2007 WATER MONITORING REPORT

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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	Browns 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
TSS	Total Suspended Solids
µg/L	microgram per liter
µmhos/cm	micromhos per centimeter
VSS	Volatile Suspended Solids
WCD	Washington Conservation District

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 2000-2007 and previous monitoring seasons. In 2007, two stream monitoring sites were added to the monitoring program as part of the larger Brown's Creek TMDL (Total Maximum Daily Load) study; Brown's Creek Headwaters (at 110th St.) and Brown's Creek at Gateway Trail. In addition to these sites, 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, Goggins Lake, Kismet Basin, Long Lake, South School Section Lake, and Benz Lake. Brown's Creek was monitored at the Headwaters, Gateway Trail, Highway 15, McKusick Road, and Highway 96, and Long Lake drainage sites were monitored at 62nd St. and the Marketplace Pond (Figure 1). Three stream sites on Brown's Creek were sampled for macroinvertebrate data collected by volunteer stream monitors. The purpose of the monitoring program was to assess and document the current water quality conditions of the lakes and streams and to continue a long-term monitoring program which will enable the BCWD to identify trends associated with land use changes in their watershed.

In 2007, the 12 lakes monitored had good to very poor water quality ratings and were classified as mesotrophic (Bass Lake West), eutrophic (Kismet, Bass Lake East, Long Lake, Masterman Lake, Pat Lake, and Wood Pile Lake) and hypereutrophic (Benz Lake, Goggins Lake, South School Section Lake, July Avenue Wetland, and Lynch Lake). The overall 2007 lake grades for BCWD lakes were: Bass Lake West – B, Bass Lake East – B-, Wood Pile Lake – B-, South School Section Lake – D+, Masterman Lake – C+, Pat Lake – C+, Kismet Basin – C, Goggins Lake – F, Long Lake – C-, Benz Lake – F, July Avenue Wetland – F, Lynch Lake – F. Of the lakes with historical data available, four lakes showed a slight deterioration in water quality for the 2007 season (Bass Lake West, Benz Lake, Goggins Lake, and South School Section Lake), two lakes maintained their water quality (July Avenue and Lynch Lake), and six lakes improved in water quality (Bass Lake East, Kismet Basin, Long Lake, Masterman Lake, Pat Lake, and Wood Pile Lake). Goggins Lake, Long Lake, South School Section Lake, July Avenue Wetland,

Lynch Lake, and Benz Lake were considered worse than the ecoregion range for total phosphorus, total Kjeldahl nitrogen, chlorophyll-*a*, and Secchi disk transparency. Bass Lake East, Bass Lake West, Masterman Lake, and Pat Lake were within the ecoregion range for total phosphorus, total Kjeldahl nitrogen, chlorophyll-*a*, and Secchi disk transparency. In 2007, the Washington Conservation District conducted Kendal Tau statistical analysis of all lakes monitored by WCD for the first time to determine any long-term water quality trends. For Brown's Creek Watershed District lakes, only three lakes had a significant trend. Goggins Lake had a statistically significant decreasing Secchi transparency trend ($p<0.10$) and Kismet Basin and Long Lake both had significantly increasing Secchi disk transparency trends.

In 2007, BCWD added two stream monitoring stations to its existing network of stream monitoring sites as part of the Brown's Creek TMDL. New stations were installed to measure discharge, water chemistry, and water quality along Brown's Creek at the Browns' Creek Headwaters and at the Gateway Trail. BCWD continued monitoring stream/stormwater sites at: Brown's Creek at the mouth (Hwy 96), Brown's Creek at the Diversion Structure, Brown's Creek at McKusick Road, Brown's Creek at Hwy 15, 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 and Brown's Creek at Highway 96 showed decreased total discharges in 2007 compared to 2006 (Figure 9 and Figure 10). Of these six sites, Brown's Creek at Highway 15 and at Highway 96, Brown's Creek at the Diversion Structure, and Long Lake Inlet at 62nd St. showed reductions in total loads of TSS during the 2007 season compared to 2006 as well (Figure 10). Brown's Creek at McKusick Road, at Highway 15, and at the Diversion Structure showed reduced TP loads in 2007 compared to 2006 (Figure 9).

Temperatures in Brown's Creek in 2007 displayed some interesting results when looking at thermal impacts. The minimum daily temperature at Brown's Creek at the mouth's never exceeded 20° C (Figure 61), which is the temperature threshold where low impacts to trout survival are observed. Surprisingly, the Hwy 15 and McKusick Road sites

recorded no daily minimum temperatures above 20° C (Figure 59 and Figure 60). One important and equally interesting note is that the Headwaters and Diversion Structure sites have the highest daily maximum temperatures (Figure 75 and Figure 78). These large diurnal temperature swings are difficult to explain, but may be due to the lack of stream channel confinement in the wetland complexes upstream of Diversion Structure and Brown's Creek Headwaters. This lack of confinement may be allowing more surface area of water to be affected by atmospheric diurnal warming and cooling temperatures. The average daily temperature at the Hwy 15 site and the McKusick Road site had a little more variability in daily temperature fluctuation when compared to 2006. The main change seen in these 2007 data was the large divergence between each site compared Highway 96 (Figure 63 and Figure 64). Another interesting find in 2007 was that Brown's Creek at the Diversion Structure daily average temperatures were cooler than both the Hwy 15 site and the McKusick Road site during early summer months and substantially warmer from August to October (Figure 75 through Figure 80).

The MPCA and the MN DNR, as part of the Brown's Creek TMDL, conducted fisheries surveys in 2007 as well as historically as part of their biological monitoring programs. 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 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 2007, 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 the lake and stream water quality data collected by the Washington Conservation District (WCD) from 2000-2007 and previous monitoring seasons. In 2007, Brown's Creek Watershed District (BCWD) monitored twelve lakes: Bass Lake (East), Bass Lake (West), July Avenue Wetland, Lynch Lake, Masterman Lake, Pat Lake, Wood Pile Lake, Goggin's Lake, Kismet Basin, Long Lake, South School Section Lake, Benz Lake. Nine stream/stormwater sites were monitored and located at: Brown's Creek at the Headwaters (110th St.), Gateway Bike Trail, Hwy 15, McKusick Road, Highway 96, Brown's Creek Diversion Structure, Long Lake Inlet at 62nd St., and Long Lake Inlet at Marketplace Pond (Figure 1). Continuous elevation data were collected at two sites: Kern Center Pond and Bradshaw Funeral Home treatment system, and the data was provided to Emmons and Olivier Resources, Inc. for their reporting of BMP (Best Management Practice) performance. Multiple parameters were monitored at each lake and stream/stormwater site. Also included in this report are temperature data for 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 2007 included the following activities: bi-weekly sampling (14 sampling sessions) of Benz Lake, Masterman Lake, Goggin's Lake, Kismet Basin, Long 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, Lynch, Lake, Pat Lake, and Wood Pile Lake from April through October, and water elevation readings on sixteen water bodies. Five continuous monitoring stations were installed on Brown's Creek Headwaters, at Gateway Bike Trail, Highway 15, McKusick Road, and at Highway 96, two continuous monitoring stations were installed on inlets to Long Lake at 62nd St. and Marketplace Pond, and one continuous monitoring station was installed at the Brown's Creek Diversion Drainage from Long Lake. Table 1 summarizes monitoring

site locations and parameters monitored in 2007. The WCD performed the sampling for the BCWD. Metropolitan Council Environmental Services Lab performed the analytical lab analyses.

In 2007, BCWD in partnership with the WCD and MPCA, began a TMDL 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 districts and agencies collected any additional data that was 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 by the WCD for the BCWD are contained within this report.

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 at Mouth (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, Macroinvertebrates
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 Drive	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 Gateway Trail	Gateway Trail	Field Discharge Measurements and Grab Samples
Stream Monitoring	**8**	Brown's Creek Headwaters	110th St.	Discharge and Water Quality Composite Samples
Infiltration Monitoring	**9**	Bradshaw Property Pond	Curve Crest Blvd.	Elevation
Infiltration Monitoring	**10**	Kern Center Pond	Hwy 5	Elevation
Lake Monitoring	**11**	Kismet Basin	--	Surface Water Quality Samples, Elevation
Lake Monitoring	**12**	Long Lake	--	Surface Water Quality Samples, Elevation
Lake Monitoring	**13**	Goggin's Lake	--	Surface Water Quality Samples, Elevation
Lake Monitoring	**14**	South School Section Lake	--	Surface Water Quality Samples, Elevation
Lake Monitoring	**15**	Benz Lake	--	Surface Water Quality Samples, Elevation
Lake Monitoring	**16**	Masterman Lake	--	Surface Water Quality Samples, Elevation
Lake Monitoring	**17**	Wood Pile Lake	--	Surface Water Quality Samples, Elevation
Lake Monitoring	**18**	Lynch Lake	--	Surface Water Quality Samples, Elevation
Lake Monitoring	**19**	Bass Lake (West)	--	Surface Water Quality Samples, Elevation
Lake Monitoring	**20**	July Avenue Pond	--	Surface Water Quality Samples, Elevation
Lake Monitoring	**21**	Bass Lake (East)	--	Surface Water Quality Samples, Elevation
Lake Monitoring	**22**	Pat Lake	--	Surface Water Quality Samples, Elevation
Lake Monitoring	**23**	Hwy 12 & Kimbro Pond	--	Elevation
Lake Monitoring	**24**	Jackson Wildlife Management Area Pond	--	Elevation
Lake Monitoring	**25**	Plaisted Lake	--	Elevation
Lake Monitoring	**26**	Brown's Creek at Gateway Trail	--	Elevation
Lake Monitoring	**27**	55th St. Pond	--	Elevation

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

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

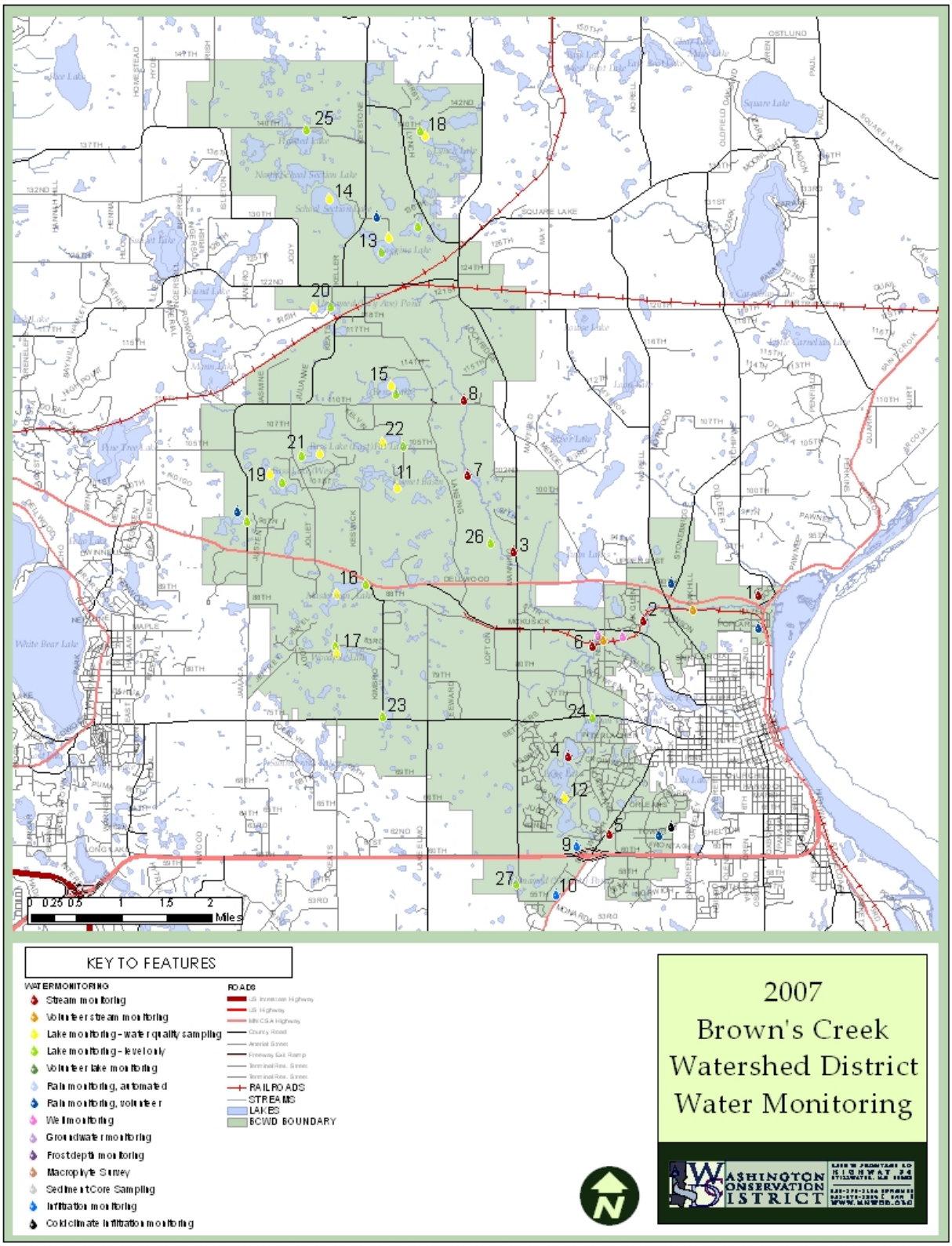


Figure 1: Sampling Location Map

II. LAKES

A. METHODS, RESULTS AND DISCUSSION

In 2007, water quality data was collected biweekly or monthly over seven consecutive months (April–October) by the WCD on Long Lake, Goggin's Lake, Kismet Basin, Benz Lake, South School Section Lake, Bass Lake East, Bass Lake West, July Avenue Wetland, Lynch Lake, Masterman Lake, Pat Lake, and Wood Pile Lake. 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. Total chloride ion concentrations were also collected and analyzed for Kismet Basin only. 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 at the Metropolitan Council's EIMS (Environmental Information Management System) Water Quality Database (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 2 through Figure 5 show the historic summer averages for each parameter.

Table 2: Ecoregion Values and Average 2007 Parameters

2007 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	0.157	88.00	2.0	3.39
Kismet	0.044	22.53	4.9	1.16
South School Section	0.064	48.89	3.4	1.61
Long	0.067	26.20	3.6	2.63
Benz	0.181	143.89	1.8	3.19
Bass East	0.043	15.24	7.8	1.14
Bass West	0.027	11.04	9.9	0.83
July Ave	0.294	437.20	0.5	9.40
Lynch	0.379	363.80	0.9	11.82
Masterman	0.042	16.17	6.4	1.01
Pat	0.046	9.20	5.8	0.91
Wood Pile	0.051	11.60	7.3	1.14

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 2007 study can be seen in Figure 2 and Table 2. Typical ranges for this ecoregion are 4.9 - 10.5 feet. Goggin's Lake, South School Section Lake, Long Lake, Benz Lake, July Avenue Wetland, and Lynch Lake had Secchi disk readings less (worse) than the ecoregion range, while Kismet Basin, Bass Lake East, Bass Lake West, Masterman, Pat, and Wood Pile Lake were within the ecoregion range and no lakes were better than the ecoregion rage 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 2007 summer average chlorophyll-*a* concentrations of BCWD lakes can be seen in Figure 3 and Table 2. The ecoregion value range for chlorophyll-*a* is 5-22 μg/L. Benz Lake, Goggin's Lake, Long Lake, Kismet Basin, South School Section Lake, July Avenue Wetland, and Lynch Lake exceeded (were poorer than) the ecoregion values for chlorophyll-*a*. Bass Lake East, Bass Lake West, Masterman Lake, Pat Lake, and Wood Pile Lake were within the ecoregion range and no lake was better than the ecoregion values 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 2007 can be found in Figure 4 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 East, Bass Lake West , Kismet Basin, Masterman Lake, and Pat Lake exceeded (were poorer than) the ecoregion value for total phosphorus in 2007.

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 2007 can be found in Figure 5 and Table 2. The ecoregion value range for total Kjeldahl nitrogen is 0.60-1.20 mg/L. Bass Lake East, Bass Lake West, Kismet Basin, Masterman Lake, Pat Lake, and Wood Pile Lake were within the ecoregion value range, but the

remaining lakes exceeded (were poorer than) the ecoregion values for total Kjeldahl nitrogen.

5. TEMPERATURE AND DISSOLVED OXYGEN

In addition to surface water measurements, a temperature and dissolved oxygen profile was 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 (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. South School Section Lake, Long Lake, Goggin's Lake, Bass Lake East, Bass Lake West, Kismet Basin, Masterman Lake, Pat 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, July Avenue Wetland, Lynch Lake, 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 2007 data and utilizing the Carlson's Trophic State Index (Table 3), Goggin's Lake, Benz Lake, July Avenue Wetland, South School Section Lake, and Lynch Lake are classified as hypereutrophic; Kismet Basin, Bass Lake East, Masterman Lake, Pat Lake, Long Lake, and Wood Pile Lake are classified as eutrophic; Bass Lake West is 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 2007; the grades are 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: 2007 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	F	F	F	**F**	Hypereutrophic
	77	75	67	**73**	
Kismet	C	C	C	**C**	Eutrophic
	59	61	54	**58**	
Long	C	C	D	**C-**	Eutrophic
	65	63	59	**62**	
S School Sec	C	D	D	**D+**	Hypereutrophic
	64	69	59	**64**	
Benz	F	F	F	**F**	Hypereutrophic
	79	79	68	**76**	
Bass East	C	B	B	**B-**	Eutrophic
	58	57	48	**54**	
Bass West	B	B	B	**B**	Mesotrophic
	52	54	47	**51**	
July Ave	F	F	F	**F**	Hypereutrophic
	86	90	89	**88**	
Lynch	F	F	F	**F**	Hypereutrophic
	90	88	84	**87**	
Masterman	C	B	C	**C+**	Eutrophic
	58	58	50	**55**	
Pat	C	B	C	**C+**	Eutrophic
	59	52	52	**54**	
Wood Pile	C	B	B	**B-**	Eutrophic
	61	55	48	**55**	

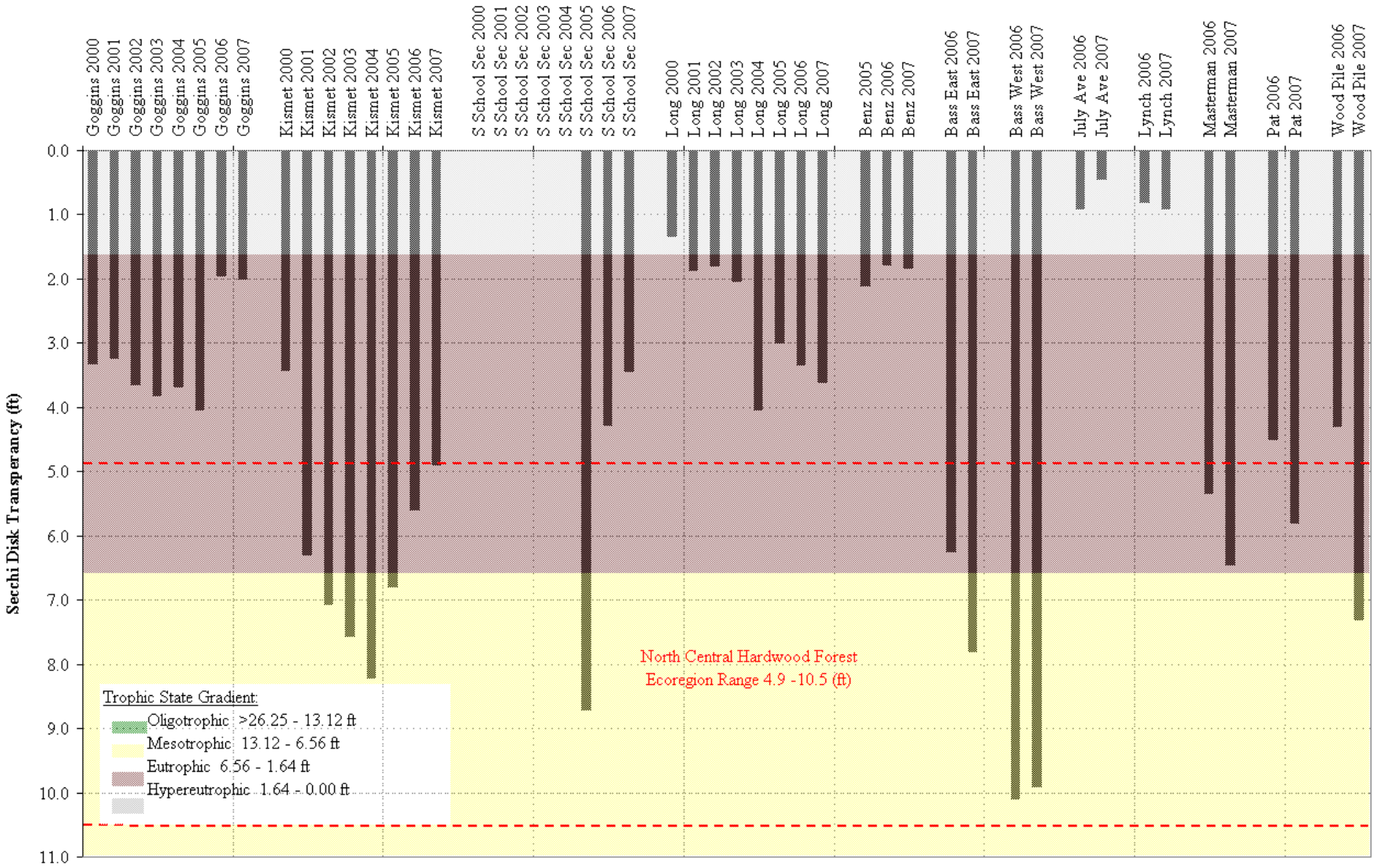


Figure 2: 2007 and Historic Secchi Records

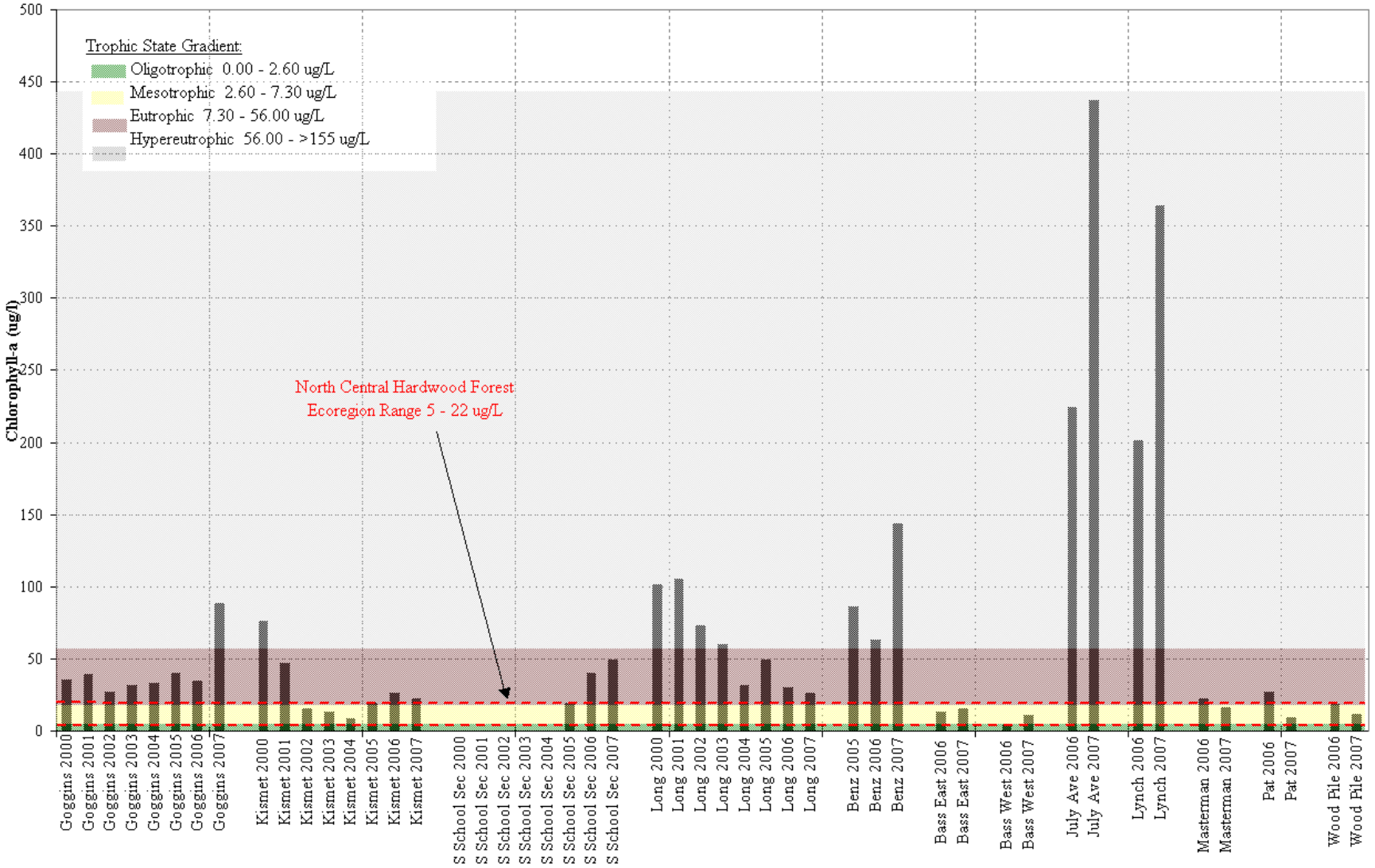


Figure 3: 2007 and Historic Chlorophyll-*a* Data

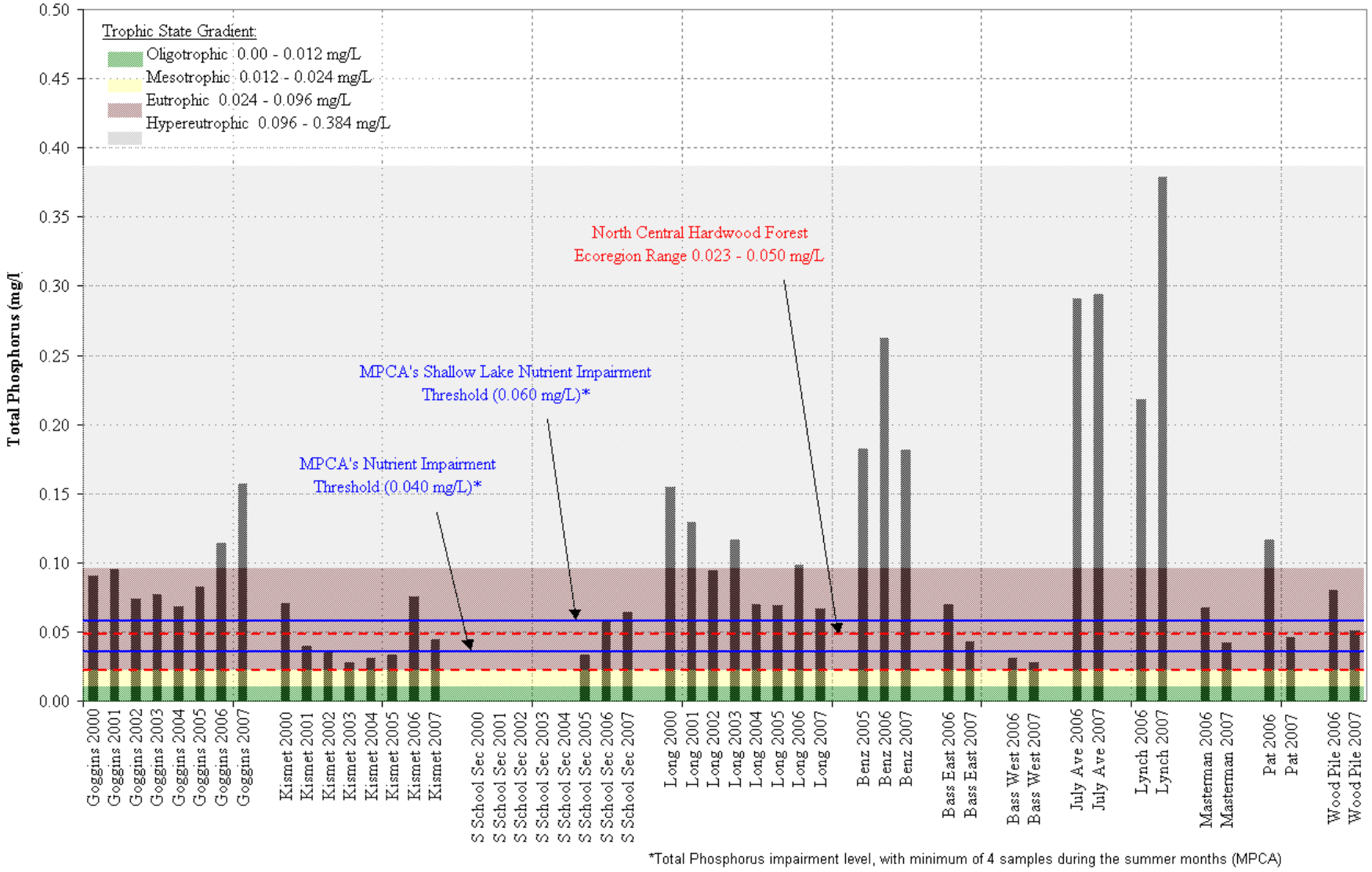


Figure 4: 2007 and Historic Total Phosphorus Data

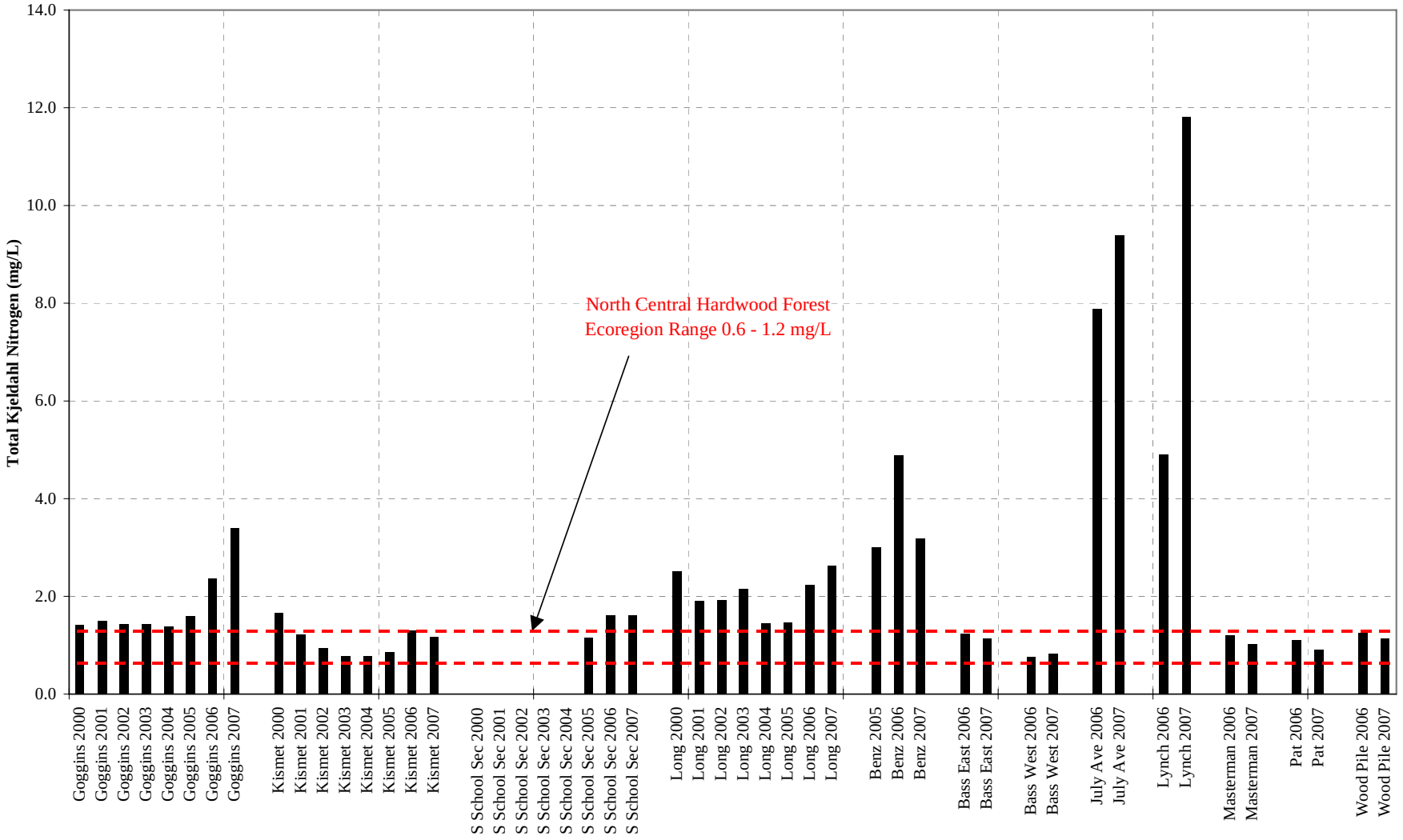


Figure 5: 2007 and Historic Total Kjeldahl Nitrogen Data

7. LAKE ELEVATIONS

Lake elevation gages are located on sixteen lakes and/or wetlands throughout BCWD and are monitored by both WCD staff and volunteers. Complete lake/wetland elevation data for 2007 can be found in Figure 7.

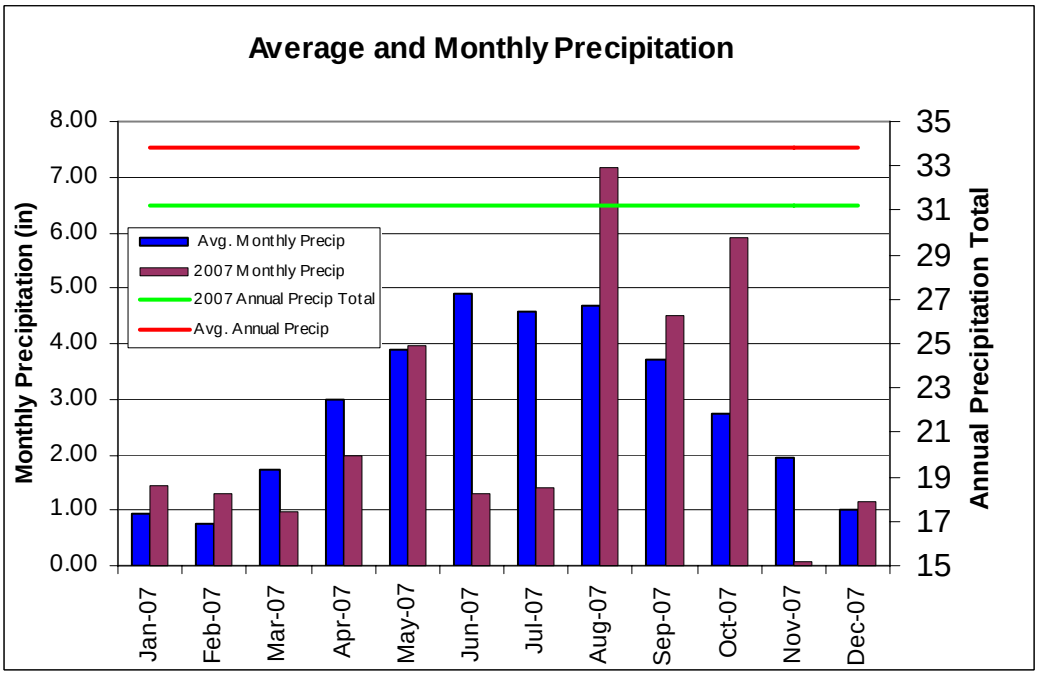
Brown's Creek Watershed District Hydrologic/Hydraulic Study November 1998 (H&H) developed an issues matrix to quantify and summarize flooding impacts. Impacts due to water elevations were determined relative to land that is normally not inundated such as septic systems, wells, residential structures, 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. Brown's Creek Watershed District completed the 2003 Hydrologic/Hydraulic Study. The issues matrix to quantify and summarize flooding impacts has remained unchanged in the 2003 H&H Study.

Despite the dry summers of 2003-2007, the elevations of some of the lakes in Brown's Creek Watershed District were within these developed flooding impact ranges (Table 6). Plaisted Lake, South School Section, Kismet Basin, and Wood Pile Lake were within the low impact range for portions of 2007.

Table 6: 2007 Water Elevation Flooding Impacts

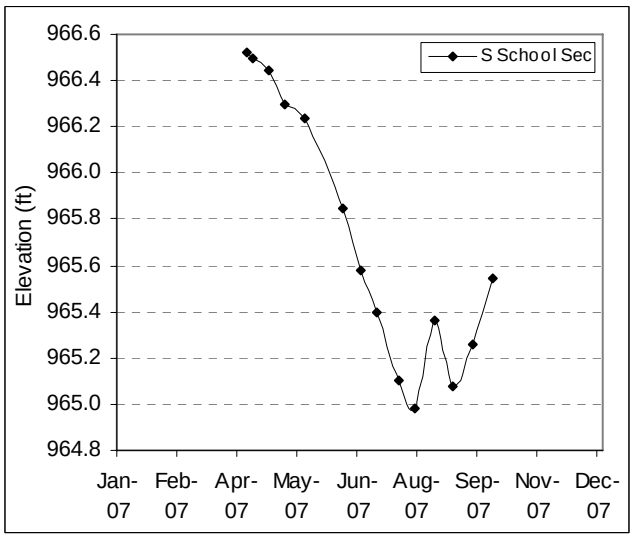
LAKE/WATERBODY	Average Elevation for 2007	Highest Elevation for 2007	Low Impact*	Moderate Impact*	High Impact*
Plaisted	965.73	966.36	*966.0-970.5*	*970.5-971.7*	*>971.7*
School Section	965.73	966.52	*965.3-971.0*	*971-977.2*	*>977.2*
Lynch	1003.68	1004.42	NA	NA	NA
Goggins	964.65	965.74	*966.5-968.2*	----	*>968.2*
July Avenue	969.21	970.53	NA	NA	NA
Benz	953.43	954.03	NA	NA	NA
Bass (West)	950.64	951.30	NA	NA	NA
Unnamed (Bass {East})	954.86	955.79	NA	NA	NA
Pat	939.66	940.47	NA	NA	NA
Kismet	939.79	940.75	*<940.6*	*940.6-946.6*	*>946.6*
BC at Gateway Trail	908.12	909.21	NA	NA	NA
Unnamed 82-0128	978.38	979.23	NA	NA	NA
Masterman	953.19	953.88	NA	NA	NA
Wood Pile	964.61	965.37	*<968.5*	NA	NA
Kimbro and Hwy 12	925.99	926.82	NA	NA	NA
Jackson WMA	889.42	890.32	NA	NA	>893.4
Long	889.67	890.20	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 6: Annual and Monthly Precipitation


S School Sec
Elevation (ft)
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966.4
966.2
966.0
965.8
965.6
965.4
965.2
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964.8
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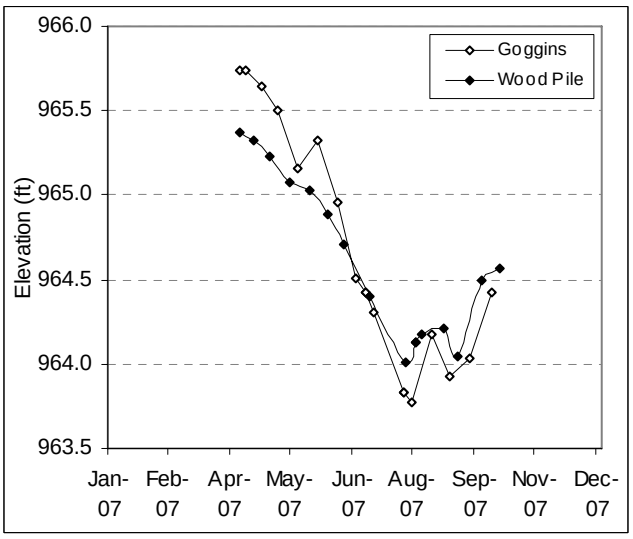
Nov-07
Dec-07


Goggins
Wood Pile
Elevation (ft)
966.0
965.5
965.0
964.5
964.0
963.5
Jan-07
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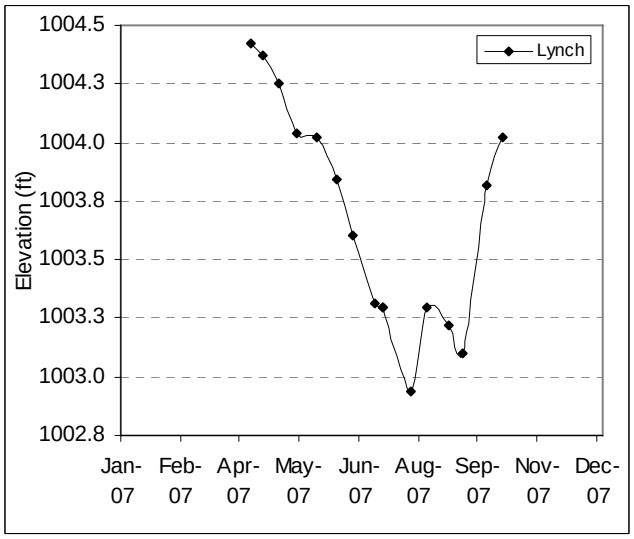
Nov-07
Dec-07


Lynch
Elevation (ft)
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1004.3
1004.0
1003.8
1003.5
1003.3
1003.0
1002.8
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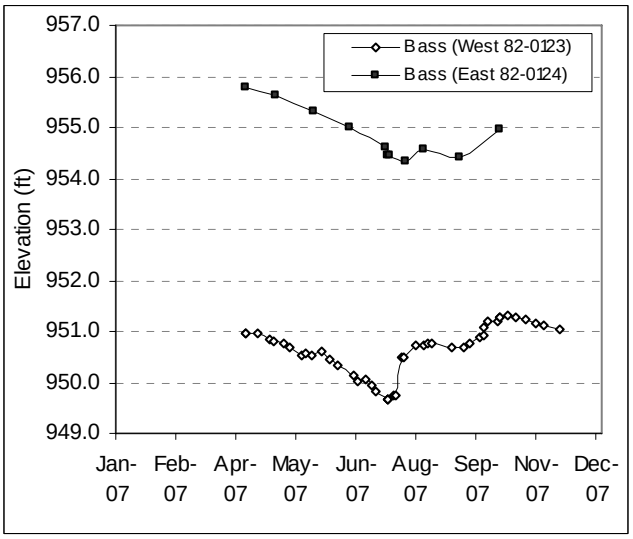
Nov-07
Dec-07


Bass (West 82-0123)
Bass (East 82-0124)
Elevation (ft)
957.0
956.0
955.0
954.0
953.0
952.0
951.0
950.0
949.0
Jan-07
Feb-07
Apr-07
May-07
Jun-07
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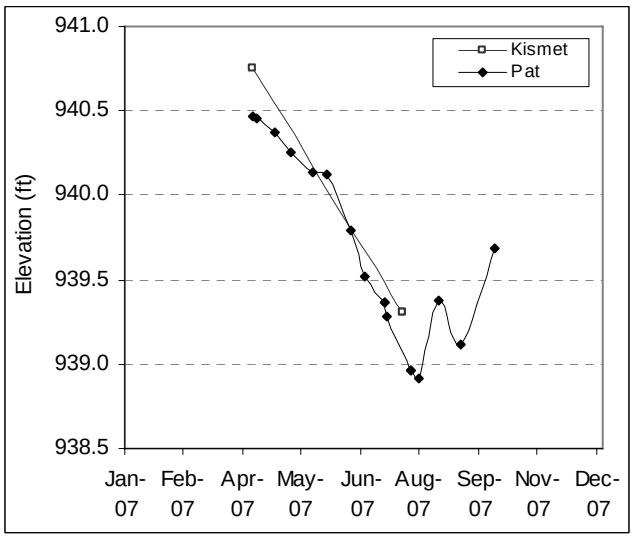
Kismet
Pat
Elevation (ft)
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940.0
939.5
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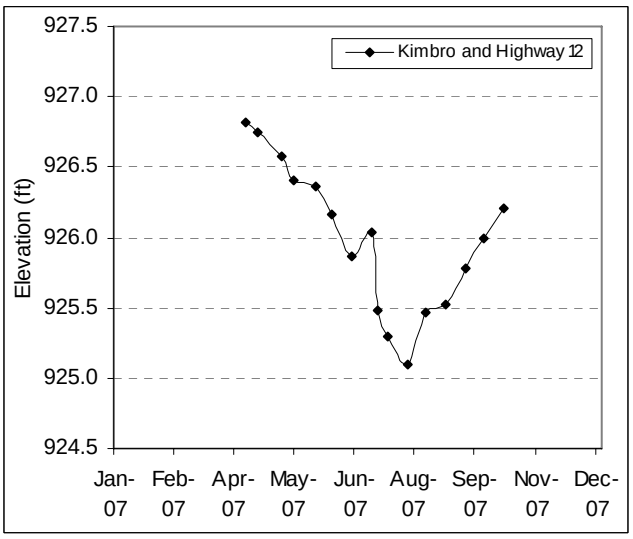
Dec-07


Kimbro and Highway 12
Elevation (ft)
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926.5
926.0
925.5
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924.5
Jan-07
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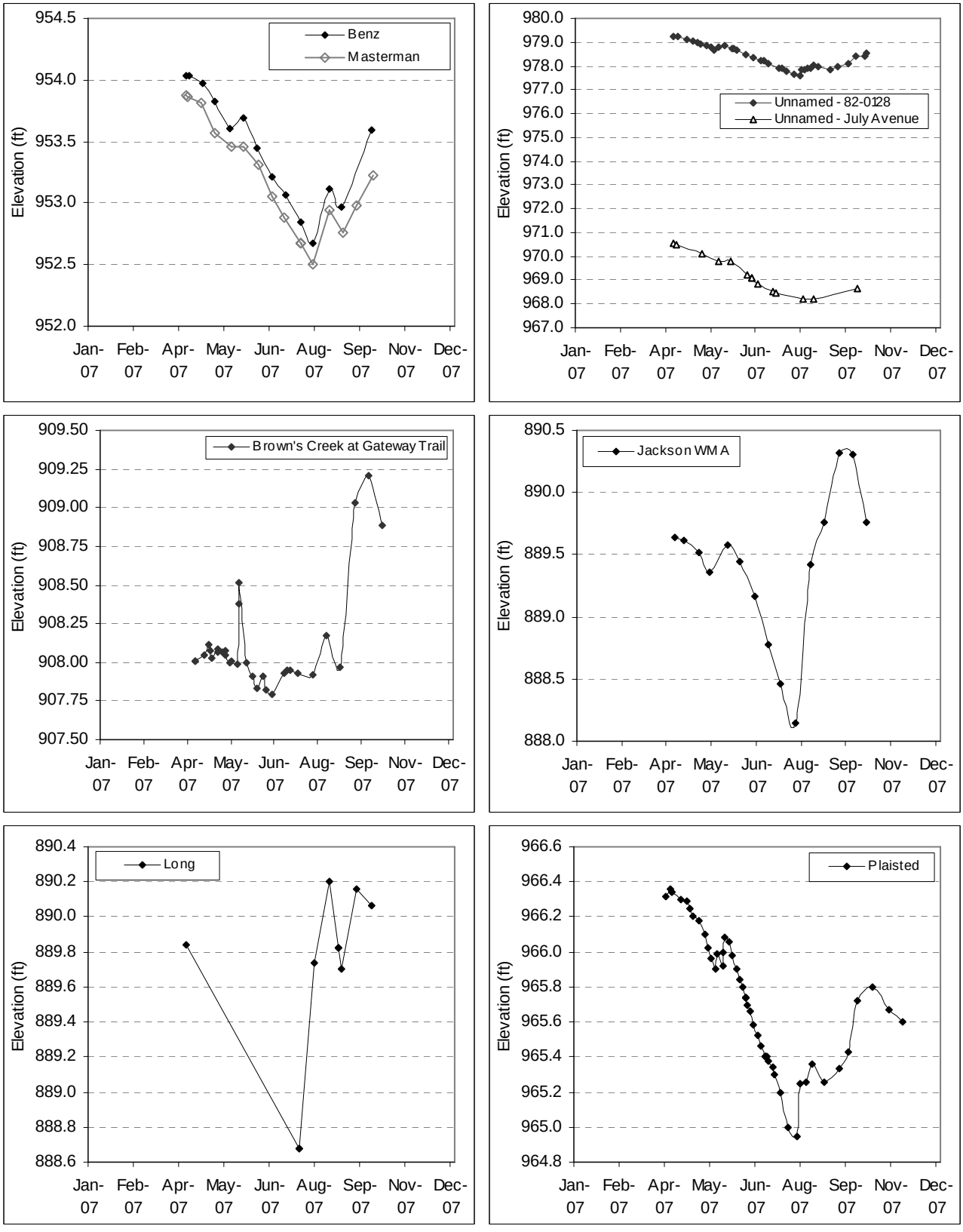


Figure 7: 2007 Lake Levels

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 and with other lakes in the region.

In 2007, the 12 lakes monitored had good to very poor water quality ratings and were classified as mesotrophic (Bass Lake West), eutrophic (Kismet Basin, Bass Lake East, Long Lake, Masterman Lake, Pat Lake, and Wood Pile Lake) and hypereutrophic (Benz Lake, Goggin's Lake, South School Section Lake, July Avenue Wetland, and Lynch Lake). The overall 2007 lake grades for BCWD lakes were: Bass Lake West – B, Bass Lake East – B-, Wood Pile Lake – B-, South School Section Lake – D+, Masterman Lake – C+, Pat Lake – C+, Kismet Basin – C, Goggin's Lake – F, Long Lake – C-, Benz Lake – F, July Avenue Wetland – F, and Lynch Lake – F. Four lakes showed a slight deterioration in water quality for the 2007 season (Base Lake West, South School Section, Goggin's, and Benz), two lakes maintained their water quality (July Avenue Wetland and Lynch), and six lakes improved in water quality (Bass East, Wood Pile, Masterman, Pat, Kismet, and Long). Goggin's, Long, South School Section, July Avenue, Lynch, and Benz Lakes were considered worse than the ecoregion range for total phosphorus, total Kjeldahl nitrogen, chlorophyll-*a*, and Secchi disk transparency. Bass East, Bass West, Masterman, and Pat Lakes were within the ecoregion range for total phosphorus, total Kjeldahl nitrogen, chlorophyll-*a*, and Secchi disk transparency. Kismet Basin was worse than the ecoregion for chlorophyll-a but within the ecoregion ranges for total phosphorus, total Kjeldahl nitrogen, and Secchi disk transparency. Wood Pile Lake was worse than the ecoregion ranges for total phosphorus and within the ranges for chlorophyll-a, Secchi disk transparency, and total Kjeldahl nitrogen.

The Washington Conservation District conducted Kendal Tau statistical analysis of all lakes monitored by WCD for the first time to determine any long-term water quality trends. For Brown's Creek Watershed District lakes, only three lakes had a significant trend. Goggins Lake had a statistically significant decreasing Secchi transparency trend

($p<0.10$) and Kismet Basin and Long Lake both had significantly increasing Secchi disk transparency trends.

Water quality in a lake depends on a number of different variables such as: size of the contributing watershed, depth of the lake, and current amount of nutrients available and periodically released from the lake bottom, as well as external nutrient 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 2007, both deep and shallow lakes throughout the county showed water quality degradation. One explanation for this countywide degradation is the very 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 breaking chemical and sediment bonds and releasing 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. This warm weather certainly allowed the mixing of the 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 shorter periods of time 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 early May and late October of 2007. Levels steadily declined from May until October. 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 in the low 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 8). 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

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

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

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

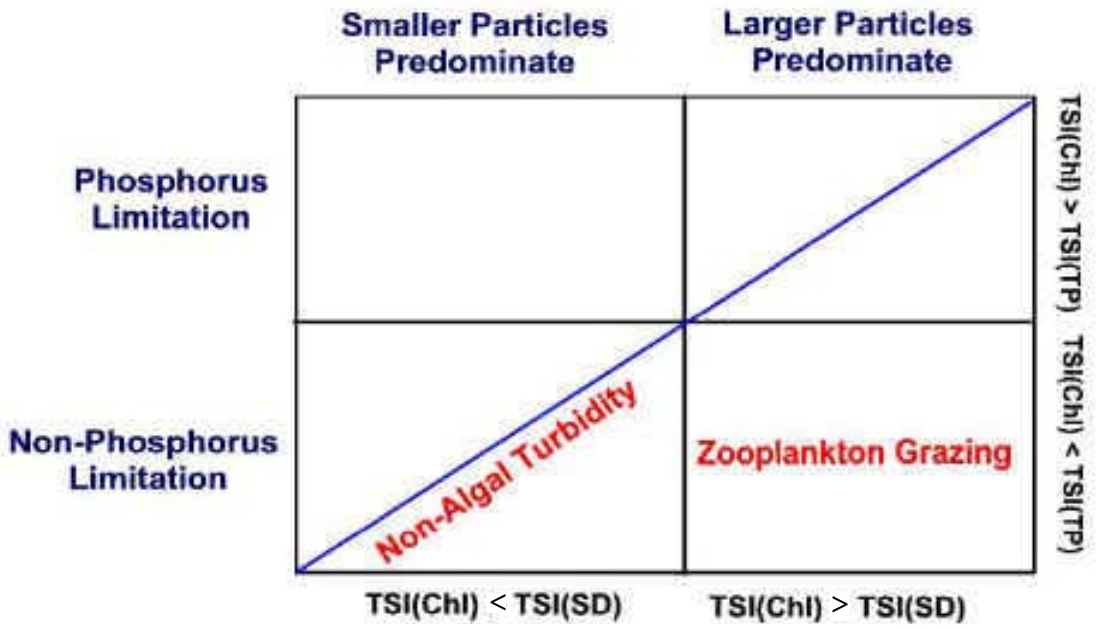
Table 8: Trophic State Gradient

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 8: 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 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.

1. FLOW AND WATER QUALITY

In 2007, the WCD took grab samples and/or flow-weighted samples during both baseflow and storm event conditions at eight locations within the watershed. Six automated samplers continuously monitored stream flow and collected storm and baseflow composite samples from March through November and one continuously monitored stream flow all year (Brown's Creek at Hwy 96). Brown's Creek was monitored at 110th Street, approximately 5.5 miles from the mouth, Gateway Trail, approximately 5.0 miles from the mouth, Highway 15, approximately 4.5 miles from the mouth, McKusick Road, approximately 1.7 miles from the mouth and at Highway 96, 0.2 miles from the mouth of the Creek (Figure 1). Tributaries to Long Lake were monitored at 62nd Street (south drainage to Long Lake), and the Marketplace pond (~0.5 miles southeast of Long Lake) (Figure 1). 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 (Figure 1). Data collected by the WCD included the total discharge, temperature, precipitation, conductivity, dissolved oxygen, pH, and analytical analysis (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 2007 can be found on pages 31-96. Historical ranges for water quality samples collected on Brown's Creek can be seen starting with Figure 9. All historical data (2000-2006) is available in Appendix B. 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 2007, 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 9 and Figure 10). The lack in overall runoff during the 2003 to 2007 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, and 2006-07 and the dry summers of 2003-2007 primarily caused the runoff reduction experienced in 2003-2007.

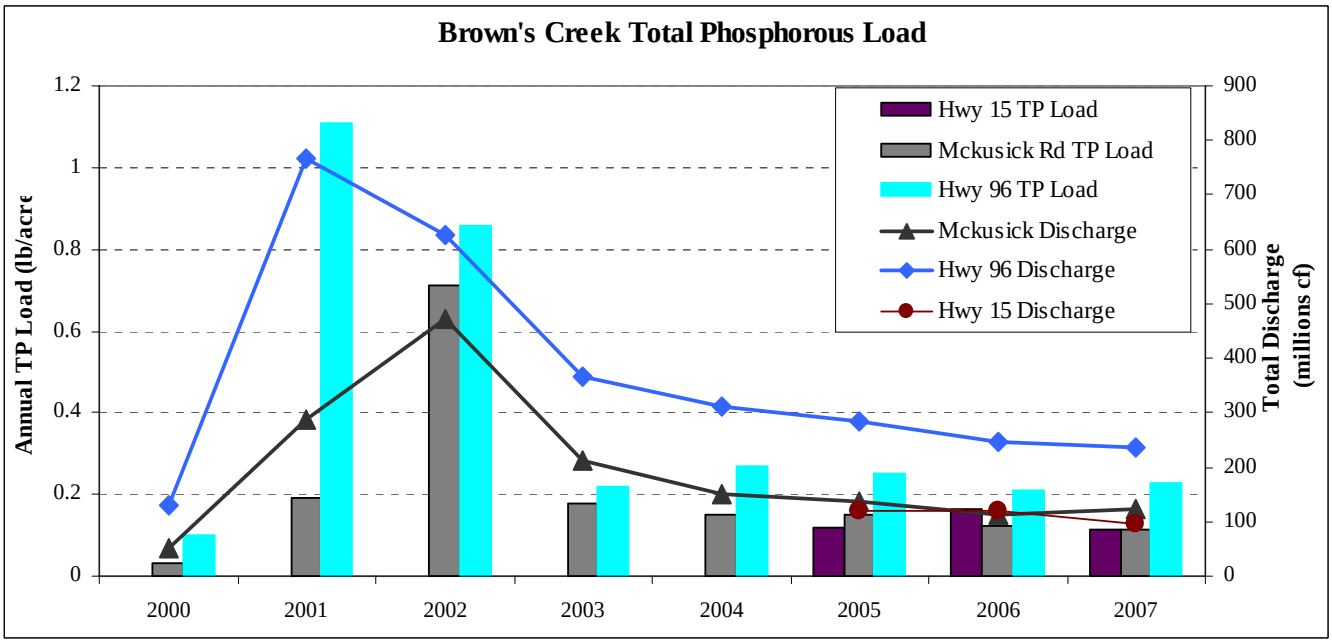


Figure 9: Brown's Creek Annual Total Phosphorous Loads

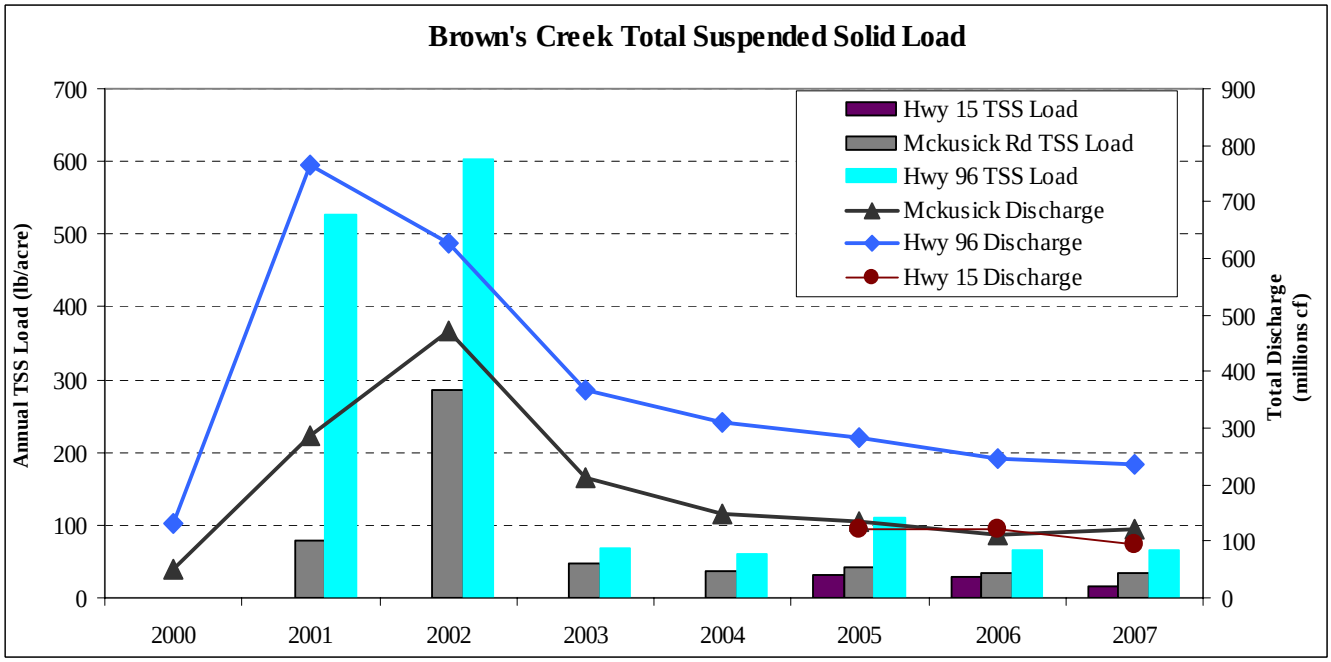


Figure 10: BCWD Annual Total Suspended Solids Loads

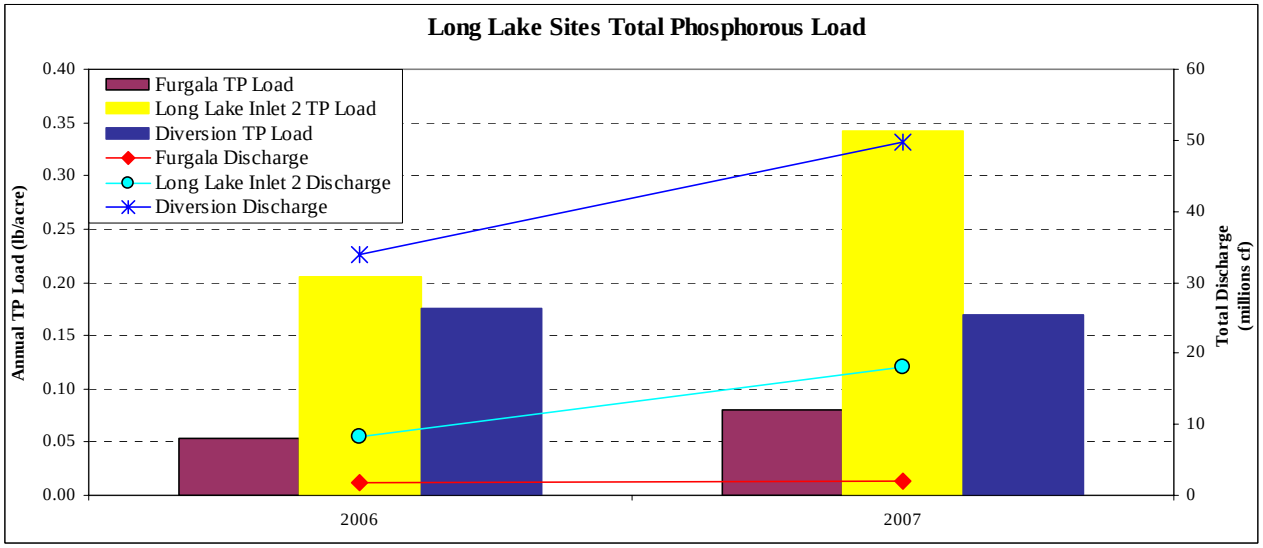


Figure 11: Long Lake Drainage Sites Total Phosphorous Loads

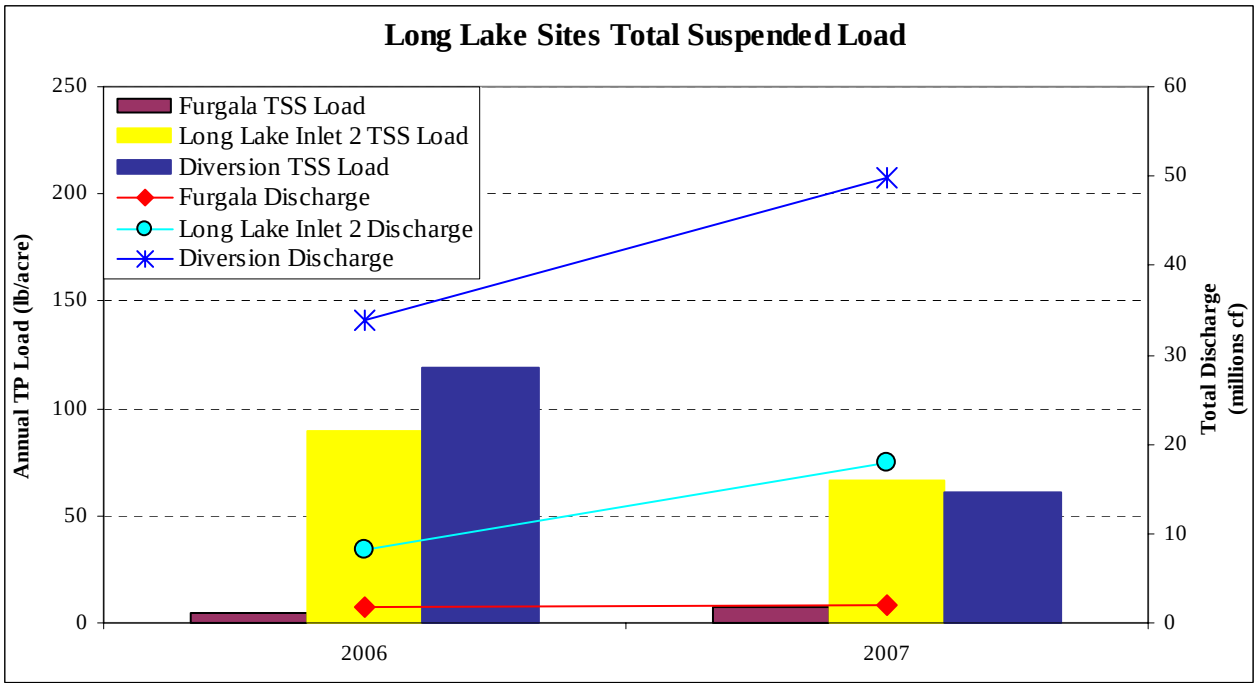


Figure 12: Long Lake Drainage Sites Total Suspended Solids Loads

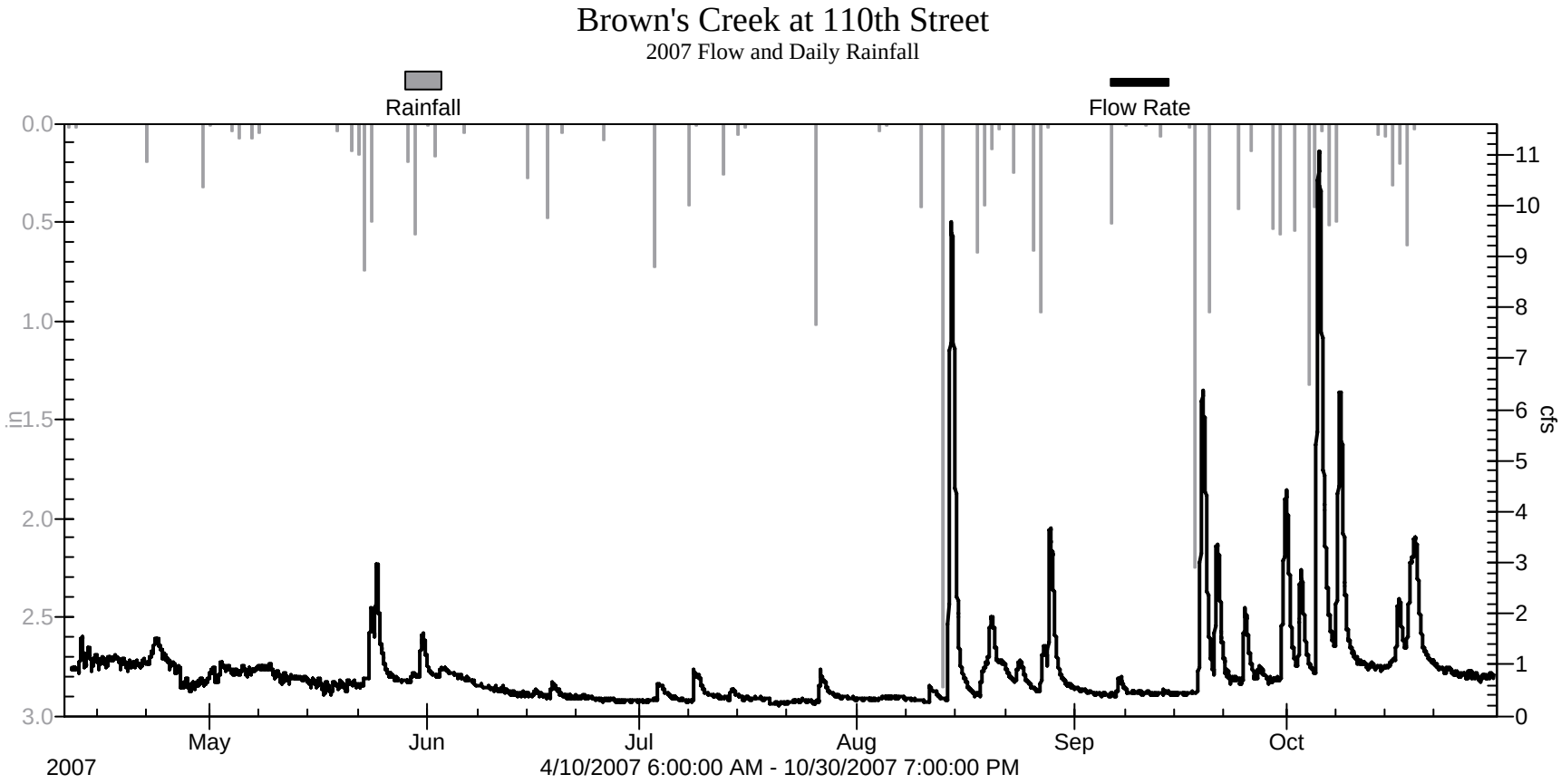


Figure 13: Brown's Creek at 110th Street 2007 Flow and Daily Rainfall

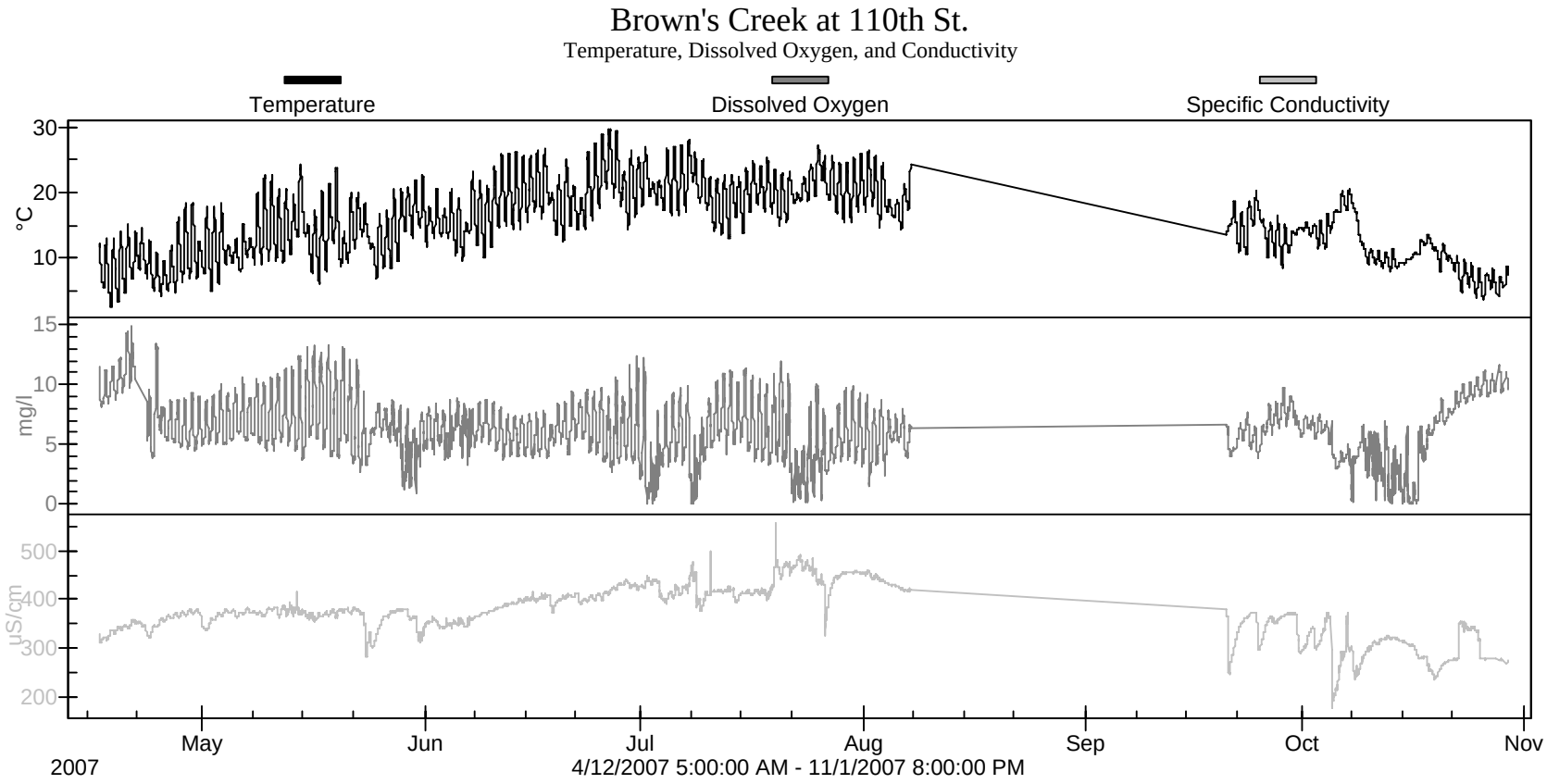


Figure 14. Brown's Creek at 110th Street 2007 15-Minute Recorded Temperature, Dissolved Oxygen, and Conductivity

Table 10. Brown's Creek at 110th Street 2007 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 TP (lb)**	**Interval TSS (lb)**
*Base***			*49*	*0.63*	*1/1/2007 0:00*	*4/11/2007 11:15*	*2,604,150*	*102.74*	*7,905*
Base Composite	4/19/2007 10:59	4/22/2007 12:57	14	0.08	4/11/2007 11:15	4/24/2007 11:15	1,238,897	*6.03*	*1,083*
Base Grab	4/24/2007 11:43	4/24/2007 11:43	12	0.08	4/24/2007 11:15	5/10/2007 10:15	1,154,922	*5.55*	*865*
Base Grab	5/10/2007 10:30	5/10/2007 10:30	3	0.07	5/10/2007 10:15	5/16/2007 13:15	379,870	*1.68*	*71*
Base Grab	5/16/2007 14:12	5/16/2007 14:12	3	0.08	5/16/2007 13:15	5/23/2007 15:15	368,553	*1.73*	*69*
Storm Composite	5/23/2007 17:21	5/25/2007 20:43	27	0.13	5/23/2007 15:15	5/25/2007 21:15	350,988	*2.78*	*592*
Base			*49*	*0.63*	*5/25/2007 21:15*	*5/30/2007 19:15*	*319,806*	*12.62*	*971*
Storm			*400*	*0.95*	*5/30/2007 19:15*	*5/31/2007 20:15*	*121,902*	*7.26*	*3,045*
Base Grab	6/13/2007 8:37	6/13/2007 8:37	2	0.07	5/31/2007 20:15	6/18/2007 12:15	917,481	*3.89*	*115*
Storm Grab	6/18/2007 15:30	6/18/2007 15:30	4	0.12	6/18/2007 12:15	6/18/2007 19:15	15,306	*0.11*	*4*
Base Grab	6/28/2007 9:04	6/28/2007 9:04	1	0.06	6/18/2007 19:15	7/3/2007 14:15	433,621	*1.68*	*27*
Storm			*400*	*0.95*	*7/3/2007 14:15*	*7/4/2007 9:15*	*38,897*	*2.32*	*972*
Base			*49*	*0.63*	*7/4/2007 9:15*	*7/8/2007 16:15*	*130,361*	*5.14*	*396*
Storm			*400*	*0.95*	*7/8/2007 16:15*	*7/9/2007 19:15*	*73,413*	*4.37*	*1,834*
Base Composite	7/16/2007 11:09	7/19/2007 10:06	121	3.72	7/9/2007 19:15	7/26/2007 15:15	485,783	*112.81*	*3,669*
Storm Composite	7/26/2007 16:13	7/26/07 18:51	*400*	*0.95*	7/26/2007 15:15	7/27/2007 19:15	67,402	*4.02*	*1,684*
Base			*49*	*0.63*	*7/27/2007 19:15*	*8/11/2007 4:15*	*427,327*	*16.86*	*1,297*
Storm Composite	8/11/2007 5:58	8/12/2007 0:51	*400*	*0.95*	8/11/2007 4:15	8/11/2007 21:15	31,099	*1.85*	*777*
Base			*49*	*0.63*	*8/11/2007 21:15*	*8/13/2007 21:15*	*64,484*	*2.54*	*196*
Storm Composite	8/13/2007 21:50	8/14/2007 6:33	704	1.46	8/13/2007 21:15	8/15/2007 12:15	746,879	*68.07*	*32,824*
Base			*49*	*0.63*	*8/15/2007 12:15*	*8/18/2007 10:15*	*156,334*	*6.17*	*475*
Storm Composite	8/19/2007 18:37	8/20/2007 12:09	594	2.06	8/18/2007 10:15	8/21/2007 20:15	350,765	*45.11*	*13,007*
Base			*49*	*0.63*	*8/21/2007 20:15*	*8/23/2007 14:15*	*122,220*	*4.82*	*371*
Storm			*400*	*0.95*	*8/23/2007 14:15*	*8/24/2007 15:15*	*87,643*	*5.22*	*2,189*
Base			*49*	*0.63*	*8/24/2007 15:15*	*8/27/2007 2:15*	*126,538*	*4.99*	*384*
Storm			*400*	*0.95*	*8/27/2007 2:15*	*8/28/2007 3:15*	*103,847*	*6.19*	*2,594*
Storm Composite	8/28/2007 5:37	8/28/2007 19:31	355	0.99	8/28/2007 3:15	8/29/2007 5:15	256,225	*15.84*	*5,678*
Base			*49*	*0.63*	*8/29/2007 5:15*	*9/6/2007 21:15*	*404,964*	*15.98*	*1,229*
Storm			*400*	*0.95*	*9/6/2007 21:15*	*9/7/2007 22:15*	*58,490*	*3.48*	*1,461*
Base Composite	9/14/2007 10:49	9/17/2007 8:51	233	0.91	9/7/2007 22:15	9/18/2007 6:15	399,160	*22.55*	*5,806*
Storm Composite	9/18/2007 17:29	9/19/2007 14:47	808	1.16	9/18/2007 6:15	9/19/2007 23:15	518,851	*37.57*	*26,171*
Base			*49*	*0.63*	*9/19/2007 23:15*	*9/20/2007 18:15*	*78,523*	*3.10*	*238*
Storm			*400*	*0.95*	*9/20/2007 18:15*	*9/21/2007 20:15*	*238,473*	*14.21*	*5,957*
Base			*49*	*0.63*	*9/21/2007 20:15*	*9/24/2007 18:15*	*205,907*	*8.12*	*625*
Storm			*400*	*0.95*	*9/24/2007 18:15*	*9/25/2007 20:15*	*148,717*	*8.86*	*3,715*
Base			*49*	*0.63*	*9/25/2007 20:15*	*9/30/2007 2:15*	*291,163*	*11.49*	*884*
Storm Composite	9/30/2007 9:36	10/1/2007 13:19	660	1.55	9/30/2007 2:15	10/1/2007 14:15	371,629	*35.96*	*15,312*
Base			*49*	*0.63*	*10/1/2007 14:15*	*10/2/2007 13:15*	*105,310*	*4.15*	*320*
Storm			*400*	*0.95*	*10/2/2007 13:15*	*10/3/2007 15:15*	*194,767*	*11.60*	*4,865*
Base			*49*	*0.63*	*10/3/2007 15:15*	*10/5/2007 2:15*	*133,795*	*5.28*	*406*
Storm Composite	10/5/2007 5:55	10/6/2007 3:27	49	0.17	10/5/2007 2:15	10/6/2007 13:15	884,502	*9.44*	*2,706*
Base			*49*	*0.63*	*10/6/2007 13:15*	*10/7/2007 23:15*	*238,500*	*9.41*	*724*
Storm			*400*	*0.95*	*10/7/2007 23:15*	*10/9/2007 14:15*	*546,029*	*32.53*	*13,639*
Base			*49*	*0.63*	*10/9/2007 14:15*	*10/16/2007 11:15*	*629,132*	*24.82*	*1,910*
Storm			*400*	*0.95*	*10/16/2007 11:15*	*10/17/2007 10:15*	*154,985*	*9.23*	*3,871*
Base			*49*	*0.63*	*10/17/2007 10:15*	*10/17/2007 22:15*	*63,478*	*2.50*	*193*
Storm			*400*	*0.95*	*10/17/2007 22:15*	*10/20/2007 2:15*	*487,551*	*29.05*	*12,178*
Base			*49*	*0.63*	*10/20/2007 2:15*	*10/30/2007 10:45*	*807,272*	*31.85*	*2,450*
*Base***			*49*	*0.63*	*10/30/2007 10:45*	*12/31/2007 23:45*	*1,621,080*	*63.96*	*4,921*
Storm Average			400	0.95					
Base Average			49	0.63					
All Average			224	0.79					
Total							**19,756,987**	**848**	**192,670**
Brown's Creek Major Subwatershed Total Acres							1,817		
Total TP/TSS(lb/ac/yr)								0.47	106.04
Total TP/TSS (kg/ha/yr)								0.52	118.85

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

** Interval volumes from 1/1/07 to 4/11/07 and 10/30/07 to 1/1/08 were estimated using base flow

Table 11. Brown's Creek at 110th Street 2007 Primary Chemistry Result Averages

Parameter	Storm Flow Average	Base Flow Average	Average (all samples)
TSS (mg/L)	1096	49	570
VSS (mg/L)	688	32	358
TKN (mg/L)	17.4	1.57	9.47
TP (mg/L)	2.30	0.63	1.44
E. Coli (mpn/100 mL)	--	--	759

Table 12. Brown's Creek at 110th Street 2007 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)	Alkalinity (mg/L)	Turbidity (NTU)
Base Composite	4/19/07 10:59	4/22/07 12:57	14	10	0.68	0.078	<0.010		26	4.1	1.9	1.4		5
Base Grab	4/24/07 11:43	4/24/07 11:43	12	8	0.72	0.077	~0.014		26	4.2	1.4	1.0	145	4
Storm Composite	5/23/07 17:21	5/25/07 20:43	27	18	1.60	0.127	<0.010		51	12.1	3.2	2.0		8
E. coli Grab	5/2/07 11:50	5/2/07 11:50						104						
Base Grab	5/10/07 10:30	5/10/07 10:30	3	2	0.64	0.071	~0.043		18	4.8	1.2			2
Base Grab	5/16/07 14:12	5/16/07 14:12	3	2	0.45	0.075	~0.016		17	5.6	<1.1			2
E. coli Grab	6/13/07 10:56	6/13/07 10:56						667						
Base Grab	6/7/07 8:37	6/7/07 8:37	~2	2	0.39	0.068	~0.043		22		<1.0	<1.0		3
Storm Grab	6/18/07 15:30	6/18/07 15:30	4	3	0.92	0.117	~0.038		20	5.3	<1.0	<1.0		5
Base Grab	6/28/07 9:04	6/28/07 9:04	~1	1	0.28	0.062	~0.028		~13	3.6	<1.0	<1.0		3
E. coli Grab	7/16/07 10:25	7/16/07 10:25						345						
Base Composite	7/16/07 11:09	7/19/07 10:06	121	78	2.30	3.720	~0.011		116	9.6				28
Storm Composite	7/26/07 16:13	7/26/07 18:51	5150	3150	80.00	9.330			3010					
Storm Composite	8/11/07 5:58	8/12/07 0:51	1520	930	28.00	3.810	~0.038		1220	12.9	39.0	22.0		270
Storm Composite	8/13/07 21:50	8/14/07 6:33	704	436	12.00	1.460	0.087		516	17.0	<16.0	<18.0		120
Storm Composite	8/19/07 18:37	8/20/07 12:09	594	396	8.70	2.060	~0.035		282	14.1	5.4	3.9		45
Storm Composite	8/28/07 5:37	8/28/07 19:31	355	250	6.50	0.990	0.067		288	15.2	12.0	7.3		60
E. coli Grab	8/28/07 9:30	8/28/07 9:30						>2420						
Base Composite	9/14/07 10:49	9/17/07 8:51	233	149	7.10	0.905	~0.023		194	4.1	5.4	<3.0		55
Storm Composite	9/18/07 17:29	9/19/07 14:47	808	516	8.60	1.160	0.087		419	15.8	4.6	1.9		120
Storm Composite	9/30/07 9:36	10/1/07 13:19	660	468	10.00	1.550	0.056		385	16.4	9.3	4.0		88
Storm Composite	10/5/07 5:55	10/6/07 3:27	49	30	1.50	0.171	0.082		65	13.9	1.3	1.1		10
E. coli Grab	10/18/07 8:45	10/18/07 8:45						259						

Exceeds Water Quality Standard

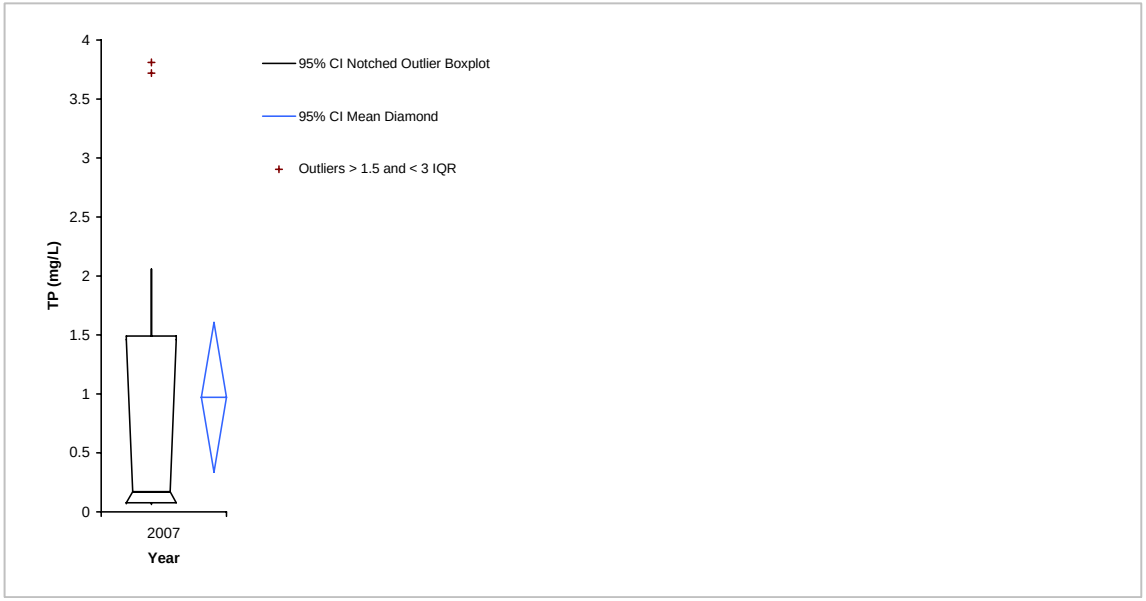
Table 13. Brown's Creek at 110th Street 2007 Secondary Chemistry Results including Exceeded MPCA 7050 Water Quality Standards

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)
Base Composite	4/19/07 10:59	4/22/07 12:57	0.0039	0.00030	0.00170	0.0064	0.00008	0.0019	19	<0.03	0.80	~0.04	
Base Grab	4/24/07 11:43	4/24/07 11:43	0.0008	0.00030	0.00150	0.0040	0.00006	0.0009	19	<0.03	0.72	~0.04	144
Storm Composite	5/23/07 17:21	5/25/07 20:43	0.0013	0.00040	0.00170	0.0069	0.00010	0.0009	17	<0.03	0.21	~0.02	
E. coli Grab	5/2/07 11:50	5/2/07 11:50											
Base Grab	5/10/07 10:30	5/10/07 10:30	<0.0005	0.00010	0.00160	0.0022	<0.00004	0.0014	21	<0.03	0.74	~0.03	
Base Grab	5/16/07 14:12	5/16/07 14:12	<0.0005	<0.00007	0.00140	0.0024	<0.00004	<0.0002	21	0.04	0.93	~0.04	
E. coli Grab	6/13/07 10:56	6/13/07 10:56											
Base Grab	6/7/07 8:37	6/7/07 8:37	<0.0005	<0.00007	0.00140	0.0011	<0.00004	0.0004	18	<0.03	0.88	~0.03	176
Storm Grab	6/18/07 15:30	6/18/07 15:30	0.0006	0.00170	0.00010	0.0008	<0.00004	0.0005		0.03	0.84	0.08	180
Base Grab	6/28/07 9:04	6/28/07 9:04	0.0008	0.00190	<0.00007	0.0014	<0.00004	0.0007	23	<0.03	0.94	~0.05	200
E. coli Grab	7/16/07 10:25	7/16/07 10:25											
Base Composite	7/16/07 11:09	7/19/07 10:06	0.0019	0.00220	0.00200	0.0074	0.00020	0.0031	24	<0.03	0.55	0.07	190
Storm Composite	7/26/07 16:13	7/26/07 18:51							19			0.34	300
Storm Composite	8/11/07 5:58	8/12/07 0:51	0.0146	0.01400	0.03200	0.0710	0.00260	0.035	24	<0.03	0.05	<0.02	170
Storm Composite	8/13/07 21:50	8/14/07 6:33	0.0070	0.00630	0.01040	0.0300	<0.0005	0.0157	11	<0.03	0.29	<0.02	68
Storm Composite	8/19/07 18:37	8/20/07 12:09	0.0032	0.00350	0.00400	0.0130	<0.0005	0.0068	13	<0.03	<0.05	<0.02	142
Storm Composite	8/28/07 5:37	8/28/07 19:31	0.0034	0.00360	0.00510	0.0154	<0.0005	0.0067	11	<0.03	<0.05	~0.03	118
E. coli Grab	8/28/07 9:30	8/28/07 9:30											
Base Composite	9/14/07 10:49	9/17/07 8:51	0.0030	0.00360	0.00400	0.0111	<0.0005	0.0068	23	<0.03	1.33	<0.02	206
Storm Composite	9/18/07 17:29	9/19/07 14:47	0.0048	0.00490	0.00740	0.0201	<0.0005	0.0116	19	<0.03	<0.05	~0.03	132
Storm Composite	9/30/07 9:36	10/1/07 13:19	0.0049	0.00580	0.00970	0.0198	<0.0005	0.0110	22	<0.03	0.06	<0.02	134
Storm Composite	10/5/07 5:55	10/6/07 3:27	0.0014	0.00140	0.00060	0.0024	<0.0005	0.0011	13	<0.03	<0.05	~0.03	116
E. coli Grab	10/18/07 8:45	10/18/07 8:45											

No Exceedance Determinable
Exceeds Chronic Standard
Exceeds Max Standard

Analyse-it v2.07

Test	**Describe - Comparative**		
	TP (mg/L) by Year		
Performed by	tthiel	Date	6 March 2008



TP (mg/L) by Year	n	Mean	95% CI	SE	SD
2007	17	0.9706	0.3364 to 1.6049	0.29921	1.23366

TP (mg/L) by Year	n	Min	1st Quartile	Median	95% CI	3rd Quartile	Max	IQR
2007	17	0.062	0.0763	0.1710	0.0770 to 1.4600	1.4900	3.810	1.4137

Figure 15. Brown's Creek at 110th St. Yearly Total Phosphorus Concentration Box and Whisker Plot

Analyse-it v2.07

Test	**Describe - Comparative**		
	TSS (mg/L) by Year		
Performed by	tthiel	Date	6 March 2008

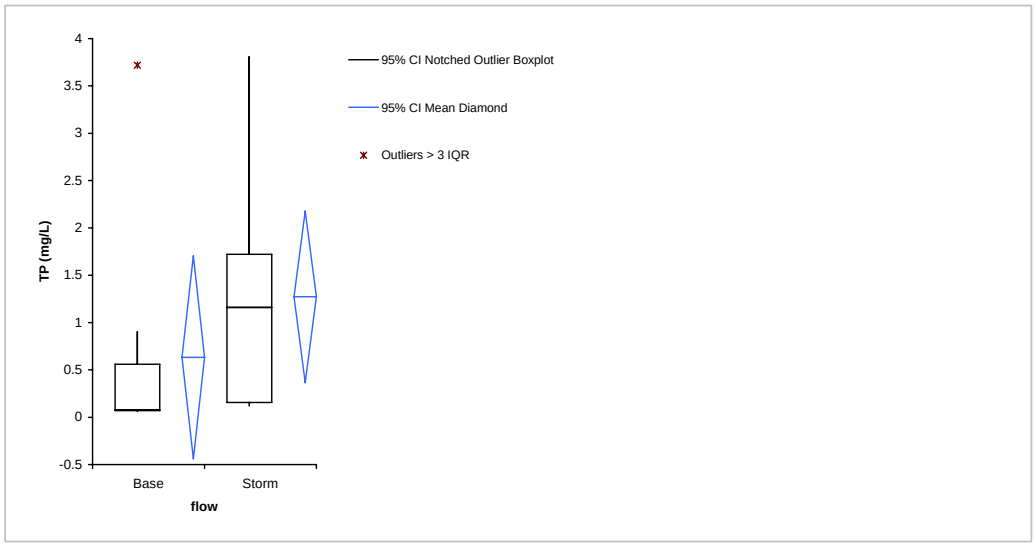
TSS (mg/L) by Year	n	Mean	95% CI	SE	SD
2007	17	300.6	81.3 to 519.8	103.43	426.45

TSS (mg/L) by Year	n	Min	1st Quartile	Median	95% CI	3rd Quartile	Max	IQR
2007	17	1	3.7	49.0	4.0 to 594.0	616.0	1520	612.3

Figure 16. Brown's Creek at 110th St. Yearly Total Suspended Solids Concentration Box and Whisker Plot

Analyse-it v2.07

Test	**Describe - Comparative**		
Performed by	TP (mg/L) by flow tthiel	Date	6 March 2008



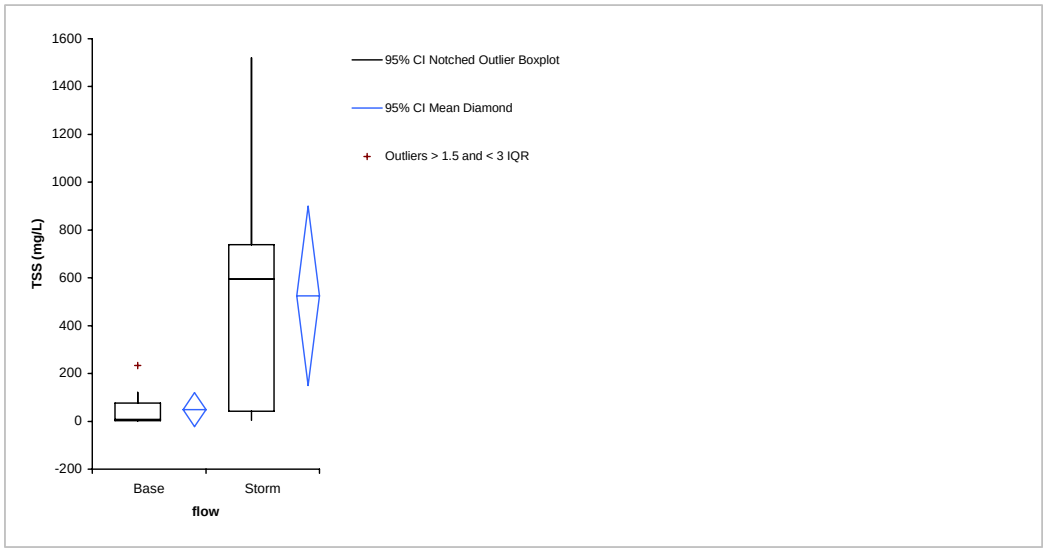
TP (mg/L) by flow	n	Mean	95% CI	SE	SD
Base	8	0.6320	-0.4392 to 1.7032	0.45303	1.28136
Storm	9	1.2717	0.3652 to 2.1781	0.39307	1.17921

TP (mg/L) by flow	n	Min	1st Quartile	Median	95% CI	3rd Quartile	Max	IQR
Base	8	0.062	0.0693	0.0760	0.0620 to 3.7200	0.5604	3.720	0.4912
Storm	9	0.117	0.1563	1.1600	0.1270 to 2.0600	1.7200	3.810	1.5637

Figure 17. Brown's Creek at 110th St. Storm and Base Flow Sample Total Phosphorus Concentration Comparison Box and Whisker Plot

Analyse-it v2.07

Test	**Describe - Comparative**		
	TSS (mg/L) by flow		
Performed by	tthiel	Date	6 March 2008



TSS (mg/L) by flow	n	Mean	95% CI	SE	SD
Base	8	48.6	-22.3 to 119.5	29.99	84.83
Storm	9	524.6	149.9 to 899.2	162.45	487.35

TSS (mg/L) by flow	n	Min	1st Quartile	Median	95% CI	3rd Quartile	Max	IQR
Base	8	1	2.4	7.5	1.0 to 233.0	76.4	233	74.0
Storm	9	4	41.7	594.0	27.0 to 808.0	738.7	1520	697.0

Figure 18. Brown's Creek at 110th St. Storm and Base Flow Sample Total Suspended Solids Concentration Comparison Box and Whisker Plot

Table 14. Brown's Creek at Gateway Bike Trail 2007 Primary Chemistry Results and Discharge Measurements

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)	COD (mg/L)	TOC (mg/L)	TBOD (mg/L)	CBOD (mg/L)	Alkalinity (mg/L)	Turbidity (NTU)	Discharge (cfs)
Base Grab	4/24/07 11:52	4/24/07 11:52	9	6	0.33	~0.043	~0.010		19	5.8	1.2	<1.0	156	2	2.55
E. Coli Grab	5/2/07 12:00	5/2/07 12:00						58							
Base Grab	5/10/07 9:45	5/10/07 9:45	13	~8	0.83	0.093	~0.041		26	4.5	1.2			14	1.91
Base Grab	5/16/07 14:29	5/16/07 14:29	10	6	0.44	0.100	~0.022		~13	4.7	<1.0			5	1.44
Storm Grab	5/24/07 15:42	5/24/07 15:42	32	19	1.00	0.099	~0.033		54	11.6	2.3			7	5.75
Base Grab	6/7/07 9:36	6/7/07 9:36	30	19	1.00	0.153	~0.032		43	5.3	<1.0	<1.0		13	1.84
E. Coli Grab	6/13/07 11:09	6/13/07 11:09						649							
Storm Grab	6/18/07 13:50	6/18/07 13:50	25	14	1.10	0.224	~0.038		24	4.7				12	1.38
Base Grab	6/28/07 9:20	6/28/07 9:20	6	3	0.39	0.093	~0.038		26	2.8	<1.0	<1.0		7	
E. Coli Grab	7/16/07 10:42	7/16/07 10:42						276							
Base Grab	7/19/07 11:22	7/19/07 11:22	~2	~1	0.28	0.159	~0.015		~9	6.7				2	0.87
Storm Grab	7/27/07 12:18	7/27/07 12:18	~3	~2	0.58	0.070	0.059		26	5.7	<1.0	<1.0		2	
Storm Grab	8/14/07 11:14	8/14/07 11:14	~2	~2	1.20	0.173	0.116		58	17.4	2.7	1.9		3	
Storm Grab	8/20/07 10:50	8/20/07 10:50	~1	~1	0.64	0.074	0.051		38	13.3	<1.0	<1.0		1	3.12
Storm Grab	8/28/07 10:00	8/28/07 10:00	3	~2	0.65	0.103	0.070		52	17.2	1.5	1.2		3	
E. Coli Grab	8/28/07 9:50	8/28/07 9:50						>2420							
Base Grab	9/17/07 10:12	9/17/07 10:12	3	~2	0.17	~0.044	~0.027		~8	2.3	<1.0	<1.0		2	
Storm Grab	9/19/07 15:24	9/19/07 15:24	~1	<1	0.69	0.094	0.071		45	16.2	1.3	<1.0		1	
Storm Grab	10/1/07 14:14	10/1/07 14:14	~2	~1	0.76	0.060	0.058		44	15.2	<1.0	<1.0		1	
Storm Grab	10/18/07 9:00	10/18/07 9:00	~1	~1	0.51	0.055	~0.033		38	8.9				3	
E. Coli Grab	10/18/07 9:00	10/18/07 9:00						76							

Exceeds Water Quality Standard

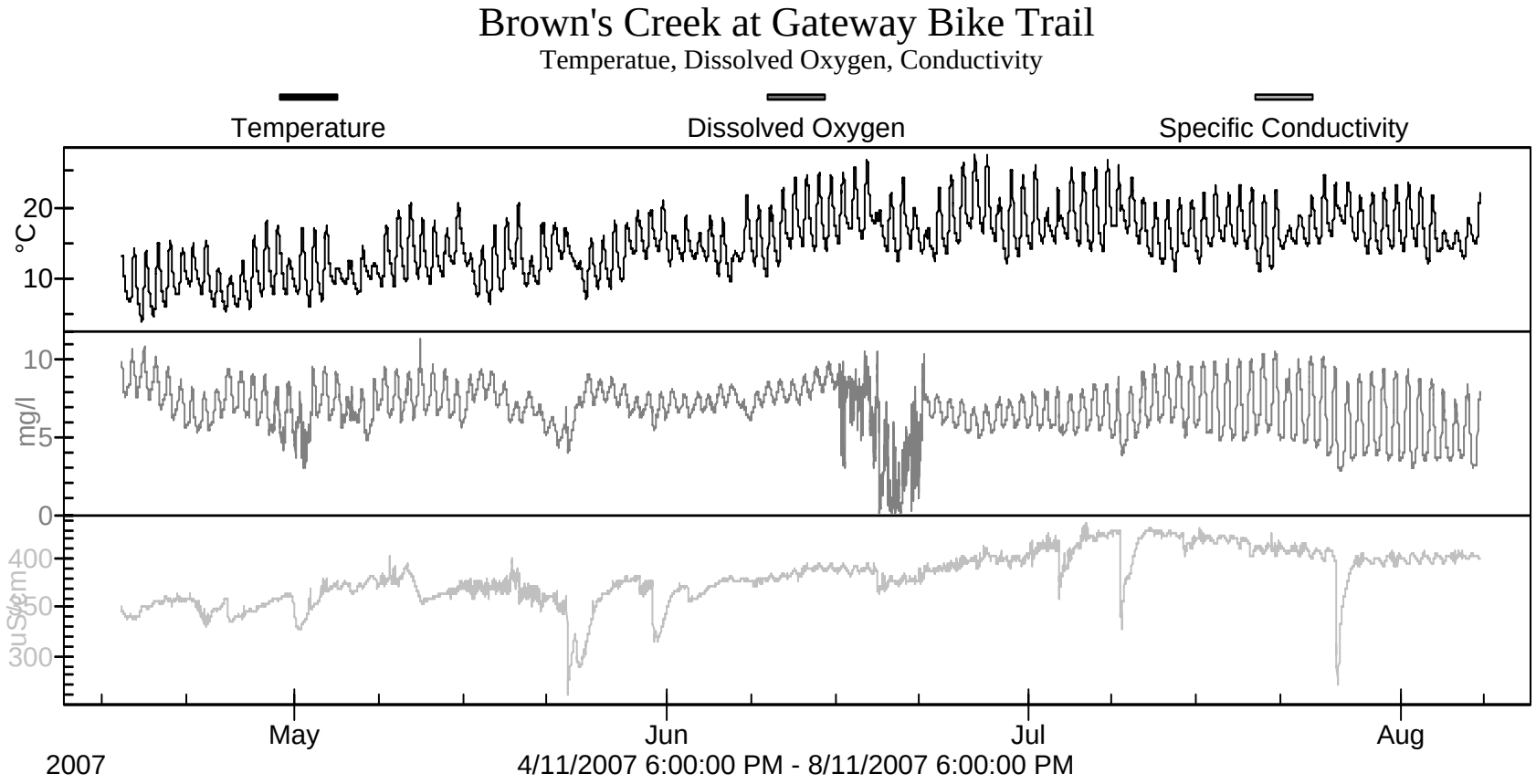


Figure 19. Brown's Creek at Gateway Trail 2007 15-Minute Recorded Temperature, Dissolved Oxygen, and Conductivity

Analyse-it v2.07

Test	**Describe - Comparative**		
Performed by	TP (mg/L) by Year tthiel	Date	10 March 2008

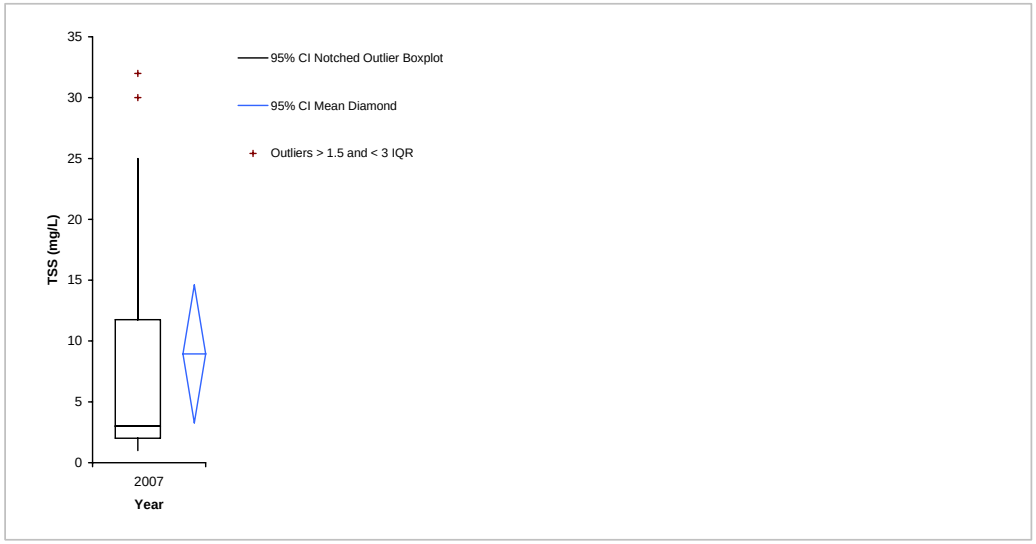
TP (mg/L) by Year	n	Mean	95% CI	SE	SD
2007	16	0.1023	0.0753 to 0.1294	0.01269	0.05075

TP (mg/L) by Year	n	Min	1st Quartile	Median	95% CI	3rd Quartile	Max	IQR
2007	16	0.043	0.0642	0.0935	0.0600 to 0.1530	0.1322	0.224	0.0680

Figure 20. Brown's Creek at Gateway Bike Trail Yearly Total Phosphorus Concentration Box and Whisker Plot

Analyse-it v2.07

Test	**Describe - Comparative**		
Performed by	TSS (mg/L) by Year tthiel	Date	10 March 2008



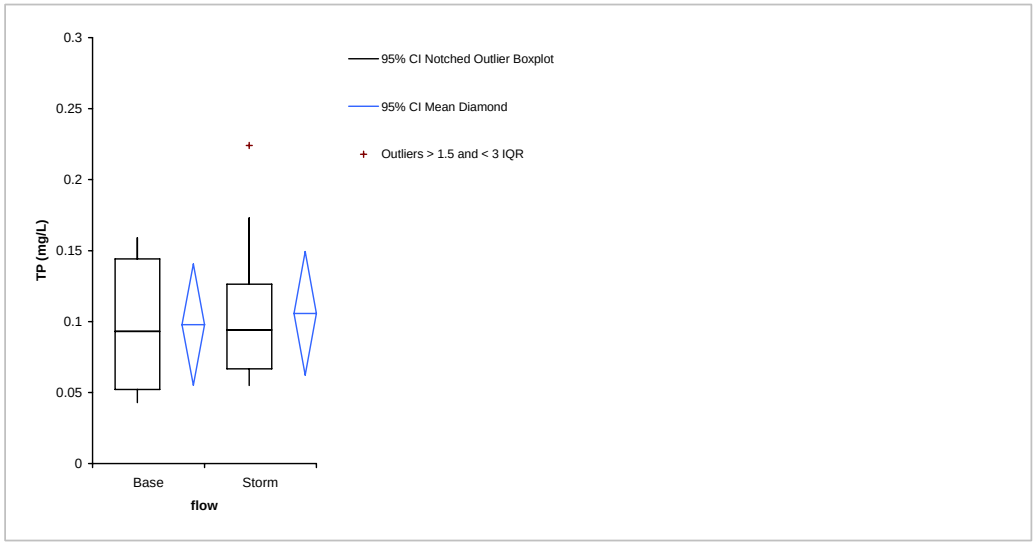
TSS (mg/L) by Year	n	Mean	95% CI	SE	SD
2007	16	8.9	3.3 to 14.6	2.66	10.64

TSS (mg/L) by Year	n	Min	1st Quartile	Median	95% CI	3rd Quartile	Max	IQR
2007	16	1	2.0	3.0	2.0 to 13.0	11.8	32	9.8

Figure 21. Brown's Creek at Gateway Bike Trail Yearly Total Suspended Solids Concentration Box and Whisker Plot

Analyse-it v2.07

Test	**Describe - Comparative**		
	TP (mg/L) by flow		
Performed by	tthiel	Date	10 March 2008



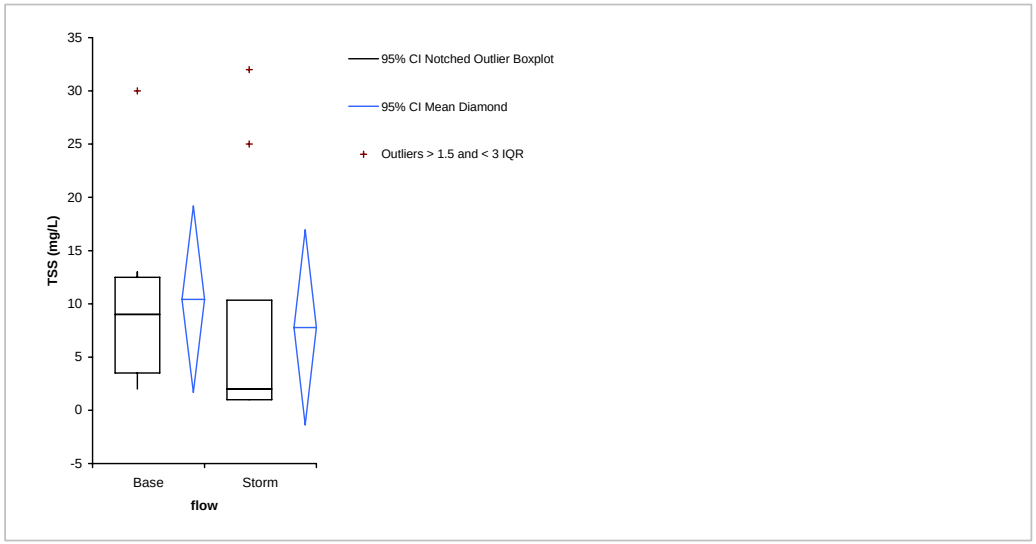
TP (mg/L) by flow	n	Mean	95% CI	SE	SD
Base	7	0.0979	0.0552 to 0.1405	0.01742	0.04608
Storm	9	0.1058	0.0623 to 0.1493	0.01888	0.05663

TP (mg/L) by flow	n	Min	1st Quartile	Median	95% CI	3rd Quartile	Max	IQR
Base	7	0.043	0.0522	0.0930	0.0430 to 0.1590	0.1442	0.159	0.0920
Storm	9	0.055	0.0667	0.0940	0.0600 to 0.1730	0.1263	0.224	0.0597

Figure 22. Brown's Creek at Gateway Bike Trail Storm and Base Flow Sample Total Phosphorus Concentration Comparison Box and Whisker Plot

Analyse-it v2.07

Test	**Describe - Comparative**		
	TSS (mg/L) by flow		
Performed by	tthiel	Date	10 March 2008



TSS (mg/L) by flow	n	Mean	95% CI	SE	SD
Base	7	10.4	1.7 to 19.2	3.58	9.47
Storm	9	7.8	-1.4 to 16.9	3.97	11.90

TSS (mg/L) by flow	n	Min	1st Quartile	Median	95% CI	3rd Quartile	Max	IQR
Base	7	2	3.5	9.0	2.0 to 30.0	12.5	30	9.0
Storm	9	1	1.0	2.0	1.0 to 25.0	10.3	32	9.3

Figure 23. Brown's Creek at Gateway Bike Trail Storm and Base Flow Sample Total Suspended Solids Concentration Comparison Box and Whisker Plot

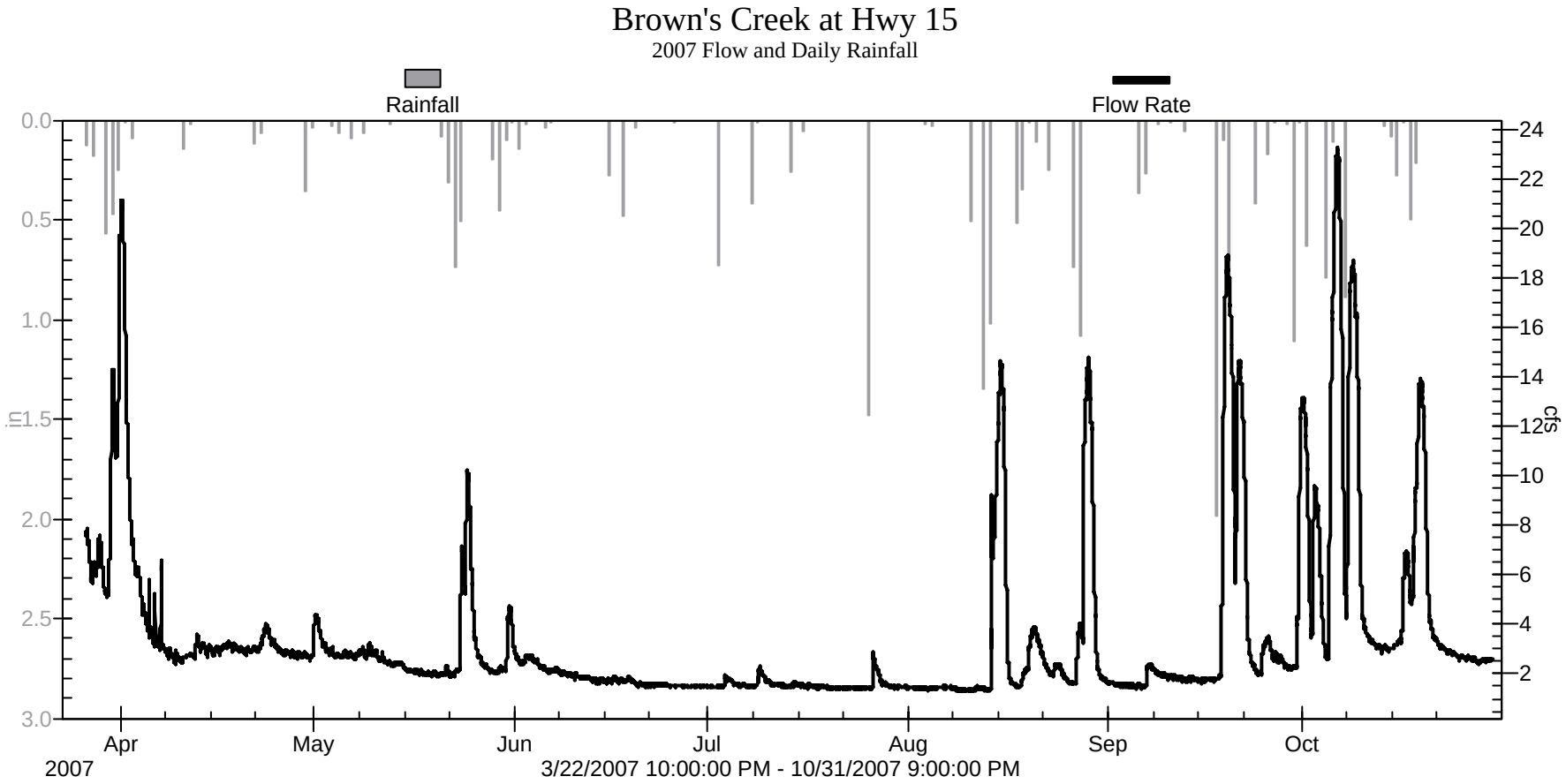


Figure 24. Brown's Creek at Hwy 15 2007 Flow and Daily Rainfall

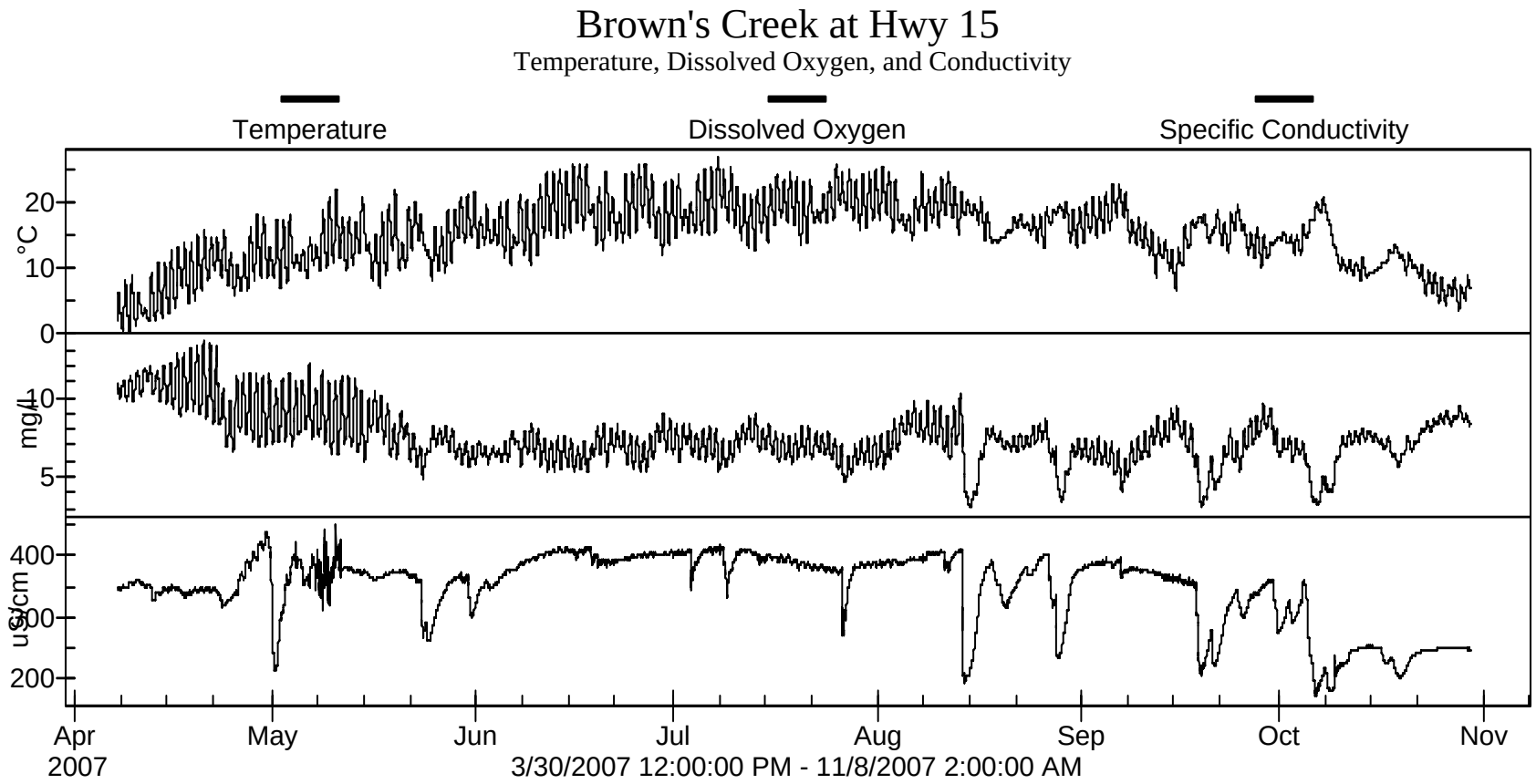


Figure 25. Brown's Creek at Hwy 15 2007 15-Minute Recorded Temperature, Dissolved Oxygen, and Conductivity

Table 15. Brown's Creek at Hwy 15 2007 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 TP (lb)	Interval TSS (lb)
*Base***			*7*	*0.100*	*1/1/2007 0:00*	*2/22/2007 0:00*	*8,985,600*	*56.16*	*3,927*
Snowmelt Grab**	2/22/07 12:45	2/22/07 12:45	13	0.089	*2/22/2007 0:00*	*2/25/2007 0:00*	*1,555,200*	*8.64*	*1,262*
*Base***			*7*	*0.100*	*2/25/2007 0:00*	*3/12/2007 0:00*	*3,888,000*	*24.30*	*1,699*
Snowmelt Grab**	3/12/07 11:39	3/12/07 11:39	15	0.185	*3/12/2007 0:00*	*3/15/2007 0:00*	*1,555,200*	*17.96*	*1,456*
*Base***			*7*	*0.100*	*3/15/2007 0:00*	*3/26/2007 12:15*	*2,983,500*	*18.65*	*1,304*
Base			*7*	*0.100*	*3/26/2007 12:15*	*3/27/2007 16:15*	*699,798*	*4.37*	*306*
Storm			*44*	*0.201*	*3/27/2007 16:15*	*3/29/2007 18:15*	*1,149,411*	*14.41*	*3,171*
Storm Composite	3/31/07 19:20	4/1/07 16:54	42	0.305	3/29/2007 18:15	4/2/2007 19:15	4,364,531	83.10	11,443
Base Composite	4/19/07 13:13	4/23/07 8:20	14	0.078	4/2/2007 19:15	4/23/2007 9:15	5,966,305	29.05	5,214
Base Grab	4/24/07 11:31	4/24/07 11:31	5	0.061	4/23/2007 9:15	4/24/2007 12:15	357,364	1.36	112
Base Grab	5/10/07 10:20	5/10/07 10:20	4	0.081	4/24/2007 12:15	5/10/2007 11:15	4,075,712	20.61	1,018
Base Grab	5/16/07 14:43	5/16/07 14:43	3	0.086	5/10/2007 11:15	5/23/2007 5:15	2,436,040	13.08	456
Storm Composite	5/23/07 6:03	5/25/07 10:35	50	0.219	5/23/2007 5:15	5/25/2007 21:15	1,403,335	19.19	4,380
Base			*7*	*0.100*	*5/25/2007 21:15*	*5/30/2007 18:15*	*987,798*	*6.17*	*432*
Storm			*44*	*0.201*	*5/30/2007 18:15*	*6/1/2007 0:15*	*419,133*	*5.25*	*1,156*
Base Grab	6/7/07 10:10	6/7/07 10:10	6	0.128	6/1/2007 0:15	6/7/2007 10:15	1,347,061	10.76	505
Base Grab	6/18/07 16:08	6/18/07 16:08	10	0.173	6/7/2007 10:15	6/18/2007 16:15	1,807,544	19.52	1,128
Base Grab	6/28/07 9:46	6/28/07 9:46	5	0.138	6/18/2007 16:15	6/28/2007 10:15	1,328,760	11.45	415
Base Composite	7/16/07 11:31	7/19/07 11:04	8	0.085	6/28/2007 10:15	7/26/2007 14:15	3,768,628	20.00	1,882
Storm Composite	7/26/07 19:46	7/27/07 13:05	31	0.114	7/26/2007 14:15	7/27/2007 23:15	249,099	1.77	482
Base			*7*	*0.100*	*7/27/2007 23:15*	*8/13/2007 21:15*	*2,114,810*	*13.22*	*924*
Storm Composite	8/13/07 22:13	8/14/07 11:13	66	0.308	8/13/2007 21:15	8/16/2007 19:15	2,267,598	43.60	9,343
Base			*7*	*0.100*	*8/16/2007 19:15*	*8/18/2007 15:15*	*250,392*	*1.56*	*109*
Storm Composite	8/20/07 2:02	8/21/07 1:36	14	0.111	8/18/2007 15:15	8/22/2007 1:15	869,717	6.03	760
Base			*7*	*0.100*	*8/22/2007 1:15*	*8/27/2007 2:15*	*874,166*	*5.46*	*382*
Storm Composite	8/28/07 3:30	8/29/07 8:45	38	0.161	8/27/2007 2:15	8/30/2007 4:15	2,235,771	22.47	5,304
Base Composite	9/14/07 8:23	9/14/07 21:35	8	0.071	8/30/2007 4:15	9/18/2007 11:15	3,008,220	13.33	1,502
Storm Composite	9/18/07 17:28	9/20/07 10:34	69	0.212	9/18/2007 11:15	9/20/2007 18:15	2,664,237	35.26	11,476
Storm Composite	9/20/07 23:12	9/22/07 0:43	27	0.154	9/20/2007 18:15	9/22/2007 16:15	1,848,470	17.77	3,116
Base			*7*	*0.100*	*9/22/2007 16:15*	*9/30/2007 3:15*	*1,666,587*	*10.42*	*728*
Storm Composite	9/30/07 15:17	10/1/07 14:18	39	0.208	9/30/2007 3:15	10/2/2007 13:15	1,847,551	23.99	4,498
Storm			*44*	*0.201*	*10/2/2007 13:15*	*10/5/2007 2:15*	*1,287,827*	*16.14*	*3,553*
Storm Composite	10/6/07 0:56	10/7/07 1:24	66	0.216	10/5/2007 2:15	10/7/2007 22:15	3,709,871	50.02	15,285
Storm			*44*	*0.201*	*10/7/2007 22:15*	*10/10/2007 7:15*	*2,785,846*	*34.92*	*7,687*
Base			*7*	*0.100*	*10/10/2007 7:15*	*10/16/2007 11:15*	*1,763,268*	*11.02*	*771*
Storm			*44*	*0.201*	*10/16/2007 11:15*	*10/20/2007 17:15*	*3,080,916*	*38.62*	*8,501*
Base			*7*	*0.100*	*10/20/2007 17:15*	*10/30/2007 14:15*	*2,450,383*	*15.31*	*1,071*
*Base***			*7*	*0.100*	*10/30/2007 14:15*	*1/1/2008 0:00*	*10,783,800*	*67.39*	*4,712*
Storm Average			41	0.192					
Base Average			7	0.100					
Snowmelt Average			14	0.137					
All Average			25	0.149					
Total							**94,837,449**	**812**	**121,471**
Brown's Creek Major Subwatershed Total Acres							7,193		
Total TP/TSS(lb/ac/yr)								0.11	16.89
Total TP/TSS (kg/ha/yr)								0.13	18.93

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

** Interval volumes from 1/1/07 to 3/26/07 and 10/30/07 to 1/1/08 were estimated using base flow

Table 16. Brown's Creek at Hwy 15 2007 Primary Chemistry Result Averages

Parameter	Storm Flow Average	Base Flow Average	Average (all samples)
TSS (mg/L)	44	7	25
VSS (mg/L)	25	5	15
TKN (mg/L)	1.50	0.54	1.06
TP (mg/L)	0.20	0.10	0.15
E. Coli (mpn/100 mL)	--	--	783

Table 17: Brown's Creek at Hwy 15 2007 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)	Alkalinity (mg/L)	Turbidity (NTU)
Snowmelt Grab	2/22/07 12:45	2/22/07 12:45	13	3	0.42	0.089	0.074			1.6				
Snowmelt Grab	3/12/07 11:39	3/12/07 11:39	15	9	2.10	0.185	0.088			8.5				10
Storm Composite	3/31/07 19:20	4/1/07 16:54	42	25	2.20	0.305	0.080			11.4				
Base Composite	4/19/07 13:13	4/23/07 8:20	14	~10	0.79	0.078	~0.040			6.3				
Base Grab	4/24/07 11:31	4/24/07 11:31	5	3	0.51	0.061	~0.013		22	4.7	1.4	<1.0	153	2
E. coli Grab	5/2/07 12:15	5/2/07 12:15						150						
Base Grab	5/10/07 10:20	5/10/07 10:20	4	3	0.50	0.081	~0.044			6.0				2
Base Grab	5/16/07 14:43	5/16/07 14:43	3	~2	0.37	0.086	~0.035			5.0				3
Storm Composite	5/23/07 6:03	5/25/07 10:35	50	32	1.80	0.219	~0.044			11.1				
Base Grab	6/7/07 10:10	6/7/07 10:10	6	4	0.84	0.128	0.054				<1.0	<1.0		6
E. coli Grab	6/13/07 11:19	6/13/07 11:19						276						
Base Grab	6/18/07 16:08	6/18/07 16:08	10	6	0.74	0.173	0.051			4.6	<1.0	<1.0		9
Base Grab	6/28/07 9:46	6/28/07 9:46	5	3	0.22	0.138	0.054			3.3	<1.0	<1.0		5
E. coli Grab	7/16/07 10:51	7/16/07 10:51						921						
Base Composite	7/16/07 11:31	7/19/07 11:04	8	6	0.57	0.085	~0.019			8.1				
Storm Composite	7/26/07 19:46	7/27/07 13:05	31	15	1.10	0.114								
Storm Composite	8/13/07 22:13	8/14/07 11:13	66	35	2.20	0.308	0.083		90	15.7	5.4	3.7		27
Storm Composite	8/20/07 2:02	8/21/07 1:36	14	9	0.79	0.111	0.054		48	12.9	1.5	1.2		6
Storm Composite	8/28/07 3:30	8/29/07 8:45	38	23	1.20	0.161	0.057		83	16.0	2.0	1.5		2
E. coli Grab	8/28/07 10:45	8/28/07 10:45						>2420						
Base Composite	9/14/07 8:23	9/14/07 21:35	8	5	0.24	0.071	~0.040		~14	4.6	<1.0	<1.0		5
Storm Composite	9/18/07 17:28	9/20/07 10:34	69	37	1.50	0.212	0.083		85	15.9	2.1	1.3		16
Storm Composite	9/20/07 23:12	9/22/07 0:43	27	16	1.30	0.154	0.064		58	14.5	1.2	<1.0		10
Storm Composite	9/30/07 15:17	10/1/07 14:18	39	24	1.80	0.208			75	14.2	1.6	<1.0		13
Storm Composite	10/6/07 0:56	10/7/07 1:24	66	35	1.10	0.216	0.066		96	16.7	1.3	1.2		16
E. coli Grab	10/18/07 9:15	10/18/07 9:15						147						

Exceeds Water Quality Standard

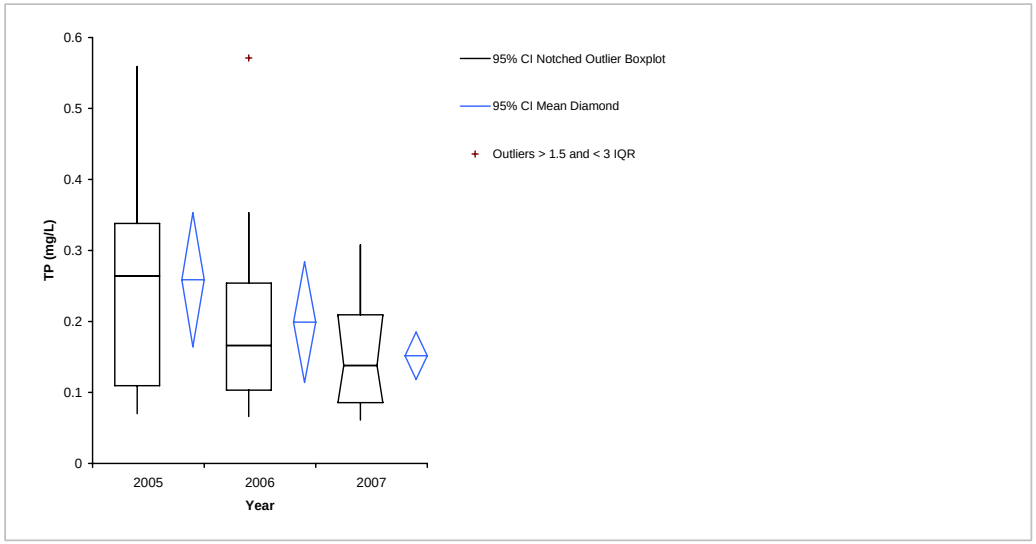
Table 18: Brown's Creek at Hwy 15 2007 Secondary Chemistry Results including Exceeded MPCA 7050 Water Quality Standards

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	2/22/07 12:45	2/22/07 12:45	0.0008	0.00030	0.0020	0.0015	0.00005	0.0015	23				
Snowmelt Grab	3/12/07 11:39	3/12/07 11:39	0.0012	0.00050	0.0015	0.0031	<0.00004	0.0011	12				
Storm Composite	3/31/07 19:20	4/1/07 16:54	0.0060	0.00140	0.0019	0.0113	0.00009	0.0018	12				100
Base Composite	4/19/07 13:13	4/23/07 8:20	0.0019	0.00020	0.0016	0.0036	0.00020	0.0010	14				152
Base Grab	4/24/07 11:31	4/24/07 11:31	<0.0005	0.00010	0.0015	0.0022	0.00004	0.0008	14	<0.03	0.56	~0.03	152
E. coli Grab	5/2/07 12:15	5/2/07 12:15											
Base Grab	5/10/07 10:20	5/10/07 10:20	<0.0005	0.00010	0.0016	0.0026	<0.00004	0.0008	13				164
Base Grab	5/16/07 14:43	5/16/07 14:43	0.0005	<0.00007	0.0014	0.0022	<0.00004	<0.0002	13				174
Storm Composite	5/23/07 6:03	5/25/07 10:35	0.0013	0.00080	0.0019	0.0072	0.00020	0.0015	12				130
Base Grab	6/7/07 10:10	6/7/07 10:10	<0.0005	0.00010	0.0015	0.0017	<0.00004	0.0005	11				178
E. coli Grab	6/13/07 11:19	6/13/07 11:19											
Storm Grab	6/18/07 16:08	6/18/07 16:08	<0.0005	0.00160	0.0002	0.0016	<0.00004	0.0006	11	0.03	0.82	0.08	180
Base Grab	6/28/07 9:46	6/28/07 9:46	<0.0005	0.00190	0.0010	0.0009	<0.00004	0.0009	11	<0.03	0.95	0.08	198
E. coli Grab	7/16/07 10:51	7/16/07 10:51											
Base Composite	7/16/07 11:31	7/19/07 11:04	0.0011	0.00140	0.0002	0.0022	0.00020	0.0006	12				192
Storm Composite	7/26/07 19:46	7/27/07 13:05											
Storm Composite	8/13/07 22:13	8/14/07 11:13	0.0022	0.00180	0.0019	0.0069	<0.00050	0.0018	8	<0.03	0.36	<0.02	100
Storm Composite	8/20/07 2:02	8/21/07 1:36	0.0009	0.00170	0.0003	0.0026	<0.00050	0.0009	11	<0.03	0.23	~0.04	154
Storm Composite	8/28/07 3:30	8/29/07 8:45	0.0013	0.00150	0.0008	0.0068	<0.00050	0.0012	8	<0.03	0.10	~0.04	118
E. coli Grab	8/28/07 10:45	8/28/07 10:45											
Base Composite	9/14/07 8:23	9/14/07 21:35	0.0006	0.00170	0.0002	0.0017	<0.00050	<0.0005	15	<0.03	0.98	<0.02	198
Storm Composite	9/18/07 17:28	9/20/07 10:34	0.0016	0.00170	0.0011	0.0054	<0.00050	0.0015	17	<0.03	0.08	~0.04	120
Storm Composite	9/20/07 23:12	9/22/07 0:43	0.0011	0.00170	0.0006	0.0031	<0.00050	0.0010	12	<0.03	0.13	<0.02	128
Storm Composite	9/30/07 15:17	10/1/07 14:18	0.0009	0.00200	0.0008	0.0030	<0.00050	0.0010	14	<0.03	0.14	<0.02	20
Storm Composite	10/6/07 0:56	10/7/07 1:24	0.0013	0.00180	0.0014	0.0047	<0.00050	0.0017	12	<0.03	<0.05	<0.02	112
E. coli Grab	10/18/2007 9:15	10/18/2007 9:15											

No Exceedance Determinable
Exceeds Chronic Standard
Exceeds Max Standard

Analyse-it v2.07

Test	**Describe - Comparative**		
	TP (mg/L) by Year		
Performed by	tthiel	Date	6 March 2008



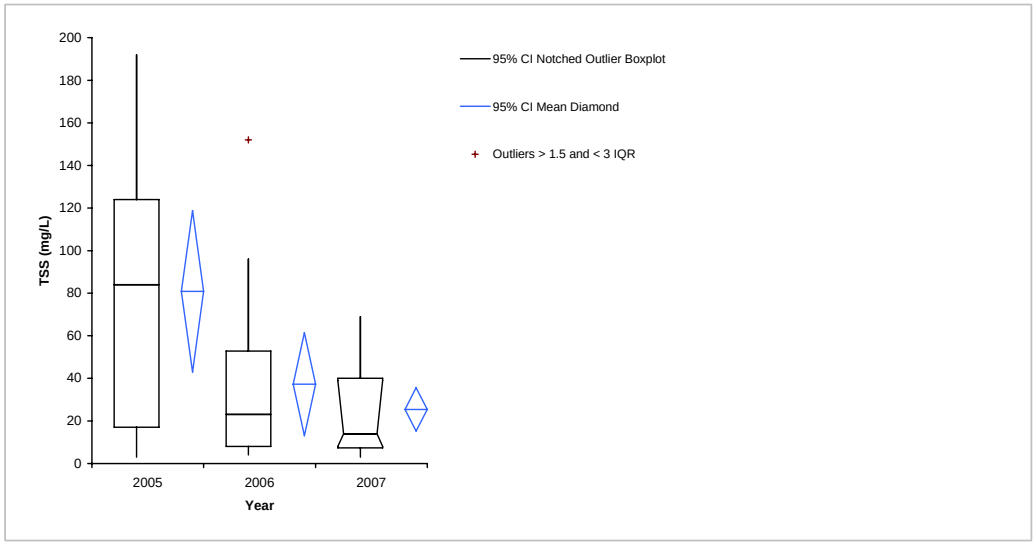
TP (mg/L) by Year	n	Mean	95% CI	SE	SD
2005	14	0.2586	0.1644 to 0.3528	0.04361	0.16318
2006	13	0.1988	0.1140 to 0.2837	0.03894	0.14039
2007	21	0.1516	0.1183 to 0.1848	0.01594	0.07306

TP (mg/L) by Year	n	Min	1st Quartile	Median	95% CI	3rd Quartile	Max	IQR
2005	14	0.070	0.1094	0.2640	0.0920 to 0.4610	0.3382	0.559	0.2288
2006	13	0.066	0.1033	0.1660	0.0980 to 0.2800	0.2540	0.571	0.1507
2007	21	0.061	0.0857	0.1380	0.0860 to 0.2080	0.2093	0.308	0.1237

Figure 26. Brown's Creek at Hwy 15 Yearly Total Phosphorus Concentration Box and Whisker Plot

Analyse-it v2.07

Test	**Describe - Comparative**		
	TSS (mg/L) by Year		
Performed by	tthiel	Date	6 March 2008



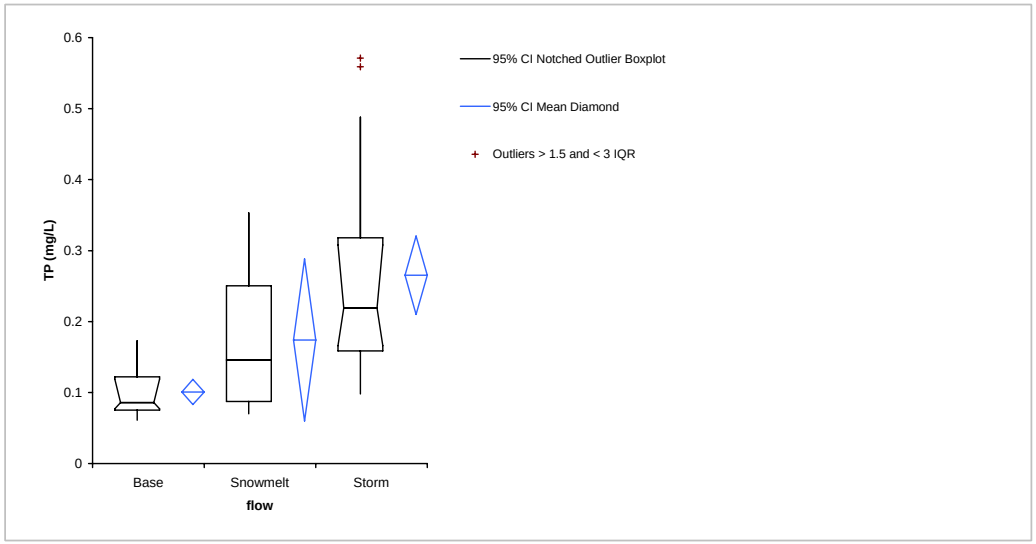
TSS (mg/L) by Year	n	Mean	95% CI	SE	SD
2005	14	80.9	42.9 to 118.8	17.56	65.70
2006	14	37.3	13.1 to 61.5	11.20	41.91
2007	21	25.4	15.2 to 35.6	4.88	22.35

TSS (mg/L) by Year	n	Min	1st Quartile	Median	95% CI	3rd Quartile	Max	IQR
2005	14	3	17.1	84.0	7.0 to 168.0	124.0	192	106.9
2006	14	4	8.0	23.0	8.0 to 62.0	52.8	152	44.8
2007	21	3	7.3	14.0	8.0 to 39.0	40.0	69	32.7

Figure 27. Brown's Creek at Hwy 15 Yearly Total Suspended Solids Concentration Box and Whisker Plot

Analyse-it v2.07

Test	**Describe - Comparative**		
	TP (mg/L) by flow		
Performed by	tthiel	Date	6 March 2008



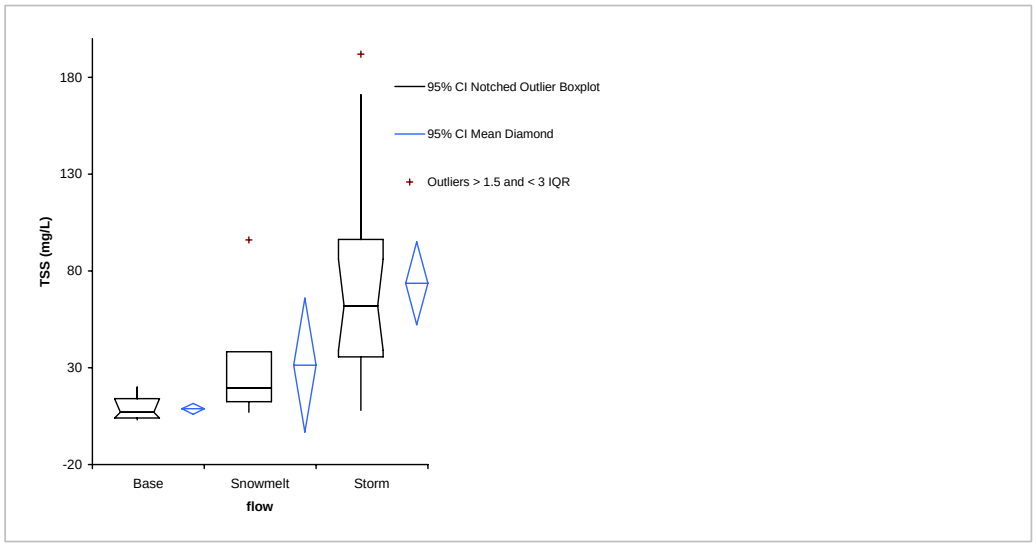
TP (mg/L) by flow	n	Mean	95% CI	SE	SD
Base	17	0.1008	0.0830 to 0.1186	0.00839	0.03457
Snowmelt	6	0.1742	0.0600 to 0.2883	0.04442	0.10879
Storm	25	0.2652	0.2098 to 0.3205	0.02680	0.13402

TP (mg/L) by flow	n	Min	1st Quartile	Median	95% CI	3rd Quartile	Max	IQR
Base	17	0.061	0.0753	0.0860	0.0770 to 0.1190	0.1220	0.173	0.0467
Snowmelt	6	0.070	0.0874	0.1460	0.0700 to 0.3530	0.2503	0.353	0.1629
Storm	25	0.098	0.1587	0.2190	0.1660 to 0.3080	0.3180	0.571	0.1593

Figure 28. Brown's Creek at Hwy 15 Storm and Base Flow Sample Total Phosphorus Concentration Comparison Box and Whisker Plot

Analyse-it v2.07

Test	**Describe - Comparative**		
Performed by	TSS (mg/L) by flow tthiel	Date	6 March 2008



TSS (mg/L) by flow	n	Mean	95% CI	SE	SD
Base	18	8.8	5.9 to 11.6	1.34	5.69
Snowmelt	6	31.3	-3.3 to 65.9	13.46	32.96
Storm	25	73.6	52.2 to 95.1	10.38	51.90

TSS (mg/L) by flow	n	Min	1st Quartile	Median	95% CI	3rd Quartile	Max	IQR
Base	18	3	4.0	7.0	4.0 to 14.0	14.1	20	10.1
Snowmelt	6	7	12.5	19.5	7.0 to 96.0	38.3	96	25.8
Storm	25	8	35.7	62.0	39.0 to 86.0	96.3	192	60.7

Figure 29. Brown's Creek at Hwy 15 Storm and Base Flow Sample Total Suspended Solids Concentration Comparison Box and Whisker Plot

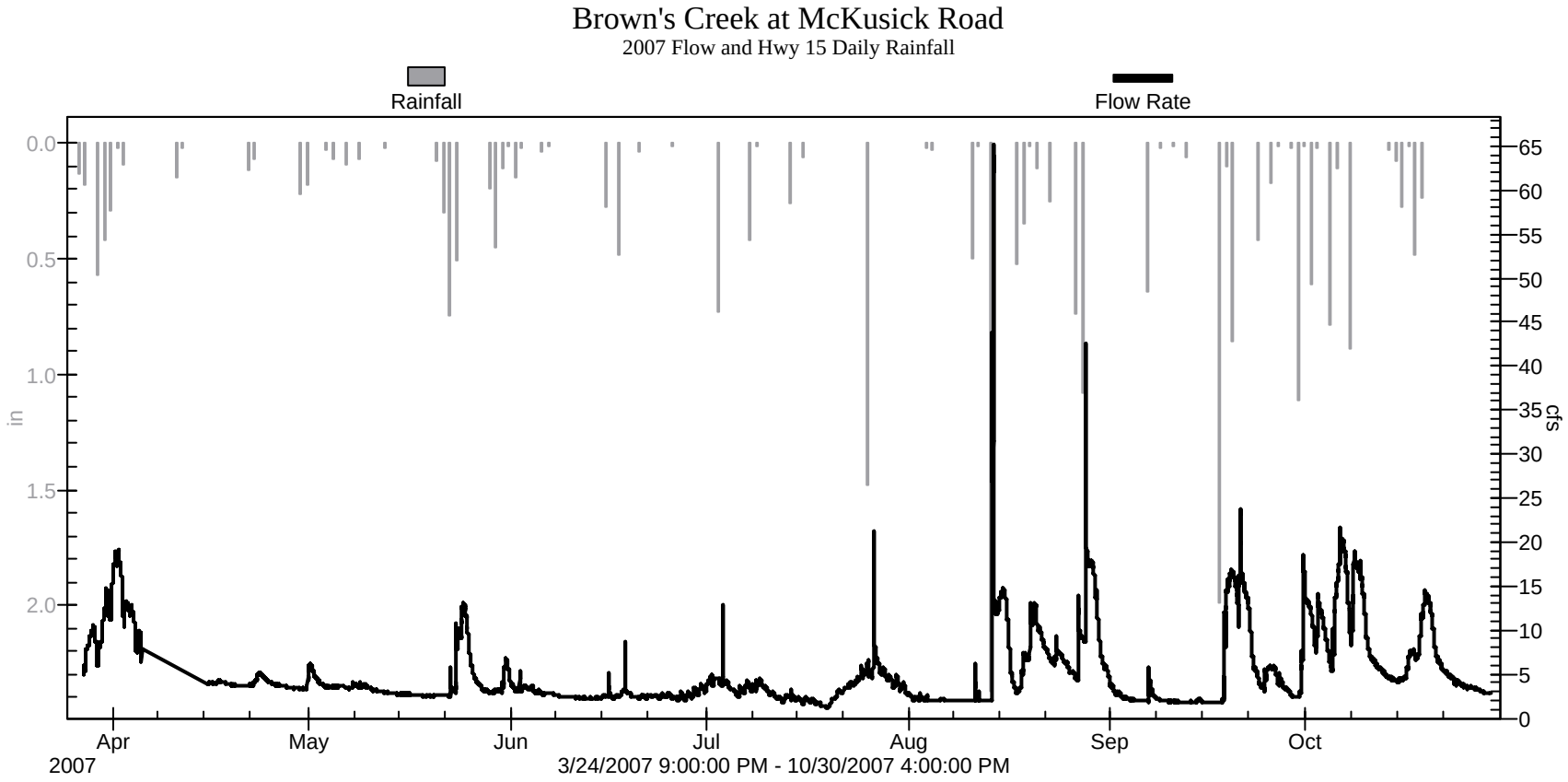


Figure 30. Brown' s Creek at McKusick Road 2007 Flow and Hwy 15 Daily Rainfall

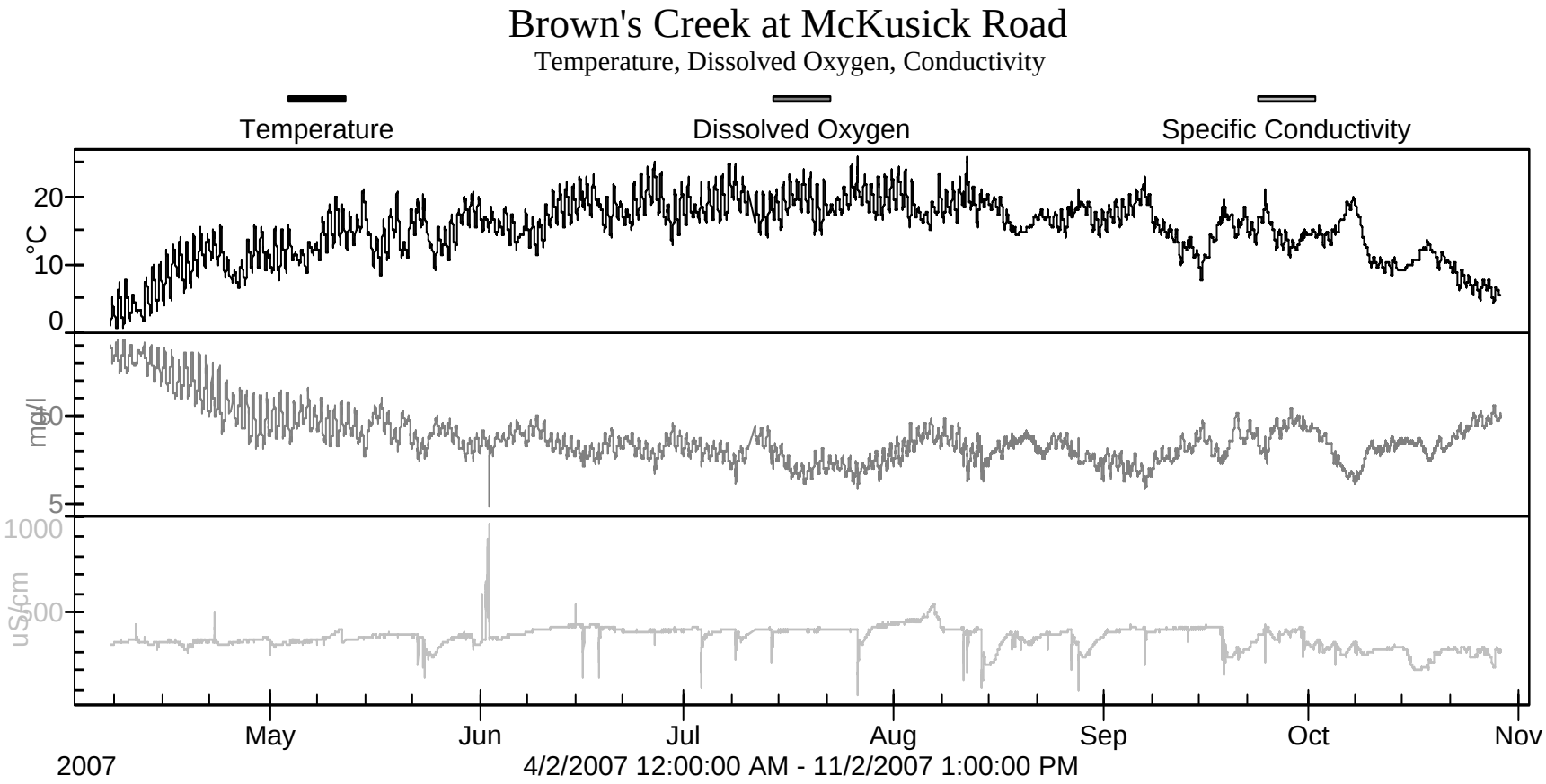


Figure 31. Brown's Creek at McKusick Road 2007 15-Minute Recorded Temperature, Dissolved Oxygen, and Conductivity

Table 19. Brown's Creek at McKusick Road 2007 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 TP (lb)	Interval TSS (lb)
*Base***			*17*	*0.119*	*1/1/2007 0:00*	*2/22/2007 0:00*	*8,985,600*	*66.5*	*9,349*
Snowmelt Grab**	2/22/07 13:10	2/22/07 13:10	7	0.076	*2/22/2007 0:00*	*2/25/2007 0:00*	*1,814,400*	*8.6*	*793*
*Base***			*17*	*0.119*	*2/25/2007 0:00*	*3/12/2007 0:00*	*5,184,000*	*38.3*	*5,394*
Snowmelt Grab**	3/12/07 10:24	3/12/07 10:24	15	0.233	*3/12/2007 0:00*	*3/15/2007 0:00*	*1,814,400*	*26.4*	*1,699*
*Base***			*17*	*0.119*	*3/15/2007 0:00*	*3/27/2007 12:30*	*4,327,200*	*32.0*	*4,502*
Base			*17*	*0.119*	*3/27/2007 12:30*	*3/27/2007 14:30*	*40,968*	*0.3*	*43*
Storm			*64*	*0.199*	*3/27/2007 14:30*	*3/29/2007 17:30*	*1,533,870*	*19.0*	*6,147*
Storm			*64*	*0.199*	*3/29/2007 17:30*	*4/5/2007 11:00*	*7,233,867*	*89.7*	*28,992*
NO DATA					**4/5/2007 11:00**	**4/15/2007 13:45**	**0**	**0.0**	**0**
Base Composite	4/19/07 13:07	4/22/07 11:30	8	0.080	4/15/2007 13:45	4/22/2007 15:30	2,349,099	11.7	1,173
Storm			*64*	*0.199*	*4/22/2007 15:30*	*4/25/2007 5:30*	*1,018,413*	*12.6*	*4,082*
Base			*17*	*0.119*	*4/25/2007 5:30*	*4/30/2007 15:30*	*1,658,367*	*12.3*	*1,725*
Storm			*64*	*0.199*	*4/30/2007 15:30*	*5/2/2007 23:30*	*965,295*	*12.0*	*3,869*
Base Grab	5/16/07 15:08	5/16/07 15:08	8	0.097	5/2/2007 23:30	5/22/2007 19:30	5,223,051	31.6	2,608
Storm			*64*	*0.199*	*5/22/2007 19:30*	*5/22/2007 22:30*	*40,410*	*0.5*	*162*
Base			*17*	*0.119*	*5/22/2007 22:30*	*5/23/2007 13:30*	*166,455*	*1.2*	*173*
Storm Composite	5/23/07 16:05	5/24/07 22:33	64	0.236	5/23/2007 13:30	5/26/2007 9:30	2,255,400	33.2	9,011
Base			*17*	*0.119*	*5/26/2007 9:30*	*5/30/2007 18:30*	*1,255,338*	*9.3*	*1,306*
Storm			*64*	*0.199*	*5/30/2007 18:30*	*6/1/2007 3:30*	*622,827*	*7.7*	*2,496*
Base			*17*	*0.119*	*6/1/2007 3:30*	*6/1/2007 13:30*	*130,563*	*1.0*	*136*
Base Composite	6/1/07 13:32	6/2/07 8:01	26	0.165	6/1/2007 13:30	6/2/2007 8:30	215,298	2.2	349
Base Composite	6/2/07 8:56	6/3/07 13:10	173	0.429	6/2/2007 8:30	6/3/2007 13:30	356,778	9.6	3,853
Base			*17*	*0.119*	*6/3/2007 13:30*	*6/15/2007 20:30*	*2,729,421*	*20.2*	*2,840*
Storm			*64*	*0.199*	*6/15/2007 20:30*	*6/16/2007 5:30*	*92,025*	*1.1*	*369*
Base			*17*	*0.119*	*6/16/2007 5:30*	*6/18/2007 11:30*	*503,343*	*3.7*	*524*
Storm			*64*	*0.199*	*6/18/2007 11:30*	*6/18/2007 17:30*	*88,191*	*1.1*	*353*
Base Grab	6/28/07 10:32	6/28/07 10:32	10	0.134	6/18/2007 17:30	7/3/2007 13:30	3,672,846	30.7	2,293
Storm			*64*	*0.199*	*7/3/2007 13:30*	*7/3/2007 17:30*	*81,045*	*1.0*	*325*
Base Composite	7/16/07 11:41	7/19/07 11:26	40	0.166	7/3/2007 17:30	7/26/2007 12:30	5,889,834	61.0	14,707
Storm Composite	7/26/07 15:55	7/26/07 18:06	1200	1.250	7/26/2007 12:30	7/27/2007 2:30	441,864	34.5	33,101
Base			*17*	*0.119*	*7/27/2007 2:30*	*8/11/2007 3:30*	*3,681,279*	*27.2*	*3,830*
Storm			*64*	*0.199*	*8/11/2007 3:30*	*8/11/2007 5:30*	*26,424*	*0.3*	*106*
Base			*17*	*0.119*	*8/11/2007 5:30*	*8/13/2007 21:30*	*453,339*	*3.4*	*472*
Storm Composite	8/13/07 21:42	8/14/07 5:56	1210	2.030	8/13/2007 21:30	8/14/2007 6:30	1,006,380	127.5	76,018
Storm			*64*	*0.199*	*8/14/2007 6:30*	*8/16/2007 10:30*	*2,418,021*	*30.0*	*9,691*
Base			*17*	*0.119*	*8/16/2007 10:30*	*8/18/2007 9:30*	*697,482*	*5.2*	*726*
Storm Composite	8/18/07 17:43	8/20/07 13:26	29	0.129	8/18/2007 9:30	8/20/2007 17:30	1,749,465	14.1	3,167
Base			*17*	*0.119*	*8/20/2007 17:30*	*8/27/2007 1:30*	*3,796,506*	*28.1*	*3,950*
Storm			*64*	*0.199*	*8/27/2007 1:30*	*8/27/2007 7:30*	*219,591*	*2.7*	*880*
Base			*17*	*0.119*	*8/27/2007 7:30*	*8/28/2007 2:30*	*620,964*	*4.6*	*646*
Storm Composite	8/28/07 3:20	8/28/07 7:09	1060	1.600	8/28/2007 2:30	8/28/2007 8:30	574,758	57.4	38,033
Storm			*64*	*0.199*	*8/28/2007 8:30*	*8/30/2007 6:30*	*2,595,195*	*32.2*	*10,401*
Base			*17*	*0.119*	*8/30/2007 6:30*	*9/6/2007 20:30*	*2,107,242*	*15.6*	*2,192*
Storm			*64*	*0.199*	*9/6/2007 20:30*	*9/7/2007 12:30*	*188,919*	*2.3*	*757*
Base Composite	9/15/07 4:19	9/17/07 2:54	8	0.069	9/7/2007 12:30	9/18/2007 8:30	1,786,626	7.7	892
Storm Composite	9/18/07 12:53	9/20/07 7:34	99	0.222	9/18/2007 8:30	9/20/2007 17:30	2,809,557	38.9	17,364
Storm			*64*	*0.199*	*9/20/2007 17:30*	*9/21/2007 1:30*	*512,487*	*6.4*	*2,054*
Storm			*64*	*0.199*	*9/21/2007 1:30*	*9/22/2007 17:30*	*1,908,234*	*23.7*	*7,648*
Base			*17*	*0.119*	*9/22/2007 17:30*	*9/24/2007 17:30*	*805,140*	*6.0*	*838*
Storm			*64*	*0.199*	*9/24/2007 17:30*	*9/24/2007 20:30*	*47,619*	*0.6*	*191*
Storm			*64*	*0.199*	*9/24/2007 20:30*	*9/26/2007 19:30*	*902,880*	*11.2*	*3,619*
Storm			*64*	*0.199*	*9/26/2007 19:30*	*9/26/2007 22:30*	*45,981*	*0.6*	*184*
Storm			*64*	*0.199*	*9/26/2007 22:30*	*9/27/2007 12:30*	*202,203*	*2.5*	*810*
Base			*17*	*0.119*	*9/27/2007 12:30*	*9/30/2007 2:30*	*620,199*	*4.6*	*645*
Storm Composite	9/30/07 5:31	10/2/07 11:56	51	0.231	9/30/2007 2:30	10/2/2007 12:30	2,286,045	33.0	7,278
Storm			*64*	*0.199*	*10/2/2007 12:30*	*10/5/2007 2:30*	*2,122,947*	*26.3*	*8,508*
Storm Composite	10/6/07 13:45	10/9/07 9:06	78	0.175	10/5/2007 2:30	10/10/2007 12:30	6,915,960	75.6	33,675
Base			*17*	*0.119*	*10/10/2007 12:30*	*10/16/2007 11:30*	*2,684,529*	*19.9*	*2,793*
Storm			*64*	*0.199*	*10/16/2007 11:30*	*10/21/2007 4:30*	*3,900,402*	*48.4*	*15,632*
Base			*17*	*0.119*	*10/21/2007 4:30*	*10/29/2007 11:30*	*2,864,619*	*21.2*	*2,980*
*Base***			*17*	*0.119*	*10/29/2007 11:30*	*1/1/2008 0:00*	*10,976,400*	*81.2*	*11,420*
Storm Average			64	0.199					
Base Average			17	0.119					
Snowmelt Average			11	0.155					
All Average			240	0.431					
Total							**122,217,561**	**1,337**	**409,774**
Brown's Creek Major Subwatershed Total Acres							11,877		
Total TP/TSS(lb/ac/yr)								0.11	34.50
Total TP/TSS (kg/ha/yr)								0.13	38.67
*Italics indicate estimated concentrations based on average base and storm flow concentrations									
** Interval volumes from 1/1/07 to 3/27/07 and 10/29/07 to 1/1/08 were estimated using base flow									

Table 20. Brown's Creek at McKusick Road 2007 Primary Chemistry Result Averages

Parameter	Storm Flow Average	Base Flow Average	Average (all samples)
TSS (mg/L)	422	39	240
VSS (mg/L)	75	17	47
TKN (mg/L)	2.29	0.92	1.77
TP (mg/L)	0.67	0.16	0.43
E. Coli (mpn/100 mL)	--	--	752

Table 21: Brown's Creek at McKusick Road 2007 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	2/22/07 13:10	2/22/07 13:10	7	3	0.62	0.076	0.067			2.6			
Snowmelt Grab	3/12/07 10:24	3/12/07 10:24	15	7	2.70	0.233				19.8			11
Base Composite	4/19/07 13:07	4/22/07 11:30	8	5	0.71	0.080	~0.018			4.5			
E. coli Grab	5/2/07 10:55	5/2/07 10:55						161					
Base Grab	5/16/07 15:08	5/16/07 15:08	8	4	0.54	0.097	~0.042			6.3			6
Storm Composite	5/23/07 16:05	5/24/07 22:33	64	28	1.60	0.236	~0.045			11.2			
Base Composite	6/1/07 13:32	6/2/07 8:01	26	12	0.99	0.165	0.087			10.5			
Base Composite	6/2/07 8:56	6/3/07 13:10	173	71	2.70	0.429	0.073			9.3			
E. coli Grab	6/13/07 9:16	6/13/07 9:16						548					
Base Grab	6/28/07 10:32	6/28/07 10:32	10	5	0.37	0.134	0.063			3.0			7
E. coli Grab	7/16/07 11:22	7/16/07 11:22						461					
Base Composite	7/16/07 11:41	7/19/07 11:26	40	19	0.87	0.166	0.050			7.3			
Storm Composite	7/26/07 15:55	7/26/07 18:06	1200	240	4.20	1.250							
Storm Composite	8/13/07 21:42	8/14/07 5:56	1210	172	4.90	2.030	0.086		290	28.7	<16.0	<18.0	1500
Storm Composite	8/18/07 17:43	8/20/07 13:26	29	13	0.84	0.129	0.058		43	8.4	1.8	1.4	12
Storm Composite	8/28/07 3:20	8/28/07 7:09	1060	164	5.00	1.600	0.054		207	11.1	9.0	<6.0	1100
E. coli Grab	8/28/07 11:58	8/28/07 11:58						>2420					
Base Composite	9/15/07 4:19	9/17/07 2:54	8	3	0.28	0.069	~0.032		~10	4.2	<1.0	<1.0	5
Storm Composite	9/18/07 12:53	9/20/07 7:34	99	20	1.20	0.222	0.069		60	16.1	2.4	1.4	37
Storm Composite	9/30/07 5:31	10/2/07 11:56	51	16	1.30	0.231	0.068		59	18.9	1.4	<1.0	28
Storm Composite	10/6/07 13:45	10/9/07 9:06	78	18	1.20	0.175	0.085		75	17.1	2.2	1.3	16
E. coli Grab	10/18/07 9:45	10/18/07 9:45						172					

Exceeds Water Quality Standard

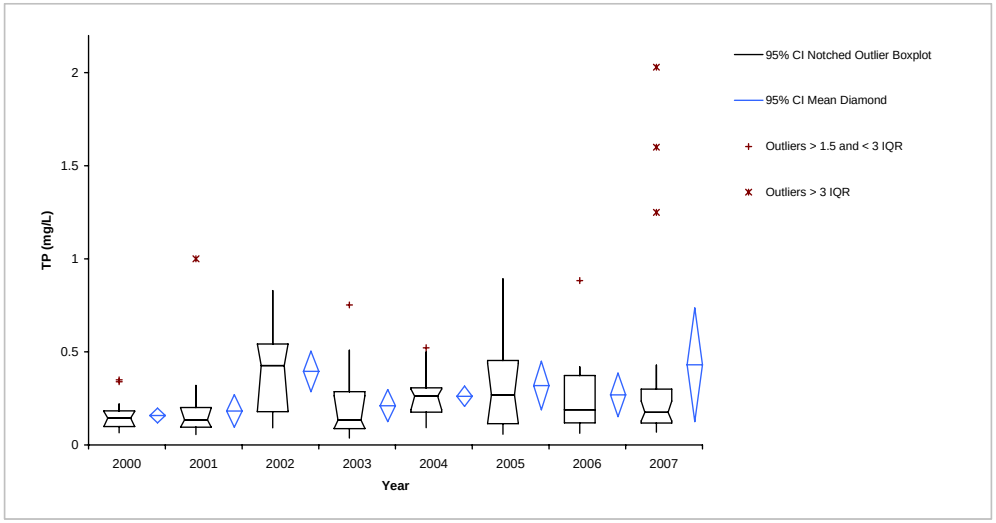
Table 22: Brown's Creek at McKusick Road 2007 Secondary Chemistry Results including Exceeded MPCA 7050 Water Quality Standards

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	2/22/07 13:10	2/22/07 13:10	0.0008	0.0018	0.0002	0.0015	<0.00004	0.0010	19				
Snowmelt Grab	3/12/07 10:24	3/12/07 10:24	0.0018	0.0016	0.0005	0.0035	<0.00004	0.0012	32				
Base Composite	4/19/07 13:07	4/22/07 11:30	0.0019	0.0019	0.0002	0.0035	0.00020	0.0009	18				168
E. coli Grab	5/2/07 10:55	5/2/07 10:55											
Base Grab	5/16/07 15:08	5/16/07 15:08	0.0008	0.0017	0.0002	0.0029	0.00004	<0.0002	17				188
Storm Composite	5/23/07 16:05	5/24/07 22:33	0.0012	0.0025	0.0011	0.0089	0.00008	0.0019	15				140
Base Composite	6/1/07 13:32	6/2/07 8:01	0.0012	0.0022	0.0006	0.0053	<0.00004	0.0010	15				176
Base Composite	6/2/07 8:56	6/3/07 13:10	0.0034	0.0038	0.0026	0.0126	0.00010	0.0042	15				172
E. coli Grab	6/13/07 9:16	6/13/07 9:16											
Base Grab	6/28/07 10:32	6/28/07 10:32	0.0006	0.0022	0.0002	0.0016	<0.00004	0.0011	17				210
E. coli Grab	7/16/07 11:22	7/16/07 11:22											
Base Composite	7/16/07 11:41	7/19/07 11:26	0.0012	0.0019	0.0007	0.0044	<0.00004	0.0014	17				208
Storm Composite	7/26/07 15:55	7/26/07 18:06							10	0.03	0.63	~0.04	
Storm Composite	8/13/07 21:42	8/14/07 5:56	0.0370	0.0360	0.0300	0.0820	<0.00050	0.0390	18	0.06	0.43	~0.02	104
Storm Composite	8/18/07 17:43	8/20/07 13:26	0.0013	0.0023	0.0006	0.0039	<0.00050	0.0012	17	<0.03	0.29	<0.02	166
Storm Composite	8/28/07 3:20	8/28/07 7:09	0.0245	0.0250	0.0260	0.0610	<0.00050	0.0320	10	<0.03	<0.05	~0.03	110
E. coli Grab	8/28/07 11:58	8/28/07 11:58											
Base Composite	9/15/07 4:19	9/17/07 2:54	0.0006	0.0018	0.0002	0.0013	<0.00050	0.0006	19	<0.03		<0.02	212
Storm Composite	9/18/07 12:53	9/20/07 7:34	0.0025	0.0028	0.0012	0.0062	<0.00050	0.0022	17	<0.03	0.12	~0.04	128
Storm Composite	9/30/07 5:31	10/2/07 11:56	0.0019	0.0029	0.0011	0.0047	<0.00050	0.0020	17	<0.03	0.19	~0.02	138
Storm Composite	10/6/07 13:45	10/9/07 9:06	0.0015	0.0021	0.0008	0.0043	<0.00050	0.0015	14	<0.03	<0.05	~0.02	118
E. coli Grab	10/18/07 9:45	10/18/07 9:45											

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

Analyse-it v2.07

Test	**Describe - Comparative**		
	TP (mg/L) by Year		
Performed by	tthiel	Date	6 March 2008



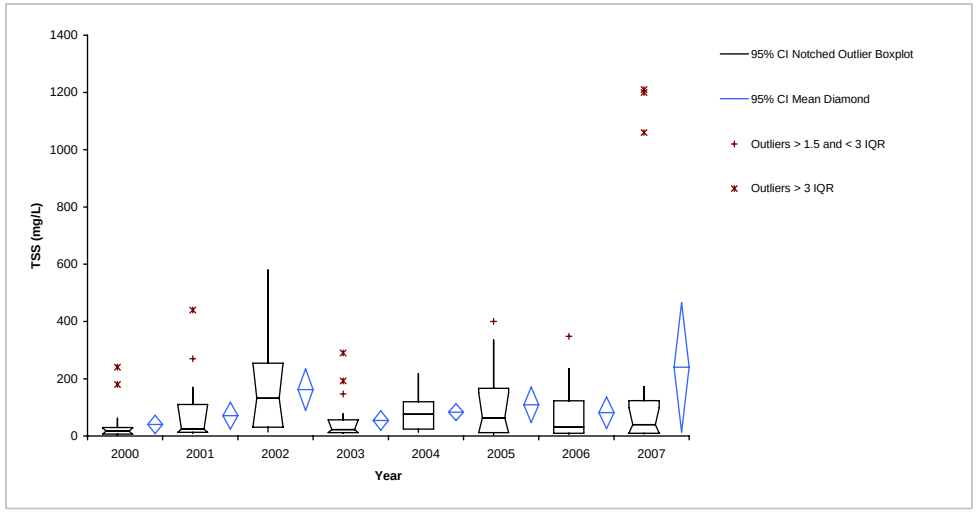
TP (mg/L) by Year	n	Mean	95% CI	SE	SD
2000	18	0.1584	0.1186 to 0.1982	0.01886	0.08002
2001	22	0.1828	0.0960 to 0.2695	0.04172	0.19568
2002	18	0.3952	0.2863 to 0.5041	0.05161	0.21895
2003	20	0.2112	0.1248 to 0.2975	0.04125	0.18447
2004	20	0.2620	0.2075 to 0.3164	0.02600	0.11628
2005	17	0.3189	0.1884 to 0.4495	0.06159	0.25393
2006	15	0.2687	0.1516 to 0.3857	0.05456	0.21131
2007	17	0.4307	0.1256 to 0.7358	0.14391	0.59334

TP (mg/L) by Year	n	Min	1st Quartile	Median	95% CI	3rd Quartile	Max	IQR
2000	18	0.065	0.0983	0.1450	0.0990 to 0.1800	0.1833	0.350	0.0850
2001	22	0.056	0.0959	0.1350	0.0960 to 0.2000	0.2008	1.000	0.1049
2002	18	0.092	0.1788	0.4260	0.1810 to 0.5420	0.5424	0.830	0.3637
2003	20	0.037	0.0878	0.1335	0.0890 to 0.2640	0.2868	0.752	0.1989
2004	20	0.093	0.1756	0.2625	0.1890 to 0.3000	0.3064	0.522	0.1308
2005	17	0.058	0.1143	0.2690	0.1170 to 0.4390	0.4540	0.892	0.3397
2006	15	0.063	0.1190	0.1890	0.1150 to 0.3810	0.3730	0.883	0.2540
2007	17	0.069	0.1183	0.1750	0.1290 to 0.2360	0.3003	2.030	0.1820

Figure 32. Brown's Creek at McKusick Road Yearly Total Phosphorus Concentration Box and Whisker Plot

Analyse-it v2.07

Test	**Describe - Comparative**		
	TSS (mg/L) by Year		
Performed by	tthiel	Date	6 March 2008



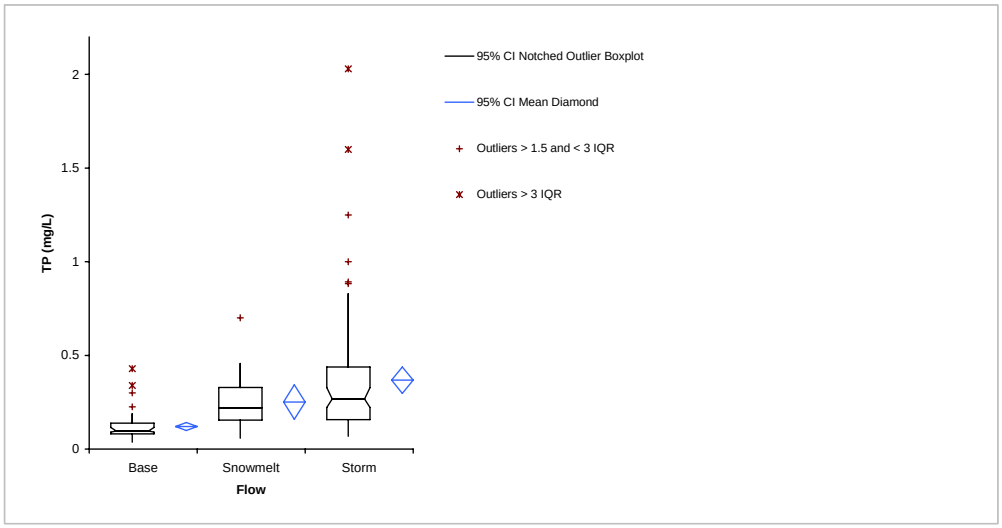
TSS (mg/L) by Year	n	Mean	95% CI	SE	SD
2000	18	40.3	8.1 to 72.4	15.24	64.64
2001	22	70.8	24.1 to 117.5	22.45	105.30
2002	18	162.1	89.3 to 234.9	34.50	146.36
2003	20	54.3	19.8 to 88.7	16.45	73.58
2004	19	83.3	54.2 to 112.4	13.84	60.34
2005	17	109.1	47.1 to 171.1	29.23	120.53
2006	15	81.2	26.1 to 136.3	25.71	99.58
2007	17	240.4	14.0 to 466.7	106.79	440.30

TSS (mg/L) by Year	n	Min	1st Quartile	Median	95% CI	3rd Quartile	Max	IQR
2000	18	2	6.8	17.5	7.0 to 28.0	30.0	240	23.3
2001	22	8	12.9	24.0	13.0 to 110.0	110.0	440	97.1
2002	18	14	31.1	132.0	32.0 to 254.0	254.2	580	223.1
2003	20	9	12.0	22.5	12.0 to 56.0	56.0	290	44.0
2004	19	13	24.0	76.0	24.0 to 120.0	119.8	218	95.8
2005	17	3	11.7	63.0	12.0 to 152.0	166.3	400	154.7
2006	15	5	9.7	31.0	9.0 to 128.0	123.3	348	113.7
2007	17	7	9.3	40.0	10.0 to 99.0	123.7	1210	114.3

Figure 33. Brown's Creek at McKusick Road Yearly Total Suspended Solids Concentration Box and Whisker Plot

Analyse-it v2.07

Test	**Describe - Comparative**
	TP (mg/L) by Flow
Performed by	tthiel
Date	6 March 2008



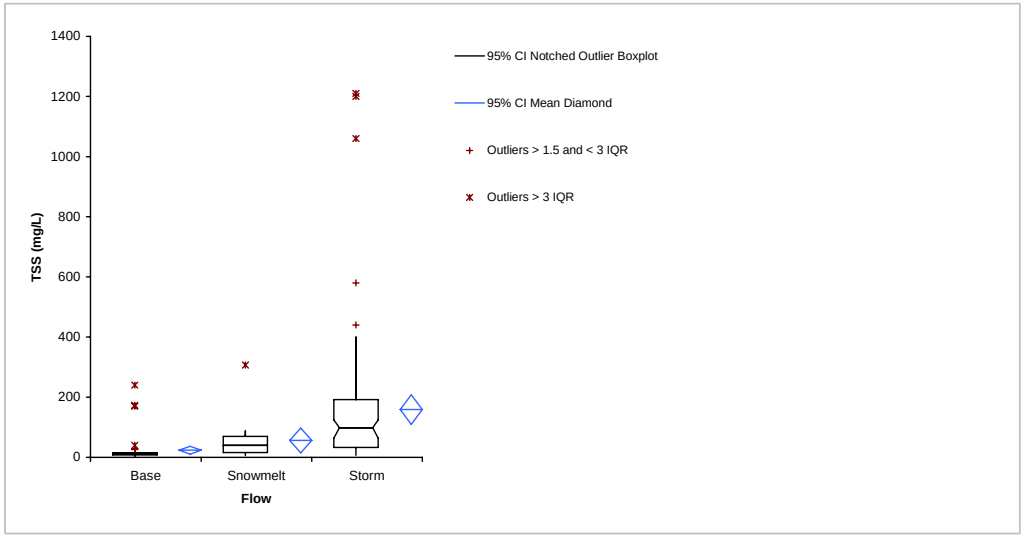
TP (mg/L) by Flow	n	Mean	95% CI	SE	SD
Base	49	0.1205	0.0996 to 0.1415	0.01042	0.07292
Snowmelt	15	0.2512	0.1592 to 0.3432	0.04288	0.16606
Storm	83	0.3680	0.2973 to 0.4388	0.03556	0.32396

TP (mg/L) by Flow	n	Min	1st Quartile	Median	95% CI	3rd Quartile	Max	IQR
Base	49	0.037	0.0807	0.0970	0.0900 to 0.1150	0.1383	0.429	0.0577
Snowmelt	15	0.058	0.1550	0.2200	0.1540 to 0.3330	0.3283	0.701	0.1733
Storm	83	0.068	0.1573	0.2670	0.2220 to 0.3280	0.4385	2.030	0.2812

Figure 34. Brown's Creek at McKusick Road Storm and Base Flow Sample Total Phosphorus Concentration Comparison Box and Whisker Plot

Analyse-it v2.07

Test	**Describe - Comparative**		
Performed by	TSS (mg/L) by Flow tthiel	Date	6 March 2008



TSS (mg/L) by Flow	n	Mean	95% CI	SE	SD
Base	49	23.8	10.7 to 36.8	6.48	45.33
Snowmelt	15	56.0	14.8 to 97.2	19.23	74.49
Storm	82	158.8	109.5 to 208.1	24.77	224.34

TSS (mg/L) by Flow	n	Min	1st Quartile	Median	95% CI	3rd Quartile	Max	IQR
Base	49	2	8.0	12.0	11.0 to 14.0	15.0	240	7.0
Snowmelt	15	6	16.0	40.0	15.0 to 72.0	70.0	307	54.0
Storm	82	7	32.9	98.5	64.0 to 124.0	192.3	1210	159.3

Figure 35. Brown's Creek at McKusick Road Storm and Base Flow Sample Total Suspended Solids Concentration Comparison Box and Whisker Plot

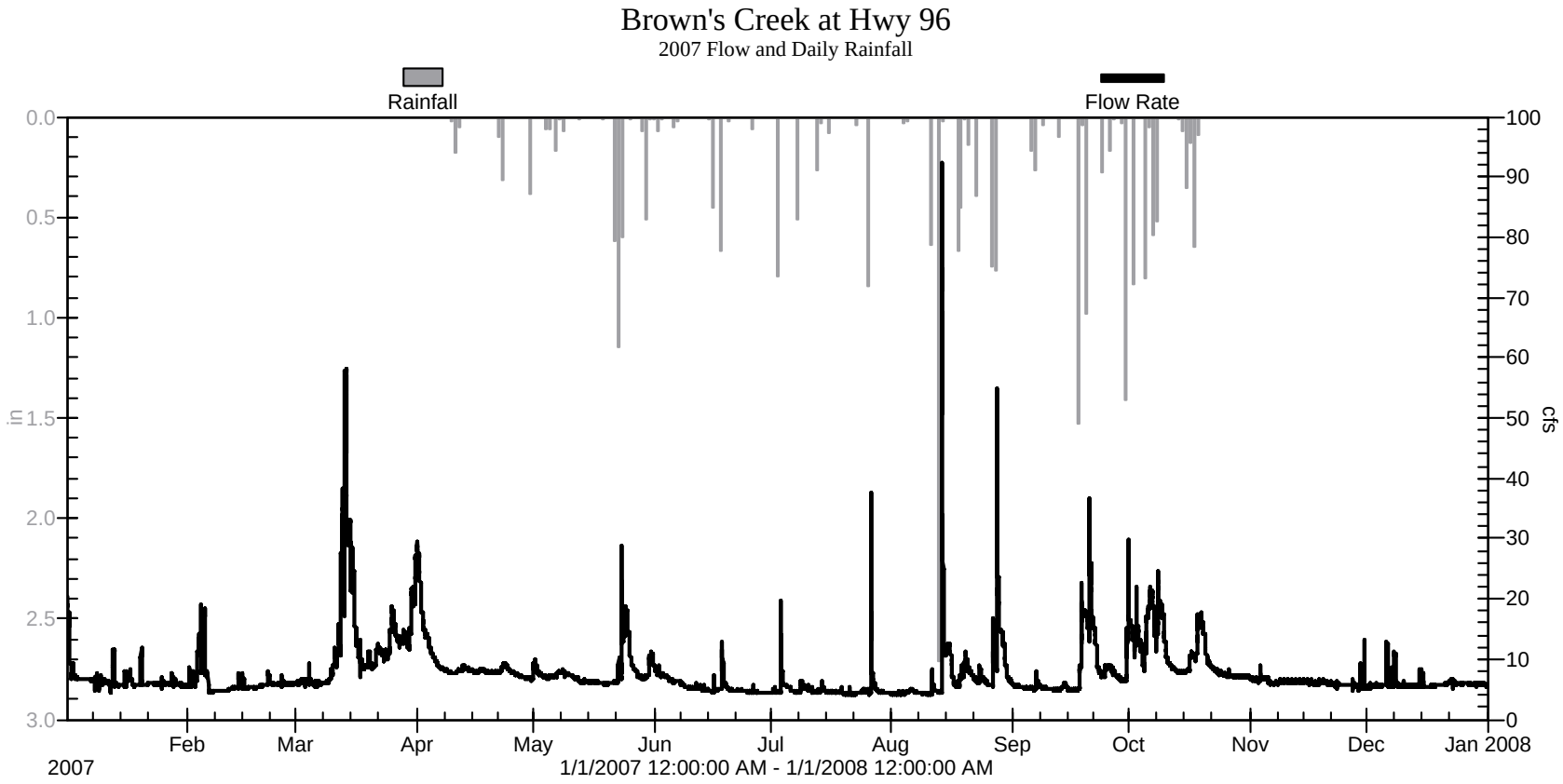


Figure 36. Brown's Creek at Hwy 96 2007 Flow and Daily Rainfall

Table 23. Brown's Creek at Hwy 96 2007 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 TSS (lb)	Interval TP (lb)
Snow Melt			*46*	*0.262*	*1/1/2007 0:00*	*1/2/2007 20:00*	*1,906,616*	*5,435*	*31.14*
Base			*5*	*0.070*	*1/2/2007 20:00*	*1/12/2007 11:00*	*5,340,983*	*1,584*	*23.21*
Snow Melt			*46*	*0.262*	*1/12/2007 11:00*	*1/13/2007 10:00*	*744,050*	*2,121*	*12.15*
Base			*5*	*0.070*	*1/13/2007 10:00*	*1/15/2007 21:00*	*1,205,314*	*357*	*5.24*
Snow Melt			*46*	*0.262*	*1/15/2007 21:00*	*1/17/2007 20:00*	*1,187,638*	*3,386*	*19.40*
Base			*5*	*0.070*	*1/17/2007 20:00*	*1/19/2007 23:00*	*1,040,481*	*309*	*4.52*
Snow Melt			*46*	*0.262*	*1/19/2007 23:00*	*1/20/2007 16:00*	*529,307*	*1,509*	*8.65*
Base Grab	1/24/07 10:02	1/24/07 10:02	6	0.103	1/20/2007 16:00	2/3/2007 4:00	6,872,802	2,574	44.19
Snow Melt			*46*	*0.262*	*2/3/2007 4:00*	*2/6/2007 15:00*	*2,944,530*	*8,394*	*48.10*
Base			*5*	*0.070*	*2/6/2007 15:00*	*2/14/2007 6:00*	*3,203,052*	*950*	*13.92*
Snowmelt	2/22/07 11:54	2/22/07 11:54	8	0.084	2/14/2007 6:00	2/14/2007 11:00	110,669	55	0.58
Base			*5*	*0.070*	*2/14/2007 11:00*	*2/15/2007 3:00*	*301,981*	*90*	*1.31*
Snowmelt			*46*	*0.262*	*2/15/2007 3:00*	*2/15/2007 15:00*	*258,256*	*736*	*4.22*
Base			*5*	*0.070*	*2/15/2007 15:00*	*2/21/2007 13:00*	*2,750,655*	*816*	*11.96*
Snowmelt			*46*	*0.262*	*2/21/2007 13:00*	*2/22/2007 13:00*	*564,208*	*1,608*	*9.22*
Base			*5*	*0.070*	*2/22/2007 13:00*	*3/9/2007 14:00*	*7,790,817*	*2,310*	*33.86*
Snowmelt Grab	3/12/07 10:19	3/12/07 10:19	24	0.205	3/9/2007 14:00	3/13/2007 11:00	4,574,896	6,854	58.55
Snowmelt Grab	3/14/07 11:28	3/14/07 11:28	105	0.496	3/13/2007 11:00	3/16/2007 13:00	7,401,497	48,515	229.18
Base			*5*	*0.070*	*3/16/2007 13:00*	*3/24/2007 18:00*	*7,203,128*	*2,136*	*31.31*
Snow Melt			*46*	*0.262*	*3/24/2007 18:00*	*3/26/2007 11:00*	*2,241,915*	*6,391*	*36.62*
Base			*5*	*0.070*	*3/26/2007 11:00*	*3/30/2007 2:00*	*4,138,757*	*1,227*	*17.99*
Storm Composite	3/31/07 16:56	4/1/07 18:09	223	0.385	3/30/2007 2:00	4/3/2007 3:00	7,207,660	100,338	173.23
Base Grab	4/23/07 11:40	4/23/07 11:40	8	0.061	4/3/2007 3:00	4/30/2007 16:00	19,826,412	9,901	75.50
Storm			*137*	*0.453*	*4/30/2007 16:00*	*5/2/2007 9:00*	*1,244,648*	*10,606*	*35.21*
Base Grab	5/17/07 9:27	5/17/07 9:27	6	0.079	5/2/2007 9:00	5/22/2007 17:00	11,799,820	4,420	58.19
Storm Composite**	5/23/07 16:51	5/24/07 16:20	137	0.816	5/22/2007 17:00	5/26/2007 2:00	3,700,402	31,532	188.50
Base			*5*	*0.070*	*5/26/2007 2:00*	*5/30/2007 19:00*	*3,068,401*	*910*	*13.34*
Storm			*137*	*0.453*	*5/30/2007 19:00*	*6/1/2007 1:00*	*1,095,454*	*9,335*	*30.99*
Base			*5*	*0.070*	*6/1/2007 1:00*	*6/16/2007 3:00*	*7,793,462*	*2,311*	*33.87*
Storm			*137*	*0.453*	*6/16/2007 3:00*	*6/16/2007 8:00*	*110,644*	*943*	*3.13*
Base			*5*	*0.070*	*6/16/2007 8:00*	*6/18/2007 12:00*	*938,363*	*278*	*4.08*
Storm			*137*	*0.453*	*6/18/2007 12:00*	*6/18/2007 22:00*	*274,505*	*2,339*	*7.77*
Base Grab	6/29/07 15:18	6/29/07 15:18	3	0.088	6/18/2007 22:00	7/3/2007 14:00	5,940,324	1,112	32.63
Storm			*137*	*0.453*	*7/3/2007 14:00*	*7/4/2007 1:00*	*324,741*	*2,767*	*9.19*
Base			*5*	*0.070*	*7/4/2007 1:00*	*7/8/2007 15:00*	*1,959,114*	*581*	*8.52*
Storm			*137*	*0.453*	*7/8/2007 15:00*	*7/9/2007 14:00*	*460,369*	*3,923*	*13.02*
Base			*5*	*0.070*	*7/9/2007 14:00*	*7/13/2007 23:00*	*1,788,908*	*530*	*7.78*
Storm			*137*	*0.453*	*7/13/2007 23:00*	*7/14/2007 6:00*	*133,254*	*1,135*	*3.77*
Base Composite	7/16/07 13:03	7/19/07 16:31	3	0.057	7/14/2007 6:00	7/26/2007 16:00	4,779,298	895	17.01
Storm			*137*	*0.453*	*7/26/2007 16:00*	*7/27/2007 6:00*	*540,936*	*4,609*	*15.30*
Base			*5*	*0.070*	*7/27/2007 6:00*	*8/11/2007 4:00*	*5,799,132*	*1,720*	*25.21*
Storm			*137*	*0.453*	*8/11/2007 4:00*	*8/12/2007 2:00*	*424,029*	*3,613*	*12.00*
Base			*5*	*0.070*	*8/12/2007 2:00*	*8/13/2007 21:00*	*713,073*	*211*	*3.10*
Storm Composite	8/13/07 22:10	8/14/07 5:57	968	1.300	8/13/2007 21:00	8/16/2007 19:00	3,732,343	225,540	302.89
Base			*5*	*0.070*	*8/16/2007 19:00*	*8/18/2007 10:00*	*793,737*	*235*	*3.45*
Storm			*137*	*0.453*	*8/18/2007 10:00*	*8/19/2007 0:00*	*367,246*	*3,129*	*10.39*
Base			*5*	*0.070*	*8/19/2007 0:00*	*8/19/2007 14:00*	*357,437*	*106*	*1.55*
Storm			*137*	*0.453*	*8/19/2007 14:00*	*8/19/2007 23:00*	*287,723*	*2,452*	*8.14*
Base			*5*	*0.070*	*8/19/2007 23:00*	*8/20/2007 10:00*	*321,812*	*95*	*1.40*
Storm			*137*	*0.453*	*8/20/2007 10:00*	*8/20/2007 19:00*	*300,638*	*2,562*	*8.51*
Base			*5*	*0.070*	*8/20/2007 19:00*	*8/23/2007 13:00*	*1,669,015*	*495*	*7.25*
Storm			*137*	*0.453*	*8/23/2007 13:00*	*8/23/2007 22:00*	*243,431*	*2,074*	*6.89*
Base			*5*	*0.070*	*8/23/2007 22:00*	*8/27/2007 2:00*	*1,679,942*	*498*	*7.30*
Storm			*137*	*0.453*	*8/27/2007 2:00*	*8/27/2007 8:00*	*240,630*	*2,050*	*6.81*
Base			*5*	*0.070*	*8/27/2007 8:00*	*8/28/2007 3:00*	*563,657*	*167*	*2.45*
Storm Composite	8/28/07 3:45	8/28/07 10:32	588	1.400	8/28/2007 3:00	8/30/2007 3:00	2,729,038	100,174	238.51
Base			*5*	*0.070*	*8/30/2007 3:00*	*9/6/2007 22:00*	*3,851,943*	*1,142*	*16.74*
Storm			*137*	*0.453*	*9/6/2007 22:00*	*9/7/2007 9:00*	*278,127*	*2,370*	*7.87*
Base Composite	9/13/07 11:13	9/17/07 7:57	3	0.066	9/7/2007 9:00	9/18/2007 5:00	4,778,721	895	19.69
Storm Composite	9/18/07 14:03	9/19/07 12:33	79	0.26	9/18/2007 5:00	9/19/2007 20:00	2,161,029	10,657	35.08
Storm Composite	9/20/07 21:27	9/20/07 22:42	174	0.459	9/19/2007 20:00	9/22/2007 14:00	3,552,293	38,586	101.79
Base			*5*	*0.070*	*9/22/2007 14:00*	*9/24/2007 18:00*	*1,497,117*	*444*	*6.51*
Storm			*137*	*0.453*	*9/24/2007 18:00*	*9/24/2007 23:00*	*149,617*	*1,275*	*4.23*
Base			*5*	*0.070*	*9/24/2007 23:00*	*9/30/2007 2:00*	*3,345,530*	*992*	*14.54*
Storm Composite	9/30/07 16:02	10/1/07 2:57	70	0.346	9/30/2007 2:00	10/1/2007 4:00	1,403,710	6,134	30.32
Base			*5*	*0.070*	*10/1/2007 4:00*	*10/2/2007 13:00*	*1,653,741*	*490*	*7.19*
Storm			*137*	*0.453*	*10/2/2007 13:00*	*10/3/2007 6:00*	*967,388*	*8,243*	*27.37*
Base			*5*	*0.070*	*10/3/2007 6:00*	*10/5/2007 2:00*	*1,759,892*	*522*	*7.65*
Storm			*137*	*0.453*	*10/5/2007 2:00*	*10/10/2007 8:00*	*7,840,992*	*66,814*	*221.83*
Base			*5*	*0.070*	*10/10/2007 8:00*	*10/16/2007 12:00*	*4,503,842*	*1,335*	*19.58*
Storm			*137*	*0.453*	*10/16/2007 12:00*	*10/20/2007 20:00*	*4,890,936*	*41,676*	*138.37*
Base Grab	11/27/2007 8:30	11/27/2007 8:30	5	0.049	10/20/2007 20:00	11/29/2007 3:00	22,283,550	6,955	68.16
Snowmelt			*46*	*0.262*	*11/29/2007 3:00*	*11/30/2007 18:00*	*936,583*	*2,670*	*15.30*
Base			*5*	*0.070*	*11/30/2007 18:00*	*12/5/2007 19:00*	*2,372,198*	*703*	*10.31*
Snowmelt			*46*	*0.262*	*12/5/2007 19:00*	*12/6/2007 17:00*	*644,092*	*1,836*	*10.52*
Base			*5*	*0.070*	*12/6/2007 17:00*	*12/7/2007 22:00*	*603,459*	*179*	*2.62*
Snowmelt			*46*	*0.262*	*12/7/2007 22:00*	*12/8/2007 19:00*	*614,885*	*1,753*	*10.04*
Base			*5*	*0.070*	*12/8/2007 19:00*	*12/10/2007 7:00*	*720,318*	*214*	*3.13*
Snowmelt			*46*	*0.262*	*12/10/2007 7:00*	*12/10/07 16:00*	*192,186*	*548*	*3.14*
Base			*5*	*0.070*	*12/10/2007 16:00*	*12/14/07 6:00*	*1,721,540*	*510*	*7.48*
Snowmelt			*46*	*0.262*	*12/14/2007 6:00*	*12/14/07 13:00*	*167,664*	*478*	*2.74*
Base			*5*	*0.070*	*12/14/2007 13:00*	*12/14/07 23:00*	*194,967*	*58*	*0.85*
Snowmelt			*46*	*0.262*	*12/14/2007 23:00*	*12/15/07 19:00*	*481,199*	*1,372*	*7.86*
Base Grab	12/27/2007 14:05	12/27/2007 14:05	4	0.054	12/15/2007 19:00	1/1/2008 0:00	8,087,745	2,020	27.26
Storm Average			137	0.453					
Base Average			5	0.070					
Snowmelt Average			46	0.262					
All Average			134	0.350					
Total							**237,176,413**	**831,819**	**2,850**
Brown's Creek Major Subwatershed Total Acres							12,864		
Total TP/TSS (lb/ac/yr)								64.66	0.22
Total TP/TSS (kg/ha/yr)								72.48	0.25
*Italics indicate estimated concentrations based on average base and storm flow concentrations									
**TSS values based upon Storm Average concentrations									

Table 24. Brown's Creek at Hwy 96 (WOMP) 2007 Primary Chemistry Result Averages

Parameter	Storm Flow Average	Base Flow Average	Average (all samples)
TSS (mg/L)	350	5	142
VSS (mg/L)	73	2	33
TKN (mg/L)	2.71	0.36	1.56
TP (mg/L)	0.47	0.07	0.37
E. Coli (mpn/100 mL)	--	--	654
COD (mg/L)	122	10	62
Alkalinity (mg/L)	86	181	131
Hardness (mg/L)	125	207	162

Table 25: Brown's Creek at Mouth (Highway 96) 2007 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	1/24/07 10:02	1/24/07 10:02	6	3	0.32	0.103			~10	1.7	<1.0	10.05	0.034	186	4
Snowmelt Grab	2/22/07 11:54	2/22/07 11:54	8	~2	0.45	0.084	0.067		<5	2.2	<1.0	16.10	0.034	171	9
Snowmelt Grab	3/12/07 10:19	3/12/07 10:19	24	8	1.30	0.205	0.112		38	10.8	5.0	7.92	0.107	97	13
Snowmelt Grab	3/14/07 11:28	3/14/07 11:28	105	38	3.30	0.496	0.144		94	13.5	8.4	5.13	0.102		36
Storm Composite	3/31/07 16:56	4/1/07 18:09	223	37	2.20	0.385	0.086		70	16.2		7.06		97	43
Base Grab	4/23/07 11:40	4/23/07 11:40	8	3	0.51	0.061	~0.032		21	4.8	1.5	7.99	0.027	177	2
E. Coli Sample	5/2/07 11:47	5/2/07 11:47						102							
Base Grab	5/17/07 9:27	5/17/07 9:27	6	~3	0.26	0.079	~0.034		15	3.3	<1.0	8.55	0.033	176	5
Storm Composite	5/23/07 16:51	5/24/07 16:20			3.90	0.816	~0.032		152	7.7		6.35		115	148
E. Coli Sample	6/13/07 9:58	6/13/07 9:58						275							
Base Grab	6/29/07 15:18	6/29/07 15:18	3	~1	0.60	0.088	~0.044		~7	2.3	<1.0	9.52	0.054	197	5
E. Coli Sample	7/16/07 10:10	7/16/07 10:10						318							
Base Composite	7/16/07 13:03	7/19/07 16:31	3	~2	0.30	0.057	~0.024		~10	5.2		8.96			3
Storm Composite	8/13/07 22:10	8/14/07 5:57	968	164	3.00	1.300	0.105		250	11.8		7.83		41	750
Storm Composite	8/28/07 3:45	8/28/07 10:32	588	142	4.30	1.400	0.098		172	21.6		7.24		64	500
E. Coli Sample	8/28/07 10:40	8/28/07 10:40						>2420							
Base Composite	9/13/07 11:13	9/17/07 7:57	3	~1	0.33	0.066	~0.042		<5	2.1		9.11		178	3
Storm Composite	9/18/07 14:03	9/19/07 12:33	79	21	0.84	0.260	0.083		54	11.2		9.54		93	55
Storm Composite	9/20/07 21:27	9/20/07 22:42	174	55	3.10	0.459			95					93	75
Storm Composite	9/30/07 16:02	10/1/07 2:57	70	20	1.60	0.346	0.086		59	11.3		8.20		105	60
E. Coli Sample	10/18/07 10:00	10/18/07 10:00						156							
Base Grab	11/27/07 8:30	11/27/07 8:30	5	~2	0.18	~0.049	~0.014		~5	2.7	1.3	9.56	0.024	174	6
Base Grab	12/27/07 14:05	12/27/07 14:05	4	~2	0.30	0.054	~0.010		~9	2.6	<1.0		0.027	183	5

Exceeds Water Quality Standard

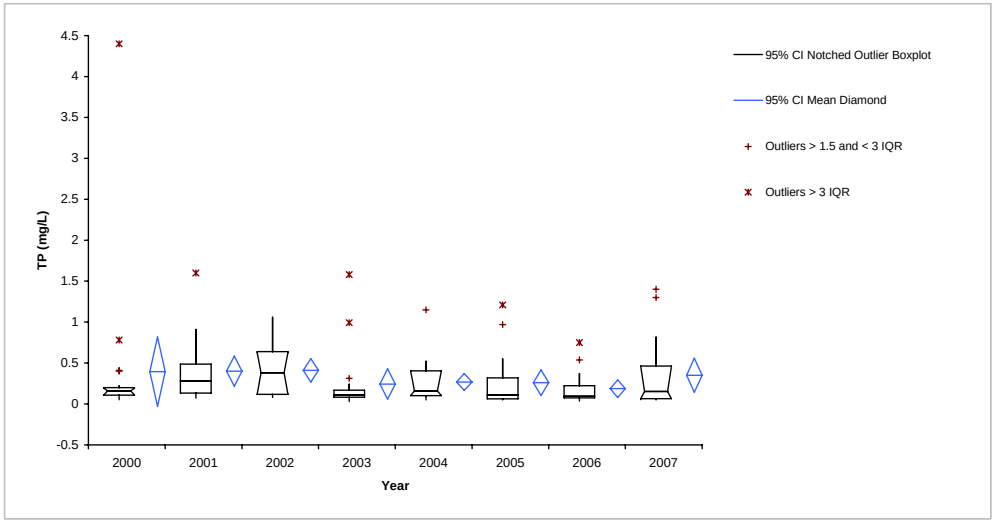
Table 26: Brown's Creek at Mouth (Highway 96) 2007 Secondary Water Quality Results

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	1/24/07 10:02	1/24/07 10:02	0.0008	0.0019	0.00020	0.0015	<0.00004	0.0010	21	<0.03	1.50	~0.03	212
Snowmelt Grab	2/22/07 11:54	2/22/07 11:54	0.0013	0.0022	0.00030	0.0081	0.00070	0.0011	37	<0.03	1.62	0.09	200
Snowmelt Grab	3/12/07 10:19	3/12/07 10:19	0.0017	0.0017	0.00050	0.0030	<0.00004	0.0015	29	<0.03	1.19	0.27	120
Snowmelt Grab	3/14/07 11:28	3/14/07 11:28	0.0034	0.0025	0.00180	0.0086	<0.00004	0.0038	18	<0.03	0.59	0.48	82
Storm Composite	3/31/07 16:56	4/1/07 18:09	0.0051	0.0034	0.00150	0.0102	0.00020	0.0032	17	<0.03	0.48	0.23	116
Base Grab	4/23/07 11:40	4/23/07 11:40	0.0009	0.0019	0.00020	0.0047	<0.00004	0.0011	20	<0.03	0.65	<0.02	174
E. Coli Sample	5/2/07 11:47	5/2/07 11:47											
Base Grab	5/17/07 9:27	5/17/07 9:27	0.0010	0.0017	0.00010	0.0036	<0.00004	<0.0002	20	0.05	0.83	~0.04	202
Storm Composite	5/23/07 16:51	5/24/07 16:20	0.0104	0.0069	0.00580	0.0260	<0.00004	0.0099	17	<0.03	0.16	~0.06	140
E. Coli Sample	6/13/07 9:58	6/13/07 9:58											
Base Grab	6/29/07 15:18	6/29/07 15:18	<0.0005	0.0019	0.00007	0.0007	<0.00004	0.0011	20	<0.03	0.95	~0.03	220
E. Coli Sample	7/16/07 10:10	7/16/07 10:10											
Base Composite	7/16/07 13:03	7/19/07 16:31	0.0014	0.0015	<0.00007	0.0020	0.00020	0.0011	22	<0.03	0.86	0.09	216
Storm Composite	8/13/07 22:10	8/14/07 5:57	0.0260	0.0220	0.02200	0.0540	<0.00050	0.0290	14	0.04	0.47	~0.04	96
Storm Composite	8/28/07 3:45	8/28/07 10:32	0.0180	0.0169	0.01440	0.0420	<0.00050	0.0218	12	<0.03	<0.05	0.08	112
E. Coli Sample	8/28/07 10:40	8/28/07 10:40											
Base Composite	9/13/07 11:13	9/17/07 7:57	0.0015	0.0018	0.00020	0.0016	<0.00050	0.0007	20	<0.03	0.88	~0.03	214
Storm Composite	9/18/07 14:03	9/19/07 12:33	0.0040	0.0036	0.00170	0.0079	<0.00050	0.0031	18	<0.03	0.31	~0.03	148
Storm Composite	9/20/07 21:27	9/20/07 22:42							14	0.04	0.54	<0.02	
Storm Composite	9/30/07 16:02	10/1/07 2:57	0.0036	0.0040	0.00200	0.0077	<0.00050	0.0034	18	<0.03	0.37	~0.03	136
E. Coli Sample	10/18/07 10:00	10/18/07 10:00											
Base Grab	11/27/07 8:30	11/27/07 8:30	<0.0005	0.0021	0.00020	<0.0010	<0.00050	0.0013	22	<0.03	1.06	~0.02	208
Base Grab	12/27/07 14:05	12/27/07 14:05	<0.0005	0.0016	<0.00050	<0.0010	<0.00050	0.0010	20	<0.03	1.15	~0.03	218

No Exceedance Determinable
Exceeds Chronic Standard
Exceeds Max Standard

Analyse-it v2.07

Test	**Describe - Comparative**		
	TP (mg/L) by Year		
Performed by	tthiel	Date	6 March 2008



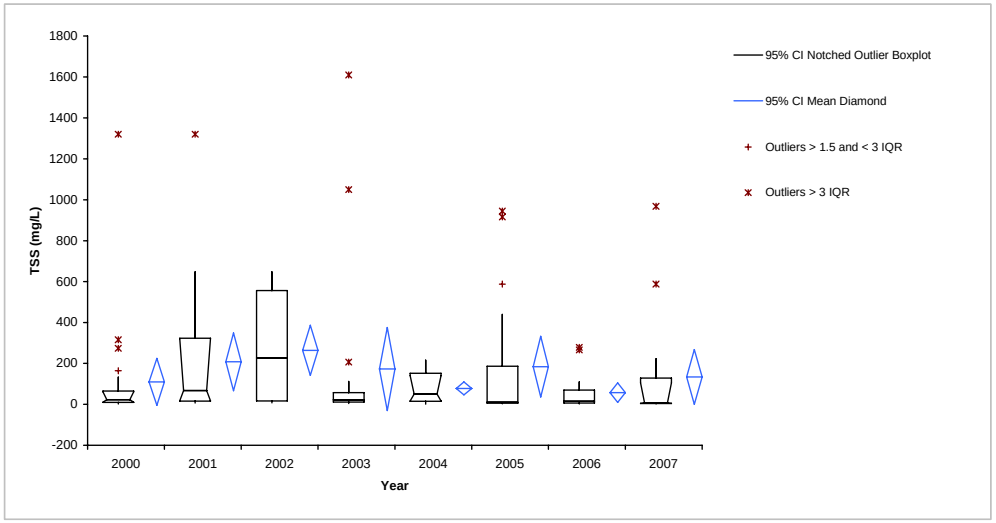
TP (mg/L) by Year	n	Mean	95% CI	SE	SD
2000	21	0.3933	-0.0311 to 0.8178	0.20347	0.93241
2001	19	0.3995	0.2148 to 0.5842	0.08791	0.38320
2002	20	0.4102	0.2678 to 0.5525	0.06803	0.30422
2003	19	0.2440	0.0581 to 0.4299	0.08846	0.38560
2004	24	0.2684	0.1662 to 0.3706	0.04939	0.24197
2005	19	0.2593	0.1027 to 0.4160	0.07456	0.32501
2006	16	0.1861	0.0787 to 0.2936	0.05041	0.20164
2007	18	0.3504	0.1420 to 0.5589	0.09881	0.41923

TP (mg/L) by Year	n	Min	1st Quartile	Median	95% CI	3rd Quartile	Max	IQR
2000	21	0.050	0.1067	0.1600	0.1100 to 0.1900	0.2000	4.400	0.0933
2001	19	0.070	0.1317	0.2800	0.1300 to 0.4900	0.4850	1.600	0.3533
2002	20	0.080	0.1184	0.3820	0.1190 to 0.6260	0.6388	1.060	0.5204
2003	19	0.031	0.0825	0.1120	0.0810 to 0.1720	0.1680	1.580	0.0855
2004	24	0.049	0.1003	0.1570	0.1020 to 0.4030	0.4042	1.150	0.3039
2005	19	0.049	0.0623	0.1080	0.0620 to 0.3220	0.3180	1.210	0.2557
2006	16	0.036	0.0740	0.0945	0.0740 to 0.2360	0.2218	0.750	0.1478
2007	18	0.049	0.0656	0.1540	0.0660 to 0.4590	0.4621	1.400	0.3965

Figure 37. Brown's Creek at Hwy 96 Yearly Total Phosphorus Concentration Box and Whisker Plot

Analyse-it v2.07

Test	**Describe - Comparative**		
	TSS (mg/L) by Year		
Performed by	tthiel	Date	6 March 2008



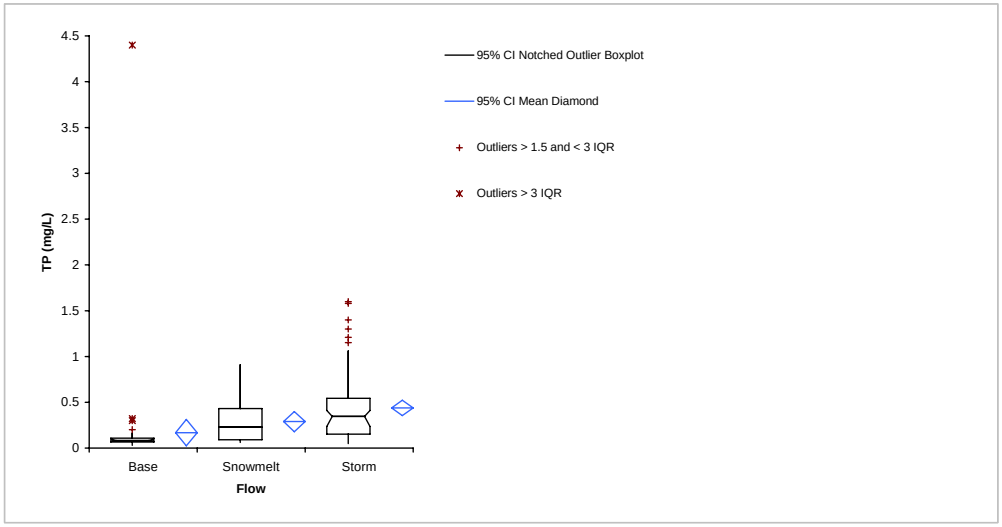
TSS (mg/L) by Year	n	Mean	95% CI	SE	SD
2000	24	110.0	-4.4 to 224.4	55.30	270.93
2001	21	208.1	66.8 to 349.5	67.77	310.58
2002	19	263.9	141.3 to 386.6	58.39	254.52
2003	19	173.2	-29.7 to 376.1	96.58	420.98
2004	23	78.1	46.4 to 109.9	15.32	73.48
2005	19	184.3	35.7 to 332.9	70.73	308.29
2006	16	57.1	9.2 to 104.9	22.44	89.77
2007	17	133.9	0.3 to 267.6	63.04	259.90

TSS (mg/L) by Year	n	Min	1st Quartile	Median	95% CI	3rd Quartile	Max	IQR
2000	24	2	9.4	23.0	10.0 to 61.0	65.1	1320	55.7
2001	21	7	15.7	68.0	18.0 to 321.0	323.0	1320	307.3
2002	19	8	17.0	226.0	15.0 to 590.0	556.2	648	539.2
2003	19	4	11.0	22.0	11.0 to 61.0	57.0	1610	46.0
2004	23	1	15.3	50.0	17.0 to 140.0	151.7	216	136.3
2005	19	3	6.0	10.0	6.0 to 188.0	186.7	944	180.7
2006	16	2	7.0	15.0	7.0 to 93.0	69.3	279	62.3
2007	17	3	4.7	8.0	5.0 to 105.0	128.0	968	123.3

Figure 38. Brown's Creek at Hwy 96 Yearly Total Suspended Solids Concentration Box and Whisker Plot

Analyse-it v2.07

Test	**Describe - Comparative**		
	TP (mg/L) by Flow		
Performed by	tthiel	Date	6 March 2008



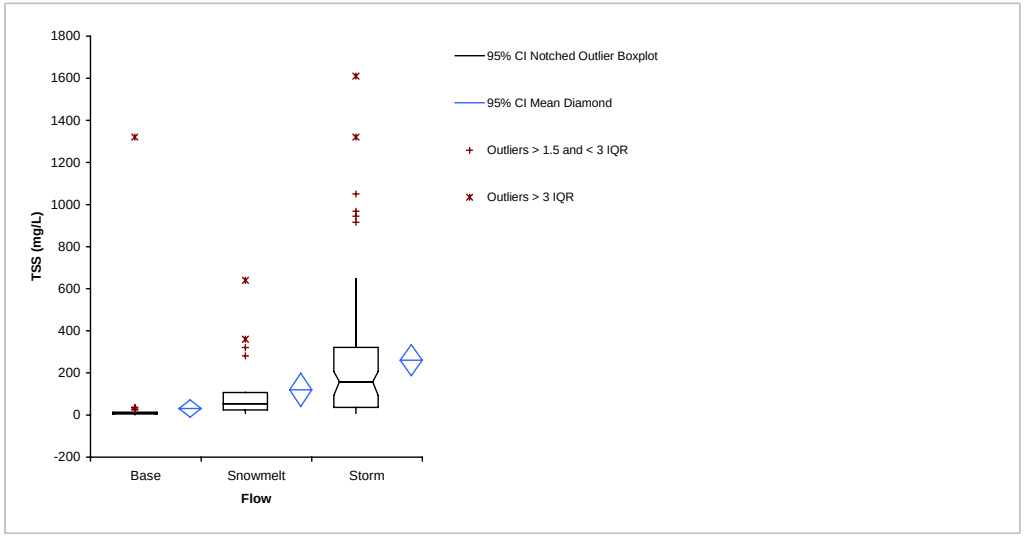
TP (mg/L) by Flow	n	Mean	95% CI	SE	SD
Base	60	0.1682	0.0240 to 0.3123	0.07204	0.55805
Snowmelt	19	0.2892	0.1793 to 0.3991	0.05229	0.22794
Storm	77	0.4384	0.3542 to 0.5227	0.04228	0.37105

TP (mg/L) by Flow	n	Min	1st Quartile	Median	95% CI	3rd Quartile	Max	IQR
Base	60	0.031	0.0660	0.0820	0.0770 to 0.1000	0.1098	4.400	0.0438
Snowmelt	19	0.062	0.0898	0.2300	0.0840 to 0.4400	0.4308	0.910	0.3410
Storm	77	0.049	0.1527	0.3460	0.2360 to 0.4100	0.5437	1.600	0.3910

Figure 39. Brown's Creek at Hwy 96 Storm and Base Flow Sample Total Phosphorus Concentration Comparison Box and Whisker Plot

Analyse-it v2.07

Test	**Describe - Comparative**		
Performed by	TSS (mg/L) by Flow tthiel	Date	6 March 2008



TSS (mg/L) by Flow	n	Mean	95% CI	SE	SD
Base	64	31.2	-9.7 to 72.1	20.48	163.84
Snowmelt	19	120.0	40.3 to 199.7	37.96	165.45
Storm	75	260.3	186.4 to 334.3	37.10	321.26

TSS (mg/L) by Flow	n	Min	1st Quartile	Median	95% CI	3rd Quartile	Max	IQR
Base	64	1	5.4	9.0	7.0 to 11.0	13.6	1320	8.2
Snowmelt	19	8	24.5	54.0	24.0 to 108.0	107.5	640	83.0
Storm	75	8	36.2	158.0	93.0 to 207.0	321.8	1610	285.7

Figure 40. Brown's Creek at Hwy 96 Storm and Base Flow Sample Total Suspended Solids Concentration Comparison Box and Whisker Plot

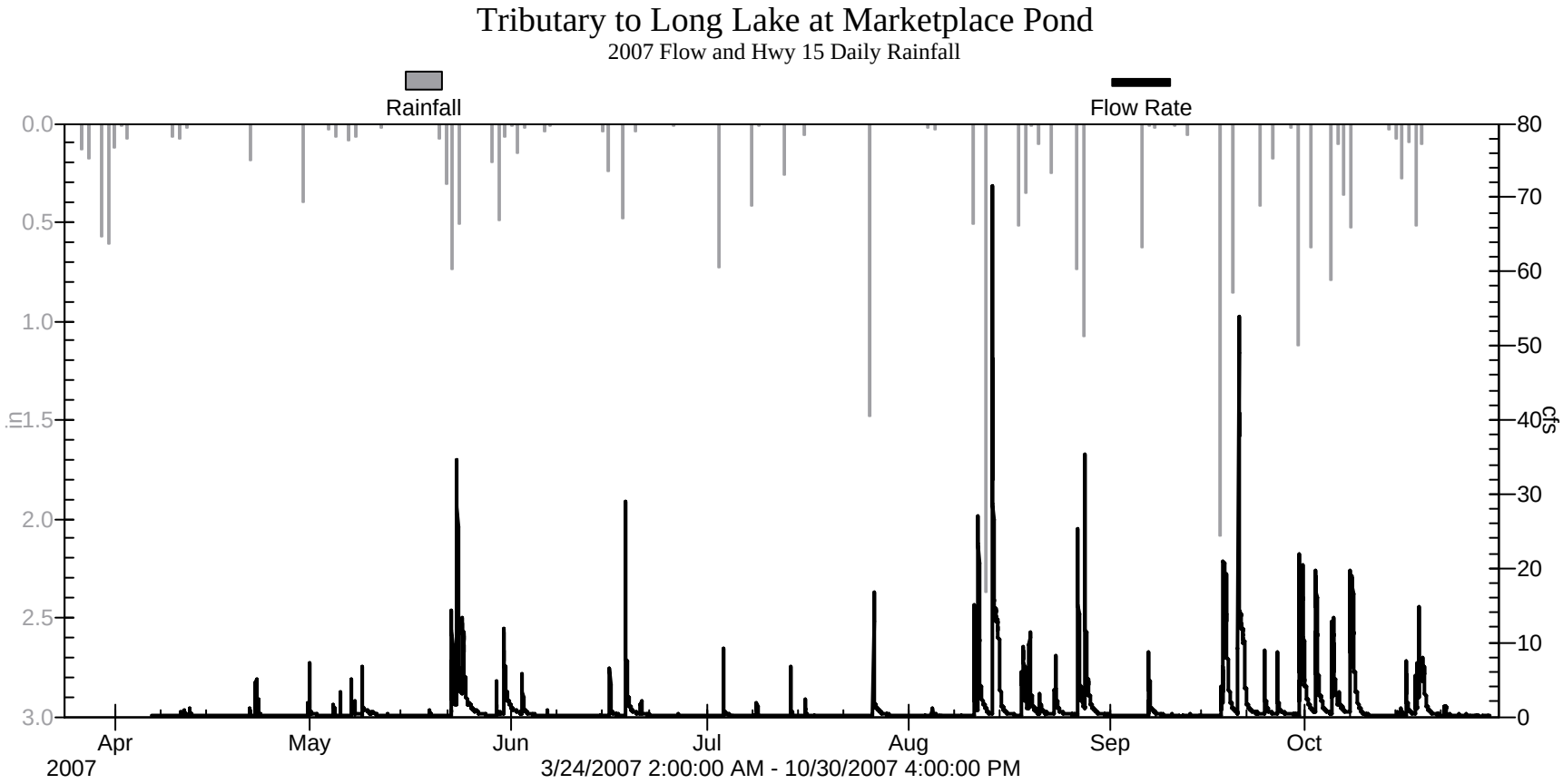


Figure 41. Tributary to Long Lake at Marketplace Pond 2007 Flow and Hwy 15 Daily Rainfall

Table 27. Tributary to Long Lake at Marketplace Pond 2007 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 TP (lb)	Interval TSS (lb)
*Base***			*4*	*0.146*	*1/1/2007 0:00*	*3/13/2007 11:45*	*123,534*	*1.13*	*31*
Snowmelt Grab**	3/13/2007 12:15	3/13/2007 12:15	32	0.387	3/13/2007 11:45	3/14/2007 11:45	864,000	*20.87*	*1,726*
*Base***			*4*	*0.146*	*3/14/2007 11:45*	*4/6/2007 14:45*	*39,960*	*0.36*	*10*
Base			*4*	*0.146*	*4/6/2007 14:45*	*4/22/2007 14:45*	*149,821*	*1.37*	*37*
Storm			*54*	*0.124*	*4/22/2007 14:45*	*4/22/2007 17:45*	*25,012*	*0.19*	*84*
Base			*4*	*0.146*	*4/22/2007 17:45*	*4/30/2007 15:45*	*61,189*	*0.56*	*15*
Storm			*54*	*0.124*	*4/30/2007 15:45*	*4/30/2007 22:45*	*54,316*	*0.42*	*183*
Base			*4*	*0.146*	*4/30/2007 22:45*	*5/7/2007 5:45*	*125,479*	*1.14*	*31*
Storm			*54*	*0.124*	*5/7/2007 5:45*	*5/7/2007 6:45*	*12,274*	*0.10*	*41*
Base			*4*	*0.146*	*5/7/2007 6:45*	*5/8/2007 22:45*	*64,619*	*0.59*	*16*
Storm			*54*	*0.124*	*5/8/2007 22:45*	*5/9/2007 0:45*	*24,379*	*0.19*	*82*
Base			*4*	*0.146*	*5/9/2007 0:45*	*5/22/2007 16:45*	*195,535*	*1.78*	*49*
Storm			*54*	*0.124*	*5/22/2007 16:45*	*5/22/2007 20:45*	*95,909*	*0.74*	*322*
Base			*4*	*0.146*	*5/22/2007 20:45*	*5/23/2007 12:45*	*143,462*	*1.31*	*36*
Storm Composite	5/23/2007 13:50	5/23/2007 18:23	78	0.130	5/23/2007 12:45	5/23/2007 21:45	467,236	*3.79*	*2,275*
Base			*4*	*0.146*	*5/23/2007 21:45*	*5/24/2007 6:45*	*147,297*	*1.34*	*37*
Storm			*54*	*0.124*	*5/24/2007 6:45*	*5/24/2007 18:45*	*396,360*	*3.07*	*1,333*
Base			*4*	*0.146*	*5/24/2007 18:45*	*5/29/2007 15:45*	*337,430*	*3.08*	*84*
Storm			*54*	*0.124*	*5/29/2007 15:45*	*5/29/2007 17:45*	*17,916*	*0.14*	*60*
Base			*4*	*0.146*	*5/29/2007 17:45*	*5/30/2007 17:45*	*34,527*	*0.31*	*9*
Storm Composite	5/30/2007 18:24	5/31/2007 2:43	28	0.097	5/30/2007 17:45	5/31/2007 3:45	230,878	*1.40*	*404*
Base			*4*	*0.146*	*5/31/2007 3:45*	*6/2/2007 15:45*	*249,072*	*2.27*	*62*
Storm			*54*	*0.124*	*6/2/2007 15:45*	*6/2/2007 17:45*	*28,686*	*0.22*	*96*
Base			*4*	*0.146*	*6/2/2007 17:45*	*6/16/2007 2:45*	*174,773*	*1.59*	*44*
Storm			*54*	*0.124*	*6/16/2007 2:45*	*6/16/2007 4:45*	*20,724*	*0.16*	*70*
Base			*4*	*0.146*	*6/16/2007 4:45*	*6/18/2007 10:45*	*58,176*	*0.53*	*15*
Storm Composite	6/18/2007 11:27	6/18/2007 18:46	31	0.140	6/18/2007 10:45	6/18/2007 19:45	293,431	*2.56*	*568*
Base			*4*	*0.146*	*6/18/2007 19:45*	*7/3/2007 13:45*	*283,218*	*2.58*	*71*
Storm			*54*	*0.124*	*7/3/2007 13:45*	*7/3/2007 15:45*	*25,885*	*0.20*	*87*
Base			*4*	*0.146*	*7/3/2007 15:45*	*7/13/2007 22:45*	*88,381*	*0.81*	*22*
Storm			*54*	*0.124*	*7/13/2007 22:45*	*7/13/2007 23:45*	*17,876*	*0.14*	*60*
Base			*4*	*0.146*	*7/13/2007 23:45*	*7/26/2007 14:45*	*74,206*	*0.68*	*19*
Storm Composite	7/26/2007 14:51	7/26/2007 17:30	124	0.204	7/26/2007 14:45	7/26/2007 18:45	105,979	*1.35*	*820*
Base			*4*	*0.146*	*7/26/2007 18:45*	*8/11/2007 2:45*	*211,914*	*1.93*	*53*
Storm Composite	8/11/2007 2:57	8/11/2007 3:25	220	0.335	8/11/2007 2:45	8/11/2007 4:45	51,248	*1.07*	*704*
Base			*4*	*0.146*	*8/11/2007 4:45*	*8/11/2007 17:45*	*58,737*	*0.54*	*15*
Storm Composite	8/11/2007 18:17	8/12/2007 2:05	32	0.128	8/11/2007 17:45	8/12/2007 2:45	318,632	*2.55*	*637*
Base			*4*	*0.146*	*8/12/2007 2:45*	*8/13/2007 20:45*	*188,132*	*1.72*	*47*
Storm Composite	8/13/2007 20:41	8/14/2007 0:32	45	0.111	8/13/2007 20:45	8/15/2007 0:45	1,851,437	*12.83*	*5,201*
Base			*4*	*0.146*	*8/15/2007 0:45*	*8/18/2007 8:45*	*201,707*	*1.84*	*50*
Storm Composite	8/18/2007 9:28	8/18/2007 18:04	16	0.060	8/18/2007 8:45	8/18/2007 20:45	221,980	*0.83*	*222*
Base			*4*	*0.146*	*8/18/2007 20:45*	*8/19/2007 9:45*	*94,907*	*0.87*	*24*
Storm			*54*	*0.124*	*8/19/2007 9:45*	*8/19/2007 18:45*	*174,801*	*1.35*	*588*
Base			*4*	*0.146*	*8/19/2007 18:45*	*8/23/2007 11:45*	*279,297*	*2.55*	*70*
Storm			*54*	*0.124*	*8/23/2007 11:45*	*8/23/2007 21:45*	*113,271*	*0.88*	*381*
Base			*4*	*0.146*	*8/23/2007 21:45*	*8/27/2007 0:45*	*119,045*	*1.09*	*30*
Storm Composite	8/27/2007 1:35	8/27/2007 13:29	17	0.090	8/27/2007 0:45	8/27/2007 13:45	396,762	*2.23*	*421*
Base			*4*	*0.146*	*8/27/2007 13:45*	*8/28/2007 1:45*	*76,944*	*0.70*	*19*
Storm			*54*	*0.124*	*8/28/2007 1:45*	*8/28/2007 12:45*	*517,349*	*4.00*	*1,739*
Base			*4*	*0.146*	*8/28/2007 12:45*	*9/6/2007 20:45*	*356,376*	*3.25*	*89*
Storm Composite	9/6/2007 23:44	9/7/2007 1:32	66	0.134	9/6/2007 20:45	9/7/2007 2:45	63,648	*0.53*	*262*
Base Grab	9/12/2007 12:05	9/12/2007 12:05	4	0.214	9/7/2007 2:45	9/18/2007 3:45	132,391	*1.77*	*33*
Storm Composite	9/18/2007 11:28	9/19/2007 10:21	18	0.061	9/18/2007 3:45	9/19/2007 1:45	763,408	*2.91*	*858*
Base			*4*	*0.146*	*9/19/2007 1:45*	*9/20/2007 16:45*	*261,979*	*2.39*	*65*
Storm Composite	9/20/2007 17:26	9/21/2007 0:16	19	0.107	9/20/2007 16:45	9/21/2007 0:45	727,527	*4.86*	*863*
Base			*4*	*0.146*	*9/21/2007 0:45*	*9/24/2007 16:45*	*929,466*	*8.47*	*232*
Storm			*54*	*0.124*	*9/24/2007 16:45*	*9/24/2007 19:45*	*48,849*	*0.38*	*164*
Base			*4*	*0.146*	*9/24/2007 19:45*	*9/26/2007 18:45*	*126,426*	*1.15*	*32*
Storm			*54*	*0.124*	*9/26/2007 18:45*	*9/26/2007 20:45*	*29,464*	*0.23*	*99*
Base			*4*	*0.146*	*9/26/2007 20:45*	*9/30/2007 1:45*	*124,840*	*1.14*	*31*
Storm Composite	9/30/2007 2:35	9/30/2007 23:03	15	0.055	9/30/2007 1:45	9/30/2007 23:45	752,418	*2.58*	*705*
Base			*4*	*0.146*	*9/30/2007 23:45*	*10/2/2007 11:45*	*221,982*	*2.02*	*55*
Storm			*54*	*0.124*	*10/2/2007 11:45*	*10/2/2007 23:45*	*512,477*	*3.97*	*1,723*
Base			*4*	*0.146*	*10/2/2007 23:45*	*10/5/2007 1:45*	*279,230*	*2.55*	*70*
Storm			*54*	*0.124*	*10/5/2007 1:45*	*10/5/2007 12:45*	*264,978*	*2.05*	*891*
Base			*4*	*0.146*	*10/5/2007 12:45*	*10/7/2007 21:45*	*307,579*	*2.80*	*77*
Storm Composite	10/7/2007 22:27	10/8/2007 7:18	45	0.084	10/7/2007 21:45	10/8/2007 12:45	698,347	*3.66*	*1,962*
Base			*4*	*0.146*	*10/8/2007 12:45*	*10/16/2007 10:45*	*350,734*	*3.20*	*88*
Storm			*54*	*0.124*	*10/16/2007 10:45*	*10/16/2007 14:45*	*62,141*	*0.48*	*209*
Base			*4*	*0.146*	*10/16/2007 14:45*	*10/17/2007 20:45*	*91,336*	*0.83*	*23*
Storm			*54*	*0.124*	*10/17/2007 20:45*	*10/19/2007 11:45*	*660,391*	*5.11*	*2,220*
Base			*4*	*0.146*	*10/19/2007 11:45*	*10/29/2007 13:00*	*207,183*	*1.89*	*52*
*Base***			*4*	*0.146*	*10/29/2007 13:00*	*12/31/2007 23:45*	*109,638*	*1.00*	*27*
Storm Average			54	0.124					
Base Average			4	0.214					
Snowmelt Average			32	0.387					
All Average			49	0.146					
Total							**17,990,506**	**153**	**29,827**
Brown's Creek Major Subwatershed Total Acres							448		
Total TP/TSS(lb/ac/yr)								0.34	*66.58*
Total TP/TSS (kg/ha/yr)								0.38	*74.62*
*Italics indicate estimated concentrations based on average base and storm flow concentrations									
** Interval volumes from 1/1/07 to 4/6/07 and 10/29/07 to 1/1/08 were estimated using base flow									

Table 28. Tributary to Long Lake at Marketplace Pond 2007 Primary Chemistry Result Averages

Parameter	Storm Flow Average	Base Flow Average	Average (all samples)
TSS (mg/L)	54	2	49
VSS (mg/L)	11	1	11
TKN (mg/L)	1.14	2.85	1.59
TP (mg/L)	0.12	0.11	0.15
E. Coli (mpn/100 mL)	--	--	172

Table 29: Tributary to Long Lake at Marketplace Pond 2007 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)	TOC (mg/L)
Snowmelt Grab	3/13/07 12:15	3/13/07 12:15	32	8	3.80	0.387	0.158		9.3
Storm Composite	5/23/07 13:50	5/23/07 18:23	78	15	2.00	0.130	0.013		4.9
Storm Composite	5/30/07 18:24	5/31/07 2:43	28	6	2.10	0.097	0.031		7.4
Storm Composite	6/18/07 11:27	6/18/07 18:46	31	8	2.90	0.140	0.016		6.7
Storm Composite	7/26/07 14:51	7/26/07 17:30	124	24	1.40	0.204	0.042		23.9
Storm Composite	8/11/07 2:57	8/11/07 3:25	220	43	1.20	0.335	0.032		9.4
Storm Composite	8/11/07 18:17	8/12/07 2:05	32	7	1.60	0.128	0.047		9.7
Storm Composite	8/13/07 20:41	8/14/07 0:32	45	9	0.82	0.111	0.034		3.8
Storm Composite	8/18/07 9:28	8/18/07 18:04	16	6	0.68	0.060	0.019		5.2
Storm Composite	8/27/07 1:35	8/27/07 13:29	17	4	0.07	0.090	0.029		
Storm Composite	9/6/07 23:44	9/7/07 1:32	66	21	0.76	0.134	0.015		6.7
Base Grab	9/12/07 12:05	9/12/07 12:05	4	1	5.70	0.214	0.145		3.5
Storm Composite	9/18/07 11:28	9/19/07 10:21	18	4	0.70	0.061	0.038		7.5
Storm Composite	9/20/07 17:26	9/21/07 0:16	19	4	0.34	0.107	0.043		8.9
Storm Composite	9/30/07 2:35	9/30/07 23:03	15	3	0.70	0.055	0.027		7.6
Storm Composite	10/7/07 22:27	10/8/07 7:18	45	6	0.71	0.084	0.040		4.2
E. coli Grab	10/18/07 12:30	10/18/07 12:30						172	

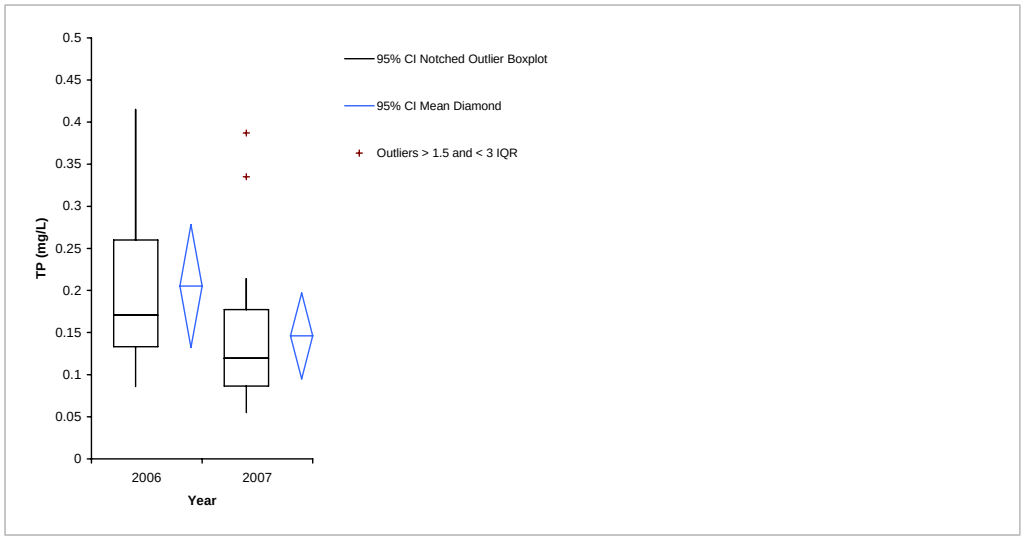
Table 30: Tributary to Long Lake at Marketplace Pond 2007 Secondary Water Quality Results

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)
Snowmelt Grab	3/13/07 12:15	3/13/07 12:15	0.0111	0.0028	0.0025	0.0290	<0.00004	0.0028	198	
Storm Composite	5/23/07 13:50	5/23/07 18:23	0.0138	0.0033	0.0032	0.0360	<0.00004	0.0057	165	32
Storm Composite	5/30/07 18:24	5/31/07 2:43	0.0095	0.0023	0.0015	0.0220	<0.00004	0.0029	147	44
Storm Composite	6/18/07 11:27	6/18/07 18:46	0.0090	0.0022	0.0014	0.0178	<0.00004	0.0032	163	38
Storm Composite	7/26/07 14:51	7/26/07 17:30	0.0207	0.0044	0.0049	0.0880	<0.00050	0.0083	9	36
Storm Composite	8/11/07 2:57	8/11/07 3:25	0.0480	0.0104	0.0186	0.2480	<0.00050	0.0119	5	
Storm Composite	8/11/07 18:17	8/12/07 2:05	0.0089	0.0019	0.0014	0.0220	<0.00050	0.0020	98	34
Storm Composite	8/13/07 20:41	8/14/07 0:32	0.0077	0.0016	0.0015	0.0171	<0.00050	0.0015	28	22
Storm Composite	8/18/07 9:28	8/18/07 18:04	0.0079	0.0014	0.0023	0.0171	<0.00050	0.0033	36	26
Storm Composite	8/27/07 1:35	8/27/07 13:29	0.0052	0.0011	0.0006	0.0560	<0.00050	0.0009	37	30
Storm Composite	9/6/07 23:44	9/7/07 1:32	0.0147	0.0028	0.0022	0.0560	<0.00050	0.0026	6	23
Base Grab	9/12/07 12:05	9/12/07 12:05	0.0042	0.0024	0.0001	0.0055	<0.00050	0.0014	441	234
Storm Composite	9/18/07 11:28	9/19/07 10:21	0.0006	0.0012	0.0007	0.0123	<0.00050	0.0022	20	28
Storm Composite	9/20/07 17:26	9/21/07 0:16	0.0051	0.0012	0.0009	0.0133	<0.00050	0.0019	9	24
Storm Composite	9/30/07 2:35	9/30/07 23:03	0.0050	0.0012	0.0007	0.0103	<0.00050	0.0013	17	28
Storm Composite	10/7/07 22:27	10/8/07 7:18	0.0081	0.0018	0.0016	0.0187	<0.00050	0.0022	7	28
E. coli Grab	10/18/07 12:30	10/18/07 12:30								

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

Analyse-it v2.07

Test	**Describe - Comparative**		
Performed by	TP (mg/L) by Year tthiel	Date	6 March 2008



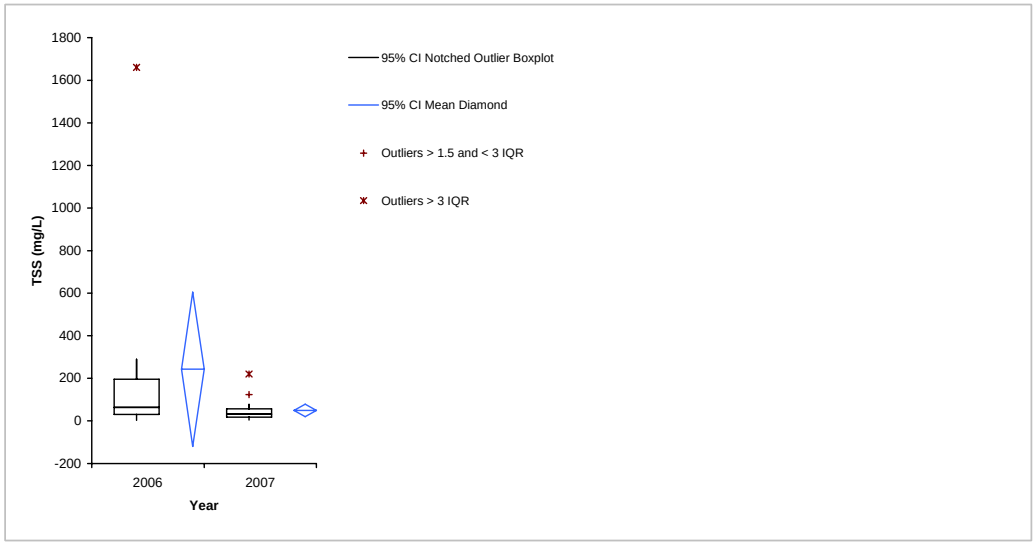
TP (mg/L) by Year	n	Mean	95% CI	SE	SD
2006	10	0.2053	0.1324 to 0.2782	0.03225	0.10198
2007	16	0.1461	0.0950 to 0.1971	0.02394	0.09577

TP (mg/L) by Year	n	Min	1st Quartile	Median	95% CI	3rd Quartile	Max	IQR
2006	10	0.086	0.1333	0.1705	0.1150 to 0.3140	0.2599	0.415	0.1266
2007	16	0.055	0.0865	0.1195	0.0840 to 0.2040	0.1773	0.387	0.0908

Figure 42. Tributary to Long Lake at Marketplace Pond Yearly Total Phosphorus Concentration Box and Whisker Plot

Analyse-it v2.07

Test	**Describe - Comparative**		
Performed by	TSS (mg/L) by Year tthiel	Date	6 March 2008



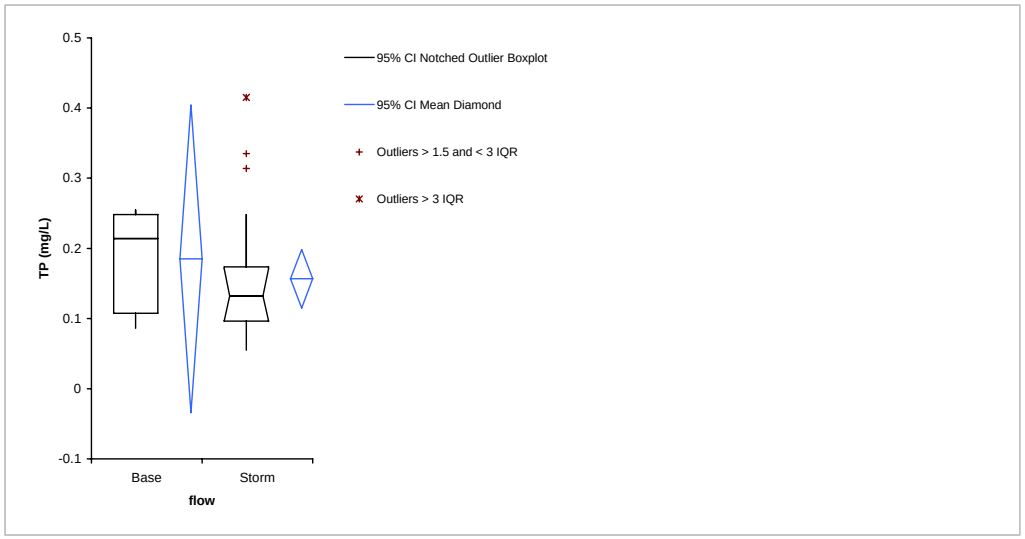
TSS (mg/L) by Year	n	Mean	95% CI	SE	SD
2006	10	242.6	-119.3 to 604.5	159.99	505.92
2007	16	49.4	20.3 to 78.4	13.62	54.48

TSS (mg/L) by Year	n	Min	1st Quartile	Median	95% CI	3rd Quartile	Max	IQR
2006	10	3	30.2	63.5	10.0 to 290.0	195.6	1660	165.4
2007	16	4	17.4	31.5	17.0 to 66.0	57.3	220	39.8

Figure 43. Tributary to Long Lake at Marketplace Pond Yearly Total Suspended Solids Concentration Box and Whisker Plot

Analyse-it v2.07

Test	**Describe - Comparative**		
	TP (mg/L) by flow		
Performed by	tthiel	Date	6 March 2008



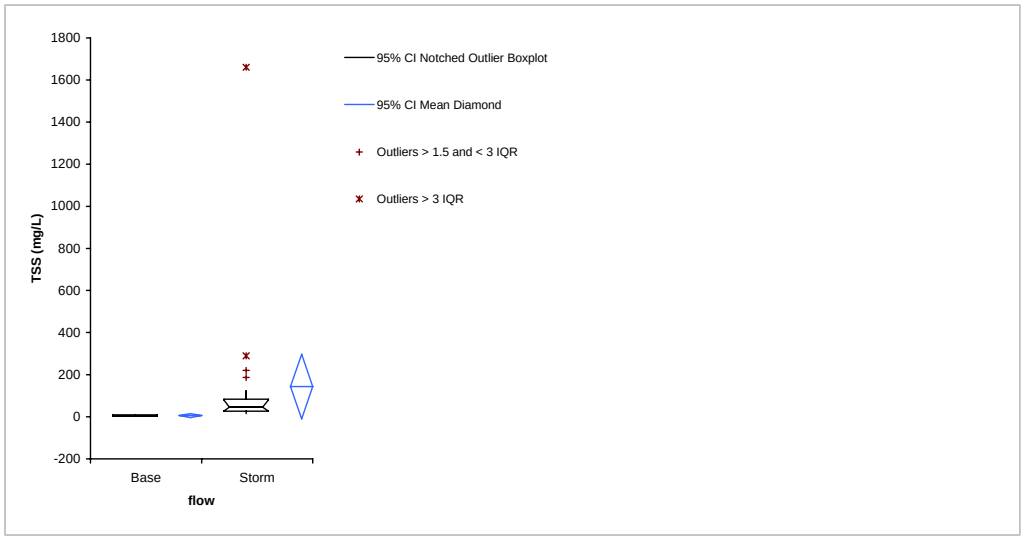
TP (mg/L) by flow	n	Mean	95% CI	SE	SD
Base	3	0.1850	-0.0340 to 0.4040	0.05090	0.08815
Storm	22	0.1567	0.1150 to 0.1984	0.02004	0.09402

TP (mg/L) by flow	n	Min	1st Quartile	Median	95% CI	3rd Quartile	Max	IQR
Base	3	0.086	0.1073	0.2140	- to -	0.2482	0.255	0.1408
Storm	22	0.055	0.0964	0.1320	0.0970 to 0.1710	0.1738	0.415	0.0773

Figure 44. Tributary to Long Lake at Marketplace Pond Storm and Base Flow Sample Total Phosphorus Concentration Comparison Box and Whisker Plot

Analyse-it v2.07

Test	**Describe - Comparative**		
Performed by	TSS (mg/L) by flow tthiel	Date	6 March 2008



TSS (mg/L) by flow	n	Mean	95% CI	SE	SD
Base	3	5.7	-3.7 to 15.1	2.19	3.79
Storm	22	144.0	-9.6 to 297.5	73.83	346.31

TSS (mg/L) by flow	n	Min	1st Quartile	Median	95% CI	3rd Quartile	Max	IQR
Base	3	3	3.2	4.0	- to -	9.0	10	5.8
Storm	22	15	27.3	45.0	28.0 to 80.0	83.7	1660	56.4

Figure 45. Tributary to Long Lake at Marketplace Pond Storm and Base Flow Sample Total Suspended Solids Concentration Comparison Box and Whisker Plot

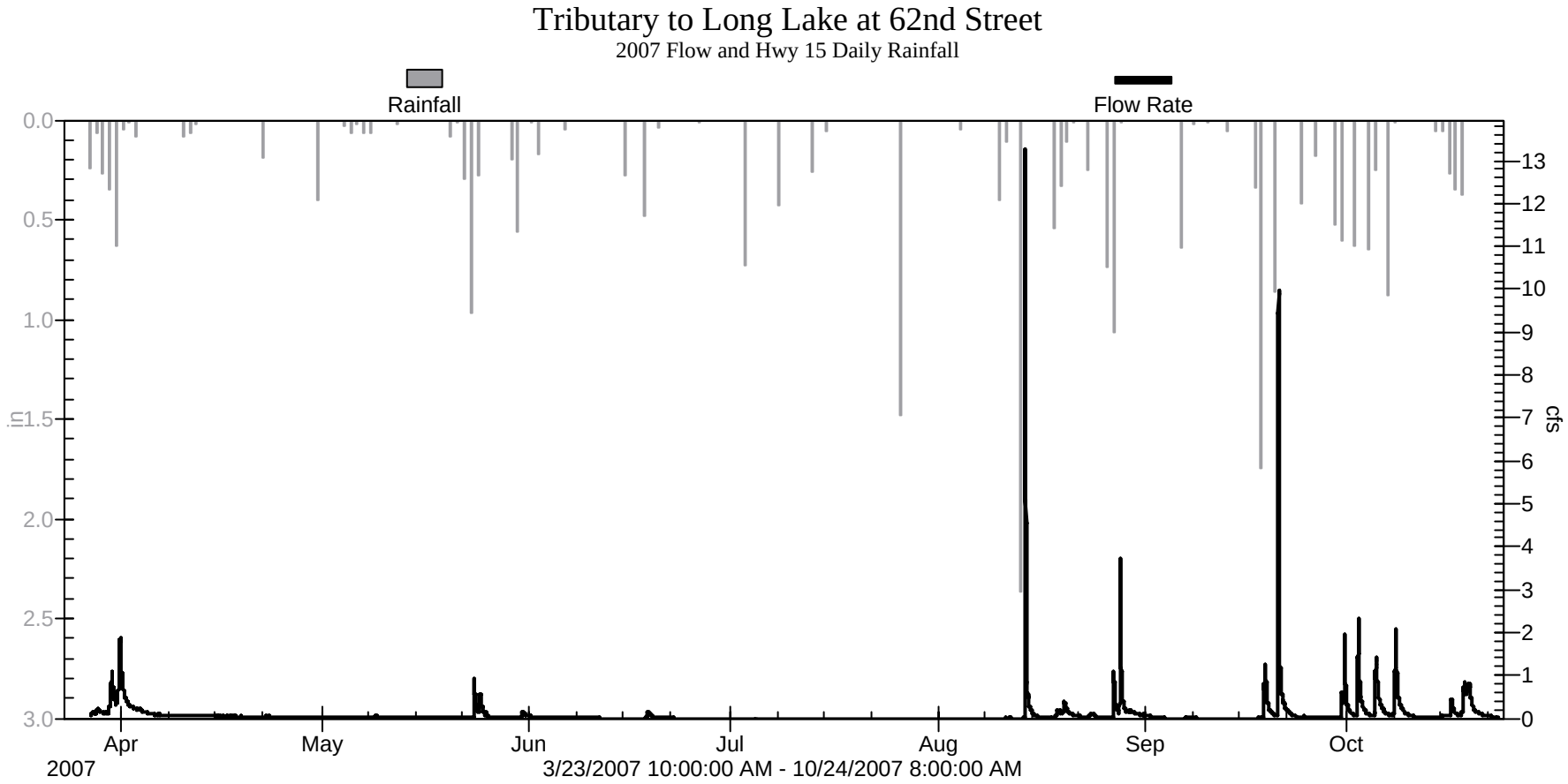


Figure 46. Tributary to Long Lake at 62nd St. 2007 Flow and Hwy 15 Daily Rainfall

Table 31. Tributary to Long Lake at 62nd St. 2007 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 TP (lb)**	**Interval TSS (lb)**
*Base***			*11*	*0.292*	*1/1/2007 0:00*	*3/12/2007 0:00*	*60,480*	*1.10*	*42*
Snowmelt Grab**	3/12/07 11:57	3/12/07 11:57	6	0.440	3/12/2007 0:00	3/14/2007 0:00	43,200	1.19	16
Snowmelt Grab**	3/14/07 11:00	3/14/07 11:00	5	0.286	3/14/2007 0:00	3/16/2007 0:00	43,200	0.77	13
*Base***			*11*	*0.292*	*3/16/2007 0:00*	*3/27/2007 10:00*	*98,640*	*1.80*	*68*
Base			*11*	*0.292*	*3/27/2007 10:00*	*3/30/2007 2:00*	*32,073*	*0.58*	*22*
Storm Composite	3/30/07 14:00	4/1/07 7:01	26	0.118	*3/30/2007 2:00*	4/1/2007 20:00	171,494	1.26	278
Base			*11*	*0.292*	*4/1/2007 20:00*	*4/19/2007 21:00*	*134,119*	*2.44*	*92*
Base Composite	4/19/07 21:38	4/24/07 3:10	1090	4.560	4/19/2007 21:00	4/24/2007 4:00	10,695	3.04	728
Base			*11*	*0.292*	*4/24/2007 4:00*	*5/23/2007 14:00*	*42,372*	*0.77*	*29*
Storm Composite	5/23/07 16:43	5/23/07 23:11	86	0.575	5/23/2007 14:00	5/24/2007 8:00	22,308	0.80	120
Storm Composite	5/24/07 13:09	5/24/07 23:41	12	0.265	5/24/2007 8:00	5/25/2007 4:00	22,208	0.37	17
Base			*11*	*0.292*	*5/25/2007 4:00*	*8/13/2007 21:00*	*46,524*	*0.85*	*32*
Storm Composite	8/13/07 22:13	8/13/07 23:04	41	0.490	8/13/2007 21:00	8/14/2007 7:00	181,640	5.56	465
Base Composite	8/19/07 17:41	8/20/07 6:06	11	0.292	8/14/2007 7:00	8/27/2007 1:00	88,159	1.61	61
Storm Composite	8/27/07 3:42	8/27/07 9:36	18	0.553	8/27/2007 1:00	8/27/2007 11:00	22,910	0.79	26
Base			*11*	*0.292*	*8/27/2007 11:00*	*8/28/2007 2:00*	*12,394*	*0.23*	*9*
Storm Composite	8/28/07 3:27	8/28/07 16:05	26	0.452	8/28/2007 2:00	8/28/2007 17:00	68,050	1.92	110
Base			*11*	*0.292*	*8/28/2007 17:00*	*9/18/2007 12:00*	*43,095*	*0.79*	*30*
Storm Composite	9/18/07 13:39	9/19/07 11:34	8	0.383	9/18/2007 12:00	9/19/2007 12:00	51,440	1.23	26
Base			*11*	*0.292*	*9/19/2007 12:00*	*9/20/2007 17:00*	*10,686*	*0.19*	*7*
Storm Composite	9/20/07 18:15	9/20/07 19:45	75	0.422	9/20/2007 17:00	9/21/2007 3:00	162,449	4.28	761
Base			*11*	*0.292*	*9/21/2007 3:00*	*9/30/2007 3:00*	*57,831*	*1.05*	*40*
Storm Composite	9/30/07 7:23	9/30/07 21:28	58	0.348	9/30/2007 3:00	10/1/2007 2:00	55,029	1.20	199
Base			*11*	*0.292*	*10/1/2007 2:00*	*10/2/2007 11:00*	*15,377*	*0.28*	*11*
Storm			*37*	*0.406*	*10/2/2007 11:00*	*10/3/2007 4:00*	*54,635*	*1.39*	*125*
Base			*11*	*0.292*	*10/3/2007 4:00*	*10/5/2007 1:00*	*24,073*	*0.44*	*17*
Storm			*37*	*0.406*	*10/5/2007 1:00*	*10/6/2007 0:00*	*62,526*	*1.59*	*143*
Base			*11*	*0.292*	*10/6/2007 0:00*	*10/7/2007 22:00*	*23,800*	*0.43*	*16*
Storm Composite	10/8/07 6:47	10/8/07 14:14	17	0.457	10/7/2007 22:00	10/9/2007 1:00	70,913	2.02	75
Base			*11*	*0.292*	*10/9/2007 1:00*	*10/17/2007 21:00*	*57,332*	*1.05*	*39*
Storm			*37*	*0.406*	*10/17/2007 21:00*	*10/20/2007 12:00*	*96,501*	*2.45*	*221*
Base			*11*	*0.292*	*10/20/2007 12:00*	*10/23/2007 15:30*	*17,471*	*0.32*	*12*
*Base***			*11*	*0.292*	*10/23/2007 15:30*	*1/1/2008 0:00*	*59,922*	*1.09*	*41*
Storm Average			37	0.406					
Base Average			11	0.292					
Snowmelt Average			6	0.363					
All Average			94	0.639					
	No Flow								
	Start	End							
	6/11/07 13:45	6/18/07 10:15							
	6/22/07 14:00	8/11/07 2:30							
	8/11/07 3:15	8/11/07 16:45							
	8/11/07 19:00	8/13/07 20:15							
	8/18/07 0:30	8/18/07 9:15							
	9/3/07 20:00	9/6/07 20:45							
	9/8/07 14:00	9/17/07 17:00							
Total							**1,963,546**	**45**	**3,890**
Brown's Creek Major Subwatershed Total Acres							561		
Total TP/TSS(lb/ac/yr)								0.08	6.93
Total TP/TSS (kg/ha/yr)								0.09	7.77

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

** Interval volumes from 1/1/07 to 3/27/07 and 10/23/07 to 1/1/08 were estimated using base flow

Table 32. Tributary to Long Lake at 62nd St. 2007 Primary Chemistry Result Averages

Parameter	Storm Flow Average	Base Flow Average	Average (all samples)
TSS (mg/L)	37	11	30
VSS (mg/L)	10	5	12
TKN (mg/L)	1.58	1.80	1.86
TP (mg/L)	0.41	0.29	0.39
E. Coli (mpn/100 mL)	--	--	887

Table 33: Tributary to Long Lake at 62nd St. 2007 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)	TOC (mg/L)
Snowmelt Grab	3/12/07 11:57	3/12/07 11:57	6	4	5.10	0.440	0.386		26.0
Snowmelt Grab	3/14/07 11:00	3/14/07 11:00	5	<1	1.50	0.286	0.186		13.4
Storm Composite	3/30/07 14:00	4/1/07 7:01	26	~4	1.20	0.118	0.112		15.8
Base Composite	4/19/07 21:38	4/24/07 3:10	1090	242	9.60	4.560	~0.022		10.6
E. coli Grab	5/2/07 10:27	5/2/07 10:27						3	
Storm Composite	5/23/07 16:43	5/23/07 23:11	86	31	1.50	0.575	0.094		9.9
Storm Composite	5/24/07 13:09	5/24/07 23:41	12	~5	1.70	0.265	0.081		11.1
Storm Composite	8/13/07 22:13	8/13/07 23:04	41	~10	1.80	0.490	0.291		17.2
Base Composite	8/19/07 17:41	8/20/07 6:06	11	~5	1.80	0.292	0.208		14.3
Storm Composite	8/27/07 3:42	8/27/07 9:36	18	6	2.10	0.553	0.351		11.4
Storm Composite	8/28/07 3:27	8/28/07 16:05	26	~8	1.40	0.452	0.334		17.1
E. coli Grab	8/28/07 11:13	8/28/07 11:13						>2420	
Storm Composite	9/18/07 13:39	9/19/07 11:34	8	3	1.30	0.383	0.340		14.3
Storm Composite	9/20/07 18:15	9/20/07 19:45	75	17	1.80	0.422	0.281		15.9
Storm Composite	9/30/07 7:23	9/30/07 21:28	58	~13	1.60	0.348	0.171		15.5
Storm Composite	10/8/07 6:47	10/8/07 14:14	17	~5	1.40	0.457	0.295		22.8
E. coli Grab	10/18/07 10:45	10/18/07 10:45						238	

Table 34: Tributary to Long Lake at 62nd St. 2007 Secondary Water Quality Result

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)
Snowmelt Grab	3/12/07 11:57	3/12/07 11:57	0.0077	0.0031	0.0008	0.03600	<0.00004	0.0012	330	
Snowmelt Grab	3/14/07 11:00	3/14/07 11:00	0.0034	0.0016	0.0004	0.01900	<0.00004	0.0010	45	
Storm Composite	3/30/07 14:00	4/1/07 7:01	0.0092	0.0045	0.0029	0.02400	<0.00004	0.0022	101	102
Base Composite	4/19/07 21:38	4/24/07 3:10	0.0270	0.0192	0.0212	0.15900	0.00030	0.0178	184	250
E. coli Grab	5/2/07 10:27	5/2/07 10:27								
Storm Composite	5/23/07 16:43	5/23/07 23:11	0.0084	0.0042	0.0025	0.03200	<0.00004	0.0029	75	92
Storm Composite	5/24/07 13:09	5/24/07 23:41	0.0095	0.0033	0.0010	0.01740	<0.00004	0.0016	74	90
Storm Composite	8/13/07 22:13	8/13/07 23:04	0.0075	0.0035	0.0020	0.03600	<0.00050	0.0022	24	46
Storm Composite	8/19/07 17:41	8/20/07 6:06	0.0083	0.0045	0.0007	0.02340	<0.00050	0.0013	76	108
Storm Composite	8/27/07 3:42	8/27/07 9:36	0.0084	0.0034	0.0010	0.01800	<0.00050	0.0011	57	78
Storm Composite	8/28/07 3:27	8/28/07 16:05	0.0116	0.0039	0.0030	0.02800	<0.00050	0.0025	41	56
E. coli Grab	8/28/07 11:13	8/28/07 11:13								
Storm Composite	9/18/07 13:39	9/19/07 11:34	0.0084	0.0027	0.0011	0.02100	<0.00050	0.0016	36	54
Storm Composite	9/20/07 18:15	9/20/07 19:45	0.0086	0.0044	0.0060	0.04200	<0.00050	0.0040	24	48
Storm Composite	9/30/07 7:23	9/30/07 21:28	0.0072	0.0050	0.0019	0.02230	<0.00050	0.0018	46	66
Storm Composite	10/8/07 6:47	10/8/07 14:14	0.0084	0.0058	0.0041	0.03100	<0.00050	0.0024	63	94
E. coli Grab	10/18/07 10:45	10/18/07 10:45								

No Exceedance Determinable
Exceeds Chronic Standard
Exceeds Max Standard

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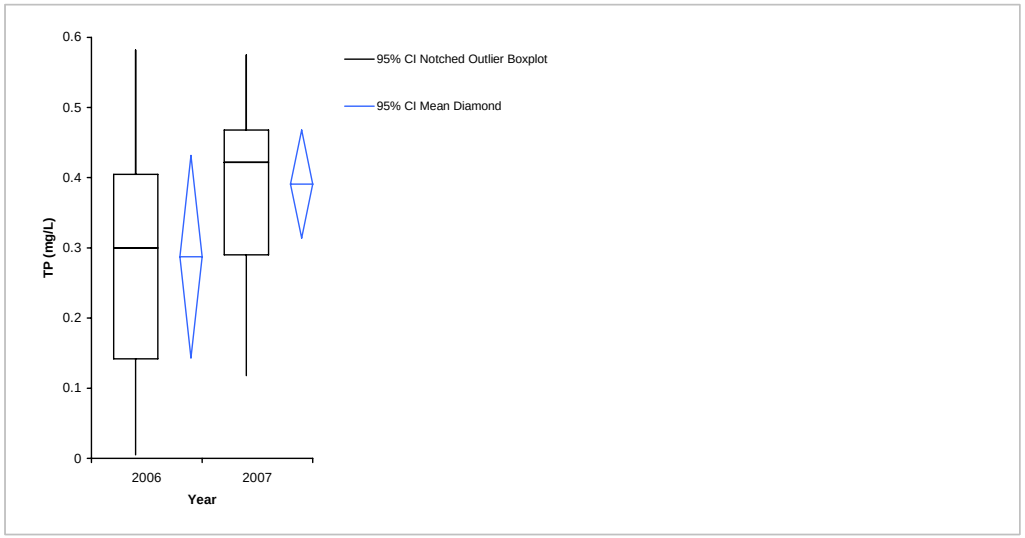
Test	**Describe - Comparative**		
Performed by	TP (mg/L) by Year tthiel	Date	6 March 2008



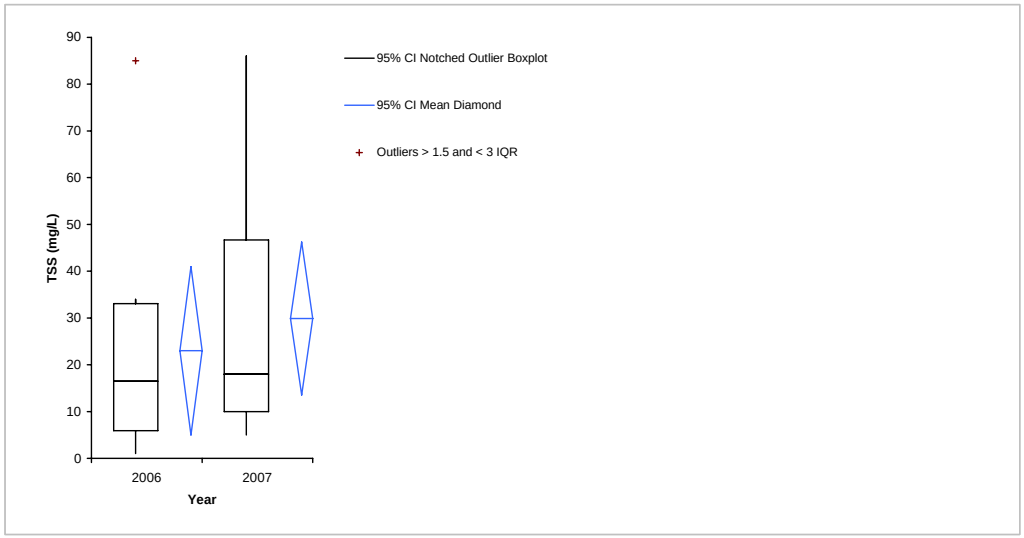
TP (mg/L) by Year	n	Mean	95% CI	SE	SD
2006	10	0.2874	0.1431 to 0.4317	0.06379	0.20173
2007	13	0.3908	0.3139 to 0.4678	0.03531	0.12731

TP (mg/L) by Year	n	Min	1st Quartile	Median	95% CI	3rd Quartile	Max	IQR
2006	10	0.005	0.1418	0.3000	0.0300 to 0.5470	0.4049	0.582	0.2631
2007	13	0.118	0.2900	0.4220	0.2860 to 0.4900	0.4680	0.575	0.1780

Figure 47. Tributary to Long Lake at 62nd St. Yearly Total Phoshorus Concentration Box and Whisker Plot

Analyse-it v2.07

Test	**Describe - Comparative**		
	TSS (mg/L) by Year		
Performed by	tthiel	Date	6 March 2008



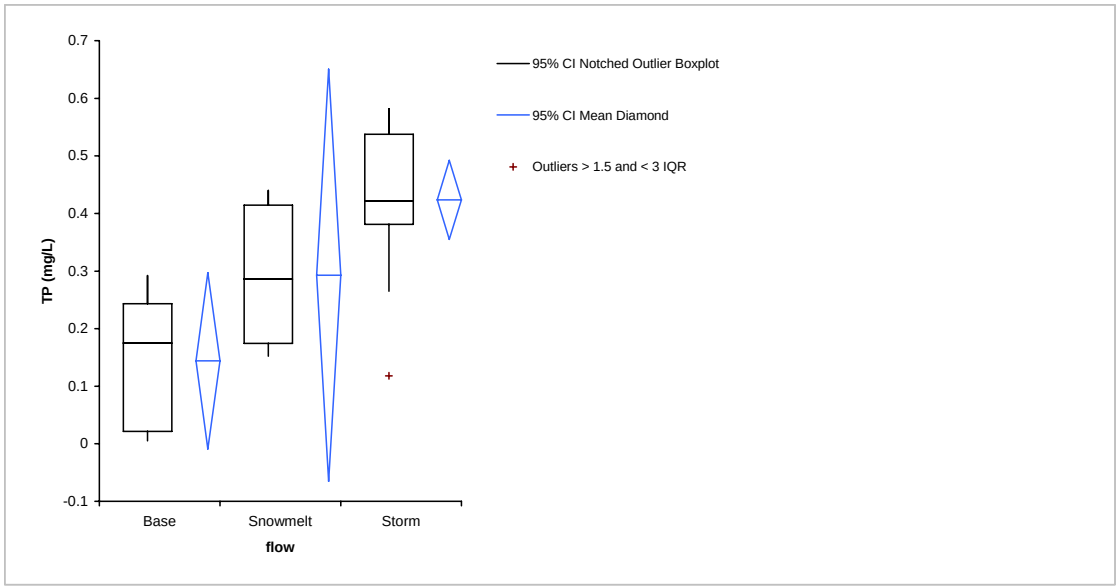
TSS (mg/L) by Year	n	Mean	95% CI	SE	SD
2006	10	23.0	5.0 to 41.0	7.96	25.16
2007	13	29.9	13.6 to 46.3	7.50	27.05

TSS (mg/L) by Year	n	Min	1st Quartile	Median	95% CI	3rd Quartile	Max	IQR
2006	10	1	5.9	16.5	5.0 to 34.0	33.1	85	27.2
2007	13	5	10.0	18.0	8.0 to 58.0	46.7	86	36.7

Figure 48. Tributary to Long Lake at 62nd St. Yearly Total Suspended Solids Concentration Box and Whisker Plot

Analyse-it v2.07

Test	**Describe - Comparative**		
Performed by	TP (mg/L) by flow tthiel	Date	6 March 2008



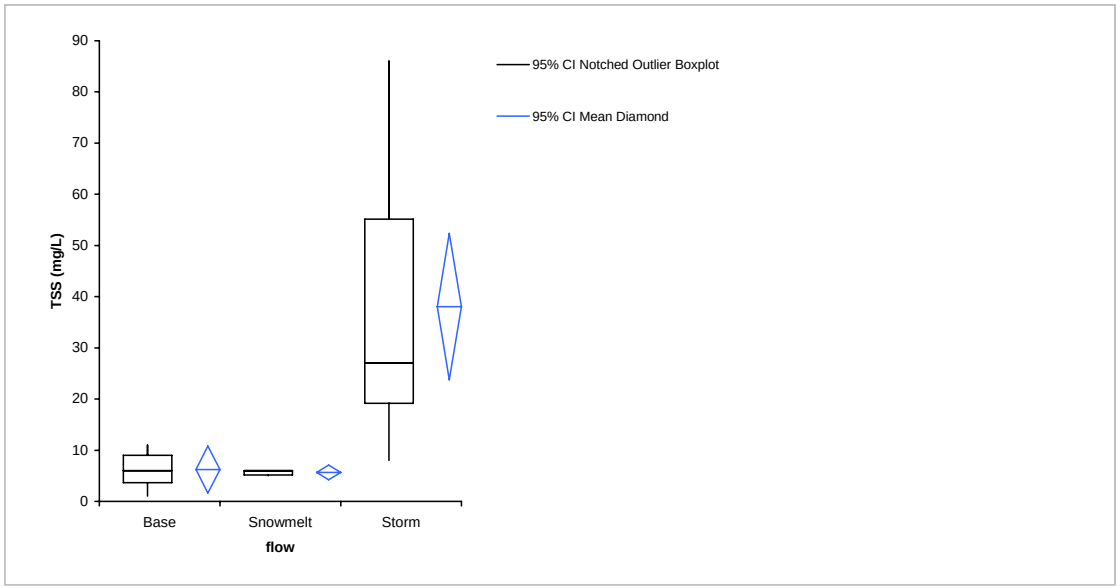
TP (mg/L) by flow	n	Mean	95% CI	SE	SD
Base	5	0.1442	-0.0089 to 0.2973	0.05514	0.12330
Snowmelt	3	0.2927	-0.0653 to 0.6507	0.08321	0.14412
Storm	15	0.4237	0.3549 to 0.4925	0.03208	0.12424

TP (mg/L) by flow	n	Min	1st Quartile	Median	95% CI	3rd Quartile	Max	IQR
Base	5	0.005	0.0217	0.1750	- to -	0.2433	0.292	0.2217
Snowmelt	3	0.152	0.1743	0.2860	- to -	0.4143	0.440	0.2400
Storm	15	0.118	0.3813	0.4220	0.3810 to 0.5470	0.5375	0.582	0.1562

Figure 49. Tributary to Long Lake at 62nd St. Storm and Base Flow Sample Total Phosphorus Concentration Comparison Box and Whisker Plot

Analyse-it v2.07

Test	**Describe - Comparative**		
	TSS (mg/L) by flow		
Performed by	tthiel	Date	6 March 2008



TSS (mg/L) by flow	n	Mean	95% CI	SE	SD
Base	5	6.2	1.6 to 10.8	1.66	3.70
Snowmelt	3	5.7	4.2 to 7.1	0.33	0.58
Storm	15	38.1	23.8 to 52.4	6.66	25.81

TSS (mg/L) by flow	n	Min	1st Quartile	Median	95% CI	3rd Quartile	Max	IQR
Base	5	1	3.7	6.0	- to -	9.0	11	5.3
Snowmelt	3	5	5.2	6.0	- to -	6.0	6	0.8
Storm	15	8	19.2	27.0	18.0 to 58.0	55.2	86	36.0

Figure 50. Tributary to Long Lake at 62nd St. Storm and Base Flow Sample Total Suspended Solids Concentration Comparison Box and Whisker Plot

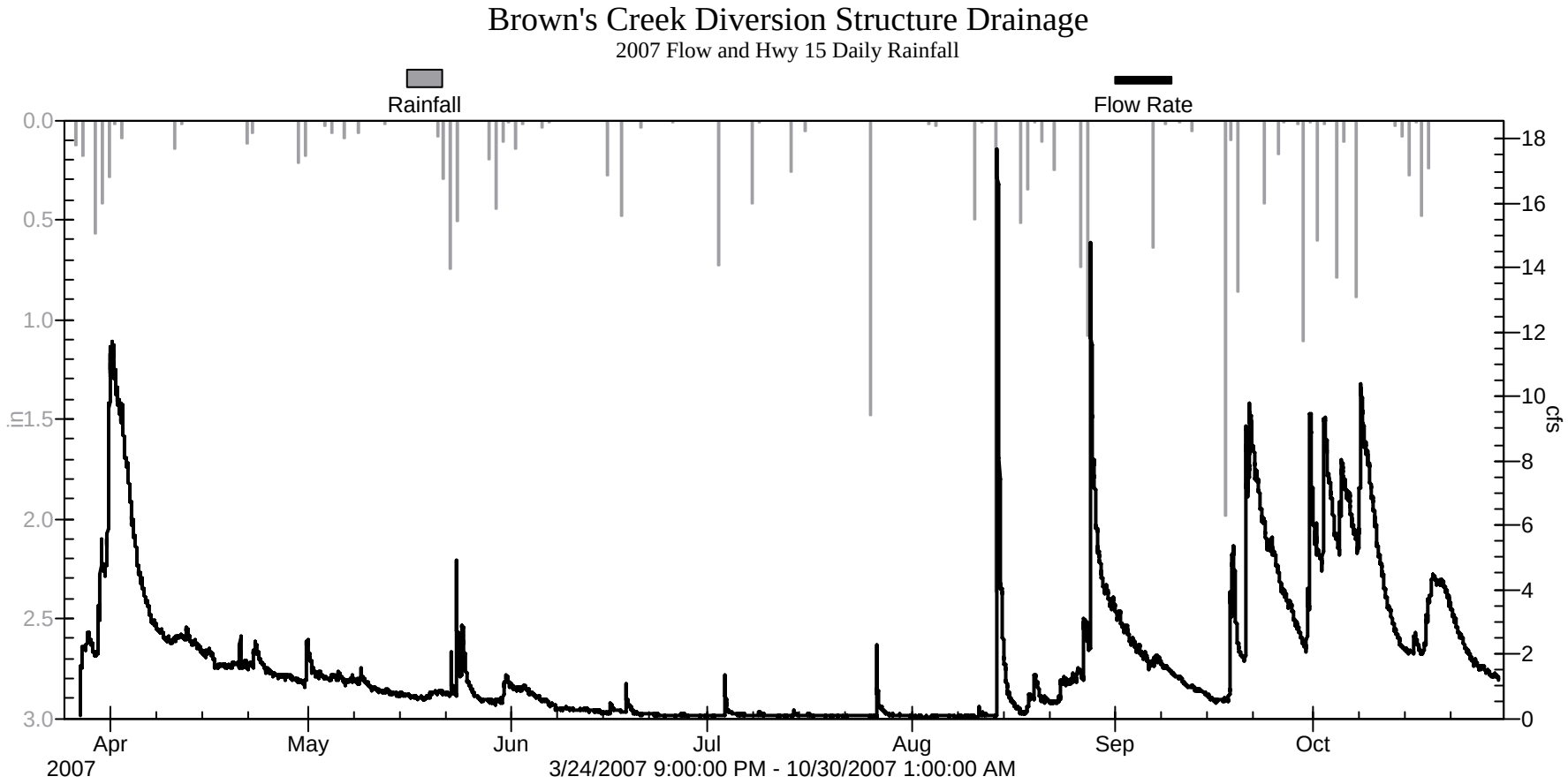


Figure 51. Brown's Creek Diversion Structure Drainage 2007 Flow and Hwy 15 Daily Rainfall

Table 35. Brown's Creek Diversion Structure Drainage 2007 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 TP (lb)	Interval TSS (lb)
*Base***			*18*	*0.113*	*1/1/2007 0:00*	*2/21/2007 0:00*	*2,203,200*	*15.57*	*2,503*
Snowmelt Grab**	2/22/07 13:00	2/22/07 13:00	8	0.062	2/21/2007 0:00	2/23/2007 0:00	604,800	2.34	302
*Base***			*18*	*0.113*	*2/23/2007 0:00*	*3/12/2007 0:00*	*2,203,200*	*15.57*	*2,503*
Snowmelt Grab**	3/12/07 10:12	3/12/07 10:12	63	0.482	3/12/2007 0:00	3/13/2007 0:00	345,600	10.40	1,359
*Base***			*18*	*0.113*	*3/13/2007 0:00*	*3/27/2007 9:30*	*2,363,220*	*16.70*	*2,685*
Base			*18*	*0.113*	*3/27/2007 9:30*	*3/28/2007 7:30*	*154,381*	*1.09*	*175*
Storm			*132*	*0.379*	*3/28/2007 7:30*	*3/28/2007 22:30*	*134,561*	*3.18*	*1,105*
Base			*18*	*0.113*	*3/28/2007 22:30*	*3/30/2007 3:30*	*220,082*	*1.56*	*250*
Storm Composite	3/30/07 12:18	4/2/07 13:17	473	0.920	3/30/2007 3:30	4/5/2007 7:30	3,962,650	227.58	117,007
Base			*18*	*0.113*	*4/5/2007 7:30*	*4/12/2007 11:30*	*1,807,424*	*12.77*	*2,054*
Storm			*132*	*0.379*	*4/12/2007 11:30*	*4/13/2007 6:30*	*178,245*	*4.22*	*1,464*
Base Composite	4/19/07 16:02	4/23/07 13:36	38	0.132	4/13/2007 6:30	4/30/2007 15:30	2,485,514	20.48	5,896
Storm			*132*	*0.379*	*4/30/2007 15:30*	*5/1/2007 21:30*	*190,543*	*4.51*	*1,565*
Base Grab	5/16/07 14:55	5/16/07 14:55	3	0.050	5/1/2007 21:30	5/22/2007 18:30	1,732,386	5.41	324
Storm			*132*	*0.379*	*5/22/2007 18:30*	*5/23/2007 0:30*	*26,301*	*0.62*	*216*
Base			*18*	*0.113*	*5/23/2007 0:30*	*5/23/2007 14:30*	*42,438*	*0.30*	*48*
Storm Composite	5/23/07 16:27	5/23/07 21:35	286	0.530	5/23/2007 14:30	5/24/2007 0:30	87,463	2.89	1,562
Base			*18*	*0.113*	*5/24/2007 0:30*	*5/24/2007 9:30*	*49,708*	*0.35*	*56*
Storm Composite	5/24/07 10:49	5/24/07 20:49	33	0.120	5/24/2007 9:30	5/25/2007 3:30	144,380	1.08	297
Base			*18*	*0.113*	*5/25/2007 3:30*	*5/30/2007 18:30*	*322,128*	*2.28*	*366*
Storm			*132*	*0.379*	*5/30/2007 18:30*	*5/31/2007 17:30*	*91,291*	*2.16*	*750*
Base			*18*	*0.113*	*5/31/2007 17:30*	*6/16/2007 3:30*	*622,787*	*4.40*	*708*
Base			*18*	*0.113*	*6/16/2007 3:30*	*6/16/2007 8:30*	*6,025*	*0.04*	*7*
Base			*18*	*0.113*	*6/16/2007 8:30*	*6/18/2007 12:30*	*44,011*	*0.31*	*50*
Storm			*132*	*0.379*	*6/18/2007 12:30*	*6/18/2007 16:30*	*9,365*	*0.22*	*77*
Base Grab	6/28/07 10:14	6/28/07 10:14	8	0.125	6/18/2007 16:30	7/3/2007 14:30	140,836	1.10	70
Storm			*132*	*0.379*	*7/3/2007 14:30*	*7/4/2007 0:30*	*16,827*	*0.40*	*138*
Base			*18*	*0.113*	*7/4/2007 0:30*	*7/8/2007 15:30*	*43,855*	*0.31*	*50*
Base			*18*	*0.113*	*7/8/2007 15:30*	*7/9/2007 14:30*	*10,377*	*0.07*	*12*
Base			*18*	*0.113*	*7/9/2007 14:30*	*7/13/2007 22:30*	*28,489*	*0.20*	*32*
Storm			*132*	*0.379*	*7/13/2007 22:30*	*7/14/2007 12:30*	*6,941*	*0.16*	*57*
Base Grab	7/19/07 12:06	7/19/07 12:06	29	0.167	7/14/2007 12:30	7/26/2007 15:30	79,872	0.83	145
Storm Composite	7/26/07 16:57	7/26/07 17:50	6440	1.090	7/26/2007 15:30	7/27/2007 3:30	30,881	2.10	12,415
Base			*18*	*0.113*	*7/27/2007 3:30*	*8/11/2007 3:30*	*99,851*	*0.71*	*113*
Storm			*132*	*0.379*	*8/11/2007 3:30*	*8/12/2007 1:30*	*10,627*	*0.25*	*87*
Base			*18*	*0.113*	*8/12/2007 1:30*	*8/13/2007 21:30*	*13,369*	*0.09*	*15*
Storm Composite	8/13/07 22:21	8/14/07 3:03	486	0.967	8/13/2007 21:30	8/14/2007 14:30	555,969	33.56	16,868
Base			*18*	*0.113*	*8/14/2007 14:30*	*8/18/2007 10:30*	*277,452*	*1.96*	*315*
Storm Composite	8/19/07 16:30	8/20/07 9:19	12	0.118	8/18/2007 10:30	8/20/2007 13:30	141,929	1.05	106
Base			*18*	*0.113*	*8/20/2007 13:30*	*8/21/2007 3:30*	*29,809*	*0.21*	*34*
Base			*18*	*0.113*	*8/21/2007 3:30*	*8/21/2007 10:30*	*14,799*	*0.10*	*17*
Base			*18*	*0.113*	*8/21/2007 10:30*	*8/23/2007 12:30*	*94,084*	*0.66*	*107*
Storm			*132*	*0.379*	*8/23/2007 12:30*	*8/24/2007 9:30*	*80,141*	*1.90*	*658*
Base			*18*	*0.113*	*8/24/2007 9:30*	*8/27/2007 2:30*	*291,743*	*2.06*	*331*
Storm			*132*	*0.379*	*8/27/2007 2:30*	*8/27/2007 9:30*	*68,586*	*1.62*	*563*
Base			*18*	*0.113*	*8/27/2007 9:30*	*8/28/2007 2:30*	*157,228*	*1.11*	*179*
Storm Grab	8/28/07 14:30	8/28/07 14:30	17	0.176	8/28/2007 2:30	8/28/2007 15:30	484,420	5.32	514
Base Composite	9/15/07 9:36	9/17/07 9:36	13	0.092	8/28/2007 15:30	9/18/2007 8:30	3,600,782	20.68	2,922
Storm Composite	9/18/07 13:37	9/19/07 20:53	85	0.242	9/18/2007 8:30	9/19/2007 21:30	431,485	6.52	2,290
Base			*18*	*0.113*	*9/19/2007 21:30*	*9/20/2007 18:30*	*147,159*	*1.04*	*167*
Storm Composite	9/20/07 22:26	9/22/07 1:45	80	0.211	9/20/2007 18:30	9/22/2007 8:30	1,094,114	14.41	5,464
Base			*18*	*0.113*	*9/22/2007 8:30*	*9/30/2007 3:30*	*2,981,722*	*21.07*	*3,388*
Storm Composite	9/30/07 15:43	9/30/07 21:35	132	0.330	9/30/2007 3:30	10/1/2007 5:30	542,923	11.18	4,474
Base			*18*	*0.113*	*10/1/2007 5:30*	*10/2/2007 13:30*	*604,765*	*4.27*	*687*
Storm			*132*	*0.379*	*10/2/2007 13:30*	*10/3/2007 11:30*	*623,954*	*14.77*	*5,124*
Base			*18*	*0.113*	*10/3/2007 11:30*	*10/5/2007 2:30*	*878,261*	*6.21*	*998*
Storm			*132*	*0.379*	*10/5/2007 2:30*	*10/5/2007 21:30*	*493,895*	*11.69*	*4,056*
Base			*18*	*0.113*	*10/5/2007 21:30*	*10/7/2007 23:30*	*1,139,689*	*8.05*	*1,295*
Storm Composite	10/8/07 9:13	10/8/07 12:57	66	0.177	10/7/2007 23:30	10/8/2007 22:30	688,013	7.60	2,835
Base			*18*	*0.113*	*10/8/2007 22:30*	*10/16/2007 11:30*	*2,695,254*	*19.05*	*3,062*
Storm			*132*	*0.379*	*10/16/2007 11:30*	*10/17/2007 0:30*	*114,778*	*2.72*	*943*
Base			*18*	*0.113*	*10/17/2007 0:30*	*10/17/2007 22:30*	*168,514*	*1.19*	*191*
Storm			*132*	*0.379*	*10/17/2007 22:30*	*10/20/2007 11:30*	*820,473*	*19.42*	*6,738*
Base			*18*	*0.113*	*10/20/2007 11:30*	*10/29/2007 11:00*	*1,798,403*	*12.71*	*2,043*
*Base***			*18*	*0.113*	*10/29/2007 11:00*	*1/1/2008 0:00*	*8,235,000*	*58.19*	*9,356*
Storm Average			132	0.379					
Base Average			18	0.113					
Snowmelt Average			36	0.272					
All Average			460	0.333					
Total							**49,768,967**	**653**	**232,190**
Brown's Creek Major Subwatershed Total Acres							3,837		
Total TP/TSS(lb/ac/yr)								0.17	60.51
Total TP/TSS (kg/ha/yr)								0.19	*67.83*

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

** Interval volumes from 1/1/07 to 3/27/07 and 10/29/07 to 1/1/08 where estimated based upon base flow

Table 36. Brown's Creek Diversion Structure Drainage 2007 Primary Chemistry Result Averages

Parameter	Storm Flow Average	Base Flow Average	Average (all samples)
TSS (mg/L)	737	18	460
VSS (mg/L)	249	7	155
TKN (mg/L)	2.95	0.85	2.38
TP (mg/L)	0.44	0.11	0.33
E. Coli (mpn/100 mL)	--	--	689

Table 37: Brown's Creek Diversion Structure Drainage 2007 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)	TOC (mg/L)
Snowmelt Grab	2/22/07 13:00	2/22/07 13:00	8	6	0.42	0.062	0.050		1.4
Snowmelt Grab	3/12/07 10:12	3/12/07 10:12	63	20	5.70	0.482	0.206		21.9
Storm Composite	3/30/07 12:18	4/2/07 13:17	473	158	5.70	0.920	0.309		9.9
Base Composite	4/19/07 16:02	4/23/07 13:36	38	~12	1.10	0.132	~0.022		4.6
E. coli Grab	5/2/07 10:45	5/2/07 10:45						25	
Base Grab	5/16/07 14:55	5/16/07 14:55	3	~1	0.40	0.050	~0.012		4.0
Storm Composite	5/23/07 16:27	5/23/07 21:35	286	90	3.60	0.530	~0.047		8.4
Storm Composite	5/24/07 10:49	5/24/07 20:49	33	13	1.10	0.120	~0.033		7.7
E. coli Grab	6/13/07 9:06	6/13/07 9:06						248	
Base Grab	6/28/07 10:14	6/28/07 10:14	8	3	0.58	0.125	0.058		3.2
E. coli Grab	7/16/07 11:09	7/16/07 11:09						365	
Base Grab	7/19/07 12:06	7/19/07 12:06	29	13	0.65	0.167	0.051		6.1
Storm Composite	7/26/07 16:57	7/26/07 17:50	6440	2200	7.60	1.090			
Storm Composite	8/13/07 22:21	8/14/07 3:03	486	154	4.70	0.967	0.139		19.3
Storm Composite	8/19/07 16:30	8/20/07 9:19	12	5	0.85	0.118	~0.044		7.0
E. coli Grab	8/28/07 11:30	8/28/07 11:30						>2420	
Storm Grab	8/28/07 14:30	8/28/07 14:30	17	~8	1.00	0.176	0.059		9.5
Base Composite	9/15/07 9:36	9/17/07 9:36	13	6	1.50	0.092	~0.021		5.9
Storm Composite	9/18/07 13:37	9/19/07 20:53	85	27	1.60	0.242	0.061		9.8
Storm Composite	9/20/07 22:26	9/22/07 1:45	80	26	2.00	0.211	~0.049		7.9
Storm Composite	9/30/07 15:43	9/30/07 21:35	132	38	2.50	0.330	0.067		8.9
Storm Composite	10/8/07 9:13	10/8/07 12:57	66	15	1.80	0.177	~0.034		9.6
E. coli Grab	10/18/07 9:30	10/18/07 9:30						387	

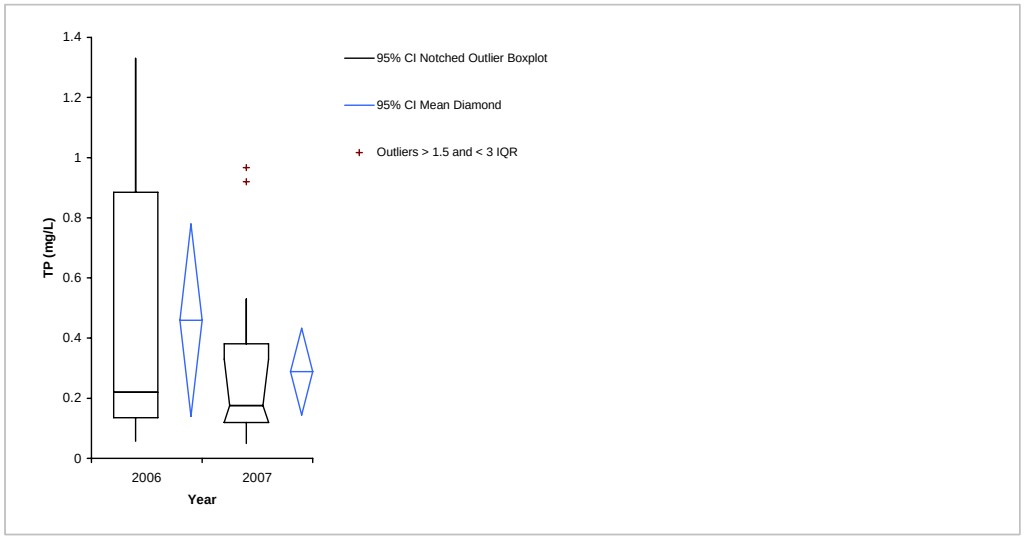
Table 38: Brown's Creek Diversion Structure Drainage 2007 Secondary Water Quality Results

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)
Snowmelt Grab	2/22/07 13:00	2/22/07 13:00	0.0007	0.0017	0.00030	0.0019	0.00007	0.0009	14	
Snowmelt Grab	3/12/07 10:12	3/12/07 10:12	0.0043	0.0027	0.00150	0.0086	<0.00040	0.0022	120	
Storm Composite	3/30/07 12:18	4/2/07 13:17	0.0082	0.0083	0.00800	0.0310	0.00020	0.0069	68	68
Base Composite	4/19/07 16:02	4/23/07 13:36	0.0024	0.0024	0.00100	0.0077	0.00008	0.0016	53	134
E. coli Grab	5/2/07 10:45	5/2/07 10:45								
Base Grab	5/16/07 14:55	5/16/07 14:55	0.0007	0.0020	<0.00007	0.0020	<0.00004	<0.0002	30	202
Storm Composite	5/23/07 16:27	5/23/07 21:35	0.0060	0.0065	0.00460	0.0230	0.00110	0.0061	28	128
Storm Composite	5/24/07 10:49	5/24/07 20:49	0.0019	0.0025	0.00060	0.0086	0.00007	0.0016	29	132
E. coli Grab	6/13/07 9:06	6/13/07 9:06								
Base Grab	6/28/07 10:14	6/28/07 10:14	0.0006	0.0025	0.00020	0.0020	<0.00004	0.0012	32	204
E. coli Grab	7/16/07 11:09	7/16/07 11:09								
Base Grab	7/19/07 12:06	7/19/07 12:06	0.0010	0.0021	0.00050	0.0034	<0.00004	0.0011	29	222
Storm Composite	7/26/07 16:57	7/26/07 17:50							17	
Storm Composite	8/13/07 22:21	8/14/07 3:03	0.0089	0.0080	0.00680	0.0280	<0.00050	0.0081	18	84
Storm Composite	8/19/07 16:30	8/20/07 9:19	0.0016	0.0028	0.00050	0.0040	<0.00050	0.0009	24	216
E. coli Grab	8/28/07 11:30	8/28/07 11:30								
Storm Grab	8/28/07 14:30	8/28/07 14:30	0.0016	0.0018	0.00040	0.0049	<0.00050	0.0008	34	104
Base Composite	9/15/07 9:36	9/17/07 9:36	0.0010	0.0015	0.00020	0.0020	<0.00050	0.0009	96	102
Storm Composite	9/18/07 13:37	9/19/07 20:53	0.0025	0.0026	0.00100	0.0074	<0.00050	0.0012	37	124
Storm Composite	9/20/07 22:26	9/22/07 1:45	0.0024	0.0026	0.00140	0.0070	<0.00050	0.0016	66	80
Storm Composite	9/30/07 15:43	9/30/07 21:35	0.0034	0.0035	0.00230	0.0094	<0.00050	0.0022	41	82
Storm Composite	10/8/07 9:13	10/8/07 12:57	0.0025	0.0024	0.00150	0.0055	<0.00050	0.0016	57	70
E. coli Grab	10/18/07 9:30	10/18/07 9:30								

No Exceedance Determinable
Exceeds Chronic Standard
Exceeds Max Standard

Analyse-it v2.07

Test	**Describe - Comparative**		
	TP (mg/L) by Year		
Performed by	tthiel	Date	6 March 2008



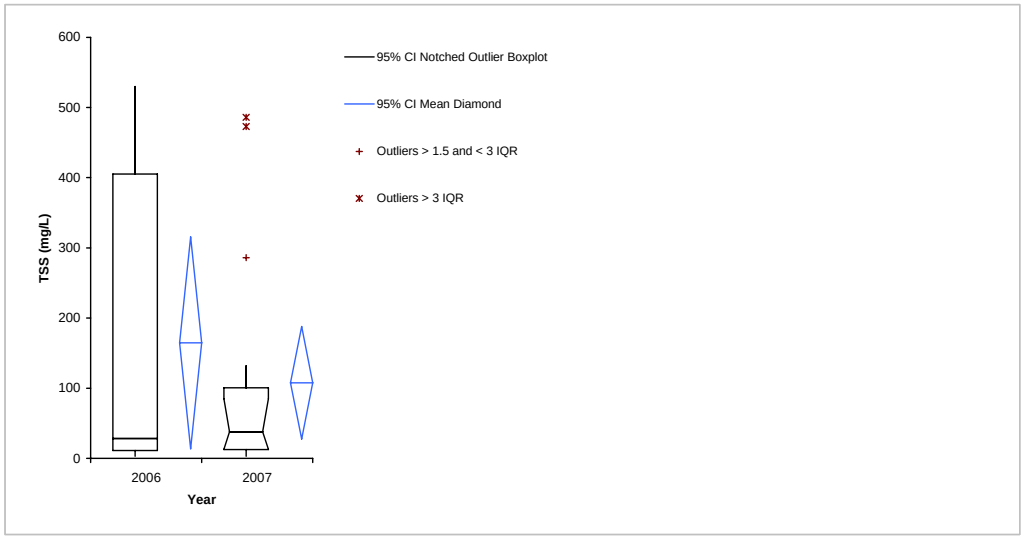
TP (mg/L) by Year	n	Mean	95% CI	SE	SD
2006	10	0.4596	0.1399 to 0.7793	0.14134	0.44697
2007	17	0.2883	0.1440 to 0.4326	0.06807	0.28064

TP (mg/L) by Year	n	Min	1st Quartile	Median	95% CI	3rd Quartile	Max	IQR
2006	10	0.057	0.1351	0.2195	0.0700 to 0.9310	0.8852	1.330	0.7501
2007	17	0.050	0.1193	0.1760	0.1200 to 0.3300	0.3807	0.967	0.2613

Figure 52. Brown's Creek Diversion Structure Yearly Total Phosphorus Concentration Box and Whisker Plot

Analyse-it v2.07

Test	**Describe - Comparative**		
Performed by	TSS (mg/L) by Year tthiel	Date	6 March 2008



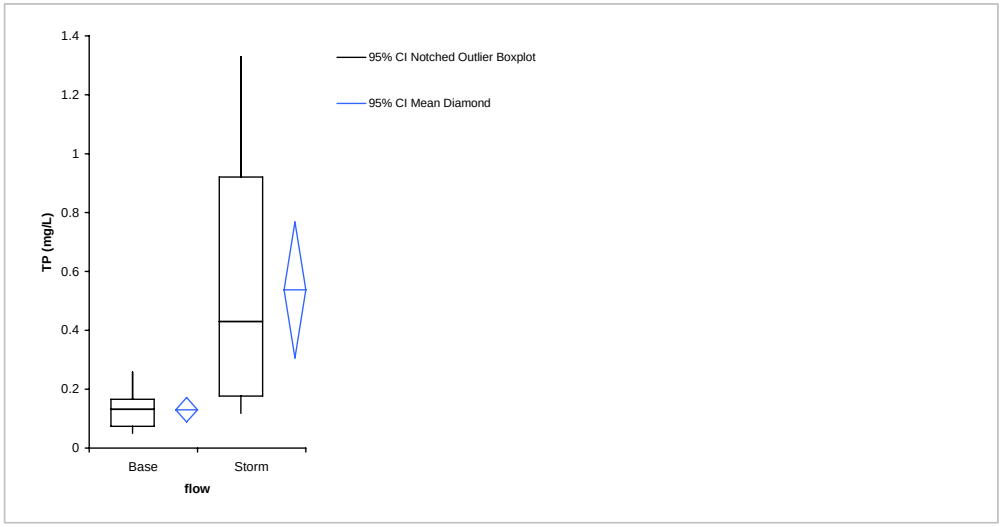
TSS (mg/L) by Year	n	Mean	95% CI	SE	SD
2006	10	164.7	13.8 to 315.6	66.72	210.99
2007	17	107.8	27.7 to 187.8	37.76	155.68

TSS (mg/L) by Year	n	Min	1st Quartile	Median	95% CI	3rd Quartile	Max	IQR
2006	10	3	11.3	28.5	4.0 to 438.0	405.0	530	393.7
2007	17	3	12.7	38.0	13.0 to 85.0	100.7	486	88.0

Figure 53. Brown's Creek Diversion Structure Yearly Total Suspended Solids Concentration Box and Whisker Plot

Analyse-it v2.07

Test	**Describe - Comparative**
	TP (mg/L) by flow
Performed by	tthiel
Date	6 March 2008



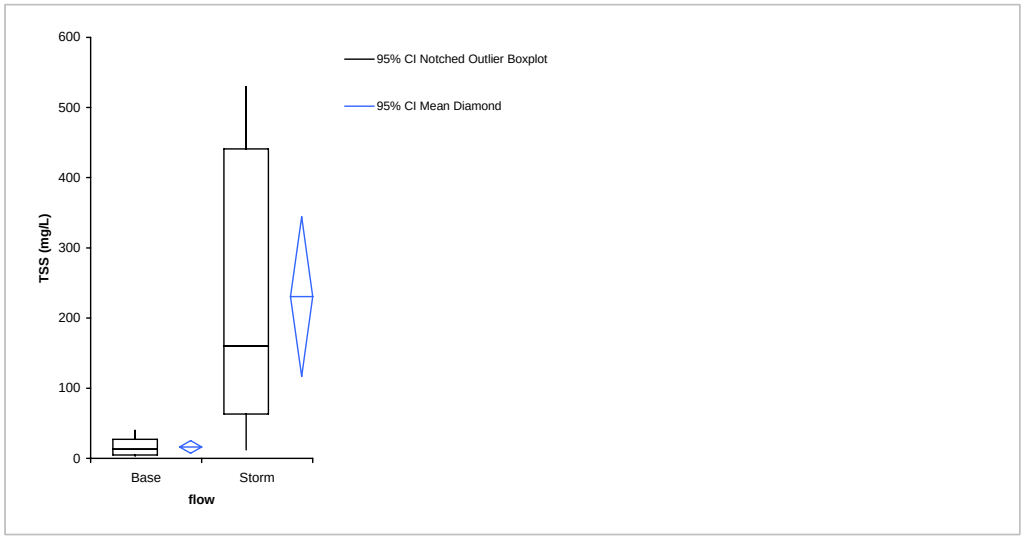
TP (mg/L) by flow	n	Mean	95% CI	SE	SD
Base	11	0.1302	0.0886 to 0.1717	0.01865	0.06187
Storm	14	0.5372	0.3061 to 0.7683	0.10696	0.40021

TP (mg/L) by flow	n	Min	1st Quartile	Median	95% CI	3rd Quartile	Max	IQR
Base	11	0.050	0.0737	0.1320	0.0570 to 0.1800	0.1657	0.259	0.0920
Storm	14	0.118	0.1769	0.4300	0.1760 to 0.9310	0.9209	1.330	0.7440

Figure 54. Brown's Creek Diversion Structure Drainage Storm and Base Flow Sample Total Phosphorus Concentration Comparison Box and Whisker Plot

Analyse-it v2.07

Test	**Describe - Comparative**		
Performed by	TSS (mg/L) by flow tthiel	Date	6 March 2008



TSS (mg/L) by flow	n	Mean	95% CI	SE	SD
Base	11	16.4	7.3 to 25.4	4.05	13.45
Storm	14	230.6	116.9 to 344.3	52.63	196.91

TSS (mg/L) by flow	n	Min	1st Quartile	Median	95% CI	3rd Quartile	Max	IQR
Base	11	3	4.7	13.0	3.0 to 38.0	27.0	40	22.3
Storm	14	12	63.3	160.0	33.0 to 473.0	440.9	530	377.7

Figure 55. Brown's Creek Diversion Structure Drainage Storm and Base Flow Sample Total Suspended Solids Concentration Comparison Box and Whisker Plot

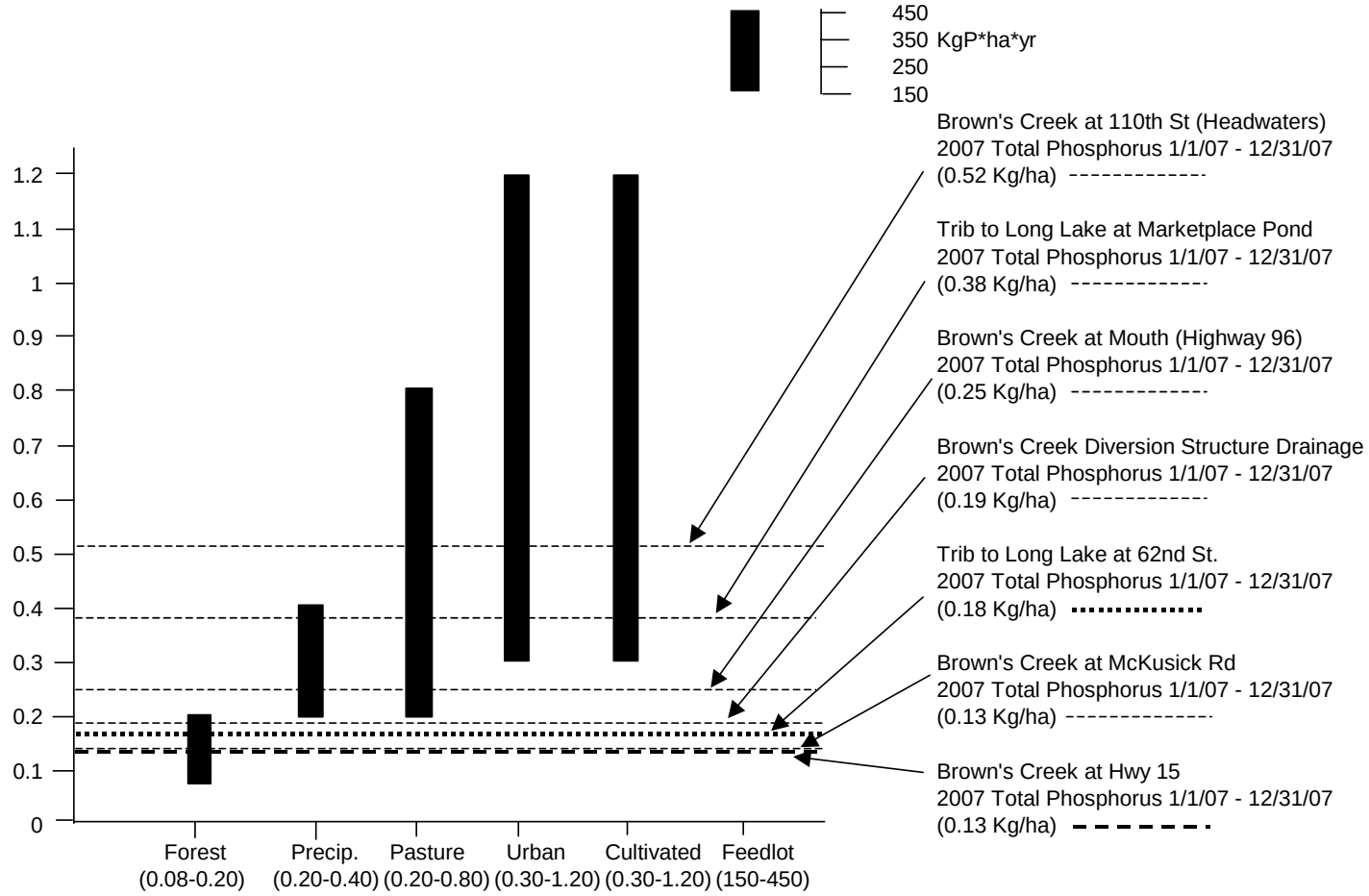


Figure 56: Total Phosphorus Export Coefficients: Brown's Creek and Estimated Range by Land Use

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 57), which replaces a 5,130-foot long section that flowed through the wetland just north of McKusick Lake and across the golf course (Figure 58). 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. A ~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 57: New channel along the golf course. This photo shows the much-improved habitat, with many native shrubs and trees growing along the banks.

Figure 58: 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 to 2007, 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 Hwy 96. The minimum daily temperature at McKusick Road and Hwy 96 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 60 and Figure 61). 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 59-Figure 62 show the correlation between the number of warm days and warm stream temperatures at the three sites where trout are known to exist or could possibly exist under the right conditions. The years 2001, 2002, and 2003 had a significant amount of above average number of these "hot days", while 2004 had the fewest days in the past 6 years shown, and 2005 and 2006 were close to average (Figure 62). 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 63-Figure 80 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 Brown's Creek Headwaters site shows a higher daily maximum temperature, higher daily average temperatures, and higher daily minimum temperatures than the respective temperatures at the Gateway Trail during the warmest portions of the summer. Surprisingly, even though the temperatures recorded were higher than at the Gateway Trail, there were only three days that the daily minimum temperatures exceeded 20º C, which is considered the low impact temperature range for trout. Although daily minimum temperatures would be suitable for trout survival, this does not mean that this reach is suitable for trout. Dissolved oxygen, habitat, macroinvertebrates, and other factors all would play a role in trout survival. The daily maximum temperatures are too high and the morphology of the stream (wetland habitat lacking gravel/rock bed material) is not suitable for trout. The fact that the daily maximum temperatures are high at this site may be due to a less channelized wetland complex that allows more surface area of water to be exposed to warming sunlight in combination with less riparian shade. Daily average dissolved oxygen concentrations in a class 2A water or trout stream would be considered impaired below 7 mg/L. The dissolved oxygen concentrations dropped well below 7 mg/L at the headwaters site (Figure 14), not making it suitable for trout as well.

During the warmest portions of the summer, temperatures at the Gateway Trail had maximum daily temperatures similar to Hwy 15. Daily average and daily minimum temperatures were slightly cooler than at Hwy 15. Similar to the Headwaters site, the daily minimum temperatures are below 20º C, but the daily average temperatures were near or below 20º C as well. The fact that the daily average and minimum temperatures are cooler than the Headwaters site would indicate that groundwater contribution is present between the two sites. Similar to the Headwaters site, the daily maximum temperatures and the morphology of the stream at this location would not make this a suitable habitat for trout. Again, these high daily maximum temperatures may be to a less channelized wetland complex that allows more surface area of

water to be exposed to warming sunlight in combination with less riparian shade. The dissolved oxygen concentrations at this site indicate that it would still not be suitable for trout, but are much closer to the 7 mg/L daily average concentration threshold (Figure 19).

The Hwy 15 site shows maximum daily and average daily temperatures that were warmer than the McKusick Road site, but the daily minimum temperatures were approximately the same. Daily average temperatures hovered around the 20º C range for the warmest portions of the summer, but the daily minimum temperatures were well below 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 and allowing the site at McKusick Road to have cooler daily minimum temperatures. Dissolved oxygen concentrations at the Hwy 15 site hover hear the 7 mg/L threshold (usually around 6 mg/L), but when heavy precipitation events occur, the concentration drops dramatically. The morphology of this site is much more suitable for trout, but the temperatures and changes in dissolved oxygen may inhibit 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 daily temperatures 2º-3º warmer, daily average temperatures 2º-4º warmer, and daily minimum temperatures 1º-2º warmer than the Hwy 96 site during the warmest portions of the summer. It is obvious from the data that additional groundwater contribution and increased riparian shading is affecting the temperature between these two sites. Daily maximum temperatures were near 25º C and not suitable for trout, but daily average and daily minimum temperatures were near or below 20º C and considered more suitable. Between June 2 and June 3, a beaver dam that was found in the channel this year was removed and around that time a significant drop in the dissolved oxygen occurred due to this. The release of the sediments and nutrients at that time also released an oxygen demand that the biological decay within the sediments likely caused. Dissolved oxygen at this location was near the 7 mg/L threshold for much of the year. 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 Brown's Creek Diversion Structure site will be discussed in this section due to the fact that this site is technically considered a part of Brown's Creek based on the MN DNR's definition of what tributaries have historically been part of Brown's Creek. For those unaware of this location and its relation and contribution to the creek, this drainage currently flows only to McKusick Lake unless a particular magnitude of storm under fully developed conditions throughout the subwatershed would occur and only then would flow into Brown's Creek. This sites data should be viewed with a different perspective in mind of a site on Brown's Creek because of its lack of contribution directly to the creek. Maximum daily temperatures at this location are higher than any of the sites on Brown's Creek during the warmest portions of the summer. Daily average and daily minimum temperatures are near or below 20º C. This sites data indicate that precipitation and the subsequent stormwater have a dramatic affect on increasing the water temperature as is evident in the fall months of 2007 where precipitation was at or above normal. Daily maximum, average, and minimum temperatures are all very similar to each other during these wet periods and increase in temperature during the heavy precipitation periods. No dissolved oxygen concentrations were logged continuously throughout the season at this location, but field measurements indicate that dissolved oxygen concentrations were above 7 mg/L. Due to the dramatic diurnal swings in dissolved oxygen that can be present at streams, a field measurement does not completely characterize the extent or lack of dissolved oxygen at a site on a daily basis.

The Hwy 96 site continues to show that groundwater contribution as well as increased riparian shade and shade from the ravine are 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 was not collected continuously at this site in 2007, but field measurements indicated only one measurement below 7 mg/L. This particular measurement was taken during a storm event

and may indicate that dissolved oxygen concentrations may be affected by stormwater runoff events, but it does not characterize normal diurnal fluctuations at this site.

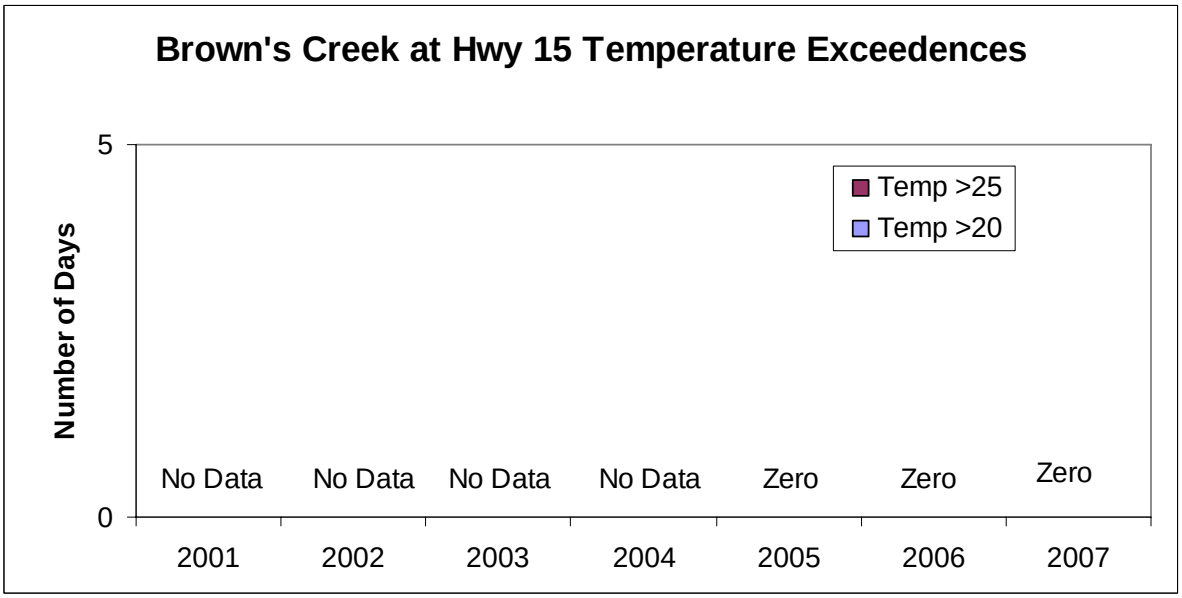


Figure 59: Occurrences of Brown's Creek Daily Minimum Water Temperature Greater than 20 and 25 degrees Celsius at Hwy 15

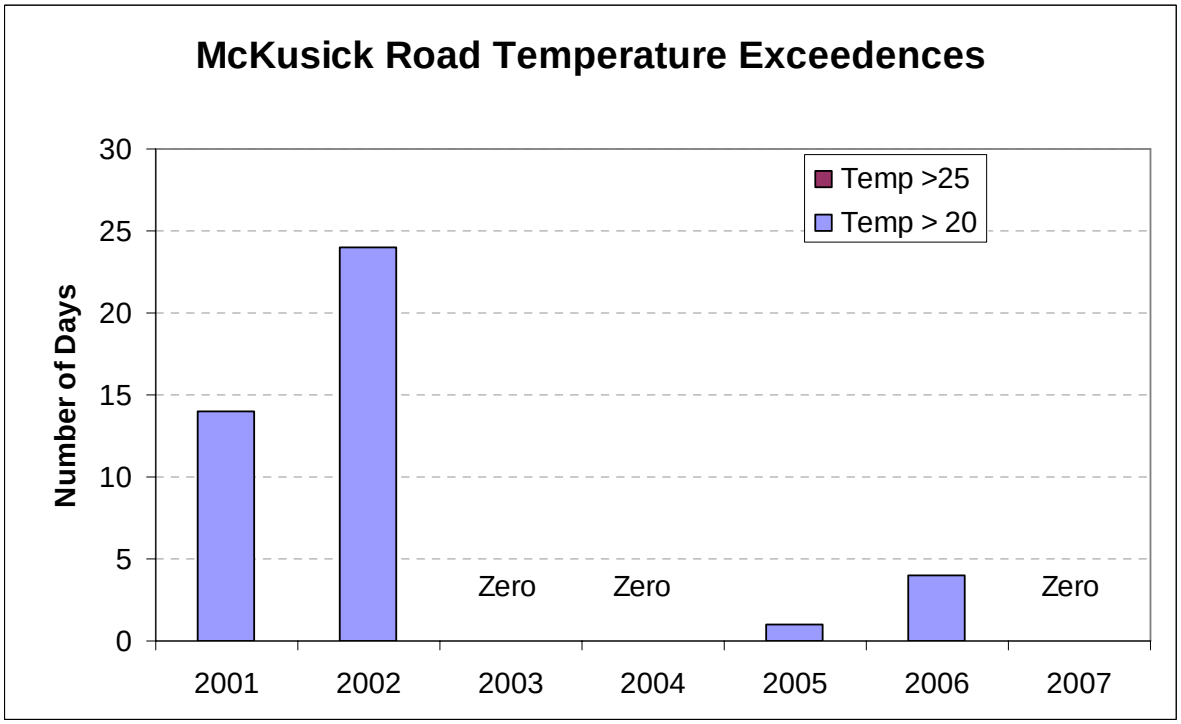


Figure 60: Occurrences of Brown's Creek Daily Minimum Water Temperature Greater than 20 and 25 degrees Celsius at McKusick Road

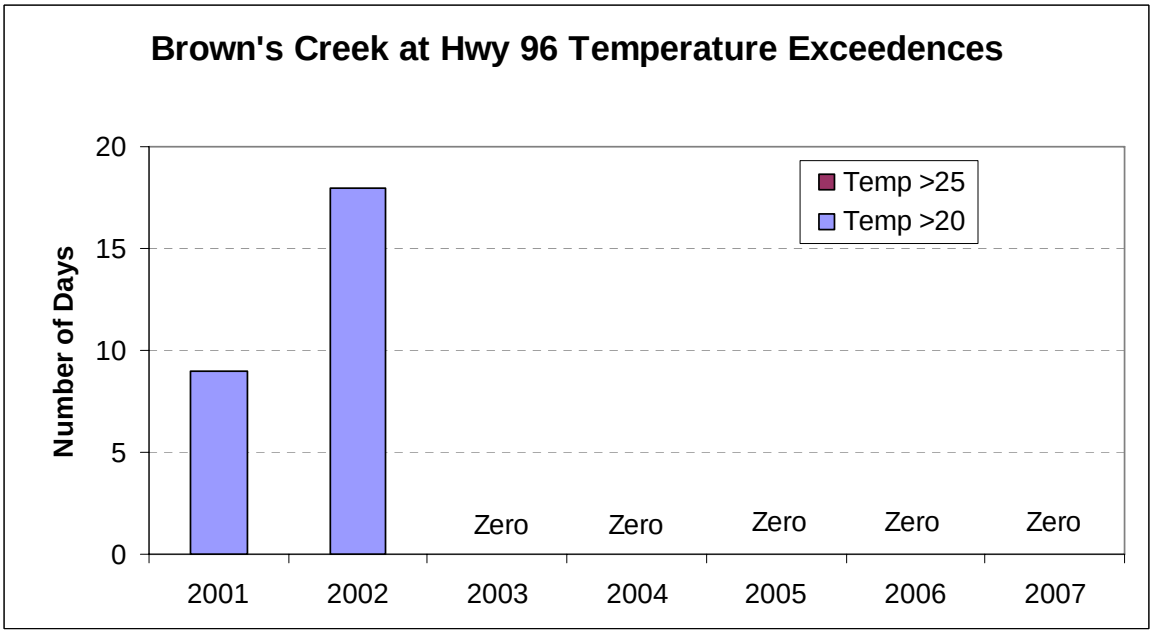


Figure 61: Occurrences of Brown's Creek Daily Minimum Water Temperature Greater than 20 and 25 degrees Celsius at Hwy 96

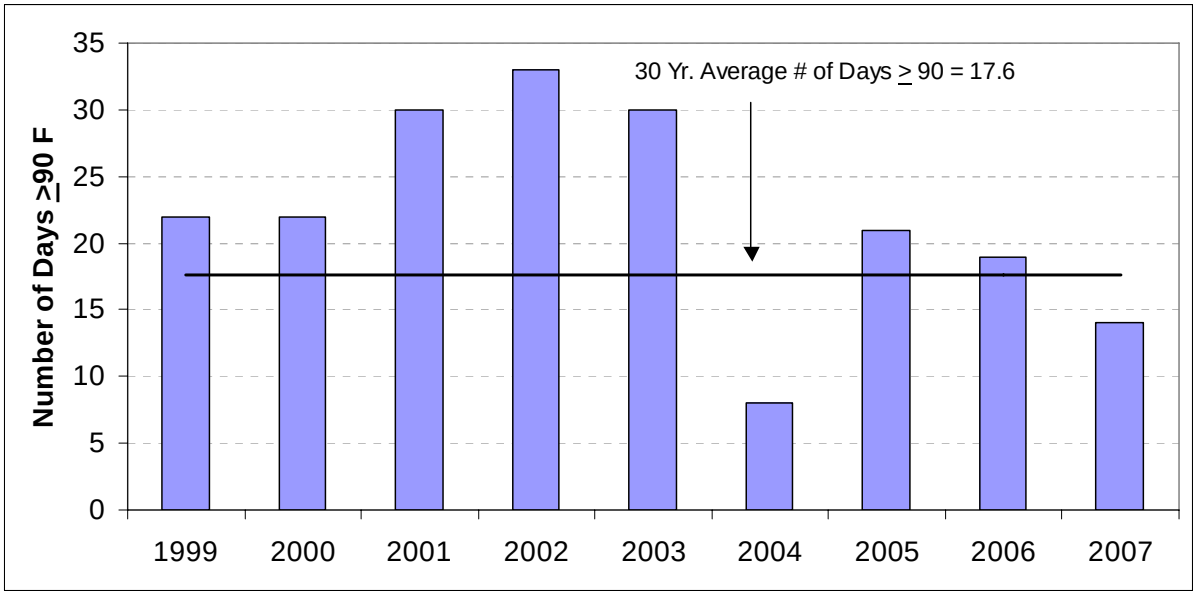


Figure 62: Days With Air Temperatures Over 90 Degrees Fahrenheit, Stillwater, MN (Source: National Weather Service {Stillwater 30N, 20W, S34})

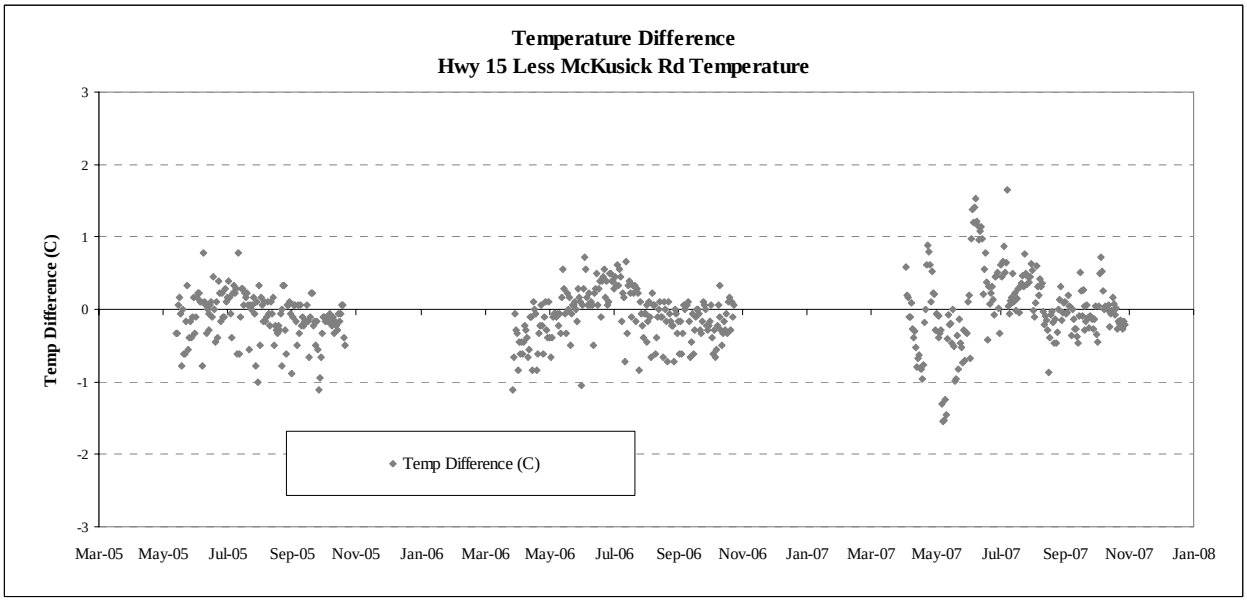


Figure 63: Temperature Differences Between Hwy 15 & McKusick Rd

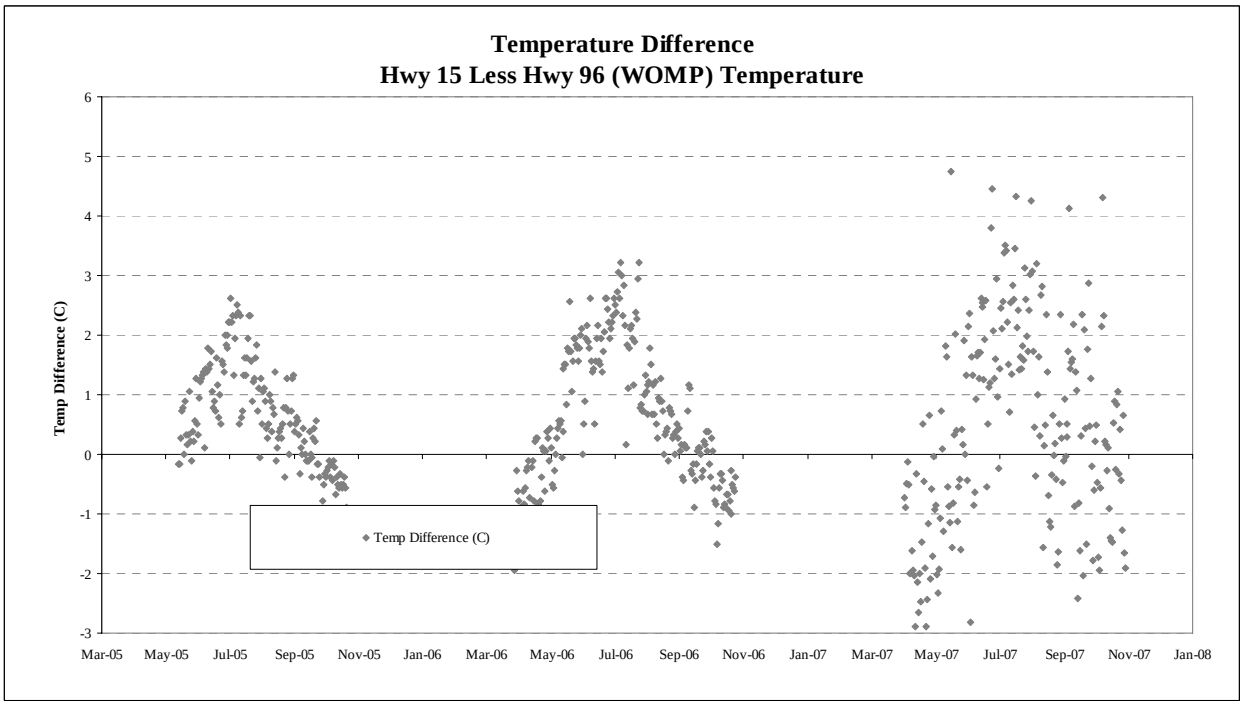


Figure 64: Temperature Differences Between Hwy 15 & Hwy 96 (WOMP) Sites

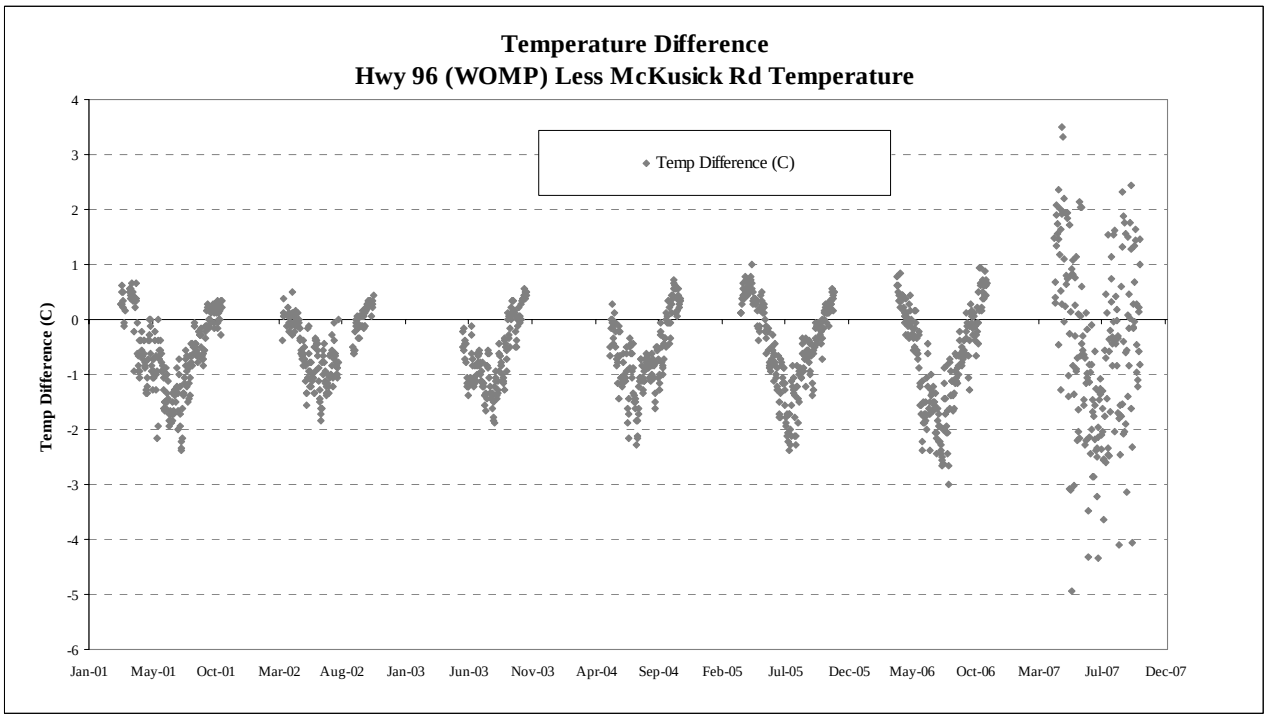


Figure 65: Temperature Differences Between McKusick Rd & Hwy 96 (WOMP) Sites

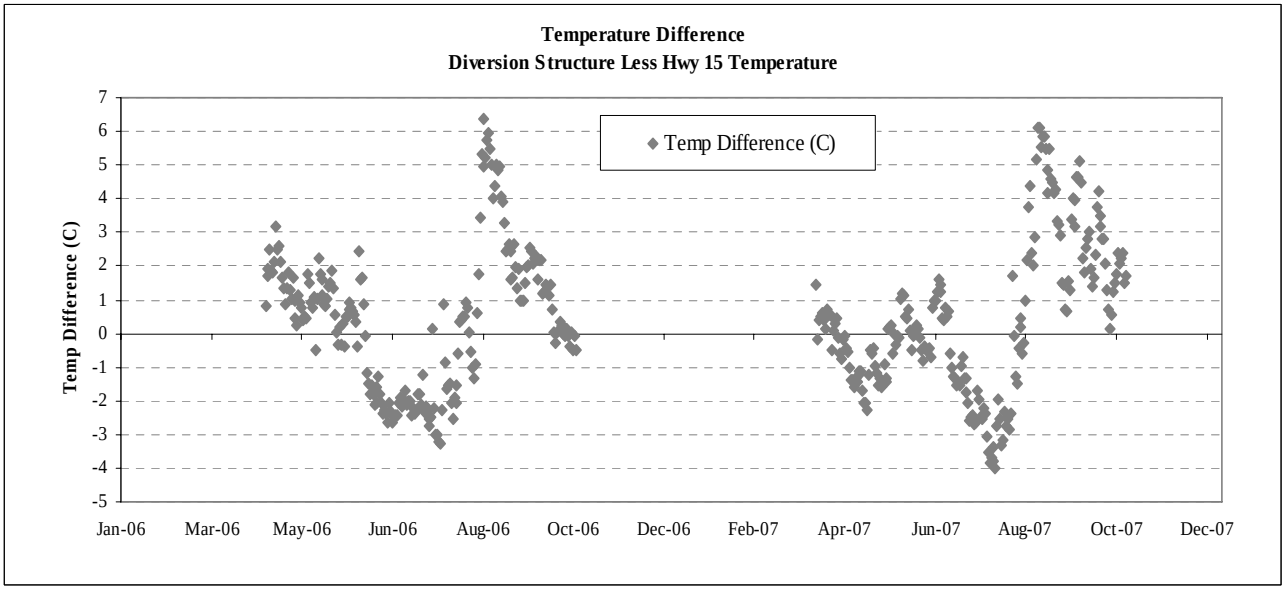


Figure 66: Temperature Differences Between Diversion & Hwy 15 Sites

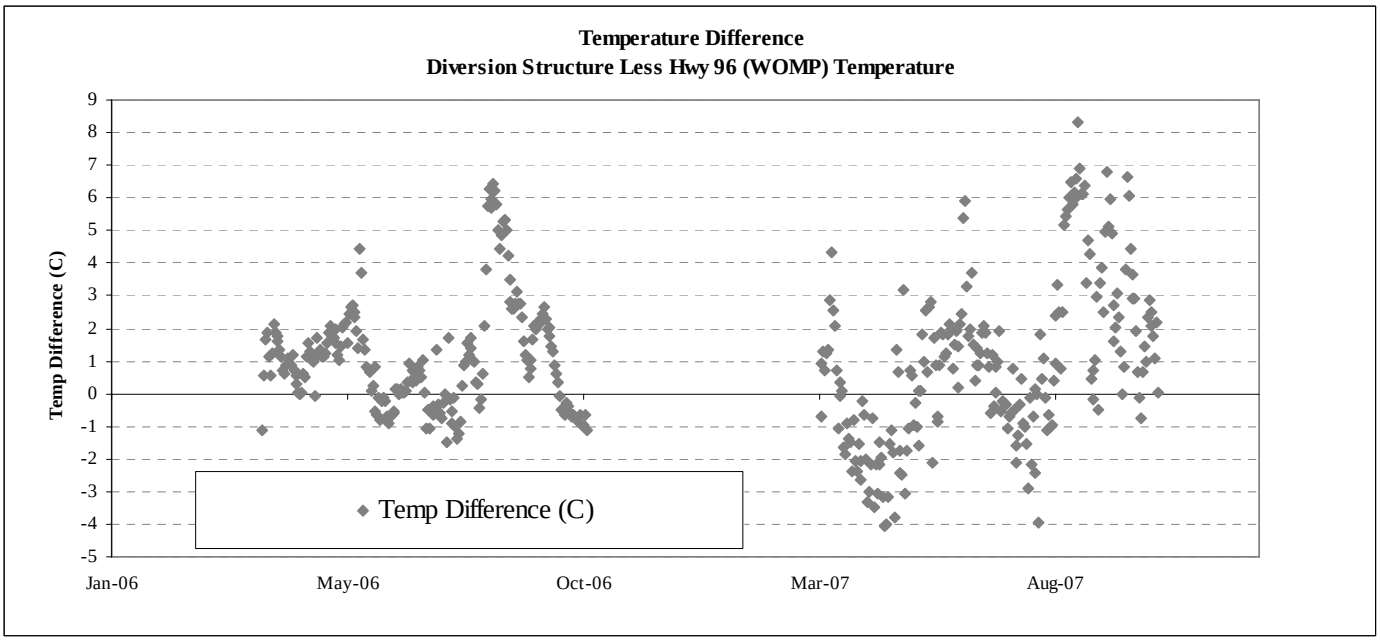


Figure 67: Temperature Differences Between Diversion & Hwy 96 (WOMP) Sites

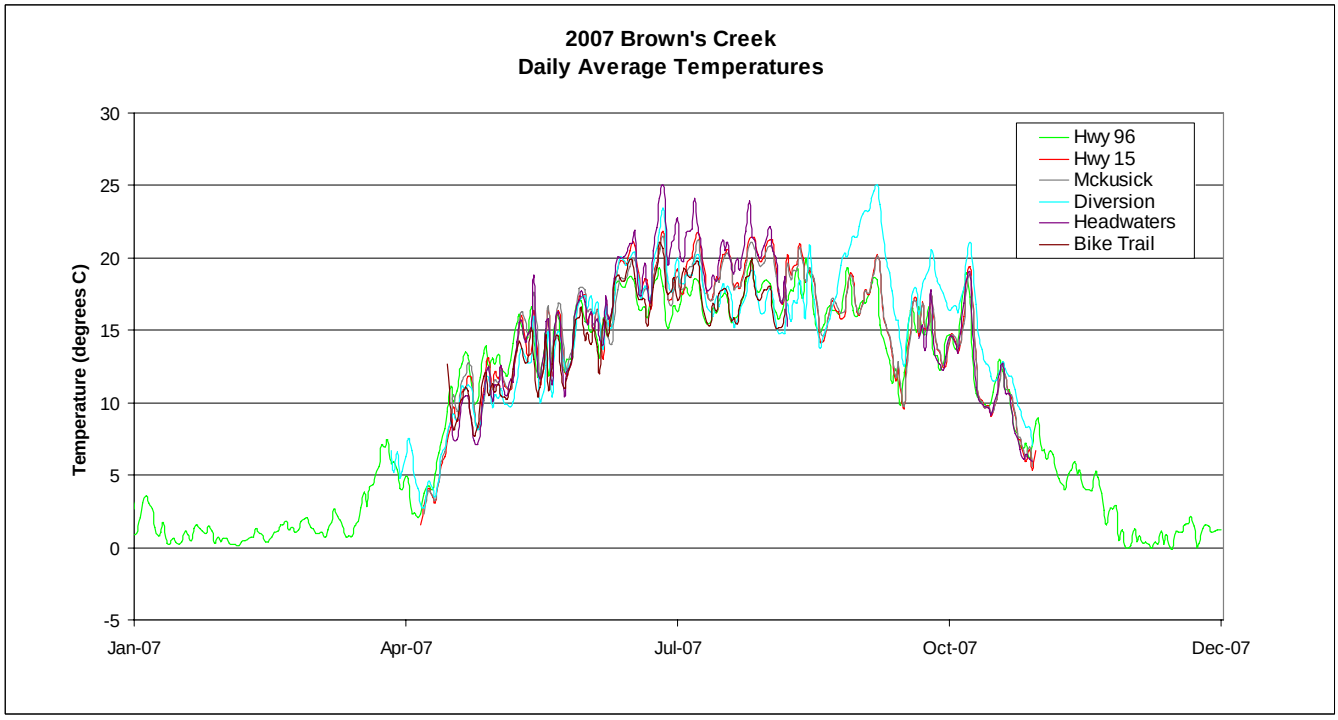


Figure 68: 2007 Daily Average Temperatures

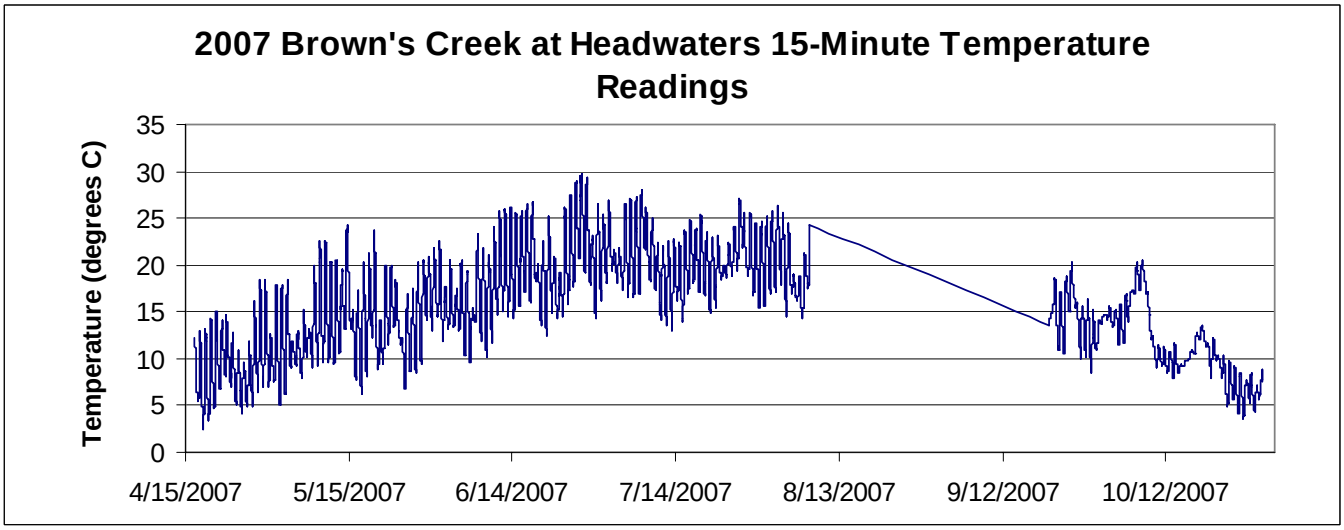


Figure 69: 2007 Brown's Creek Headwaters Temperatures

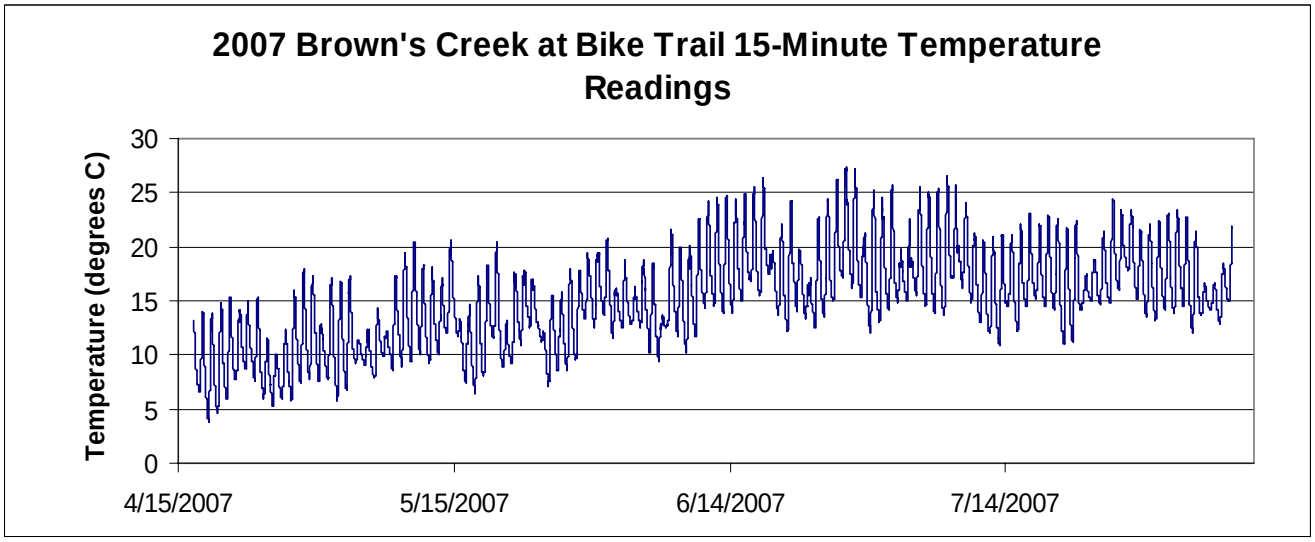


Figure 70: 2007 Brown's Creek at the Gateway Bike Trail Temperatures

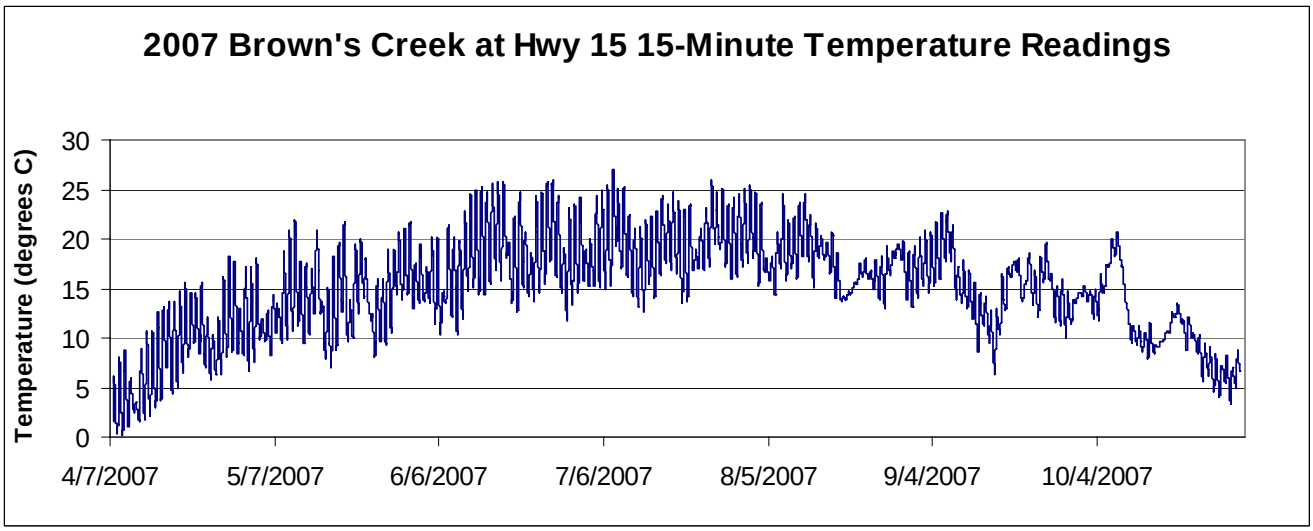


Figure 71: 2007 Brown's Creek at Hwy 15 Temperatures

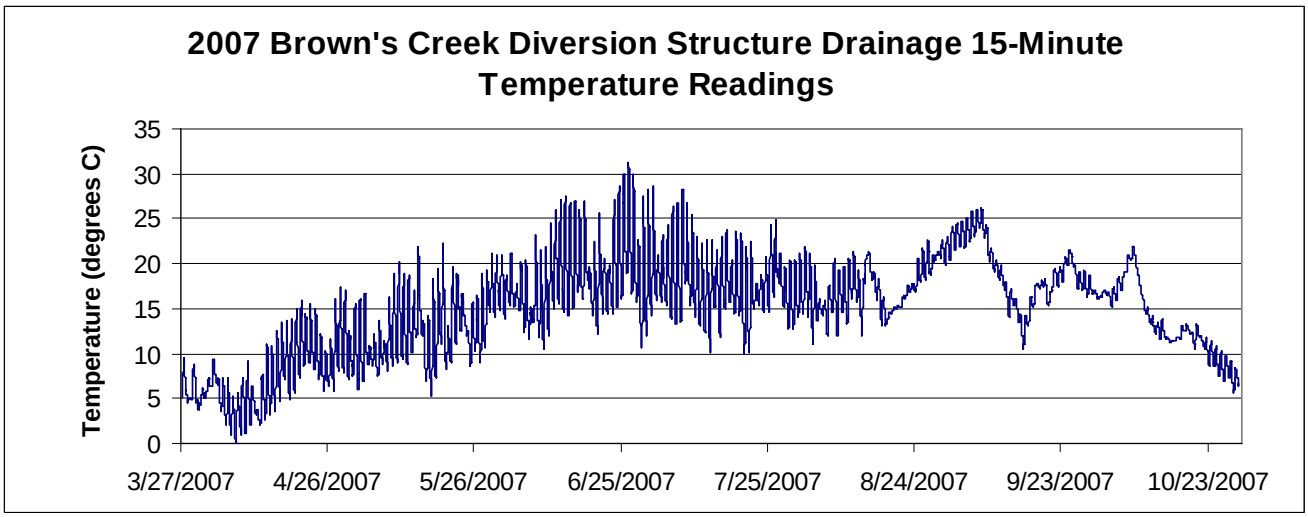


Figure 72: 2007 Brown's Creek Diversion Structure Drainage Temperature

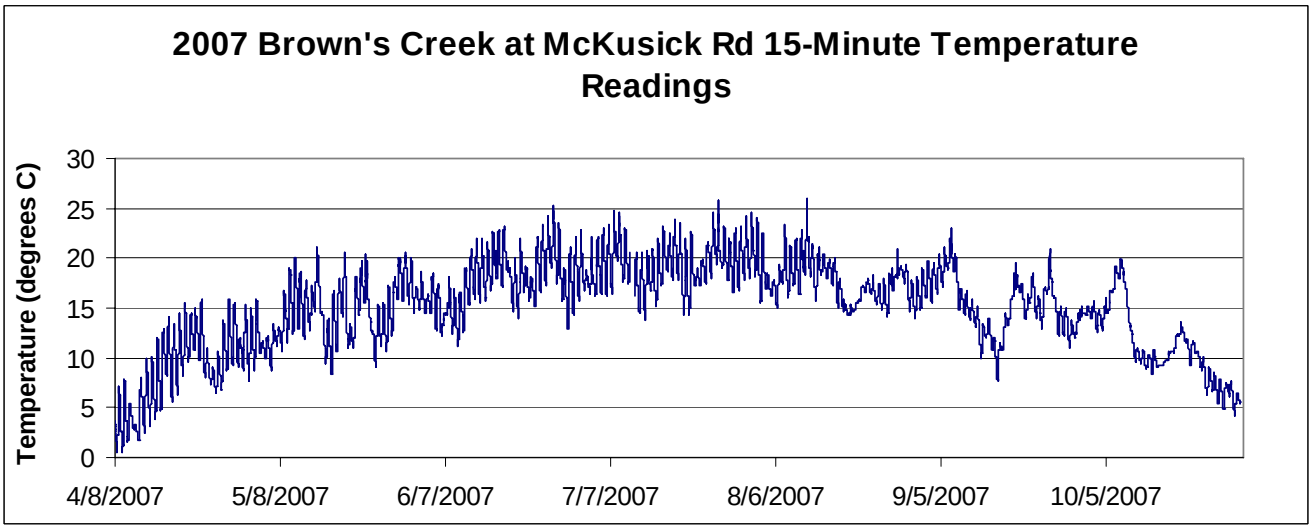


Figure 73: **2007 Brown's Creek at McKusick Road Temperature**

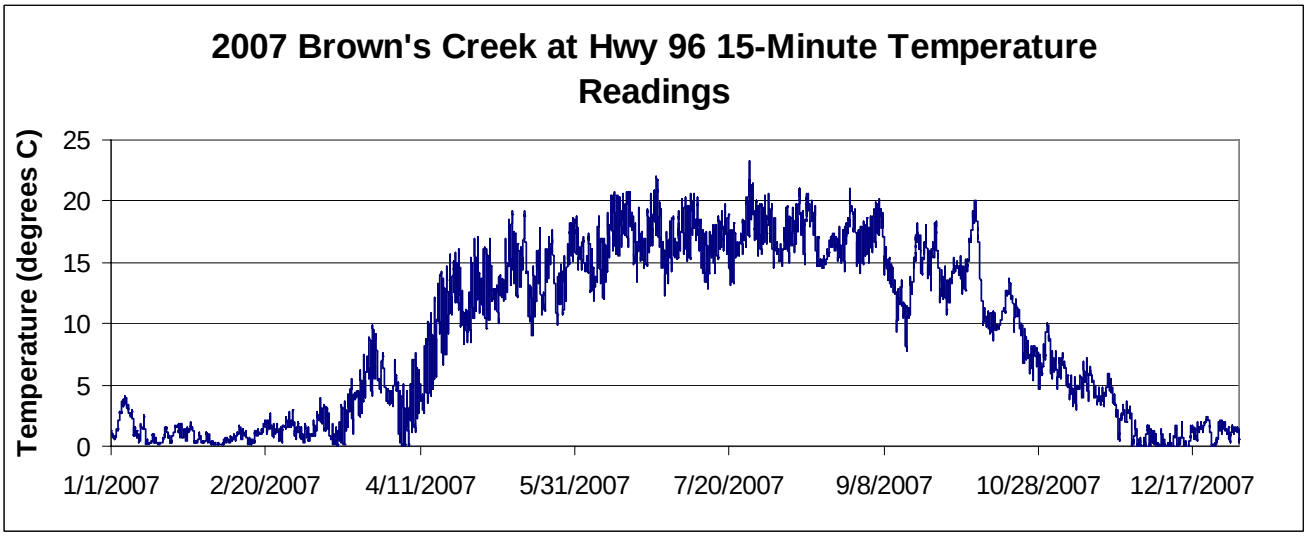


Figure 74: 2007 Brown's Creek at Hwy 96 (WOMP) Temperatures

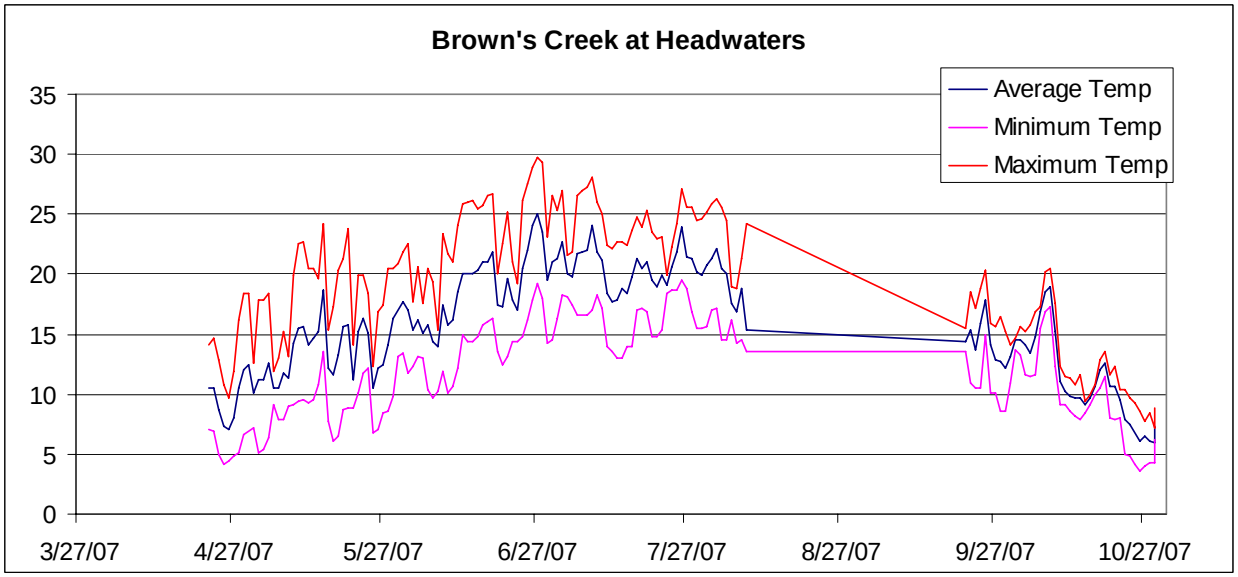


Figure 75: 2007 Brown's Creek Headwaters Daily Average, Minimum, and Maximum Temperatures

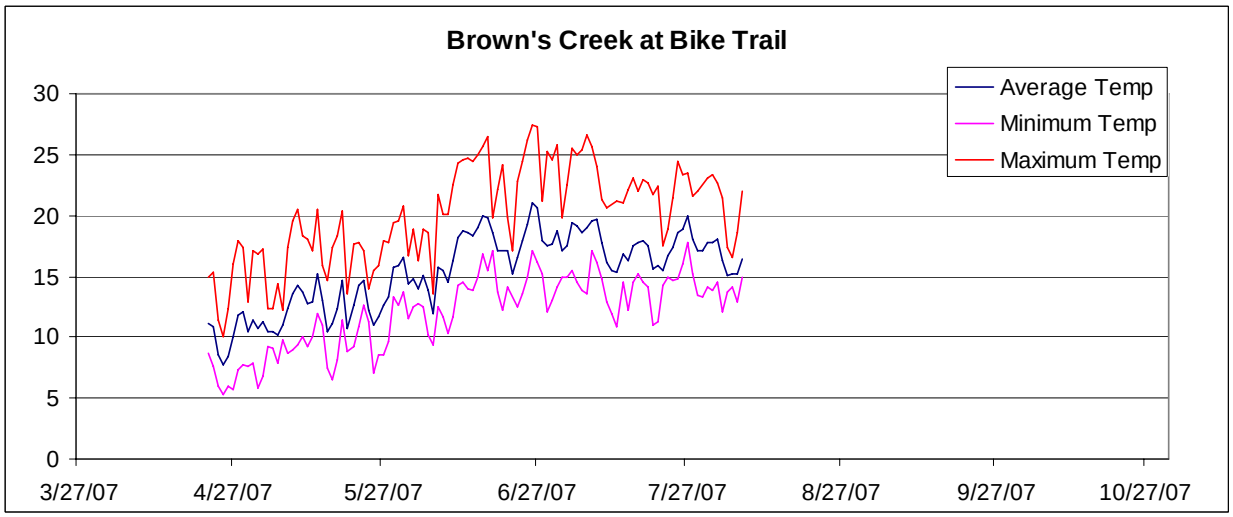


Figure 76: 2007 Brown's Creek at the Gateway Bike Trail Daily Average, Minimum, and Maximum Temperatures

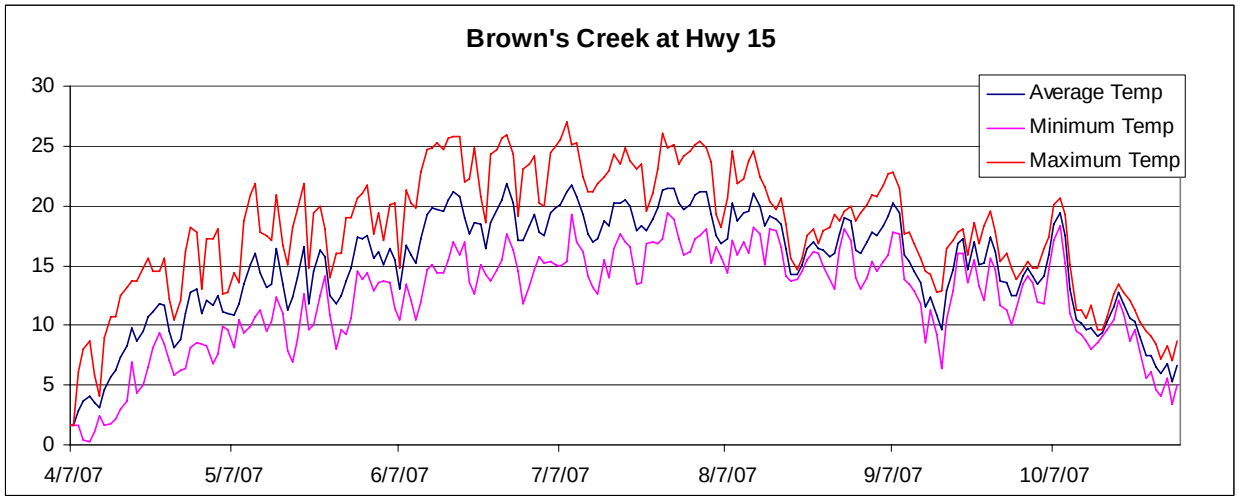


Figure 77: 2007 Brown's Creek at Hwy 15 Daily Average, Minimum, and Maximum Temperatures

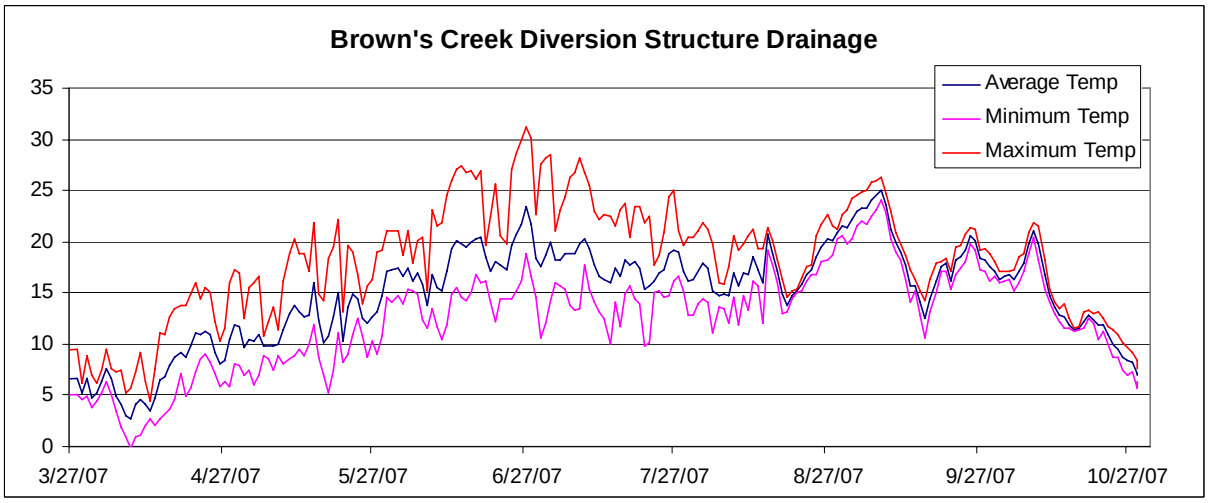


Figure 78: 2007 Brown's Creek Diversion Structure Drainage Daily Average, Minimum, and Maximum Temperatures

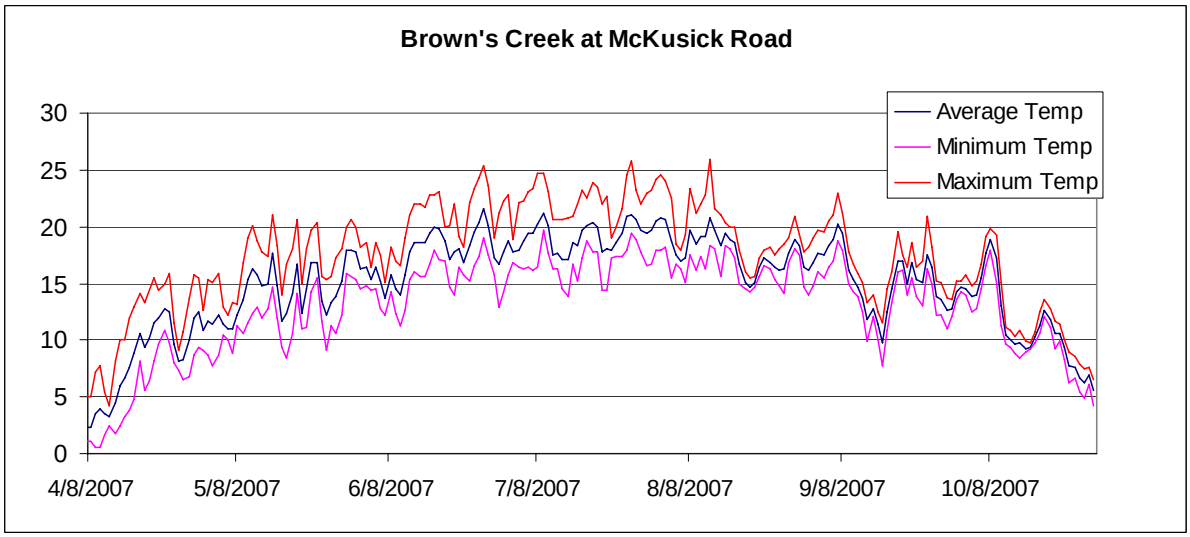


Figure 79. 2007 Brown's Creek at McKusick Road Daily Average, Minimum, and Maximum Temperatures

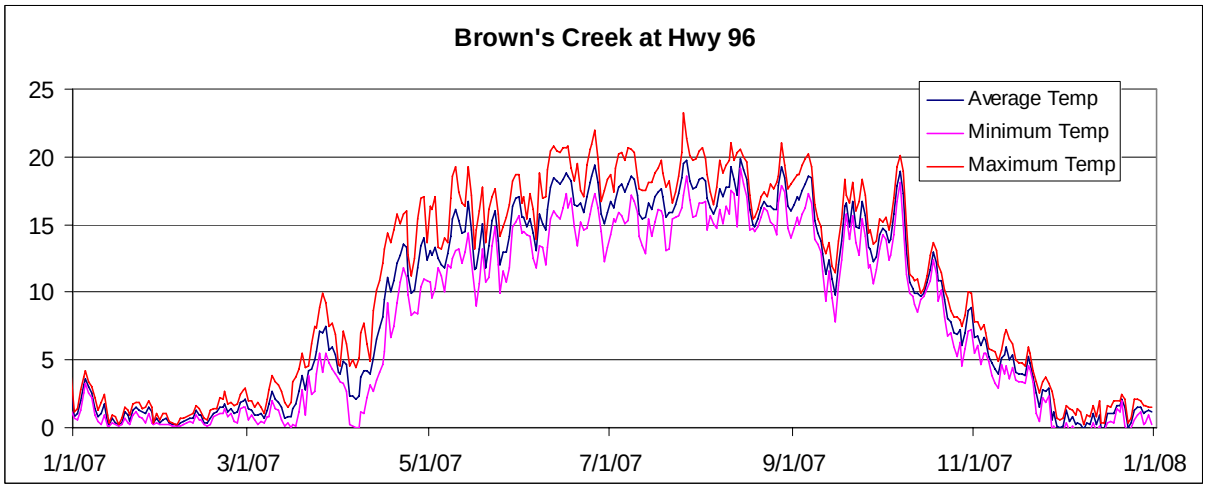


Figure 80. 2007 Brown's Creek at Hwy 96 Daily Average, Minimum, and Maximum Temperatures

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.

Baseflow at the mouth of the stream consistently averages around 7 cfs. The 2002 monitoring season had the highest baseflow of 10 cfs within the past seven years. For 2007, stream flow averaged 7.7 cfs. 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 baseflow 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 runoff events at the mouth: 92 cfs on August 14th, 58 cfs on March 13th, and 55 cfs on August 28th. High runoff rates from August were the result of high magnitude rainfall events. Runoff rates from the March 13th event were the result of snowmelt. Brown's Creek was at baseflow 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 2007, Brown's Creek at Hwy 96 exhibited annual loading rates per unit area (Kg/ha) similar to loading found between the natural atmospheric deposition range and the pasture land use range (Figure 56). The average total phosphorus concentration in the stream at Hwy 96 was 0.35 mg/L in 2007. This is consistent with the high impact range according to the H&H study (Table 39). In 2007, both the Hwy 15 and McKusick Road sites exhibited annual loading rates per unit area (Kg/ha), which were less than the outlet

station (0.13 Kg/ha and 0.13 Kg/ha respectively) and was within the forest land use range. The site at 110th St. exhibited annual loading rates per unit area (Kg/ha) similar to loading found between the pasture land use range and the cultivated land use range. The loading rates and concentrations at this site should be viewed with caution. Due to the very fine and loose nature of the streambed at the 110th St. site, bed material may have been collected during composite sample periods contributing to higher concentrations and higher loads. Monitoring in 2008 will focus on this possibility and will attempt to modify the sampling setup to alleviate or confirm this problem. 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 0.19 Kg/ha. This is consistent with a loading in the forest land use range.

The two Long Lake drainage sites (at 62nd St. and at Marketplace Pond) exhibited loadings per unit area within the forest land use range and between the deposition by precipitation and cultivated land use ranges respectively. From these loadings it is quite obvious that the Marketplace Pond subwatershed is draining either much more impervious area 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 2007 at Hwy 96 was 134 mg/L. This is within the high impact modeled condition for the Hwy 96 site from the H&H Study. All sites on Brown's Creek had average TSS concentrations less than the average concentration found at Hwy 96 except for the 110th St. location, which the caution mentioned above may explain, and the McKusick Road site which had a three storms between July and September that produced very high

concentrations of TP and TSS that skew the average concentration. The Brown's Creek Diversion Structure site had an average concentration of 108 mg/L. One storm composite sample was collected with an extremely high TSS value and was left out of this average calculation due to professional judgement. Baseflow 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 30 mg/L and 49 mg/L respectively. A baseflow composite sample between April 19th and April 24th had very high TSS concentrations and was left out of this average value because we feel that it is not representative of what actually was present.

Turbidity or suspended solids are and should continue to be monitored for Brown's Creek. Average TSS values for the Brown's Creek Diversion Structure drainage (108 mg/L), McKusick Road (240 mg/L), Headwaters (319 mg/L), and the mouth drainage were in the high water quality impact range of modeled conditions (Table 39). The TSS values for the 62nd St. site and the Marketplace pond drainage (30 and 49 mg/L respectively) were within the moderate impact range. The Highway 15 site was within the low impact range. Again, further BMP's may need to be investigated for the Marketplace Pond site as well as the Diversion Structure drainage. As mentioned previously, the Marketplace Pond site does have further treatment before reaching Long Lake, which may help to treat this stormwater.

Table 39: 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

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 mouth 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 at the mouth did not exceeded 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. 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.

Dissolved oxygen conditions at the Headwaters and Gateway Bike Trail sites were well below tolerable values for trout survival. Hwy 15 and McKusick Road sites had concentrations that did go below the water quality standard, but were hovering near the standard during the summer months. Additional thermal improvements near Hwy 15 and McKusick Road may make enough of a difference to keep dissolved oxygen concentrations above the standard, but at this time this is simply a hypothesis.

Groundwater discharge in a highly reduced (oxygen removing) form and peat/wetland decay may all be a natural condition leading to low dissolved oxygen that cannon be changed. The Brown's Creek TMDL will further study the low dissolved oxygen from McKusick Road to the Headwaters and will make recommendations for improvement or will show that this is a natural condition.

C. RECOMMENDATIONS

- Continue to gather baseline water quality data at all sites on Brown's Creek as BCWD continues to become more developed.
- Continue phosphorus loading and total suspended solid analysis on Brown's Creek at mouth, McKusick Road, Hwy 15, Headwaters, Diversion, at 62nd St. and Marketplace Pond to monitor any potential trends.
- Implementation of the Long Lake TMDL.
- Begin implementation of TMDL's on water's currently listed on the 303d impaired water's list, as well as staging implementation on waters that will be listed based on water quality data with a small period of record.
- Continue implementation of activities to de-list Brown's Creek from the MPCA's impaired waters list.
- 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 don't exist or for downstream trout tolerance benefits.
- Initiate monitoring near the Stonebridge to determine where the large change in load is originating between the McKusick Road site and the Outlet site.

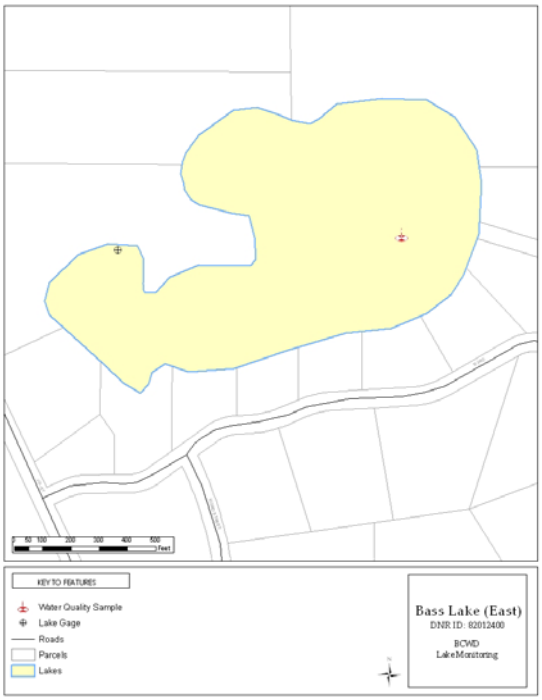
APPENDIX A - WATER QUALITY DATA – BY LAKE

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

Bass Lake (East)

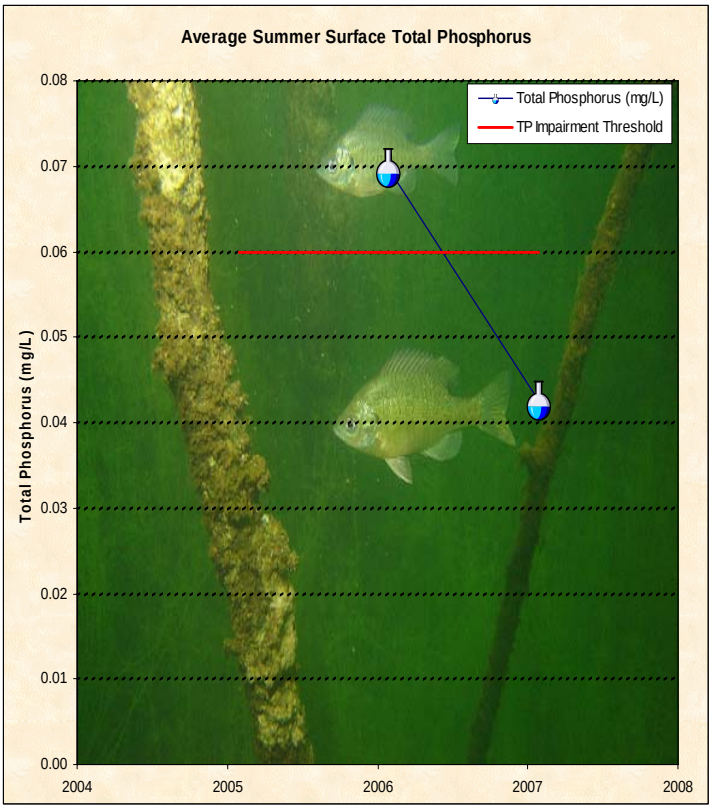
2007 Lake Grade: B-

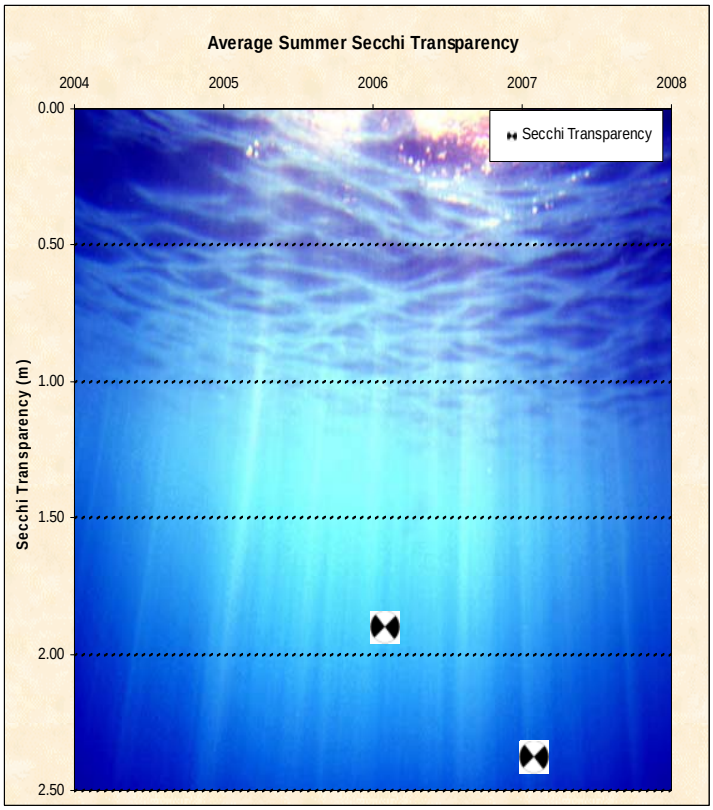
- DNR ID #: 820124
- Municipality: Township of Grant
- Location: Section 10, T30N-R21W
- Lake Size: 310.50 Acres
- Maximum Depth: 14 ft
- Ordinary High Water Mark: 960.20 ft
- 100-Year High Water Level: 960.40 ft
- 100% Littoral
  Note: Littoral area is the portion of the lake <15 ft and dominated by aquatic vegetation.



Summary Points

- Bass Lake (East) was considered a eutrophic lake in 2007, 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 2 to 4 meters.





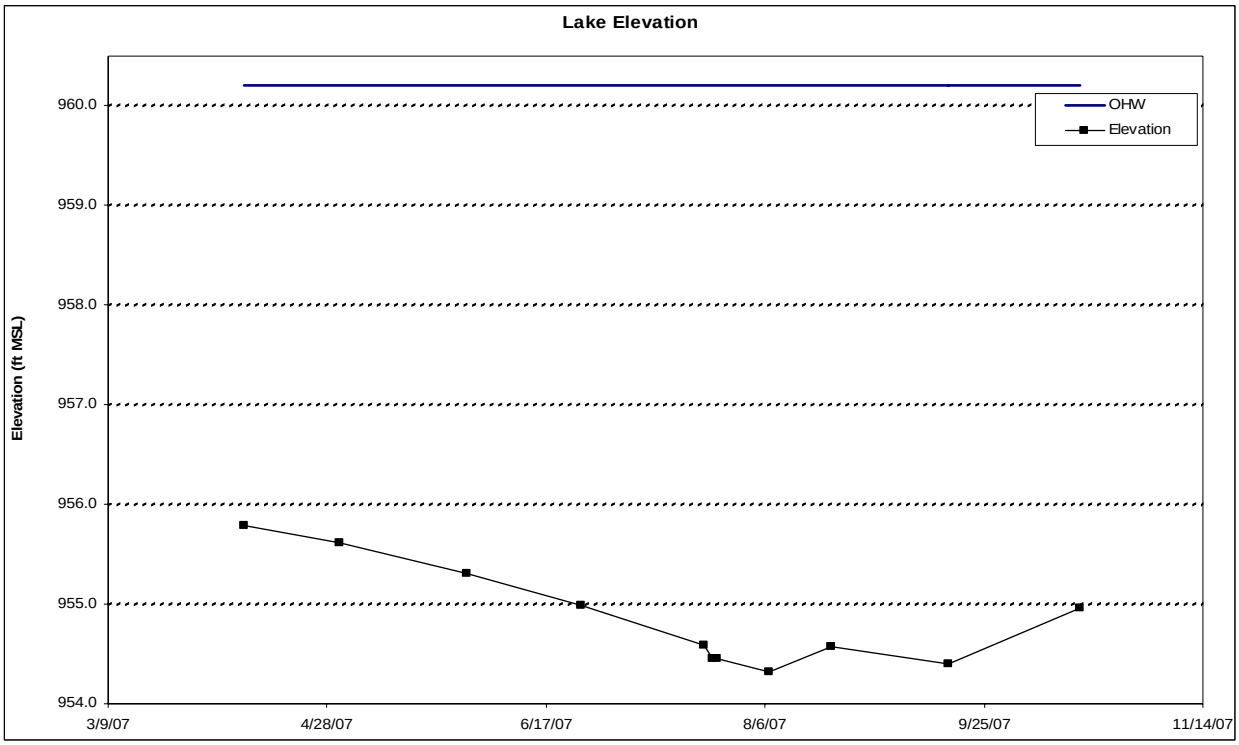
Date	Total Phosphorus (mg/L)	Chlorophyll-a (ug/L)	Total Kjeldahl Nitrogen (mg/L)	Secchi Disk Depths (m)	Surface Dissolved Oxygen Levels (mg/L)	Surface Temperature Levels (Celsius)
5/1/2007	0.034	3	0.91	3.20	9.22	18.0
5/30/2007	0.053	4	0.98	2.44	10.29	23.8
6/25/2007	0.030	4	0.94	2.59	7.54	30.7
7/23/2007	0.036	30	1.40	1.22	6.70	27.8
8/21/2007	0.059	34	1.40	1.68	4.23	22.1
9/17/2007	0.035	5	0.98	3.96	10.50	20.4
10/17/2007	0.019	3	0.80	3.20	7.11	14.7
2007 Average	0.038	12	1.06	2.61	7.94	22.5
2007 Summer Average	0.043	15	1.14	2.38	7.85	25.0

Water quality threshold is at 0.04 mg/L TP or higher*

Shallow lake water quality threshold is 0.06 mg/L TP or higher*

	High	High Date	Low	Low Date	Average
2007 Elevation (ft)	955.79	4/9/2007	954.32	8/7/2007	954.86

*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."



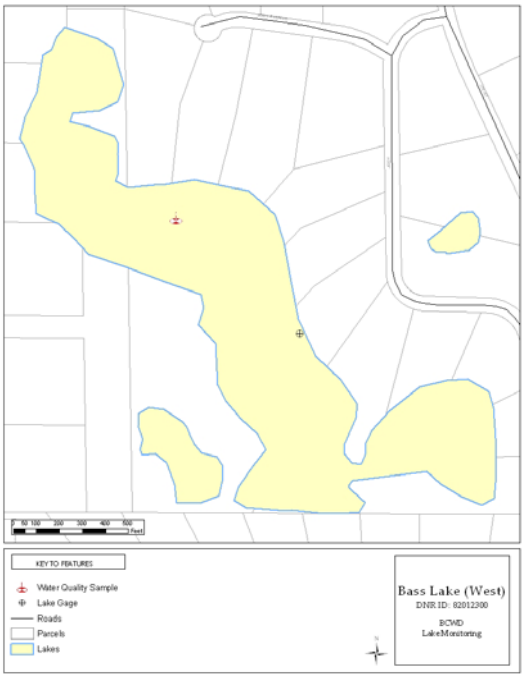
Lake Water Quality Summary

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

Bass Lake (West)

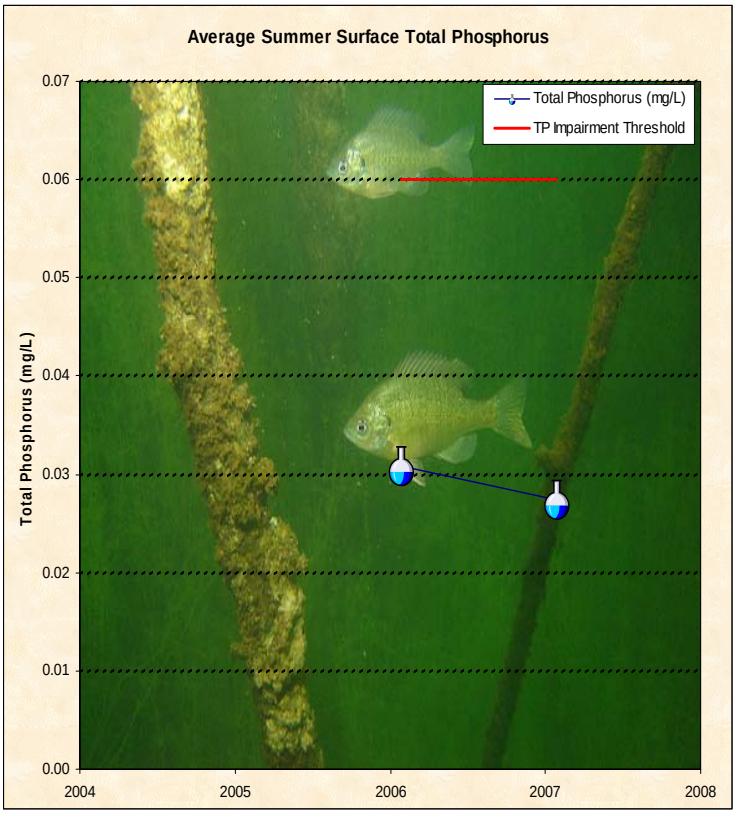
2007 Lake Grade: B

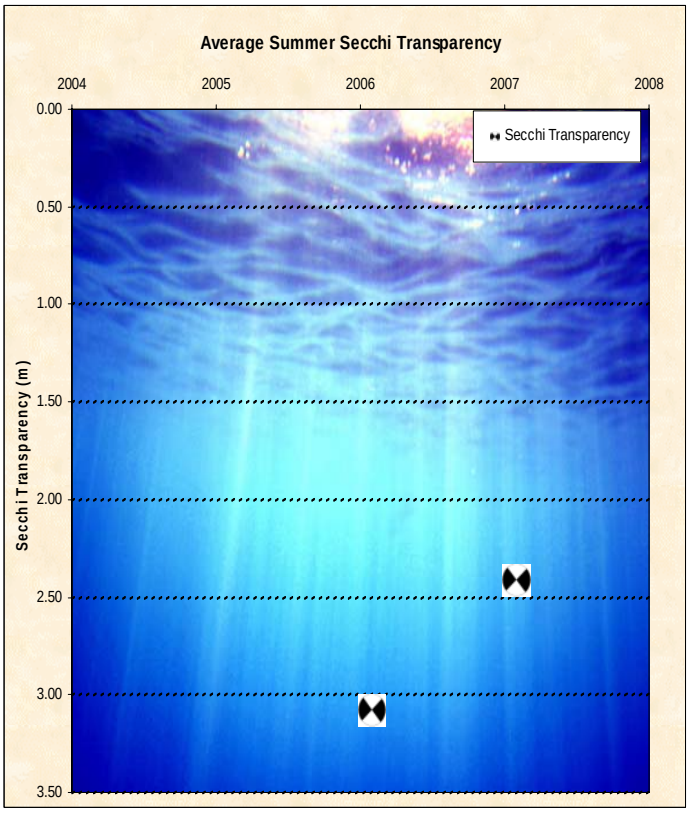
- DNR ID #: 820123
- Municipality: Township of Grant
- Location: Section 10, T30N-R21W
- Lake Size: 776 Acres
- Maximum Depth: 15 ft
- Ordinary High Water Mark: 952.60 ft
- 100-Year High Water Level: 955.90 ft
- 100% Littoral
  Note: Littoral area is the portion of the lake <15 ft and dominated by aquatic vegetation.



Summary Points

- Bass Lake (West) was considered a mesotrophic lake in 2007, 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 at a depth of 3 meters.





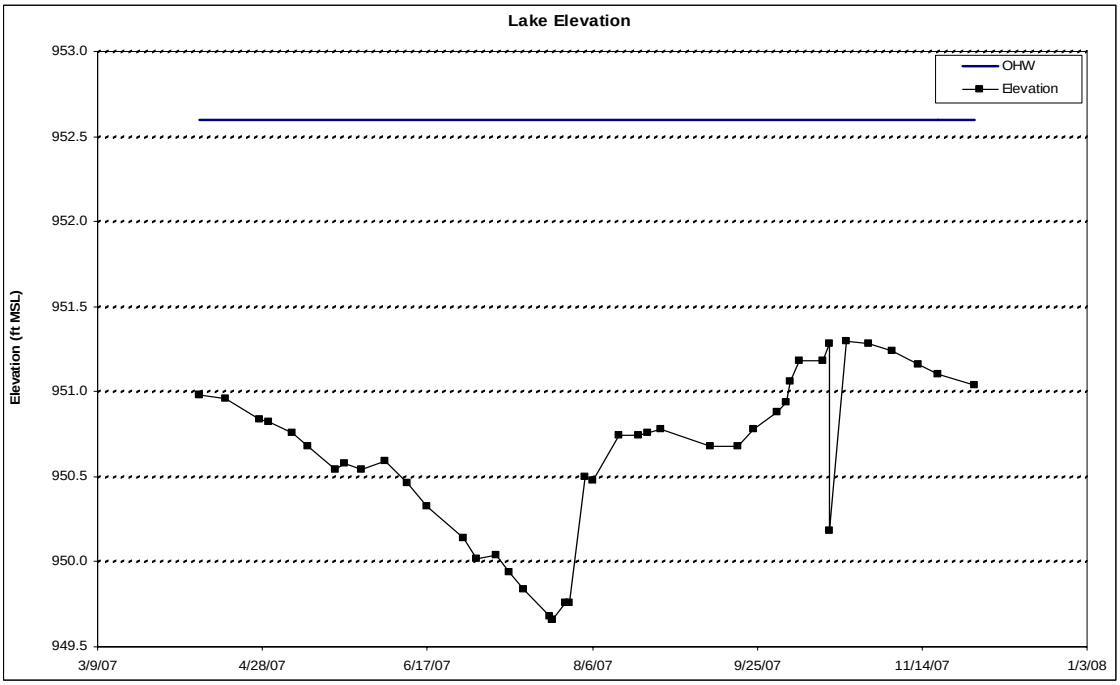
Date	Total Phosphorus (mg/L)	Chlorophyll-a (ug/L)	Total Kjeldahl Nitrogen (mg/L)	Secchi Disk Depths (m)	Surface Dissolved Oxygen Levels (mg/L)	Surface Temperature Levels (Celsius)
5/1/2007	0.018	3	0.66	3.05	9.31	16.8
5/30/2007	0.020	3	0.52	2.29	9.39	23.0
6/25/2007	0.022	9	0.74	2.90	8.09	28.8
7/23/2007	0.028	12	0.99	2.01	4.93	27.0
8/21/2007	0.048	24	1.00	1.83	4.91	22.2
9/17/2007	0.019	7	0.89	3.05	8.32	19.9
10/17/2007	0.021	5	0.69	2.44	6.34	14.7
2007 Average	0.025	9	0.78	2.51	7.33	21.8
2007 Summer Average	0.027	11	0.83	2.41	7.13	24.2

Water quality threshold is at 0.04 mg/L TP or higher*

Shallow lake water quality threshold is 0.06 mg/L TP or higher*

	High	High Date	Low	Low Date	Average
2007 Elevation (ft)	951.30	10/22/2007	949.66	7/25/2007	950.61

*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."



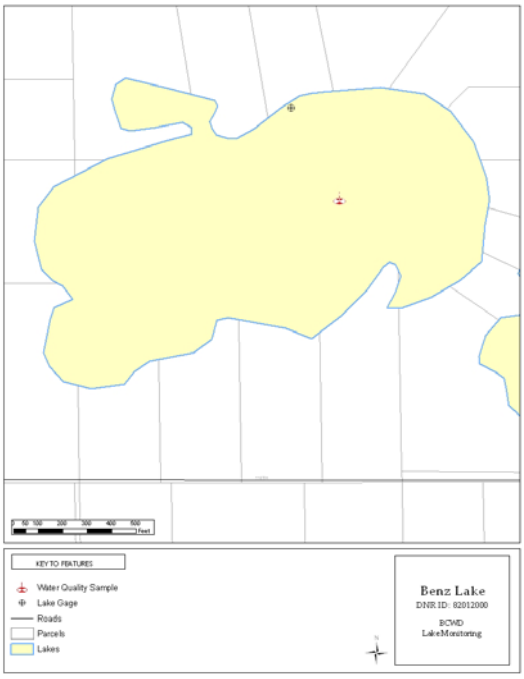
Lake Water Quality Summary

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

Benz Lake

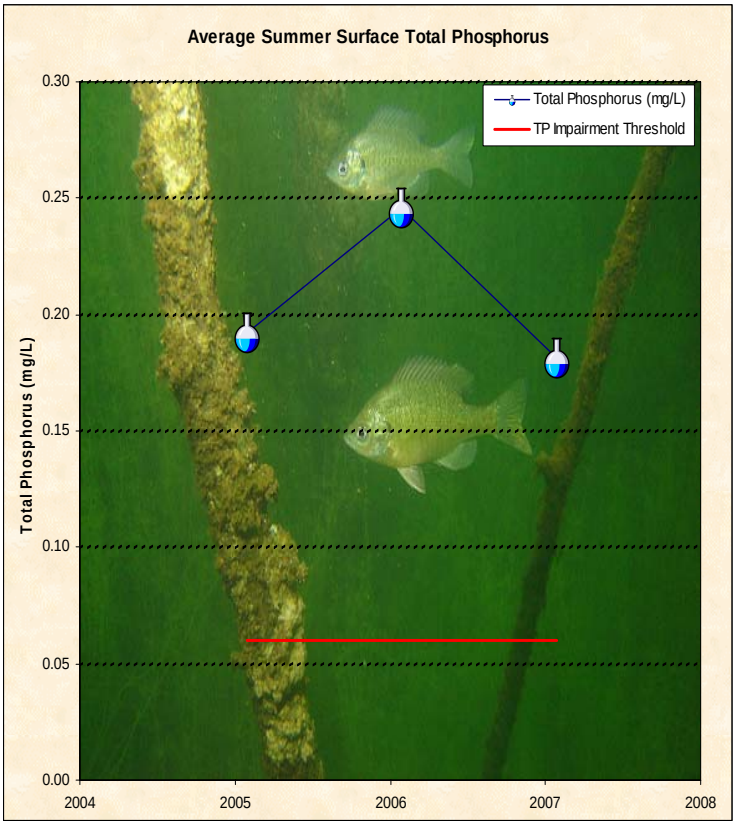
2007 Lake Grade: F

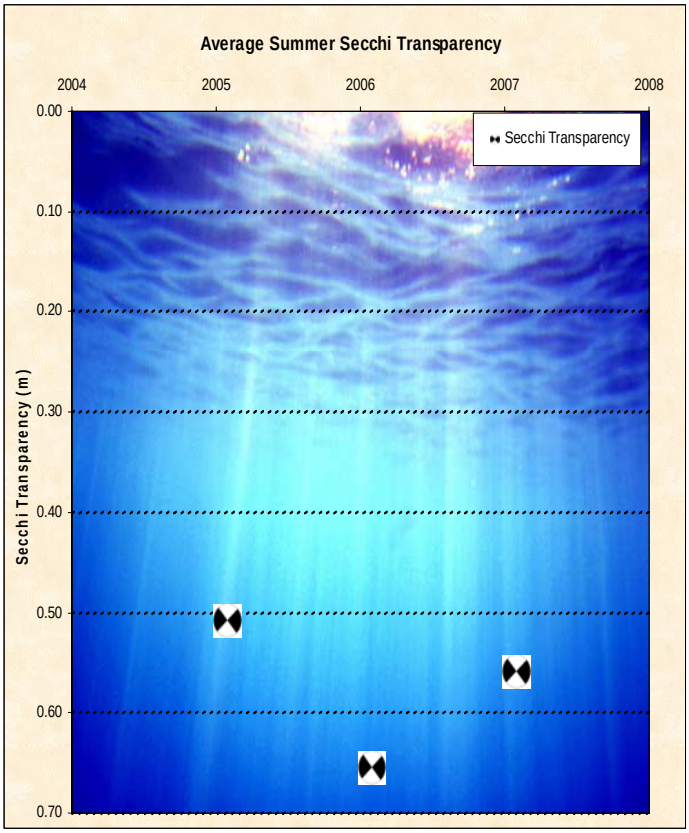
- DNR ID #: 820120
- Municipality: City of Withrow
- Location: $SE^{1/4}$ Section 2, T30N-R21W
- Lake Size: 37.6 Acres
- Maximum Depth: NA
- Ordinary High Water Mark: 954.07 ft*
- 100-Year High Water Level: 955.30 ft
- 100% Littoral
  Note: Littoral area is the portion of the lake <15 ft and dominated by aquatic vegetation.
  **Reduced by 4.84 feet due to benchmark error*



Summary Points

- Benz Lake was considered a hypereutrophic lake in 2007, 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 2007.





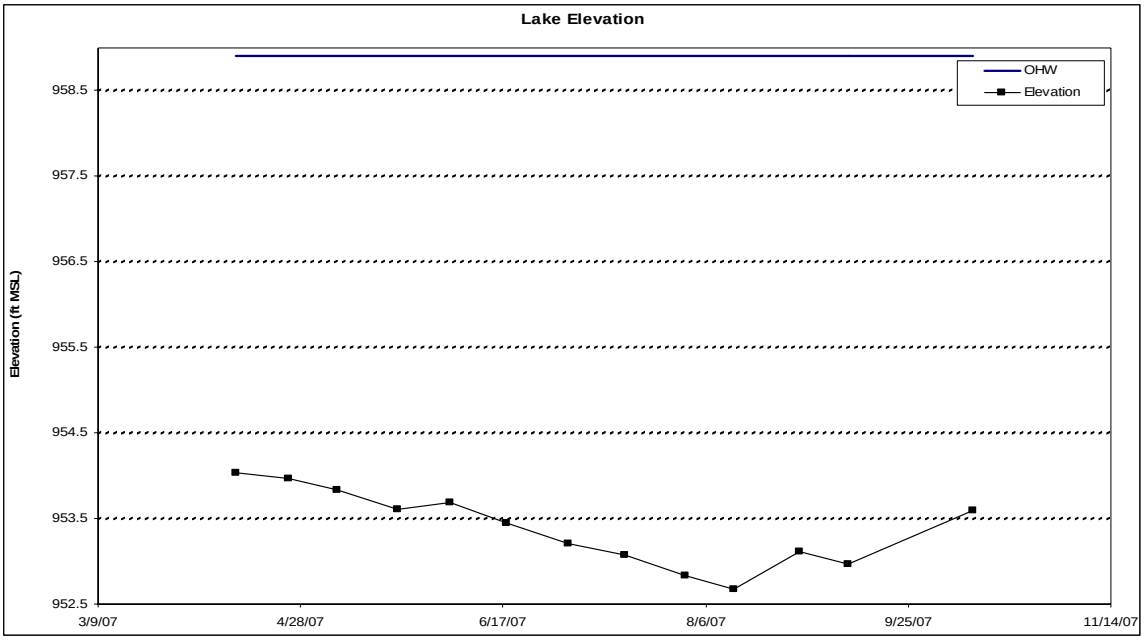
Date	Total Phosphorus (mg/L)	Chlorophyll-a (ug/L)	Total Kjeldahl Nitrogen (mg/L)	Secchi Disk Depths (m)	Surface Dissolved Oxygen Levels (mg/L)	Surface Temperature Levels (Celsius)
4/12/2007	0.218	180	2.90	0.91	13.75	6.4
4/25/2007	0.130	67	3.10	0.91	10.00	15.3
5/7/2007	0.187	38	2.90	1.22	10.45	16.3
5/22/2007	0.149	31	2.60	1.07	7.38	20.5
6/4/2007	0.123	36	2.70	0.91	11.28	24.9
6/18/2007	0.216	45	3.60	0.61	3.57	29.5
7/3/2007	0.128	110	3.60	0.46	4.77	26.9
7/17/2007	0.178	170	3.90	0.46	9.91	27.9
8/1/2007	0.222	150	2.80	0.46	6.67	30.8
8/13/2007	0.240	260	3.60	0.46	7.52	26.3
8/29/2007	0.233	360	3.20	0.30	7.06	26.0
9/10/2007	0.179	90	3.00	0.61	6.25	24.7
9/24/2007	0.114	74	2.30	0.76	10.31	23.4
10/11/2007	0.104	72	2.00	0.61	7.97	16.4
2007 Average	0.173	120	3.01	0.70	8.35	22.5
2007 Summer Average	0.181	144	3.19	0.56	7.48	26.7

Water quality threshold is at 0.04 mg/L TP or higher*

Shallow lake water quality threshold is 0.06 mg/L TP or higher*

	High	High Date	Low	Low Date	Average
2007 Elevation (ft)	954.03	4/9/2007	952.67	8/13/2007	953.43
	954.03	4/12/2007			

*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."



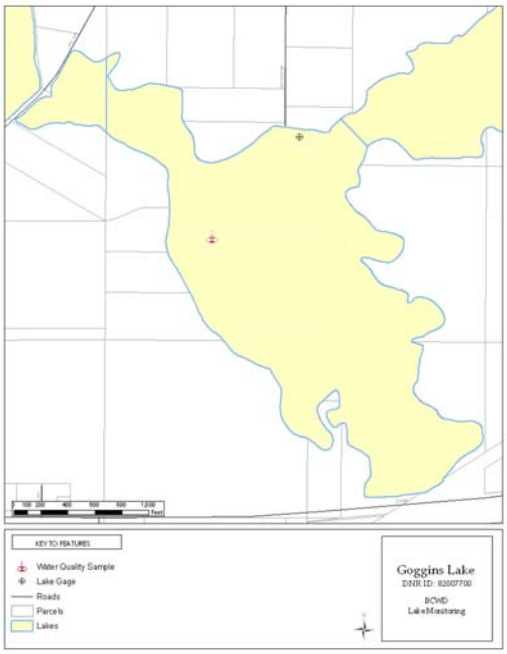
Lake Water Quality Summary

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

Goggin's Lake

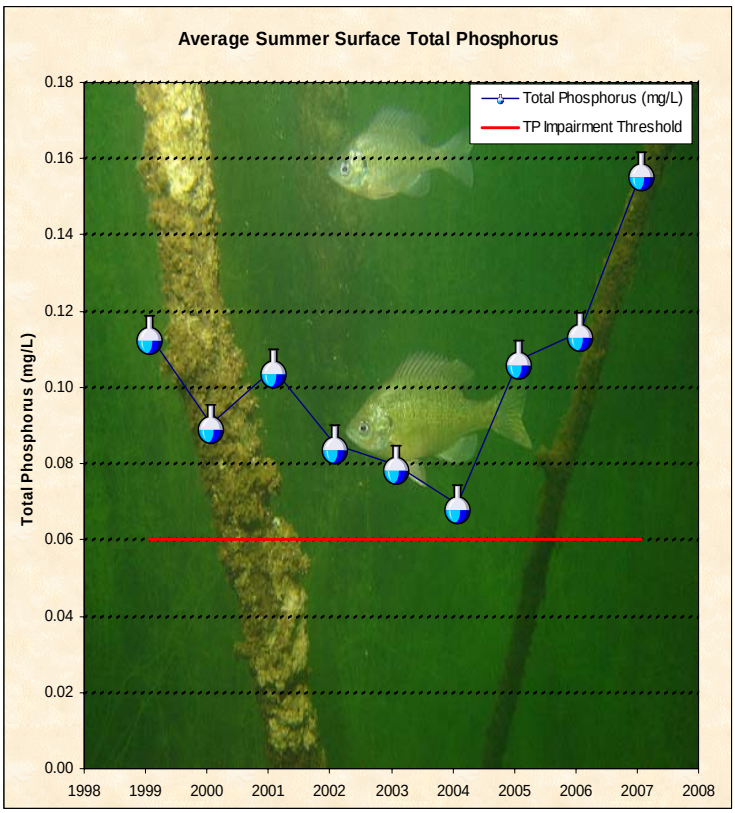
2007 Lake Grade: F

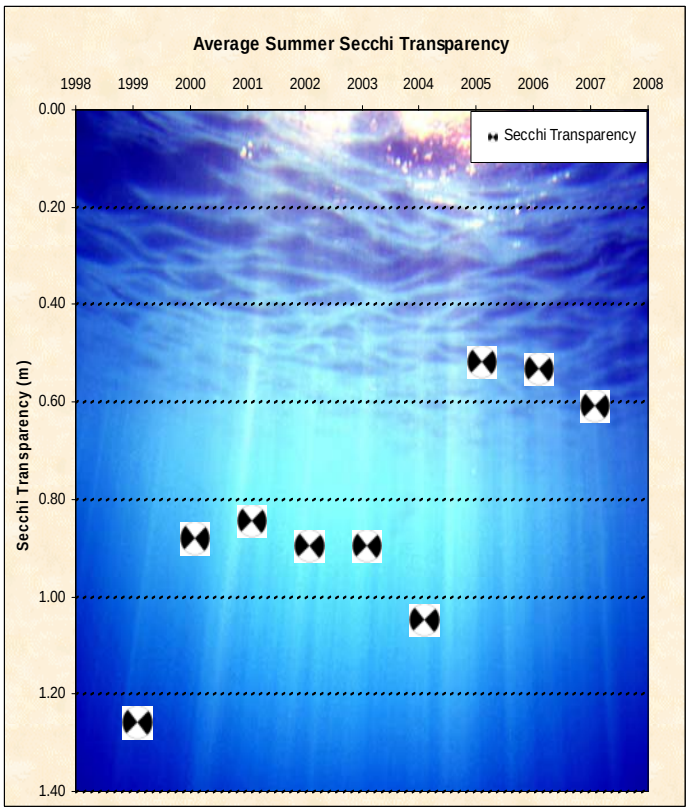
- DNR ID #: 820077
- Municipality: May Township
- Location: NW$^{1/4}$ Section 31, T31N-R20W
- Lake Size: 41 Acres
- Maximum Depth: 15 ft
- Ordinary High Water Mark: 966.50 ft
- 100-Year High Water Level: 972.20 ft
- 100% Littoral
  Note: Littoral area is the portion of the lake <15 ft and dominated by aquatic vegetation.



Summary Points

- Goggin's Lake was considered a hypereutrophic lake in 2007, 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 stratify with the thermocline varying between 2 to 4 meters.
- Goggin's Lake is listed as impaired on the Minnesota Pollution Control Agency's Impaired Waters List.





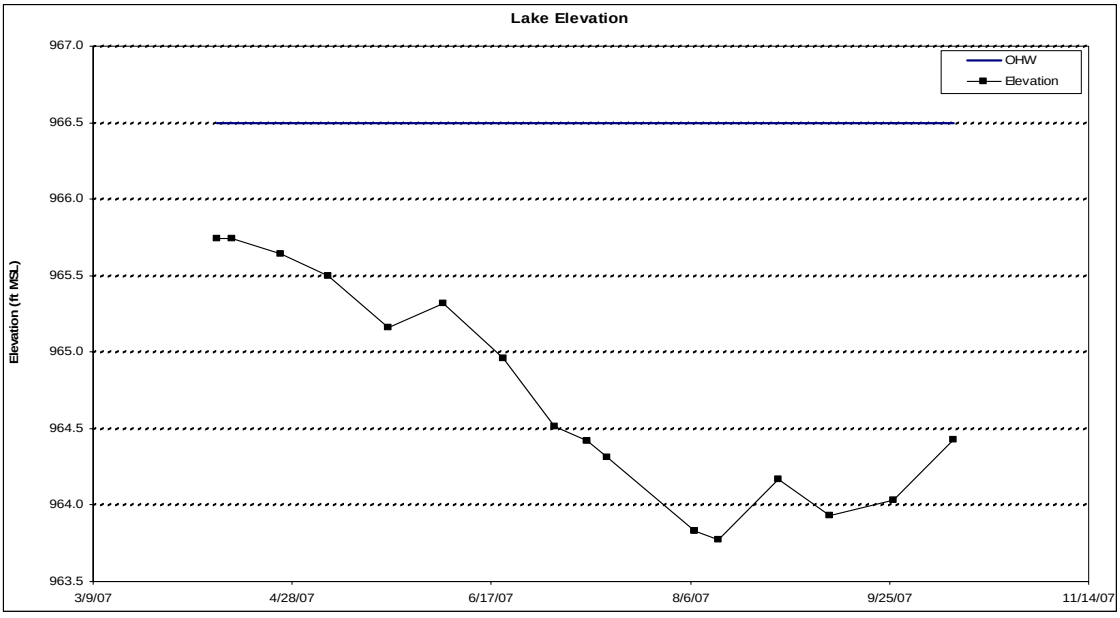
Date	Total Phosphorus (mg/L)	Chlorophyll-a (ug/L)	Total Kjeldahl Nitrogen (mg/L)	Secchi Disk Depths (m)	Surface Dissolved Oxygen Levels (mg/L)	Surface Temperature Levels (Celsius)
4/13/2007	0.054	14	1.60	1.83	12.99	4.6
4/25/2007	0.046	14	1.60	1.68	10.46	14.1
5/7/2007	0.070	40	1.70	1.22	11.93	15.5
5/22/2007	0.054	6	1.40	2.59	8.19	18.7
6/5/2007	0.061	11	1.50	2.13	6.07	21.9
6/20/2007	0.135	58	3.30	0.91	6.08	26.2
7/3/2007	0.105	63	3.70	0.61	7.06	26.4
7/16/2007	0.153	110	4.70	0.30	8.81	26.2
8/1/2007	0.183	110	3.80	0.30	8.45	29.7
8/13/2007	0.204	110	3.60	0.30	6.79	25.1
8/28/2007	0.221	140	3.80	0.30	6.99	23.9
9/10/2007	0.222	120	3.40	0.30	6.25	23.4
9/25/2007	0.126	70	2.70	0.30	8.19	22.0
10/11/2007	0.100	73	2.20	0.61	8.86	16.2
2007 Average	0.124	67	2.79	0.96	8.37	21.0
2007 Summer Average	0.157	88	3.39	0.61	7.19	25.0

Water quality threshold is at 0.04 mg/L TP or higher*

Shallow lake water quality threshold is 0.06 mg/L TP or higher*

	High	High Date	Low	Low Date	Average
2007 Elevation (ft)	965.74	4/9/2007	963.77	8/13/2007	964.65
	965.74	4/13/2007			

*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."



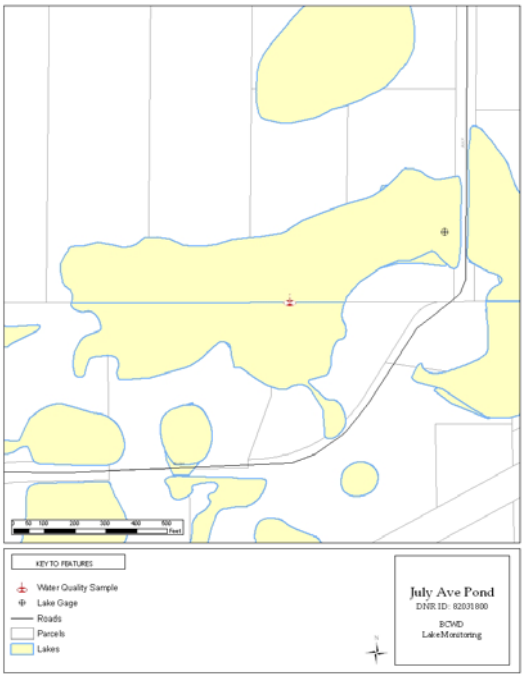
Lake Water Quality Summary

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

July Ave Pond

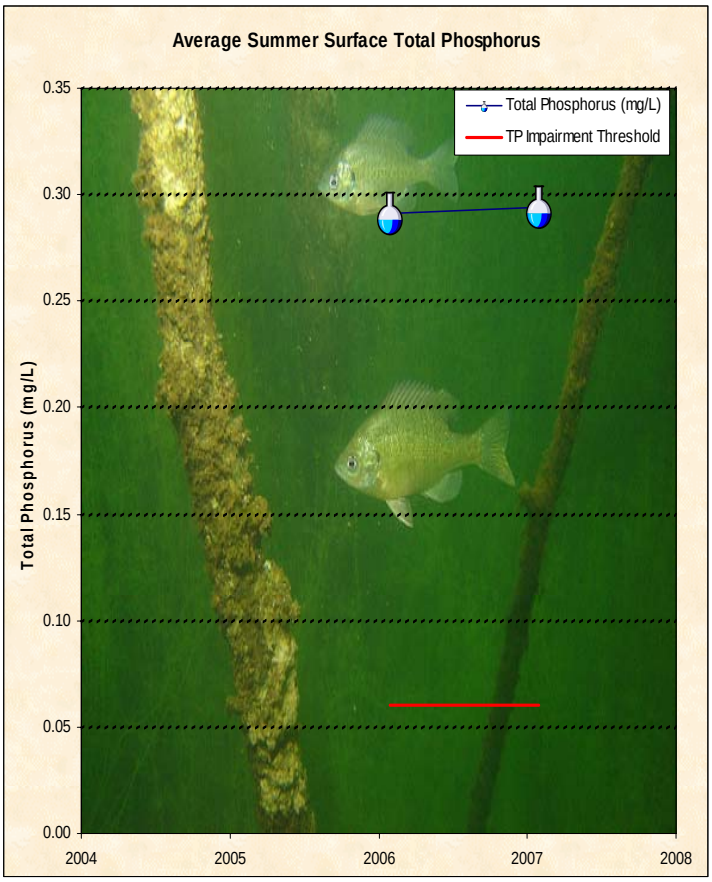
2007 Lake Grade: F

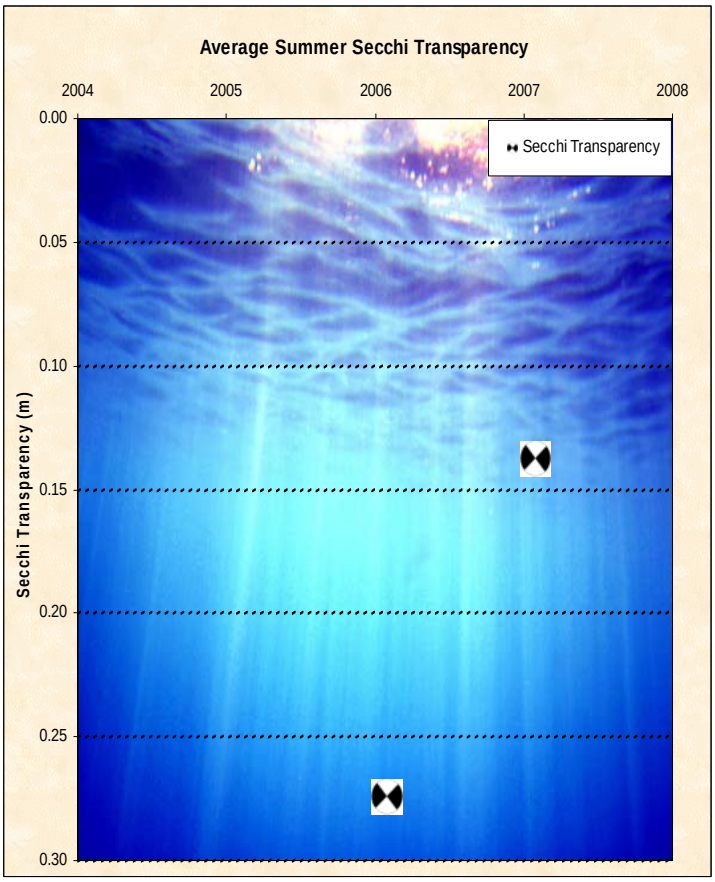
- DNR ID #: 820318
- Municipality: City of Grant
- Location: Section 23, T30N-R21W
- Lake Size: 121.9 Acres
- Maximum Depth: 7.50 ft
- Ordinary High Water Mark: NA
- 100-Year High Water Level: 979.20 ft
- 100% Littoral
  Note: Littoral area is the portion of the lake <15 ft and dominated by aquatic vegetation.



Summary Points

- July Ave Pond was considered a hypereutrophic lake in 2007, 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 2007.





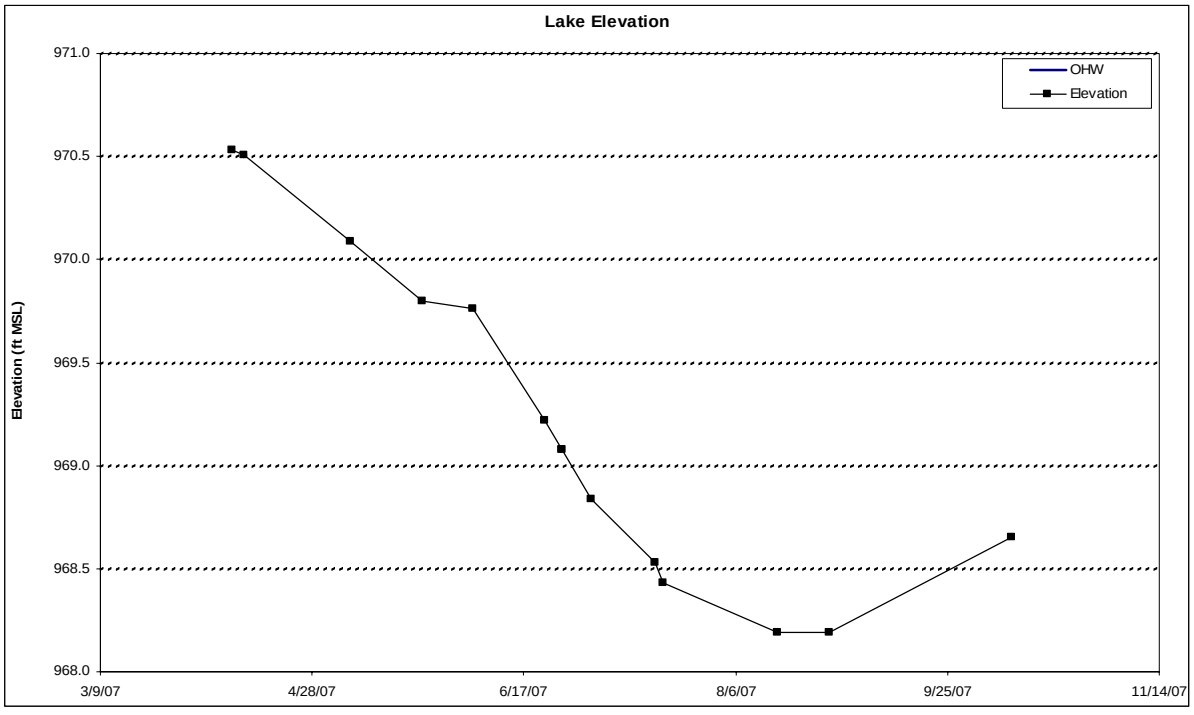
Date	Total Phosphorus (mg/L)	Chlorophyll-a (ug/L)	Total Kjeldahl Nitrogen (mg/L)	Secchi Disk Depths (m)	Surface Dissolved Oxygen Levels (mg/L)	Surface Temperature Levels (Celsius)
4/12/2007	0.210	140	3.10	0.46	14.59	6.0
5/7/2007	0.276	150	3.90	0.30	11.35	15.9
6/5/2007	0.273	350	5.00	0.15	7.13	21.7
7/3/2007	0.135	56	6.50	0.15	7.68	25.6
8/1/2007	0.387	770	22.00	0.15	11.72	30.4
8/28/2007	0.359	320	7.70	0.15	3.77	24.5
9/24/2007	0.317	690	5.80	0.08	9.16	23.7
2007 Average	0.280	354	7.71	0.21	9.34	21.1
2007 Summer Average	0.294	437	9.40	0.14	7.89	25.2

Water quality threshold is at 0.04 mg/L TP or higher*

Shallow lake water quality threshold is 0.06 mg/L TP or higher*

	High	High Date	Low	Low Date	Average
2007 Elevation (ft)	970.53	4/9/2007	968.19	8/16/2007	969.21
			968.19	8/28/2007	

*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."



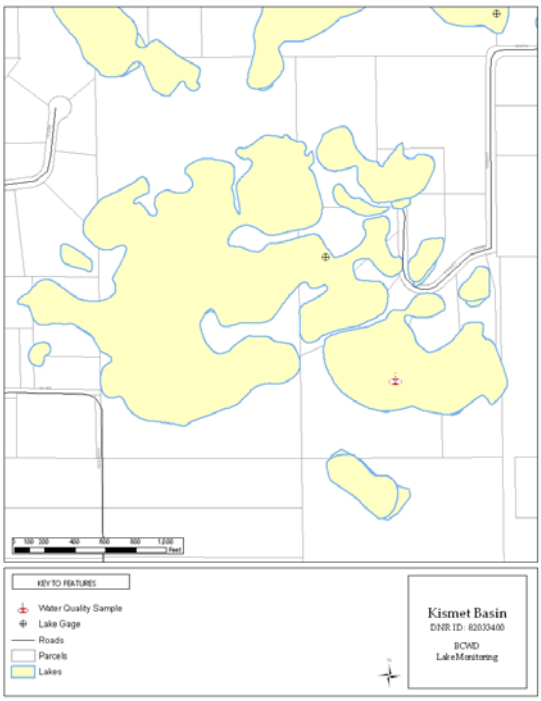
Lake Water Quality Summary

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

Kismet Basin

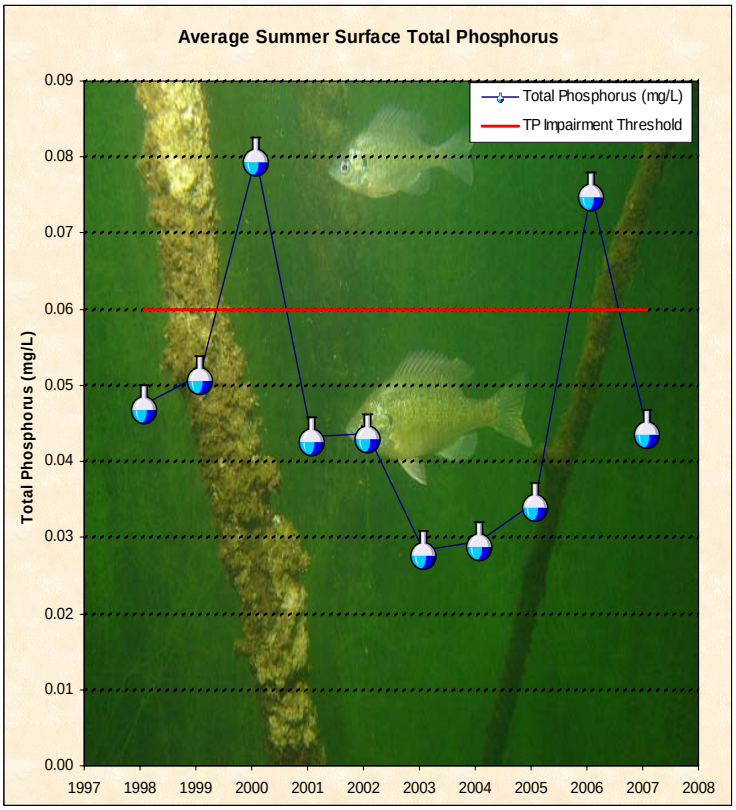
2007 Lake Grade: C

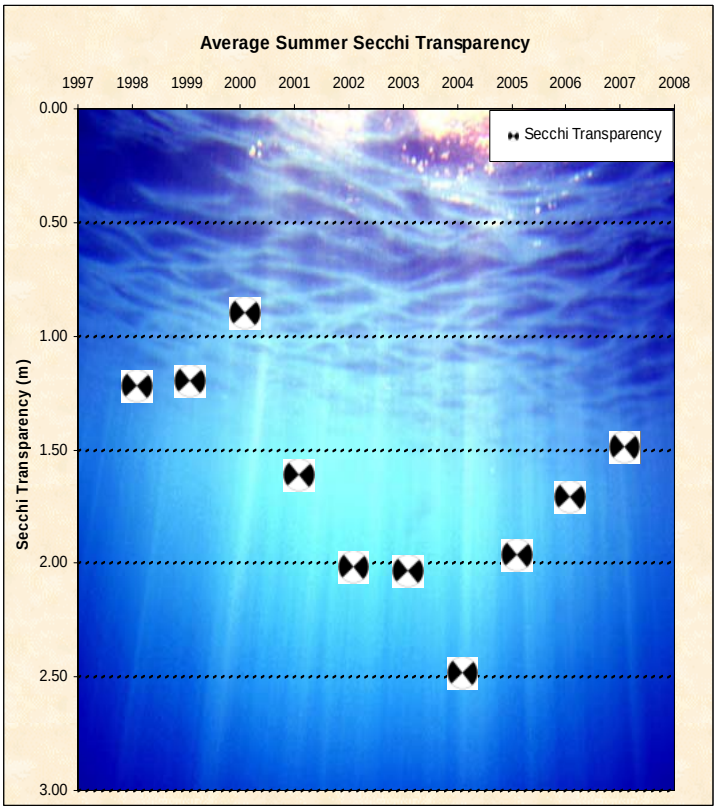
- DNR ID #: 820334
- Municipality: City of Grant
- Location: $S^{1/2}$ Section 11, T30N-R21W
- Lake Size: 23 Acres
- Maximum Depth: 12 ft
- Ordinary High Water Mark: 943.50 ft
- 100-Year High Water Level: 944.90 ft
- 100% Littoral
  Note: Littoral area is the portion of the lake <15 ft and dominated by aquatic vegetation.



Summary Points

- Kismet Basin was considered a eutrophic lake in 2007, based on the Carlson Trophic State Index.
- There is a statistically significant **improving 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 stratify with the thermocline varying between 1 to 2 meters.





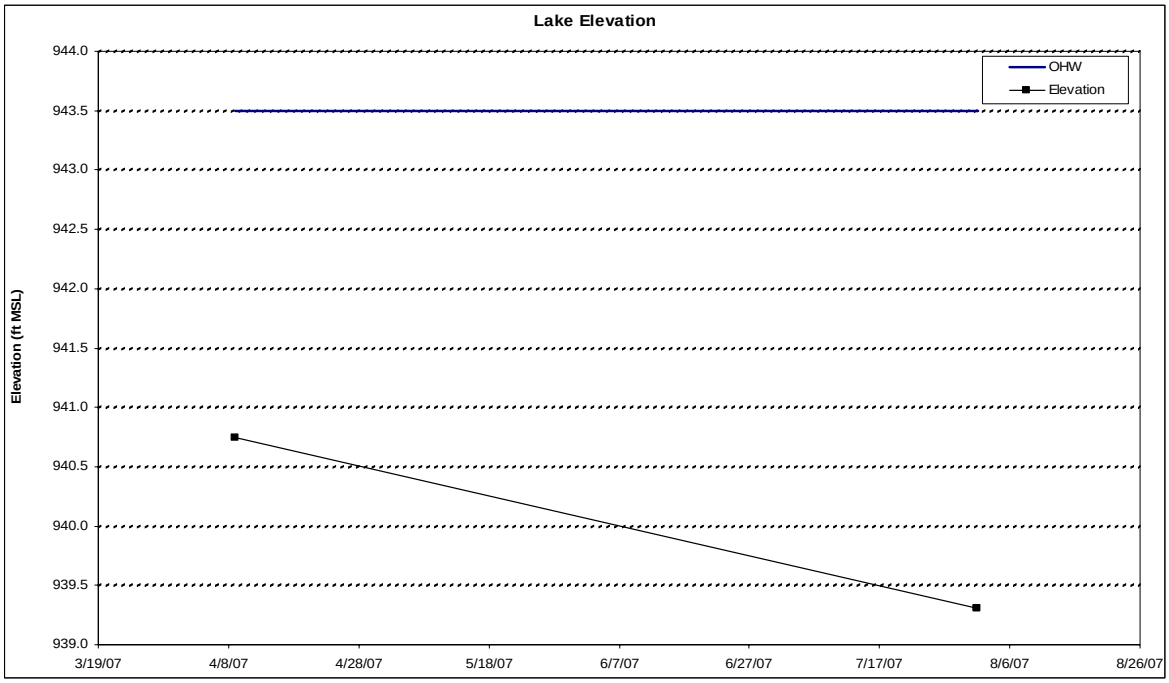
Date	Total Phosphorus (mg/L)	Chlorophyll-a (ug/L)	Total Kjeldahl Nitrogen (mg/L)	Total Chloride Ions (mg/L)	Secchi Disk Depths (m)	Surface Dissolved Oxygen Levels (mg/L)	Surface Temperature Levels (Celsius)
4/12/2007	0.018	4	0.42	5	1.83	13.28	6.0
4/25/2007	0.019	8	0.87	5	2.29	9.95	15.2
5/7/2007	0.023	5	0.75	5	1.52	11.05	16.2
5/22/2007	0.035	12	0.74	5	1.83	9.63	20.0
6/4/2007	NA	7	NA	4	1.83	9.34	24.1
6/18/2007	0.033	4	1.20	4	1.83	6.55	29.6
7/3/2007	0.014	5	0.67	5	1.22	7.99	27.4
7/17/2007	0.019	4	1.10	5	1.52	7.10	27.3
8/1/2007	0.076	110	1.50	5	1.98	7.60	31.9
8/13/2007	0.092	14	1.80	5	1.52	8.47	26.6
8/29/2007	0.033	9	0.71	5	1.52	7.70	24.9
9/10/2007	0.060	43	1.50	6	1.07	6.46	23.7
9/24/2007	0.027	6	0.82	5	0.91	9.75	23.0
10/11/2007	0.065	58	1.10	5	1.68	7.60	15.5
2007 Average	0.040	21	1.01	5	1.61	8.75	22.2
2007 Summer Average	0.044	23	1.16	5	1.49	7.88	26.5

Water quality threshold is at 0.04 mg/L TP or higher*

Shallow lake water quality threshold is 0.06 mg/L TP or higher*

	High	High Date	Low	Low Date	Average
2007 Elevation (ft)	940.75	4/9/2007	939.31	8/1/2007	939.79

*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."



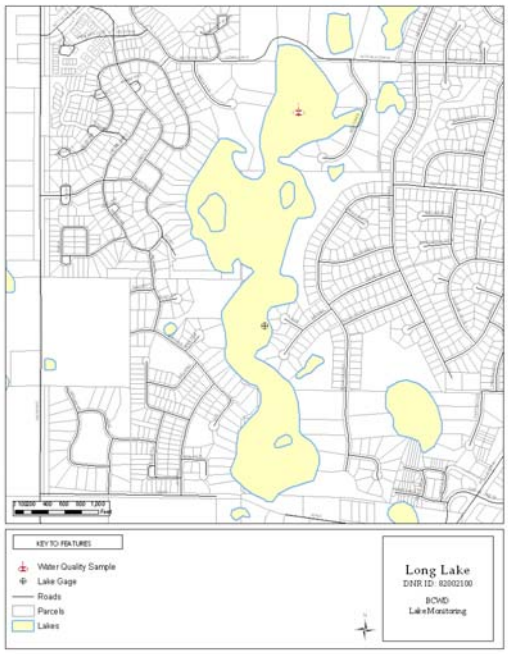
Lake Water Quality Summary

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

Long Lake

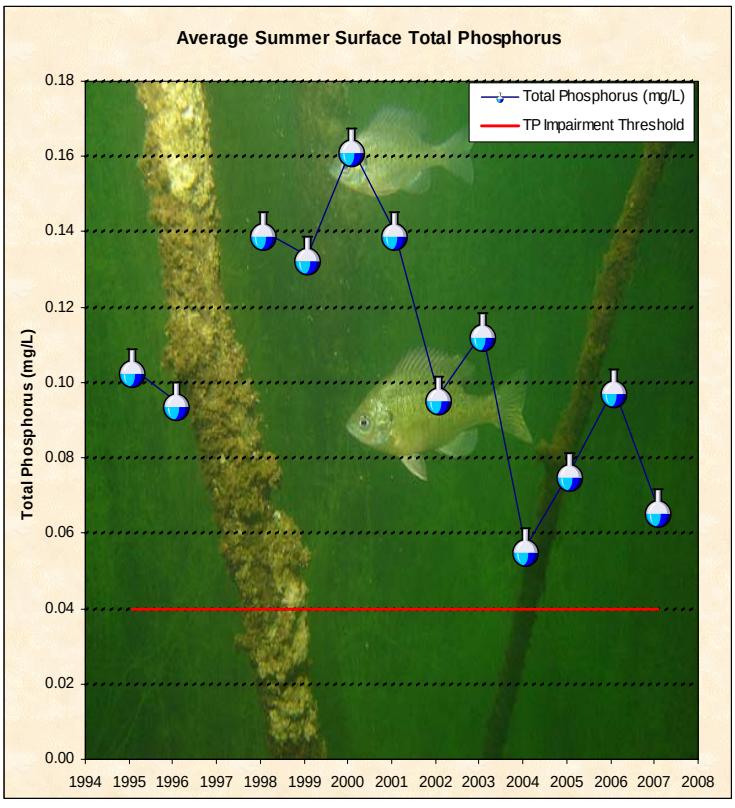
2007 Lake Grade: C-

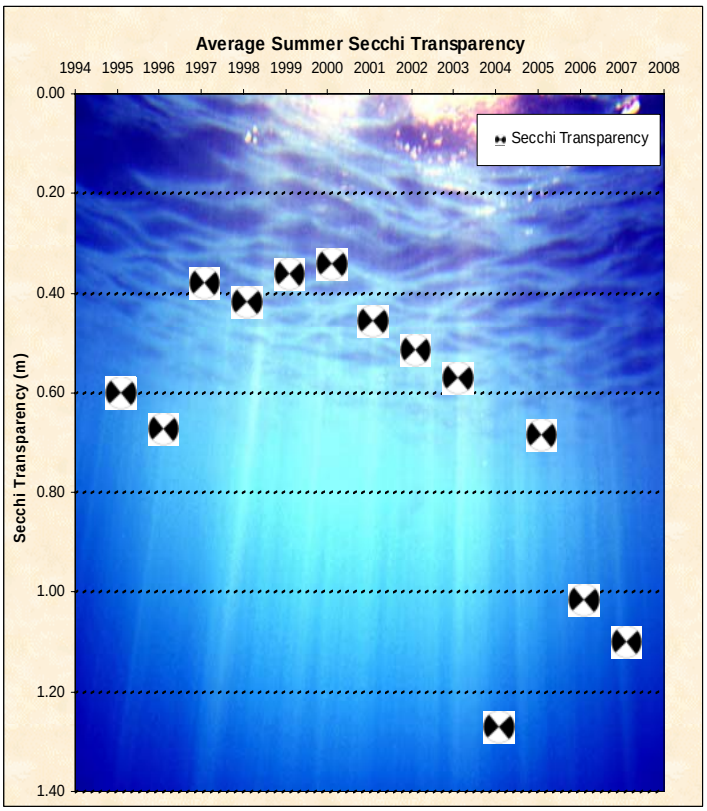
- DNR ID #: 820021
- Municipality: City of Stillwater
- Location: Section 31, T30N-R20W
- Lake Size: 110 Acres
- Maximum Depth: 22 ft
- Ordinary High Water Mark: 891.50 ft
- 100-Year High Water Level: 893.20 ft
- 95% Littoral
  Note: Littoral area is the portion of the lake <15 ft and dominated by aquatic vegetation.



Summary Points

- Long Lake was considered a eutrophic lake in 2007, based on the Carlson Trophic State Index.
- There is a statistically significant **improving trend** for both average Secchi transparency and average total phosphorus.
- The major land use is urban/residential.
- The lake did stratify with the thermocline varying between 1 to 2 meters.
- Long Lake is listed as impaired on the Minnesota Pollution Control Agency's Impaired Waters List.





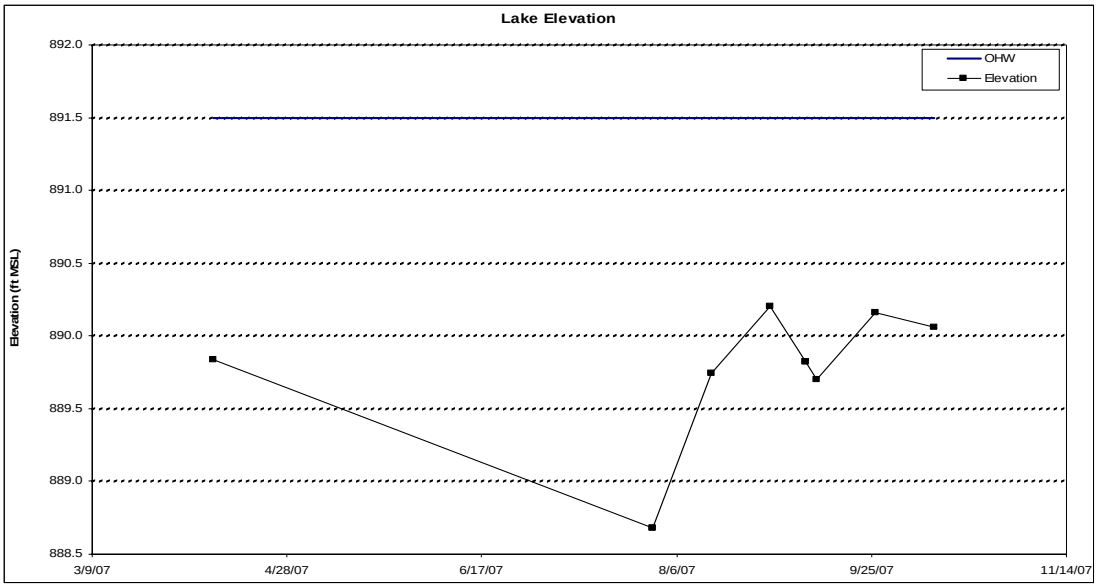
Date	Total Phosphorus (mg/L)	Chlorophyll-a (ug/L)	Total Kjeldahl Nitrogen (mg/L)	Secchi Disk Depths (m)	Surface Dissolved Oxygen Levels (mg/L)	Surface Temperature Levels (Celsius)
4/9/2007	0.062	10	1.70	1.83	12.20	6.8
4/25/2007	0.036	17	2.00	1.37	10.27	15.5
5/9/2007	0.041	13	1.70	1.52	10.92	19.8
5/23/2007	0.060	13	1.80	1.22	8.68	21.2
6/5/2007	0.047	13	1.90	1.68	8.64	24.1
6/20/2007	0.136	10	3.20	1.07	7.77	28.2
7/5/2007	0.066	29	2.60	1.07	7.82	27.8
7/16/2007	0.100	28	2.30	0.91	8.61	29.7
8/2/2007	0.045	24	3.40	0.91	7.15	30.3
8/15/2007	0.058	44	2.50	1.07	7.25	27.7
8/30/2007	0.045	30	2.40	1.07	8.49	24.7
9/11/2007	0.054	29	3.20	0.91	7.15	23.2
9/25/2007	0.049	29	2.20	1.22	8.59	22.4
10/11/2007	0.065	28	2.40	1.07	5.73	17.6
2007 Average	0.062	23	2.38	1.21	8.52	22.8
2007 Summer Average	0.067	26	2.63	1.10	7.94	26.5

Water quality threshold is at 0.04 mg/L TP or higher*

Shallow lake water quality threshold is 0.06 mg/L TP or higher*

	High	High Date	Low	Low Date	Average
2007 Elevation (ft)	890.20	8/30/2007	888.68	7/31/2007	889.67

*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."



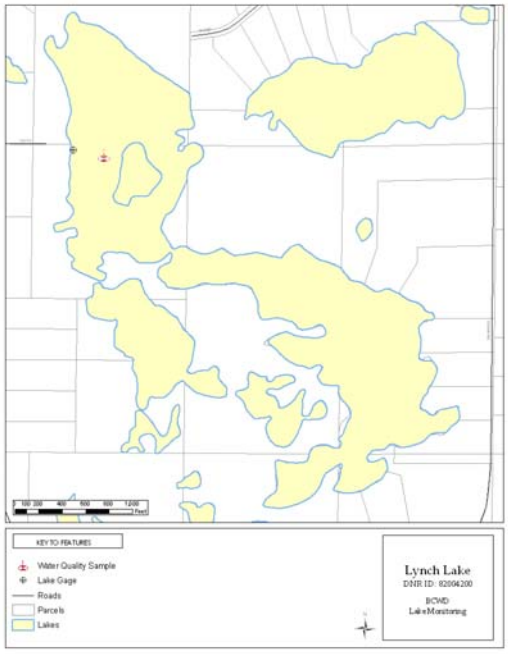
Lake Water Quality Summary

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

Lynch Lake

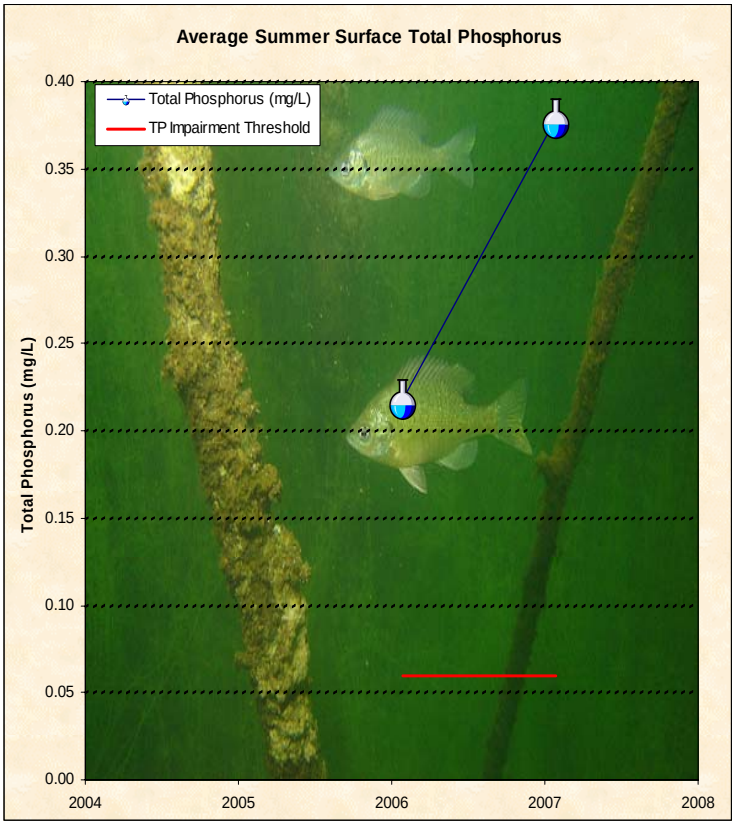
2007 Lake Grade: F

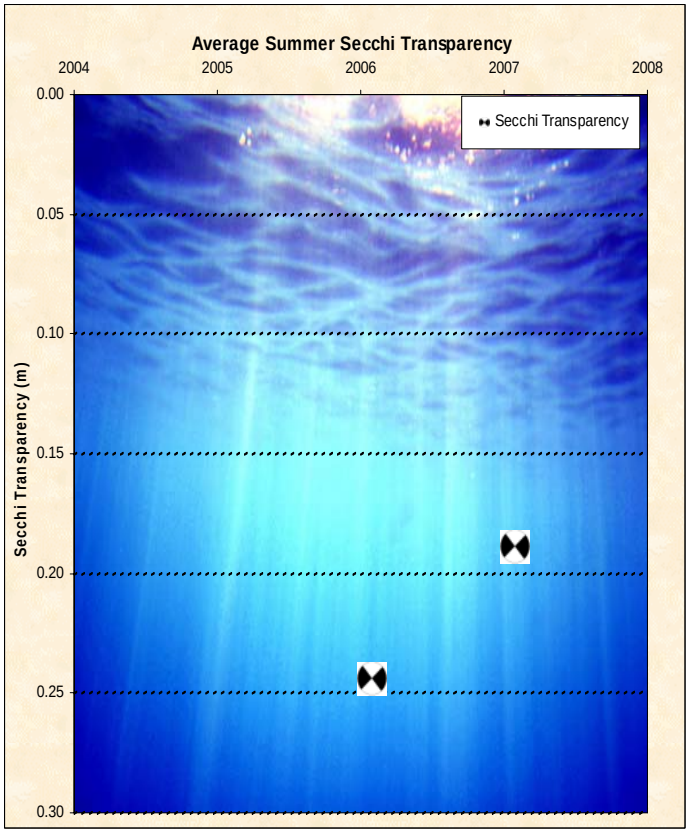
- DNR ID #: 820042
- Municipality: May Township
- Location: Section 29, T31N-R19W
- Lake Size: 941.4 Acres
- Maximum Depth: 6 ft
- Ordinary High Water Mark: 1005.30 ft
- 100-Year High Water Level: 1008.10 ft
- 100% Littoral
  Note: Littoral area is the portion of the lake <15 ft and dominated by aquatic vegetation.



Summary Points

- Lynch Lake was considered a hypereutrophic lake in 2007, 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 2007.





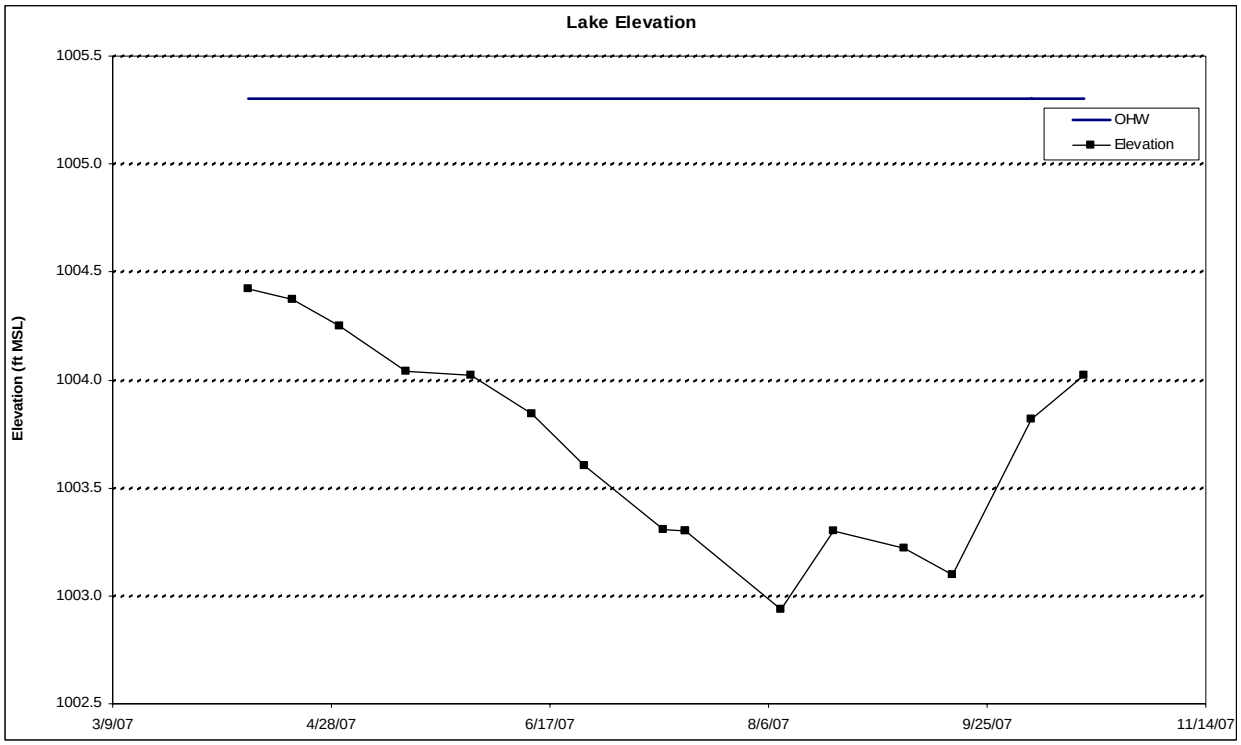
Date	Total Phosphorus (mg/L)	Chlorophyll-a (ug/L)	Total Kjeldahl Nitrogen (mg/L)	Secchi Disk Depths (m)	Surface Dissolved Oxygen Levels (mg/L)	Surface Temperature Levels (Celsius)
4/30/2007	NA	NA	NA	0.30	11.93	17.7
5/30/2007	0.372	290	6.40	0.30	10.35	23.4
6/25/2007	0.441	39	11.00	0.15	7.03	28.0
7/23/2007	0.380	630	20.00	0.18	8.99	25.7
8/21/2007	0.386	530	9.70	0.15	9.06	21.0
9/17/2007	0.315	330	12.00	0.15	8.01	18.9
10/17/2007	0.209	170	5.30	0.30	8.70	14.1
2007 Average	0.351	332	10.73	0.22	9.15	21.3
2007 Summer Average	0.379	364	11.82	0.19	8.69	23.4

Water quality threshold is at 0.04 mg/L TP or higher*

Shallow lake water quality threshold is 0.06 mg/L TP or higher*

	High	High Date	Low	Low Date	Average
2007 Elevation (ft)	1004.42	4/9/2007	1002.94	8/9/2007	1003.68

*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."



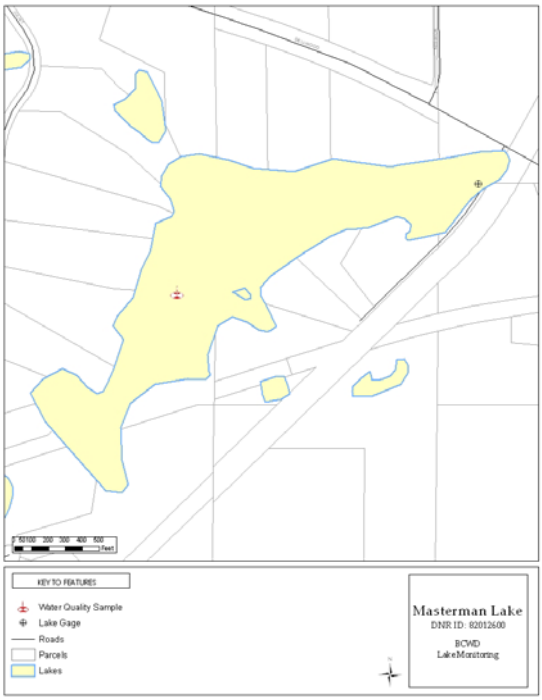
Lake Water Quality Summary

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

Masterman Lake

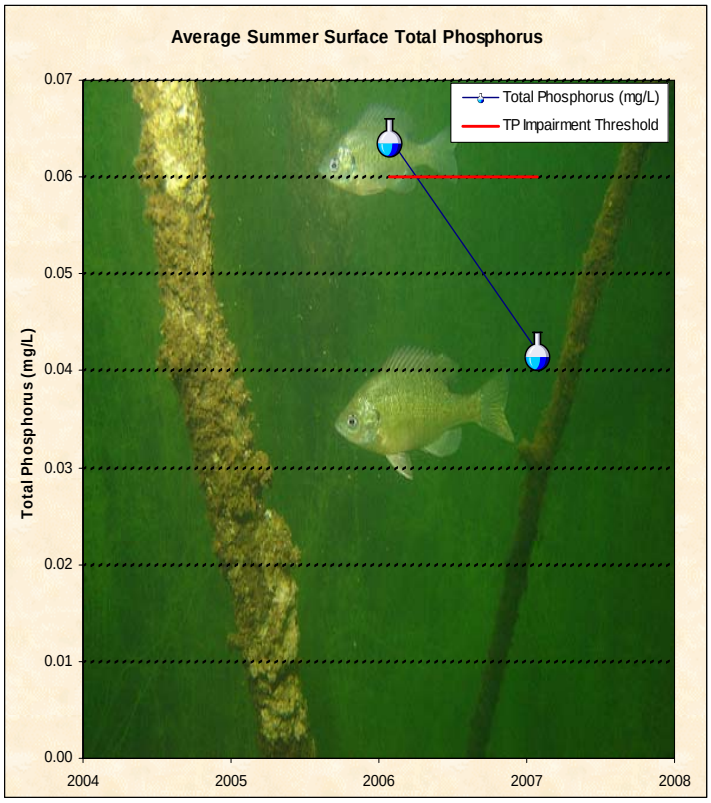
2007 Lake Grade: C+

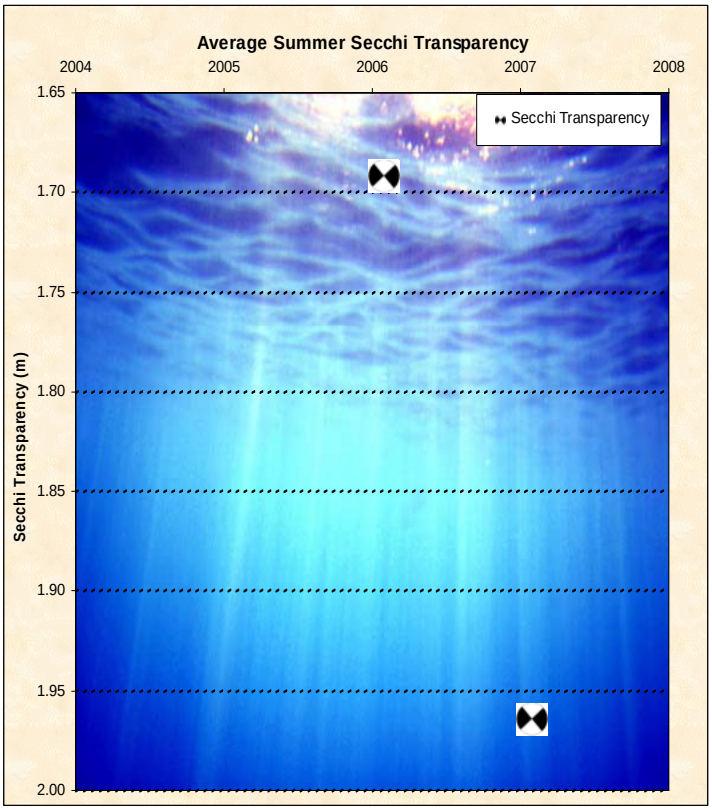
- DNR ID #: 820126
- Municipality: Township of Grant
- Location: Section 23, T30N-R21W
- Lake Size: 422.60 Acres
- Maximum Depth: 11 ft
- Ordinary High Water Mark: 955.70 ft
- 100-Year High Water Level: 955.90 ft
- 100% Littoral
  Note: Littoral area is the portion of the lake <15 ft and dominated by aquatic vegetation.



Summary Points

- Masterman Lake was considered a eutrophic lake in 2007, 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 at a depth of 2 meters.





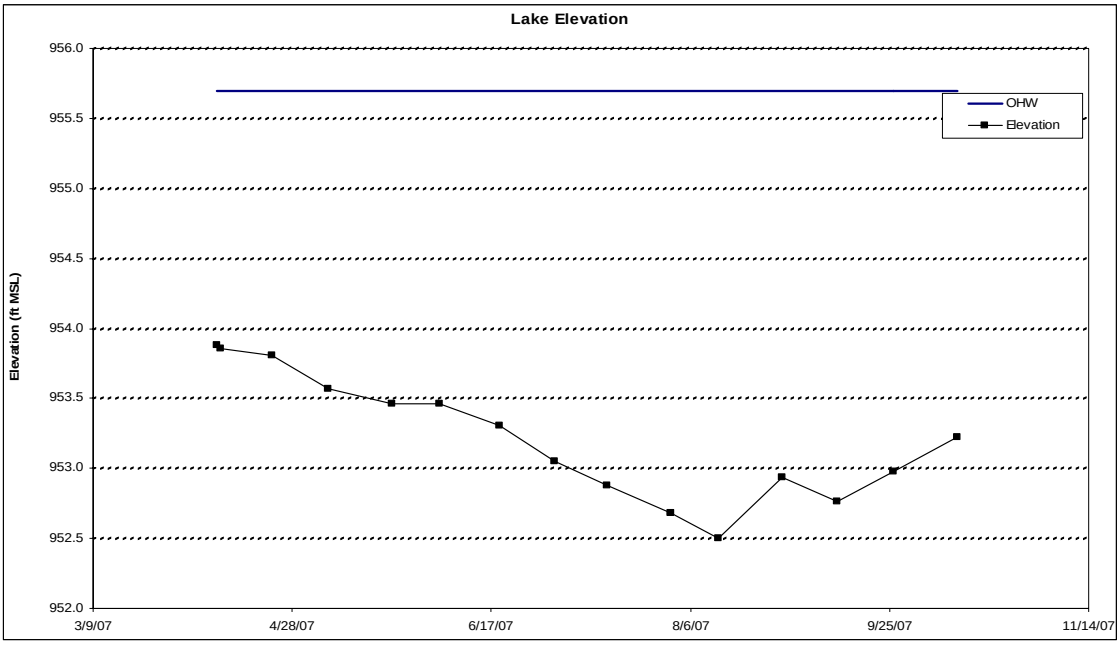
Date	Total Phosphorus (mg/L)	Chlorophyll-a (ug/L)	Total Kjeldahl Nitrogen (mg/L)	Secchi Disk Depths (m)	Surface Dissolved Oxygen Levels (mg/L)	Surface Temperature Levels (Celsius)
4/10/2007	0.028	5	0.76	2.74	14.13	5.6
4/23/2007	0.020	5	0.55	2.29	9.69	17.7
5/7/2007	0.014	5	0.65	2.59	10.91	16.4
5/23/2007	0.023	3	0.70	2.13	8.78	22.0
6/4/2007	0.028	3	0.79	2.44	9.43	24.3
6/19/2007	0.026	5	0.86	2.13	6.63	26.7
7/3/2007	0.054	17	0.97	1.83	7.28	28.1
7/16/2007	0.042	6	0.92	1.68	7.59	29.0
7/31/2007	0.074	27	1.50	1.83	7.17	32.2
8/13/2007	0.036	7	1.10	1.83	8.01	27.1
8/29/2007	0.039	21	0.91	2.44	6.95	26.0
9/12/2007	0.031	10	0.88	1.68	4.43	21.2
9/25/2007	0.048	50	1.20	1.83	7.72	22.8
10/12/2007	0.031	5	0.86	1.83	5.09	15.7
2007 Average	0.035	12	0.90	2.09	8.13	22.5
2007 Summer Average	0.042	16	1.01	1.96	7.25	26.4

Water quality threshold is at 0.04 mg/L TP or higher*

Shallow lake water quality threshold is 0.06 mg/L TP or higher*

	High	High Date	Low	Low Date	Average
2007 Elevation (ft)	953.88	4/9/2007	952.50	8/13/2007	953.19

*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."



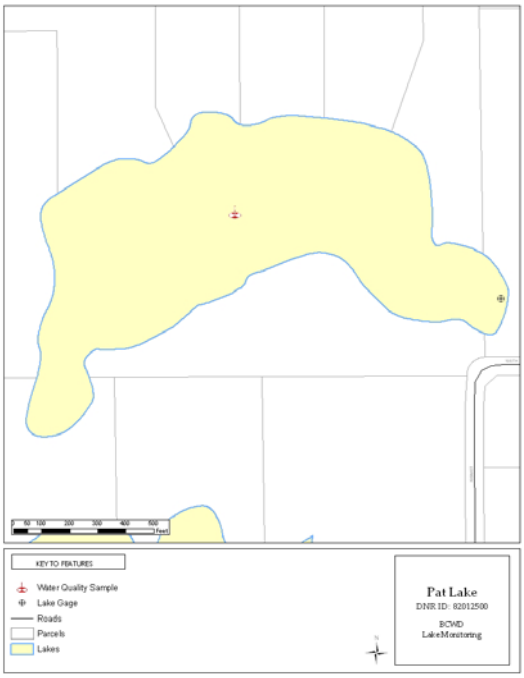
Lake Water Quality Summary

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

Pat Lake

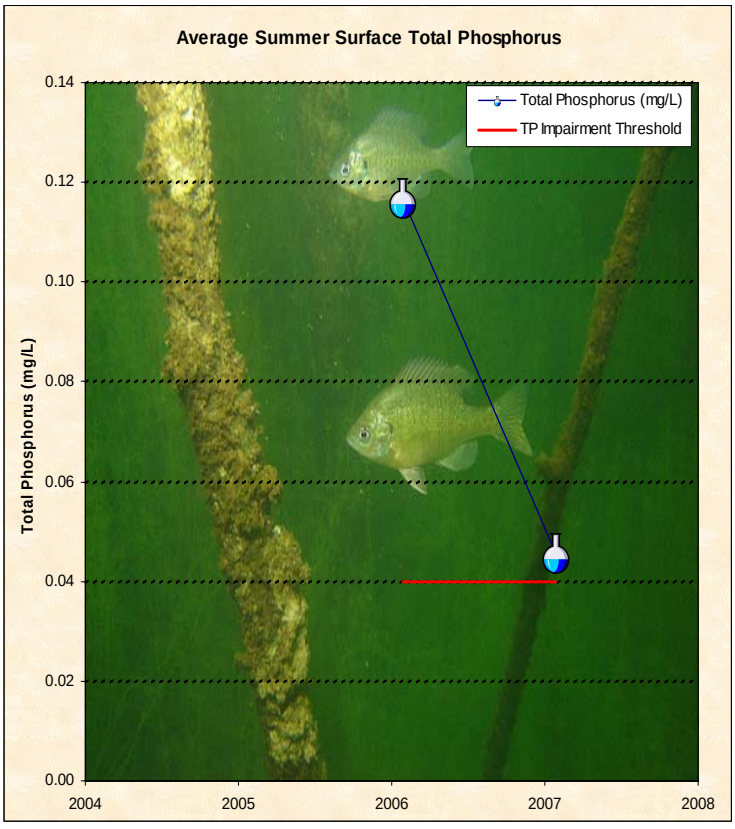
2007 Lake Grade: C+

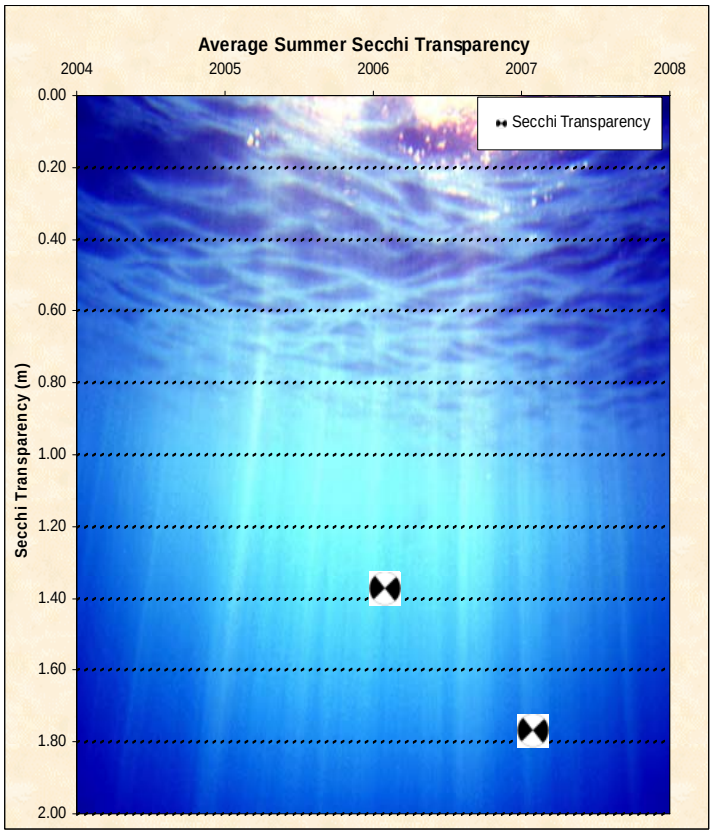
- DNR ID #: 820125
- Municipality: Township of Grant
- Location: Section 11, T30N-R21W
- Lake Size: 233 Acres
- Maximum Depth: 16 ft
- Ordinary High Water Mark: 941.80 ft
- 100-Year High Water Level: 949.10 ft
- % Littoral: NA
  Note: Littoral area is the portion of the lake <15 ft and dominated by aquatic vegetation.



Summary Points

- Pat Lake was considered a eutrophic lake in 2007, 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 at a depth of 2 meters.





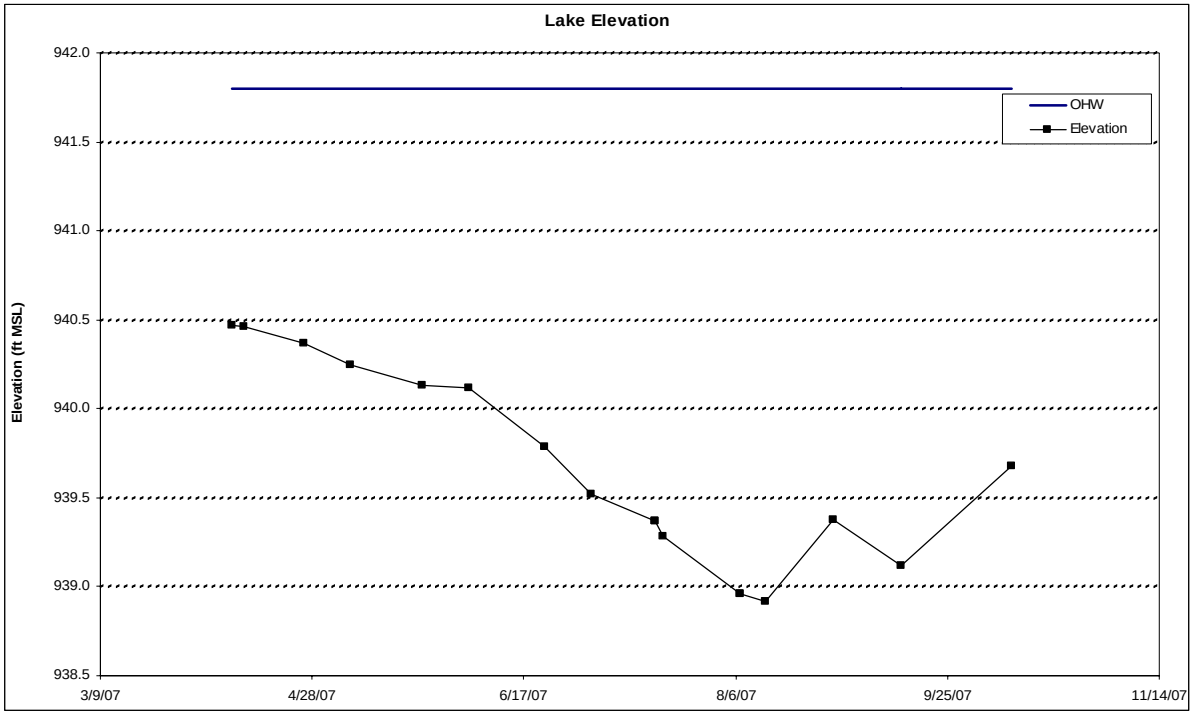
Date	Total Phosphorus (mg/L)	Chlorophyll-a (ug/L)	Total Kjeldahl Nitrogen (mg/L)	Secchi Disk Depths (m)	Surface Dissolved Oxygen Levels (mg/L)	Surface Temperature Levels (Celsius)
4/12/2007	0.031	18	0.70	1.68	13.31	5.9
5/7/2007	0.040	10	0.82	1.83	9.21	16.4
6/4/2007	0.070	11	0.94	1.83	9.17	24.3
7/3/2007	0.034	13	0.85	1.52	6.92	27.4
8/1/2007	0.032	4	0.94	2.13	8.89	31.9
8/29/2007	0.046	9	0.92	1.52	7.18	25.4
9/24/2007	0.046	10	0.92	1.83	8.69	23.4
2007 Average	0.043	11	0.87	1.76	9.05	22.1
2007 Summer Average	0.046	9	0.91	1.77	8.17	26.5

Water quality threshold is at 0.04 mg/L TP or higher*

Shallow lake water quality threshold is 0.06 mg/L TP or higher*

	High	High Date	Low	Low Date	Average
2007 Elevation (ft)	940.47	4/9/2007	938.92	8/13/2007	939.66

*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."



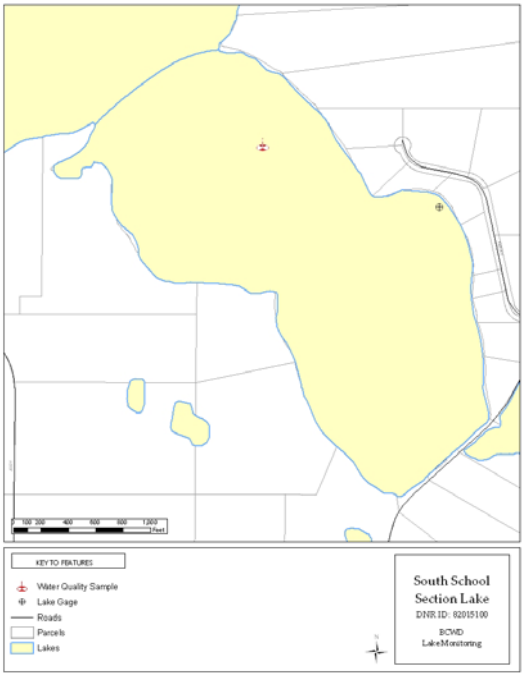
Lake Water Quality Summary

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

South School Section Lake

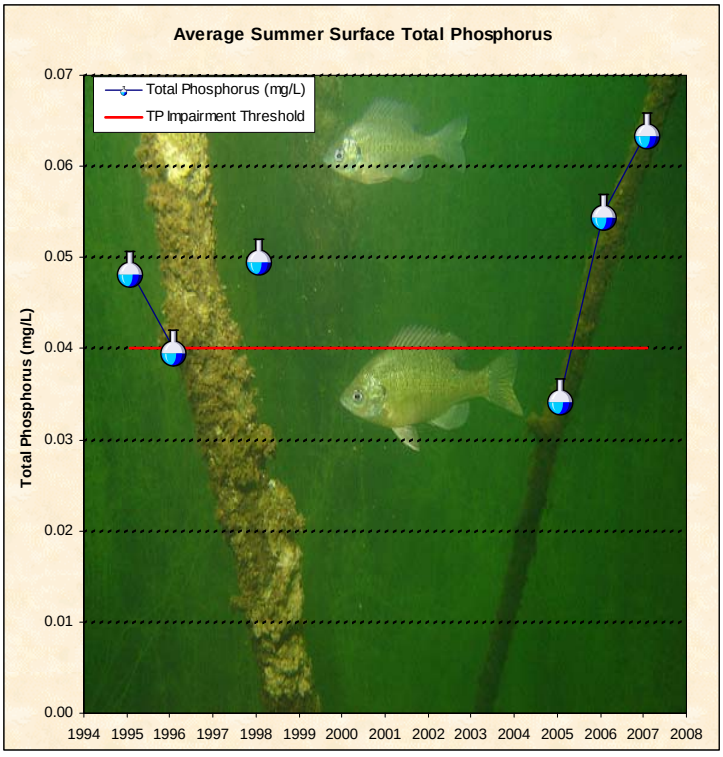
2007 Lake Grade: D+

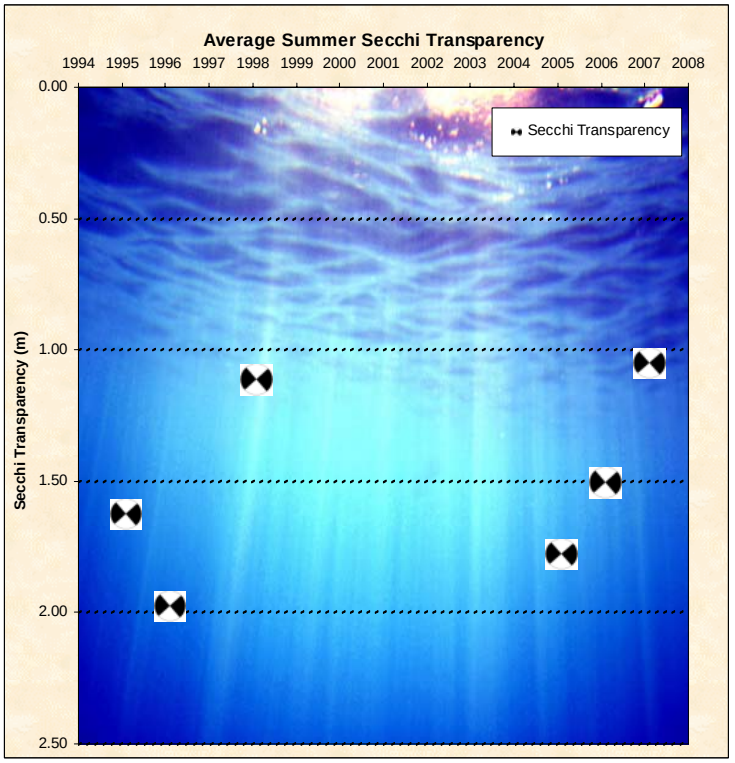
- DNR ID #: 820151
- Municipality: City of Hugo
- Location: S ½ Section 25, T31N-R21W
- Lake Size: 124 Acres
- Maximum Depth: 26 ft
- Ordinary High Water Mark: 965.30 ft
- 100-Year High Water Level: 972.20 ft
- 41% Littoral
  Note: Littoral area is the portion of the lake <15 ft and dominated by aquatic vegetation.



Summary Points

- South School Section Lake was considered a hypereutrophic lake in 2007, 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 3 to 6 meters.
- South School Section Lake is listed as impaired on the Minnesota Pollution Control Agency's Impaired Waters List.





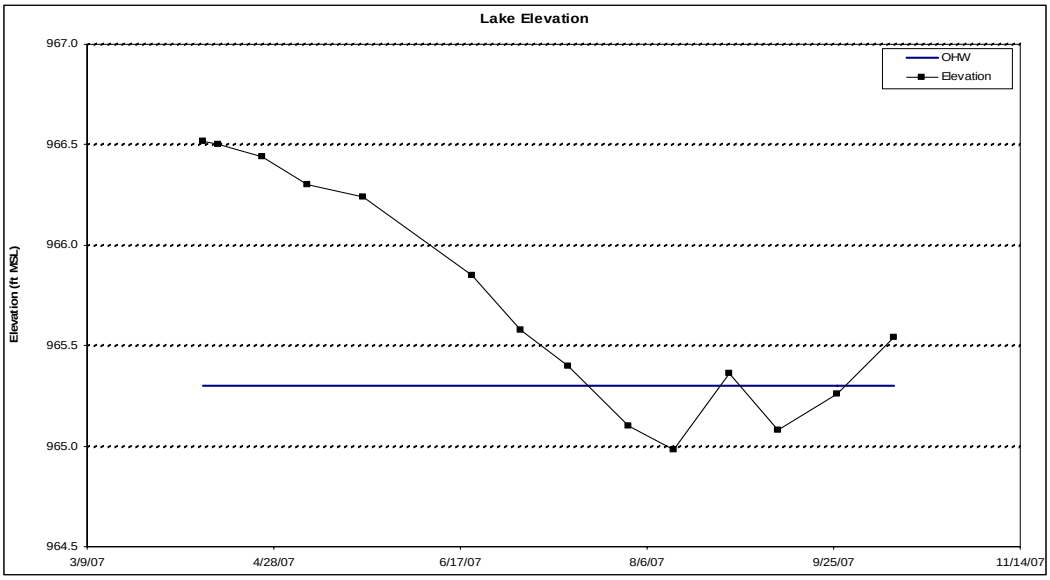
Date	Total Phosphorus (mg/L)	Chlorophyll-a (ug/L)	Total Kjeldahl Nitrogen (mg/L)	Secchi Disk Depths (m)	Surface Dissolved Oxygen Levels (mg/L)	Surface Temperature Levels (Celsius)
4/13/2007	0.026	6	0.90	2.74	13.20	4.1
4/25/2007	0.017	5	0.85	3.81	10.91	12.6
5/7/2007	0.029	6	0.75	3.51	11.32	15.7
5/22/2007	0.034	8	1.00	3.51	9.10	18.8
6/5/2007	0.035	15	0.88	2.29	8.53	22.1
6/20/2007	0.045	14	1.40	1.22	6.39	26.1
7/3/2007	0.054	54	1.40	0.91	6.95	26.5
7/16/2007	0.084	83	1.70	0.76	8.61	26.2
8/1/2007	0.073	49	2.00	0.76	8.59	30.2
8/13/2007	0.075	58	1.70	0.76	7.26	25.5
8/28/2007	0.088	68	1.90	0.76	7.24	24.1
9/10/2007	0.069	48	1.80	1.07	6.25	24.5
9/25/2007	0.052	51	1.70	0.91	8.02	21.5
10/11/2007	0.043	33	1.40	0.76	7.58	17.2
2007 Average	0.052	36	1.38	1.70	8.57	21.1
2007 Summer Average	0.064	49	1.61	1.05	7.54	25.2

Water quality threshold is at 0.04 mg/L TP or higher*

Shallow lake water quality threshold is 0.06 mg/L TP or higher*

	High	High Date	Low	Low Date	Average
2007 Elevation (ft)	966.52	4/9/2007	964.98	8/13/2007	965.73

*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."



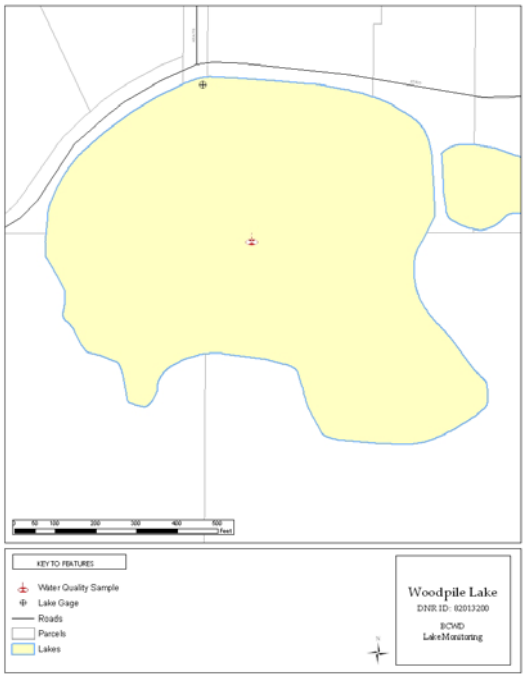
Lake Water Quality Summary

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

Woodpile Lake

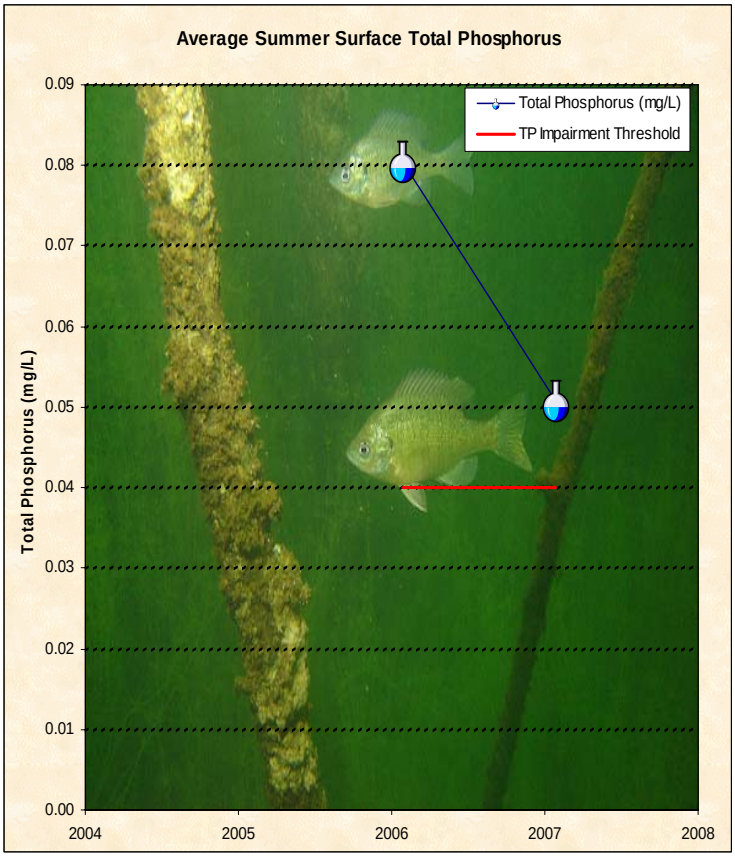
2007 Lake Grade: B-

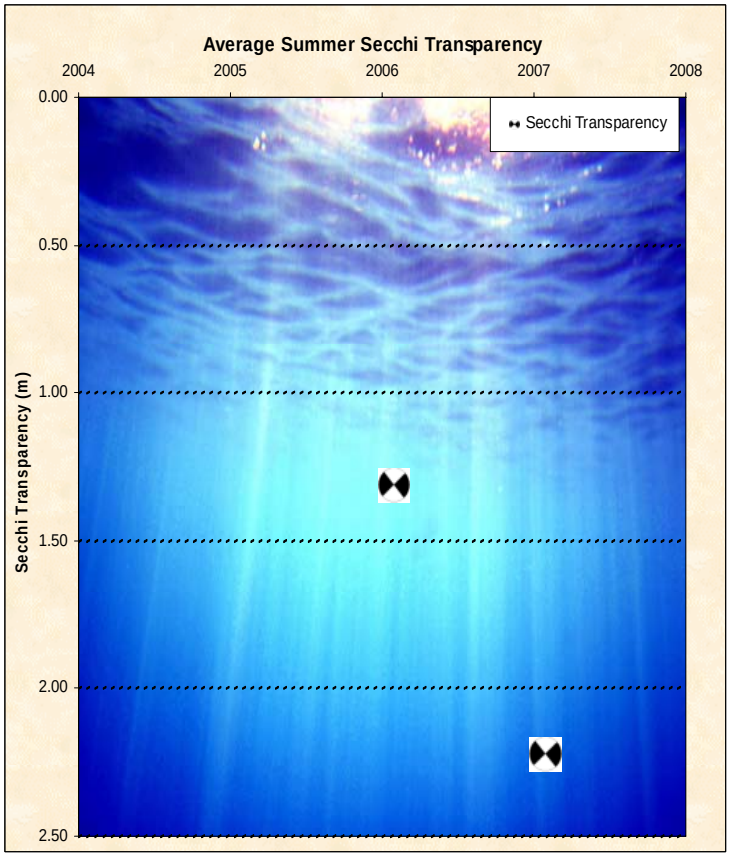
- DNR ID #: 820132
- Municipality: City of Grant
- Location: Section 23, T30N-R21W
- Lake Size: 166.40 Acres
- Maximum Depth: 27 ft
- Ordinary High Water Mark: 968.50 ft
- 100-Year High Water Level: 971.00 ft
- 8% Littoral
  Note: Littoral area is the portion of the lake <15 ft and dominated by aquatic vegetation.



Summary Points

- Woodpile Lake was considered a eutrophic lake in 2007, 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 3 to 7 meters.





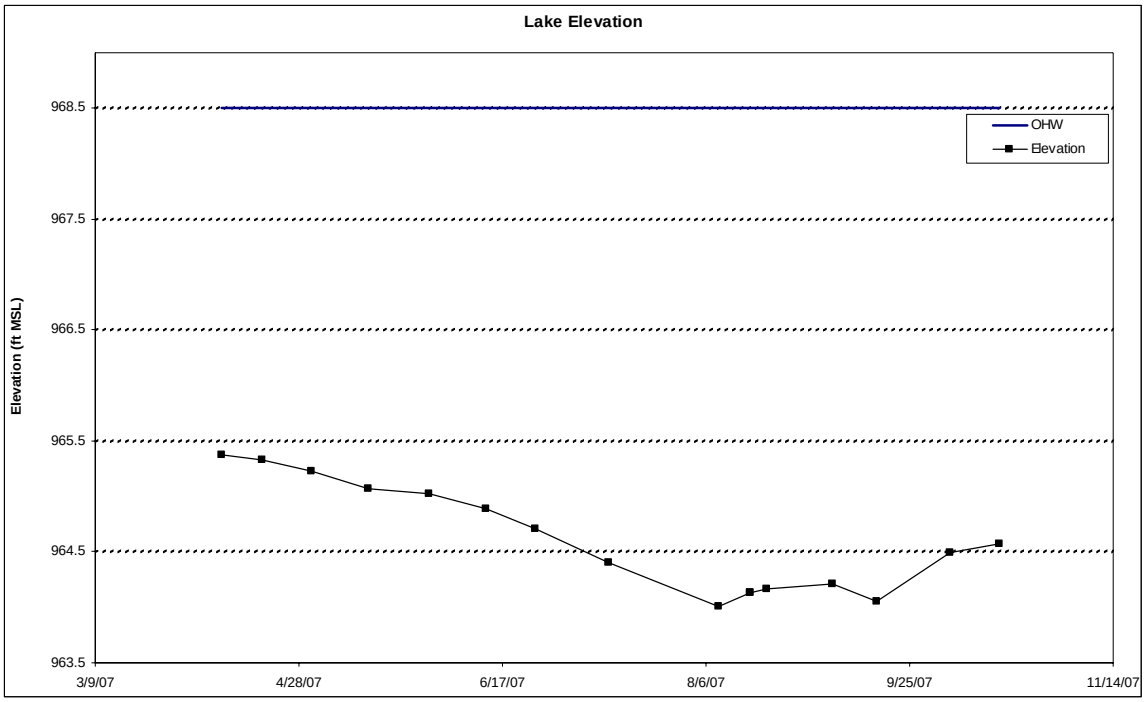
Date	Total Phosphorus (mg/L)	Chlorophyll-a (ug/L)	Total Kjeldahl Nitrogen (mg/L)	Secchi Disk Depths (m)	Surface Dissolved Oxygen Levels (mg/L)	Surface Temperature Levels (Celsius)
5/1/2007	0.048	6	1.10	2.29	10.50	17.1
5/30/2007	0.041	10	1.10	2.29	10.01	23.2
6/25/2007	0.039	11	1.00	2.13	9.40	29.6
7/23/2007	0.054	13	1.20	1.68	5.82	27.0
8/21/2007	0.062	10	1.20	2.59	5.29	23.0
9/17/2007	0.058	14	1.20	2.44	8.24	20.7
10/17/2007	0.046	11	1.10	2.13	5.36	15.2
2007 Average	0.050	11	1.13	2.22	7.80	22.3
2007 Summer Average	0.051	12	1.14	2.23	7.75	24.7

Water quality threshold is at 0.04 mg/L TP or higher*

Shallow lake water quality threshold is 0.06 mg/L TP or higher*

	High	High Date	Low	Low Date	Average
2007 Elevation (ft)	965.37	4/9/2007	964.01	8/9/2007	964.61

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