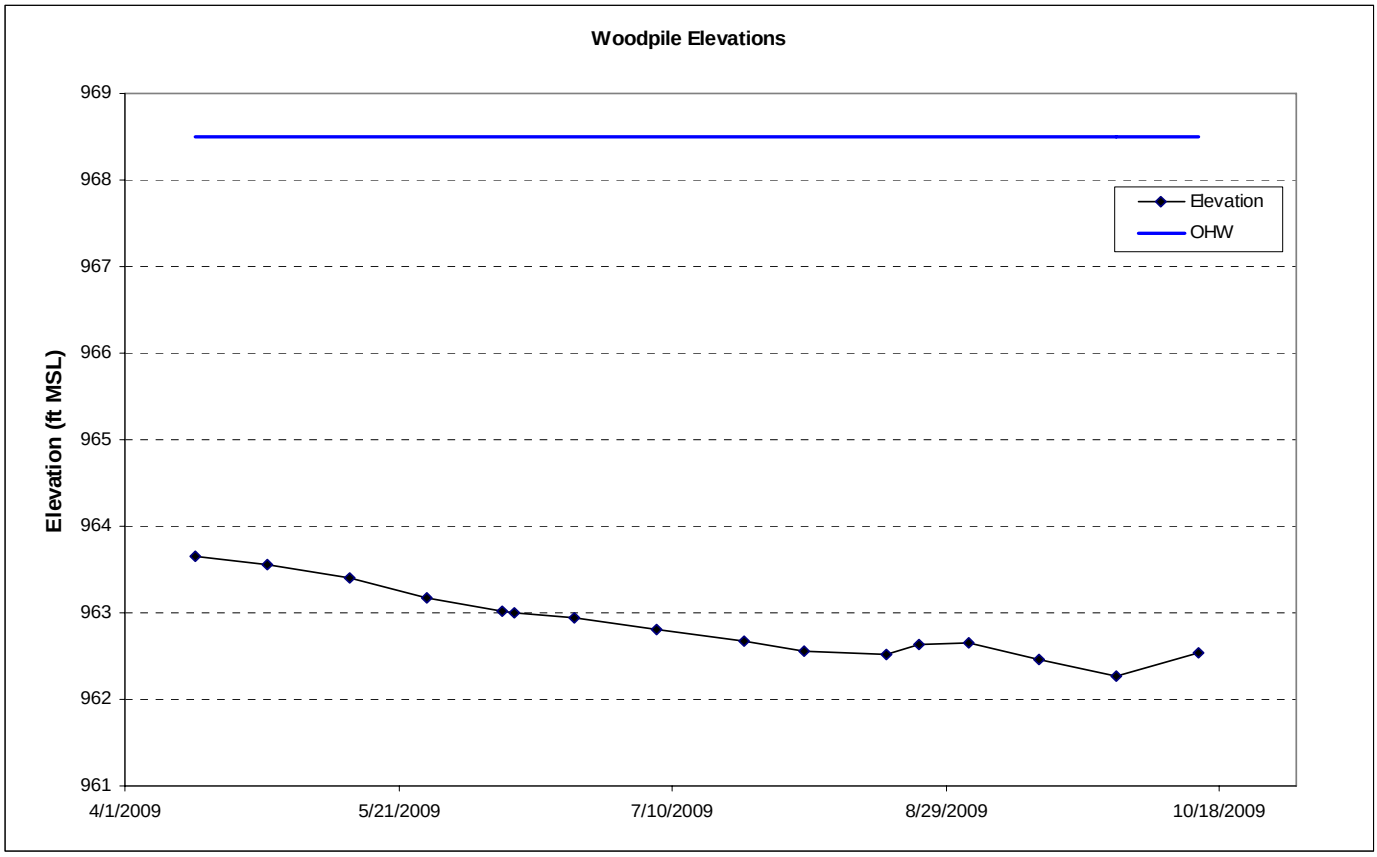
Date	Total Phosphorus (mg/L)	Chlorophyll-a (ug/L)	Total Kjeldahl Nitrogen (mg/L)	Secchi Disk Depths (m)	Surface Dissolved Oxygen Levels (mg/L)	Surface Temperature Levels (Celsius)
4/13/2009	0.044	9	1.10	1.83		10.3
4/27/2009	0.039	5	1.10	3.66	10.79	12.6
5/12/2009	0.028	6	0.96	3.96	11.16	15.5
5/26/2009	0.045	14	1.10	3.05	9.77	20.0
6/9/2009	0.045	9	1.10	3.35	6.24	16.8
6/22/2009	0.038	7	1.20	2.90	10.98	28.5
7/7/2009	0.032	10	1.20	2.44	11.08	23.9
7/23/2009	0.063	32	1.50	1.07	11.88	22.1
8/3/2009	0.040	27	1.20	1.22	9.67	23.9
8/18/2009	0.032	18	1.10	1.83	6.01	23.7
9/2/2009	0.037	10	0.94	2.44	8.05	20.4
9/15/2009	0.031	10	0.86	3.81	7.61	24.1
9/30/2009	0.035	10	0.92	1.83	6.09	15.6
10/14/2009	0.047	7	1.10	3.35	7.89	8.0
2009 Average	0.040	12	1.10	2.62	9.02	19.0
2009 Summer Average	0.040	15	1.11	2.39	8.74	21.9

Water quality thresholds are 0.04 mg/L TP, 14 µg/L CL-a, 1.4 m Secchi depth*

Shallow lake water quality thresholds are 0.06 mg/L TP, 20 µg/L CL-a, 1.0 m Secchi depth*

	High	High Date	Low	Low Date	Average
2009 Elevation (ft)	963.66	4/14/2009	962.26	9/29/2009	962.87

*MPCA description of Imparied Lake's Listing criteria: "At a minimum, a decision that a given lake is impaired for the 303(d) list due to excessive nutrients will be supported by data for both causal and response factors. Data requirements for 303(d) listing consist of 12 or more TP measurements collected from June through September over the most recent 10-year period. Ideally this should represent 12 separate visits to the lake over the course of two summers; however it might also reflect four monthly samples over the course of three years (a typical sampling regimen for many lake monitoring programs). In addition to exceeding the TP guideline thresholds, lakes to be considered for 303(d) listing should have at least 12 Secchi measurements and 12 chlorophyll-a measurements. This amount of data will allow for at least one season (preferably more) for paired TP, chlorophyll-a, and Secchi disk data and provide a basis for evaluating their interrelationships and hence the trophic status of the lake."

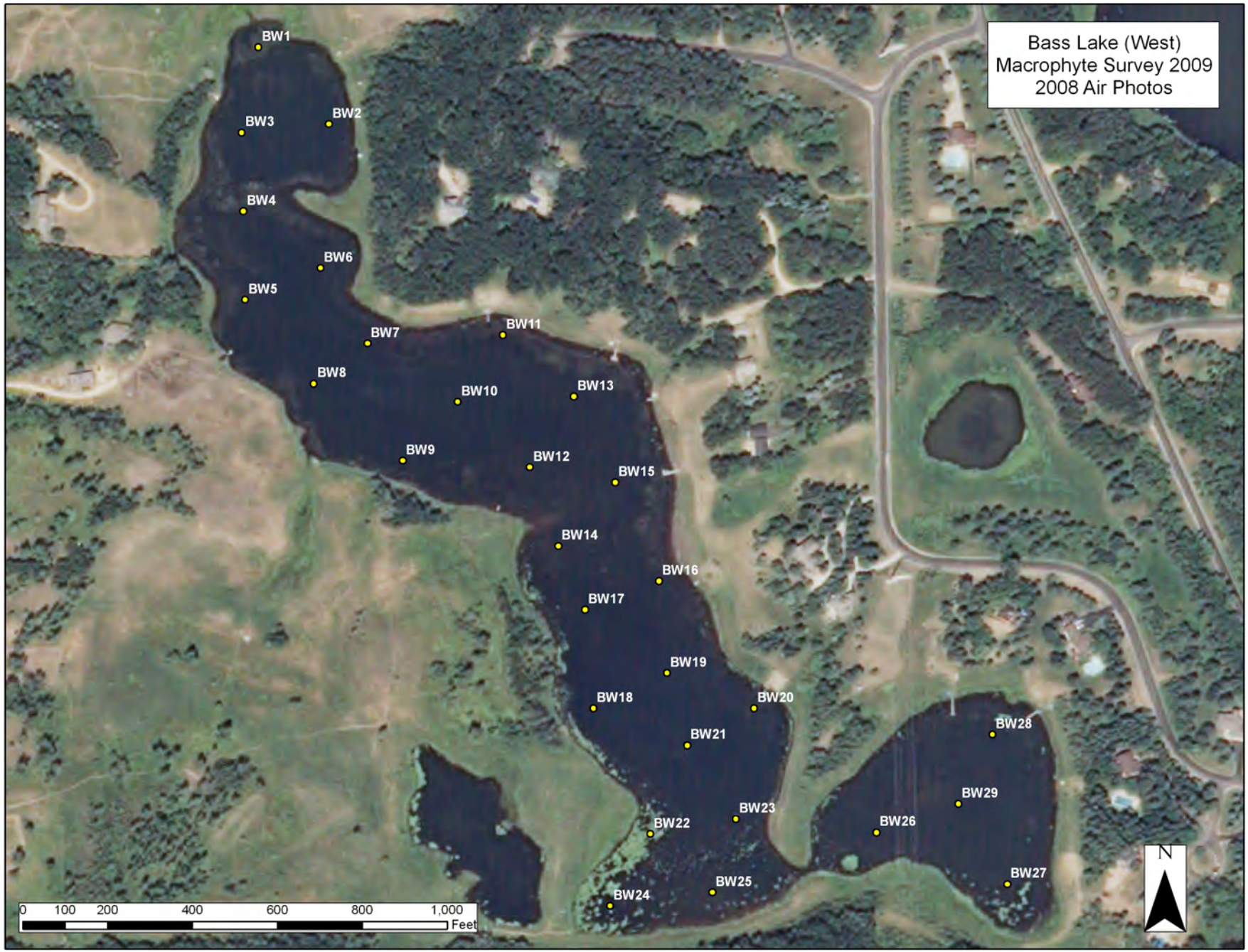


Lake Water Quality Summary

	Trophic Status	Summertime Lake Grades									
	2009	2009	2008	2007	2006	2005	2004	2003	2002	2001	2000
Total Phosphorus (mg/l)	Eutrophic	C	C	C	D	NA	NA	NA	NA	NA	NA
Chlorophyll-*a* (ug/l)	Eutrophic	B	C	B	B	NA	NA	NA	NA	NA	NA
Secchi disk (ft)	Mesotrophic	B	C	B	C	NA	NA	NA	NA	NA	NA
Overall	Eutrophic	B-	C	B-	C	NA	NA	NA	NA	NA	NA

APPENDIX B – MACROPHYTE SURVEYS – BY LAKE

Bass West, Lynch, Masterman, and Wood Pile


Bass Lake (West)
Macrophyte Survey 2009
2008 Air Photos
BW1
BW2
BW3
BW4
BW5
BW6
BW7
BW8
BW9
BW10
BW11
BW12
BW13
BW14
BW15
BW16
BW17
BW18
BW19
BW20
BW21
BW22
BW23
BW24
BW25
BW26
BW27
BW28
BW29
0 100 200 400 600 800 1,000
Feet
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Bass Lake (West) Macrophyte Survey
Date: 6/3/2009

Site	Depth at Point (ft)	white water lily (Nymphaea odorata)	ribbon leaf pondweed (Pontomageton epihydrus)	large leaf pondweed (Potamogeton amplifolius)	algae present
1	1		4		x
2	3		2		x
3	9		4	2	x
4	4		4	1	
5	4.5		2	1	
6	4		3		
7	5		4		
8	4.5		4	1	x
9	4		4	1	x
10	9				
11	5		4	2	x
12	5		4		
13	5		2		
14	9.5		4		
15	4		4	1	
16	6		4	1	
17	8		4		
18	4		4		x
19	4.5		2		
20	4		4		x
21	5		4	1	
22	3	4	4		
23	3	2	4	1	x
24	4	2	4		x
25	3.5	1	4	1	
26	4		4	1	x
27	Dry				
28	3	2	4	1	x
29	8		2	2	

Species Density: 1-very sparce (barely any in rake tines), 4-very dense (covering all of rake tines)

Species density estimate graphic

Note: Water level below normal

Survey Protocol: Point Intercept Method for Aquatic Plant Management (Madsen, 1999)

http://files.dnr.state.mn.us/assistance/grants/habitat/2007Protocols_pre-trt_data.pdf

Bass Lake (West) Macrophyte Survey
Date: 9/17/2009

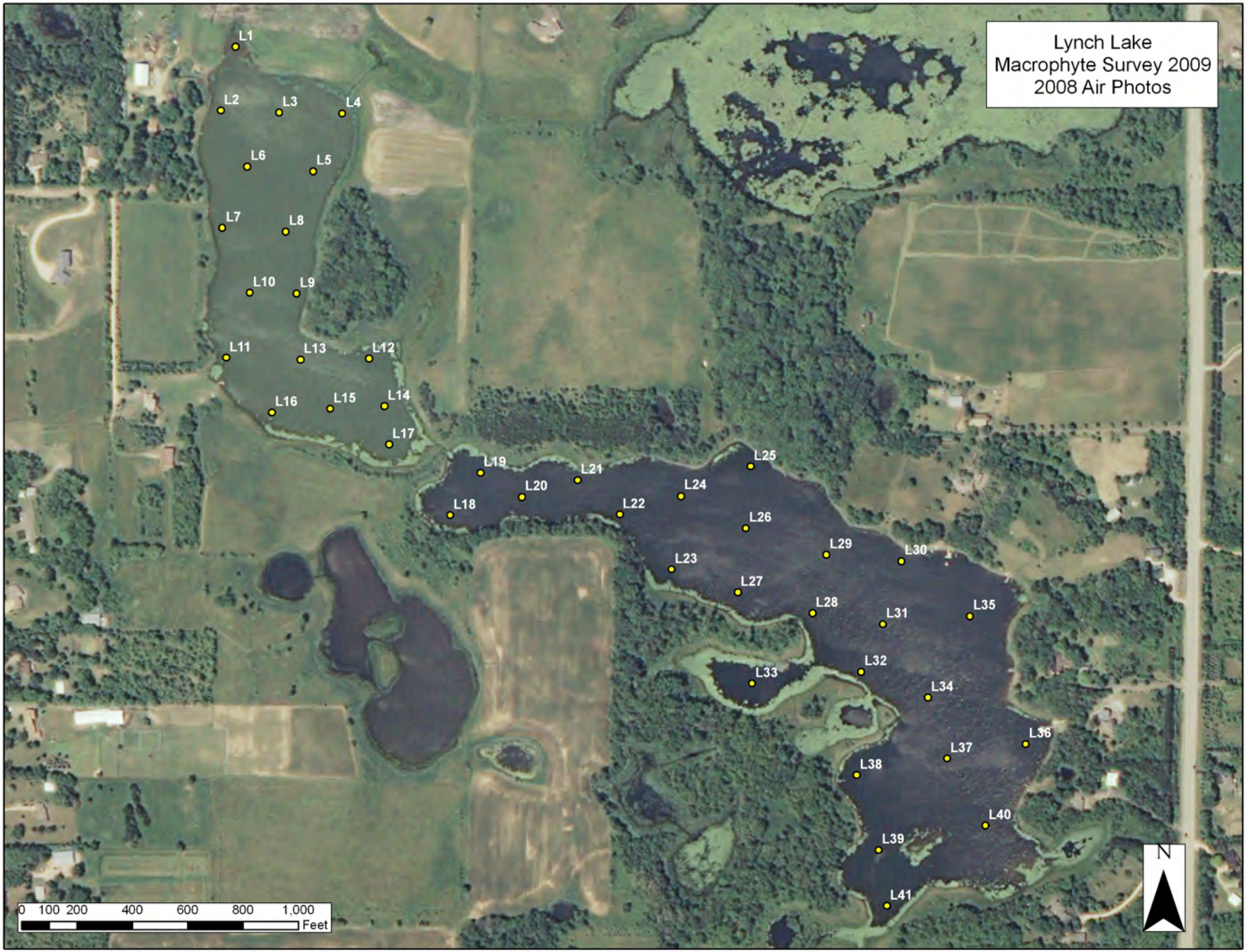
Site:	Depth at Point (ft)	white water lily (Nymphaea odorata)	lesser duckweed (Lemna minor)	ribbon leaf pondweed (Pontomageton epihydrus)	large leaf pondweed (Potamogeton amplifolius)	Illinois pondweed (Potamogeton illinoensis)	algae present
1	1		3	4	1		1
2	1.5	1	1	4	1		1
3	3			4	1		
4	3			4	1	1	x
5	3			4			
6	2.5			4	1		
7	3			4			
8	4			4			
9							
10	7.5			3			
11	2	1		4	1		
12	3.5			4			x
13	3.5			4			x
14	3.5			4			x
15	3.5			4			x
16	2.5			4	1	1	x
17	3			4	1	1	
18	3			4	1		
19	3			4	1		
20	1	2		4			x
21	3			4			x
22	1	3		4	1		
23	1.5	1		4			x
24	1	2		4	1		x
25	1.5	1		4	2		
26	3			4	1		x
27	0						
28	3	2		4			x
29	3			4	1		x

Species Density: 1-very sparce (barely any in rake tines), 4-very dense (covering all of rake tines)

Species density estimate graphic http://files.dnr.state.mn.us/assistance/grants/habitat/2007Protocols_pre-trt_data.pdf

Note: Water level below normal

Survey Protocol: Point Intercept Method for Aquatic Plant Management (Madsen, 1999)


Lynch Lake
Macrophyte Survey 2009
2008 Air Photos
L1
L2
L3
L4
L5
L6
L7
L8
L9
L10
L11
L12
L13
L14
L15
L16
L17
L18
L19
L20
L21
L22
L23
L24
L25
L26
L27
L28
L29
L30
L31
L32
L33
L34
L35
L36
L37
L38
L39
L40
L41
N
0 100 200 400 600 800 1,000
Feet

Lynch Lake Macrophyte Survey
Date: 6/4/2009

Site	Depth at Point (ft)	3 square bullrush (Scirpus americanus)	common arrowhead (Sagittaria latifolia)	white water lily (Nymphaea odorata)	watershield (Brasenia schreberi)	Illinois pondweed (Potamogeton illinoensis)	Carex sp. (more investigation needed for ID)
1	Dry						
2	4.5						
3	5						
4	0.5	4					
5	5						
6	3.5						
7	5						
8	3						
9	4		2	1		2	2
10	3.5						
11	6			4			
12	4			4			
13	3						
14	4						
15	3.5						
16	3.5			1			
17	4						
18	4						
19	4			3			
20	5						
21	4			2			1
22	6						
23	6						
24	7.5						
25	5.5						
26	11.5						
27	7						
28	10.5						
29	10						
30	4		2	1			
31	14						
32	9				1		
33	3.5			1	1		
34	12						
35	11						
36	4.5			1			
37	12						
38	9.5						
39	4.5						
40	1.5						
41	1			3	1		

Species Density: 1-very sparce (barely any in rake tines), 4-very dense (covering all of rake tines)

Species density estimate graphic http://files.dnr.state.mn.us/assistance/grants/habitat/2007Protocols_pre-trt_data.pdf

Note: Algae abundant in entire lake, Low water levels during survey, Two basins separated by land

Survey Protocol: Point Intercept Method for Aquatic Plant Management (Madsen, 1999)

Lynch Lake Macrophyte Survey
Date: 9/17/2009

Site:	Depth at Point (ft)	white water lily (Nymphaea odorata)	watershield (Brasenia schreberi)
1	Dry		
2	1		
3	3		
4	Dry		
5	2.5		
6	3		
7	1		
8	2.5		
9			
10	3		
11	2.5	2	
12	1	2	
13	3		
14	3	1	
15	3		
16	2.5	3	
17	2	2	
18	4	3	2
19	2.5	3	1
20	4.5	2	
21	3.5	2	1
22	4	2	
23	5	2	
24	7		
25	5	2	3
26	11.5		
27	5.5		
28	10.8		
29	12		
30	5		
31	13.5		
32	6.5	1	
33	3	2	3
34	10		
35	10		
36	4.5	2	
37	11		
38	6.5		3
39	4		
40	0.5		
41	3.5	3	

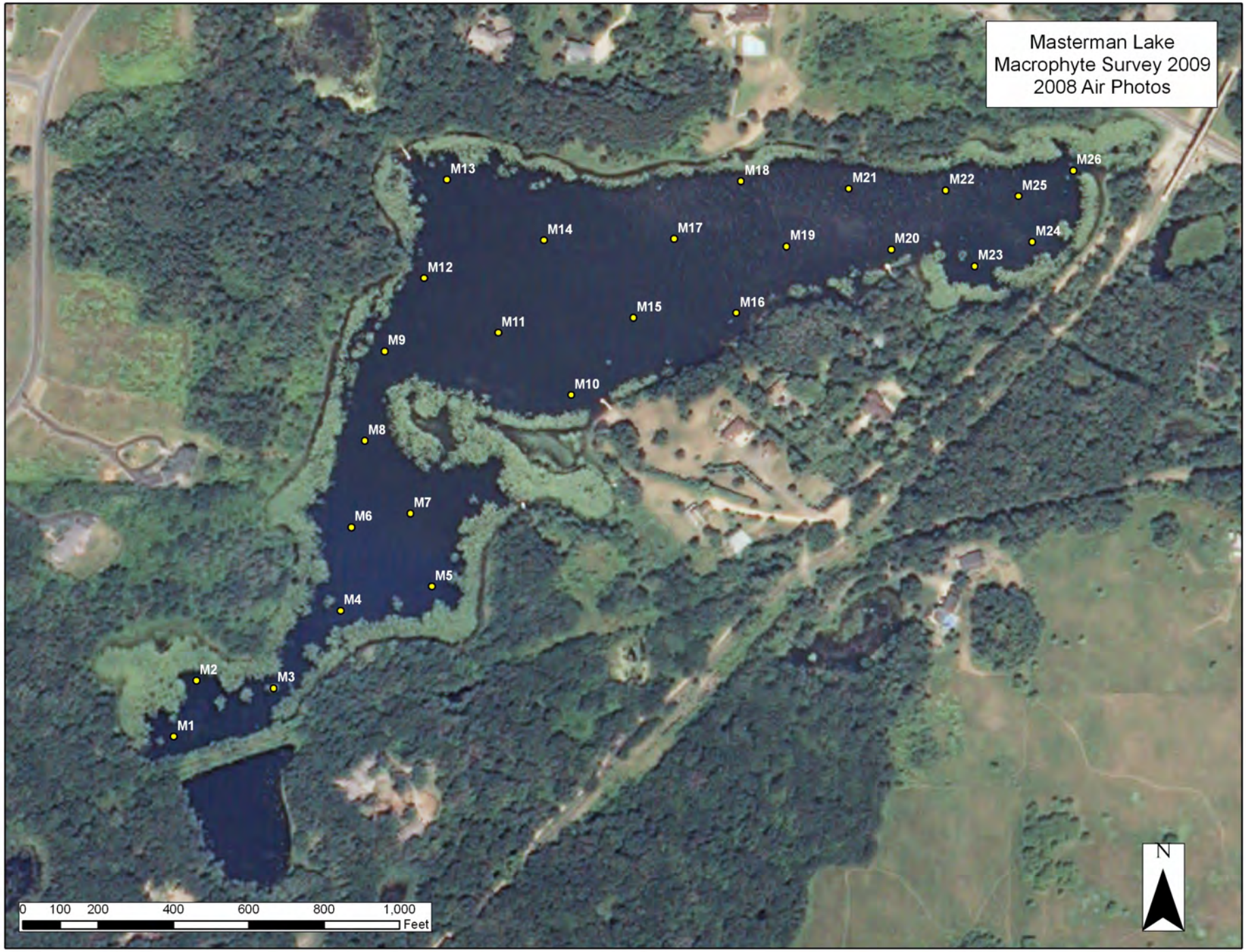
Species Density: 1-very sparce (barely any in rake tines), 4-very dense (covering all of rake tines)

Species density estimate graphic

Note: Algae abundant in entire lake, Low water levels during survey, Two basins separated by land

Survey Protocol: Point Intercept Method for Aquatic Plant Management (Madsen, 1999)

http://files.dnr.state.mn.us/assistance/grants/habitat/2007Protocols_pre-trt_data.pdf


Masterman Lake
Macrophyte Survey 2009
2008 Air Photos
M1
M2
M3
M4
M5
M6
M7
M8
M9
M10
M11
M12
M13
M14
M15
M16
M17
M18
M19
M20
M21
M22
M23
M24
M25
M26
0 100 200 400 600 800 1,000
Feet
N

Masterman Lake Macrophyte Survey
Date: 6/3/2009

Site	Depth at Point (ft)	white water lily (Nymphaea odorata)	spatterdock (Nuphar variegata)	watershield (Brasenia schreberi)	ribbon leaf pondweed (Pontomageton epihydrus)	large leaf pondweed (Potamogeton amplifolius)	coontail (Ceratophyllum demersum)	common waterweed (Elodea canadensis)
1	4.2				4		1	1
2	3	3	1		4		1	
3	3.5	3			2		1	1
4	4				4			
5	4.5				2			
6	3.5				4			1
7	4				4			
8	4.5				4			
9	4.5				4	1		
10	4				4			
11	5				4			1
12	5				4			2
13	4.5				3			
14	4.5				4			1
15	6				4		1	2
16	4				1			1
17	6				3			
18	3	2			3			
19	6				4			
20	4.5				3			
21	4.5				4			
22	4.5				4			
23	4		1		3			
24	4				4			
25	4				3			
26	4	3			4			

Species Density: 1-very sparce (barely any in rake tines), 4-very dense (covering all of rake tines)

Species density estimate graphic http://files.dnr.state.mn.us/assistance/grants/habitat/2007Protocols_pre-trt_data.pdf

Note: Water Below Normal Level

Survey Protocol: Point Intercept Method for Aquatic Plant Management (Madsen, 1999)

Masterman Lake Macrophyte Survey
Date: 9/4/2009

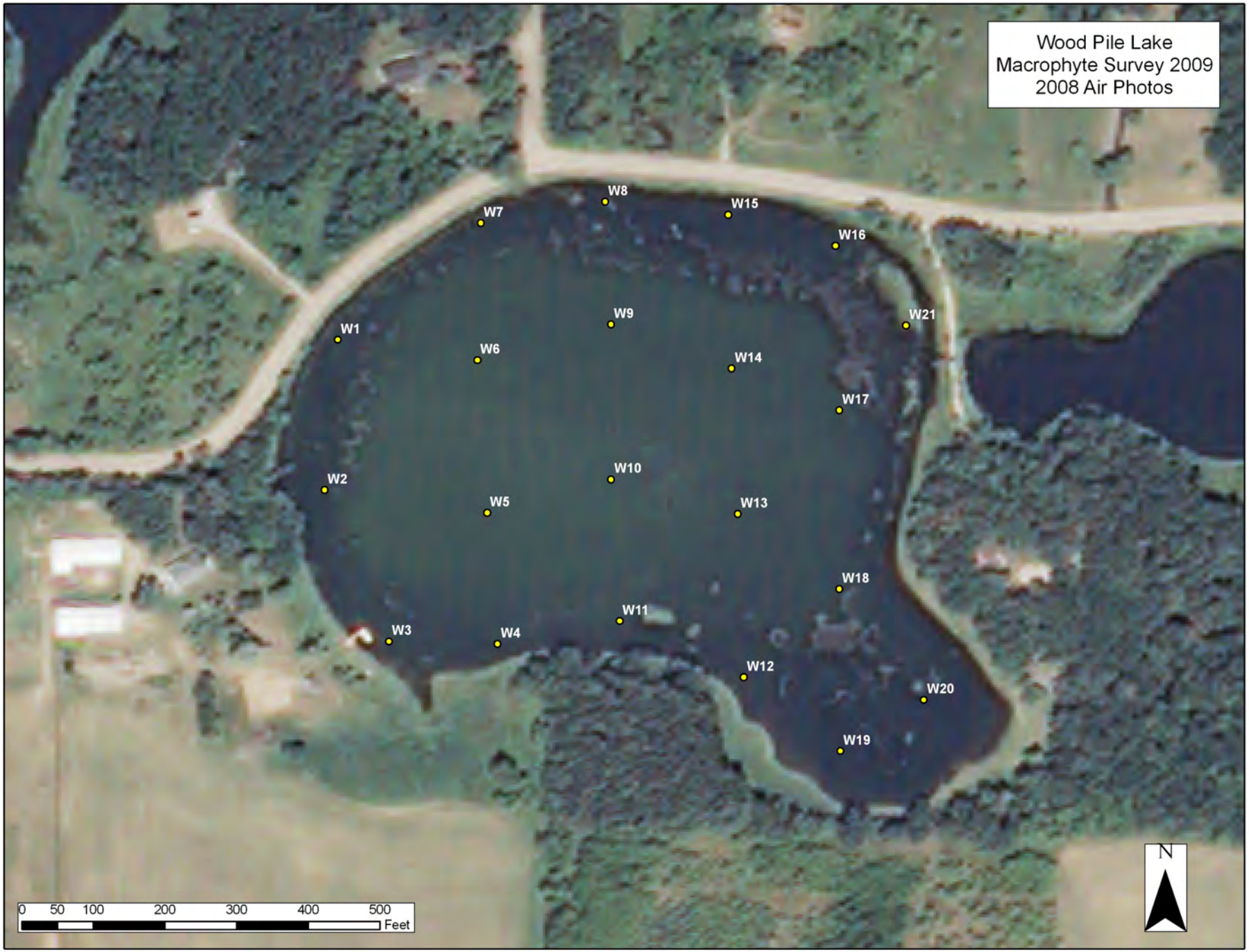
Site	Depth at Point (ft)	grass-leaved arrowhead (Sagittaria graminea)	white water lily (Nymphaea odorata)	spatterdock (Nuphar variegata)	lesser duckweed (Lemna minor)	ribbon leaf pondweed (Pontomageton epihydrus)	coontail (Ceratophyllum demersum)	common waterweed (Elodea canadensis)
1	3					4		
2	3		2	1		4		
3	3.5		2	1		3	1	
4	4		3			4		
5	3		3			4		
6	4.5				1	4		
7	5					4		
8	3.5					4		
9	4.5					4		
10	4		2			2		
11	6					4		
12	5.5					4		
13	4.5		2			4		
14	6					3		
15	6					4		1
16	3.5	1						
17	6.5					4		
18	3.5		2			2		
19	6					4		
20	3		2			1		
21	6					4		
22	4					3		
23	3.5		3			4		
24	3.5		2			4		
25	4.5					4		
26	3		4					

Species Density: 1-very sparce (barely any in rake tines), 4-very dense (covering all of rake tines)

Species density estimate graphic http://files.dnr.state.mn.us/assistance/grants/habitat/2007Protocols_pre-trt_data.pdf

Note: Water Below Normal Level

Survey Protocol: Point Intercept Method for Aquatic Plant Management (Madsen, 1999)


Wood Pile Lake
Macrophyte Survey 2009
2008 Air Photos
W1
W2
W3
W4
W5
W6
W7
W8
W9
W10
W11
W12
W13
W14
W15
W16
W17
W18
W19
W20
W21
0 50 100 200 300 400 500
Feet
N

Woodpile Lake Macrophyte Survey
Date: 6/2/2009

Site	Depth at Point (ft)	cattail_broad-leaved (Typha latifolia)	ribbon leaf pondweed (Pontomageton epihydrus)	large leaf pondweed (Potamogeton amplifolius)	curly leaf pondweed (Potomageton crispus)	coontail (Ceratophyllum demersum)	common waterweed (Elodea canadensis)	algae present
1	4				1		3	
2	5.5		1			1	1	
3	3.5					1	4	
4	4		1			4	1	
5	11						1	
6	23							
7	2	2		1	1	1	4	
8	3	3		2	1		4	
9	18							
10	22							
11	4		1	1	1	1	4	
12	4			1		1	4	x
13	10				1	1	1	
14	11					1	1	
15	?	2		1	2	2	4	
16	4	2		1		1	3	
17	?		3	3		3		
18	4		1	2		4		
19	4				1	1	3	x
20	4			1	1	1	3	
21	4.5			1	1	1	2	x

Species Density: 1-very sparce (barely any in rake tines), 4-very dense (covering all of rake tines)

Species density estimate graphic http://files.dnr.state.mn.us/assistance/grants/habitat/2007Protocols_pre-trt_data.pdf

Note: Water Below Normal Level

Survey Protocol: Point Intercept Method for Aquatic Plant Management (Madsen, 1999)

Woodpile Lake Macrophyte Survey
Date: 9/4/2009

Site	Depth at Point (ft)	cattail_broad-leaved (Typha latifolia)	ribbon leaf pondweed (Pontomageton epihydrus)	large leaf pondweed (Potamogeton amplifolius)	Illinois pondweed (Potamogeton illinoensis)	coontail (Ceratophyllum demersum)	common waterweed (Elodea canadensis)	algae present
1	4		1	1		1	4	x
2	4		4			1	3	x
3	5						4	x
4	1						4	x
5	13.5							
6	23.5							
7	3	2	2			2	4	x
8	3		1			2	3	x
9	12							
10	17							
11	5			2		1	1	x
12	3.5		1			2	4	x
13	5					2	4	
14	6						4	
15	3	1				1	4	x
16	1			1			3	x
17	6.5		1	4	2	1	2	x
18	3.5		2	3	1	4		
19	4			1		1	4	x
20	3.5			2	1	1	4	
21	2.5			3		1	4	

Species Density: 1-very sparce (barely any in rake tines), 4-very dense (covering all of rake tines)

Species density estimate graphic http://files.dnr.state.mn.us/assistance/grants/habitat/2007Protocols_pre-trt_data.pdf

Note: Water Below Normal Level

Survey Protocol: Point Intercept Method for Aquatic Plant Management (Madsen, 1999)