2006 WATER MONITORING REPORT

May 2007

Prepared for:

BROWN'S CREEK
WATERSHED DISTRICT

Prepared By:

WASHINGTON CONSERVATION DISTRICT

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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 2000-2006 and previous monitoring seasons. In 2006, Brown's Creek Watershed District (BCWD) added seven lakes and one stream site to be monitored; Masterman Lake, Bass Lake West (82-0123), Bass Lake East (82-0124), Lynch Lake, July Avenue Wetland, Wood Pile Lake, and Pat Lake and a stream site at the Brown's Creek Diversion Structure Drainage to McKusick Lake. In addition to these sites, BCWD continued to monitor Goggin's Lake, Kismet Basin, and Long Lake, South School Section Lake, and Benz Lake and Brown's Creek stream sites at Highway 15, McKusick Road and Highway 96, and Long Lake drainage sites 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 2006, the 12 lakes monitored had good to very poor water quality ratings and were classified as mesotrophic (Bass Lake West), eutrophic (Kismet, South School Section, Bass East, Long, Masterman, Pat, and Wood Pile) and hypereutrophic (Benz, Goggin's, July Avenue Wetland, and Lynch). The overall 2006 lake grades for BCWD lakes were: Bass Lake West – A-, Bass Lake East -- C, Wood Pile Lake – C, South School Section Lake -- C, Masterman Lake – C-, Pat Lake – C-, Kismet Basin – C-, Goggin's Lake -- D, Long Lake -- D+, and Benz Lake – F+, July Avenue Wetland -- F, Lynch Lake -- F. Of the lakes with historical data available (Long, South School Section, Googin's, Kismet, and Benz), one lake showed a slight deterioration in water quality for the 2006 season (Kismet Basin), two lakes maintained their water quality (Goggin's and South School Section), and two lakes improved in water quality (Benz and Long). Goggin's, Long, and Benz Lakes were considered worse than the ecoregion range for total phosphorus, total Kjeldahl nitrogen, chlorophyll-*a,* and Secchi disk transparency. Kismet Basin and South School Section Lake were within the ecoregion range for total phosphorus, total Kjeldahl

nitrogen, chlorophyll-*a,* and Secchi disk transparency. The Minnesota Pollution Control Agency monitors statistically significant trends in water quality throughout the state.

In 2006, BCWD added one stream monitoring station to its existing network of stream monitoring sites. The new station was installed to measure discharge and water quality from Long Lake and portions of the City of Stillwater at the Brown's Creek Diversion Structure. BCWD continued monitoring stream/stormwater sites at: Brown's Creek at the mouth (Hwy 96), Brown's Creek at McKusick Road, and Brown's Creek Hwy 15, Long Lake inlet at 62nd St., Long Lake inlet at Marketplace Pond (Figure 1).

Of the stream/stormwater sites monitored in BCWD, all sites with historical data (Brown's Creek at Hwy 15, McKusick Road, and at the mouth) showed decreased total discharges in 2006 compared to 2005 (Figure 9 and Figure 10). Of these three sites, all showed reductions in total loads of TSS during the 2006 season compared to 2005 as well (Figure 10). Brown's Creek at McKusick Road and at the mouth showed reduced TP loads in 2006 compared to 2005, but Hwy 15 showed an increase in TP load compared to 2005 (Figure 9). This increase in total load may be due to warm temperatures and low precipitation conditions in 2006 leading to release of nutrients from the wetland complexes upstream of the Hwy 15 site when the sediments and organic material became anoxic (lacking in oxygen).

Temperatures in Brown's Creek in 2006 displayed some interesting results when looking at thermal impacts. Brown's Creek at the mouth's minimum daily temperature showed no temperature exceedance above 20° C (Figure 30), which is the temperature threshold where low impacts to trout survival are observed. Surprisingly, the Hwy 15 site recorded no daily minimum temperatures above 20° C either (Figure 28). The McKusick Road site was the only site in 2006 on Brown's Creek to record any daily minimum temperatures that were in the low impact range (Figure 29). One important and equally interesting note is that although the Hwy 15 site recorded no daily minimum temperatures above 20° C, the sites daily maximum temperatures were warmer than any other site on Brown's Creek. 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 Hwy 15. 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 indicate that there is little difference in daily average temperature between these two sites, but between 0° C and 2° C temperature difference between these two sites and the daily average temperature at the mouth (Figure 32 and Figure 33). Another interesting find in 2006, was that the Brown's Creek Diversion Structure Drainage daily temperature was cooler than both the Hwy 15 site and the McKusick Road site (Figure 41 through Figure 44).

No fisheries surveys were conducted in 2006, but annual fish stocking occurred as it usually does. In 2006, 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.

Brown's Creek was monitored in four locations in 2006 by volunteers at sites W3, W4, and W8, and by the Washington Conservation District at Hwy 15 (Figure 1). Family biotic values (FBI) summarize the various pollution tolerance values of all macroinvertebrate families in a sample; each macroinvertebrate family has a unique pollution tolerance associated with it. FBI values range from 0 to 10, with lower values reflecting higher water quality. Based on 2006 family biotic index (FBI) values, site W3 had fair water quality in the spring and very good water quality in the fall, W4 had good water quality in the spring and excellent water quality in the fall, W8 had fair water quality in the spring and excellent water quality in the fall, and Hwy 15 had good water quality in both spring and fall. The EPT represents the number of mayfly (Ephemeroptera), stonefly (Plecoptera), and caddisfly (Trichoptera) families in each sample. These families represent the pollution intolerant macroinvertebrates. A higher EPT score reflects better water quality than a lower one. In 2006, W3, W4, and W8 had a similar EPT value compared to previous years, and Hwy 15 had a lower EPT value in the spring, but recovered in the fall with the highest EPT value recorded.

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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 2000-2006 and previous monitoring seasons. In 2006, Brown's Creek Watershed District (BCWD) added seven lakes and one stream site to be monitored: Bass Lake (East), Bass Lake (West), July Avenue Wetland, Lynch, Lake, Masterman Lake, Pat Lake, Woodpile Lake and a stream site at the Brown's Creek Diversion Drainage from Long Lake. In addition to these sites, BCWD continued to monitor Goggin's Lake, Kismet Basin, Long Lake, South School Section Lake, Benz Lake and stream sites at Hwy 15, McKusick Road, Highway 96, Long Lake Inlet at 62nd St., and Long Lake Inlet at Marketplace Pond (Figure 1). Multiple parameters were monitored at each site. Also included in this report are historical temperature data for Brown's Creek analyzed by the Minnesota Department of Natural Resources and macroinvertebrate data collected by both the WCD at the Brown's Creek at Hwy 15 site and volunteer stream monitors at numerous other locations on Brown's Creek. The purpose of this monitoring 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.

The work plan for 2006 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 Woodpile Lake from April through October, and water elevation readings on sixteen water bodies. Three continuous monitoring stations were installed on Brown's Creek at Highway 15, McKusick Road, and at Highway 96 from March through November, 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 2006. The WCD performed the sampling for

the BCWD. Metropolitan Council Environmental Services Lab performed the analytical lab analyses.

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
Infiltration Monitoring	**7**	Bradshaw Property Pond	Curve Crest Blvd.	Elevation
Infiltration Monitoring	**8**	Kern Center Pond	Hwy 5	Elevation
Lake Monitoring	**9**	Kismet Basin	--	Surface Water Quality Samples, Elevation
Lake Monitoring	**10**	Long Lake	--	Surface Water Quality Samples, Elevation
Lake Monitoring	**11**	Goggin's Lake	--	Surface Water Quality Samples, Elevation
Lake Monitoring	**12**	South School Section Lake	--	Surface Water Quality Samples, Elevation
Lake Monitoring	**13**	Benz Lake	--	Surface Water Quality Samples, Elevation
Lake Monitoring	**14**	Masterman Lake	--	Surface Water Quality Samples, Elevation
Lake Monitoring	**15**	Woodpile Lake	--	Surface Water Quality Samples, Elevation
Lake Monitoring	**16**	Lynch Lake	--	Surface Water Quality Samples, Elevation
Lake Monitoring	**17**	Bass Lake (West)	--	Surface Water Quality Samples, Elevation
Lake Monitoring	**18**	July Avenue Pond	--	Surface Water Quality Samples, Elevation
Lake Monitoring	**19**	Bass Lake (East)	--	Surface Water Quality Samples, Elevation
Lake Monitoring	**20**	Pat Lake	--	Elevation
Lake Monitoring	**21**	Hwy 12 & Kimbro Pond	--	Elevation
Lake Monitoring	**22**	Jackson Wildlife Management Area Pond	--	Elevation
Lake Monitoring	**23**	Plaisted Lake	--	Elevation
Lake Monitoring	**24**	Brown's Creek at Gateway Trail	--	Elevation
Lake Monitoring	**25**	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)--At All Sites on Brown's Creek, (Total Chemical Oxygen Demand, Total Sulfates, Total Hardness, Total Alkalinity, Ortho Phosphate, Total 5-day Biochemical Oxygen Demand, 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

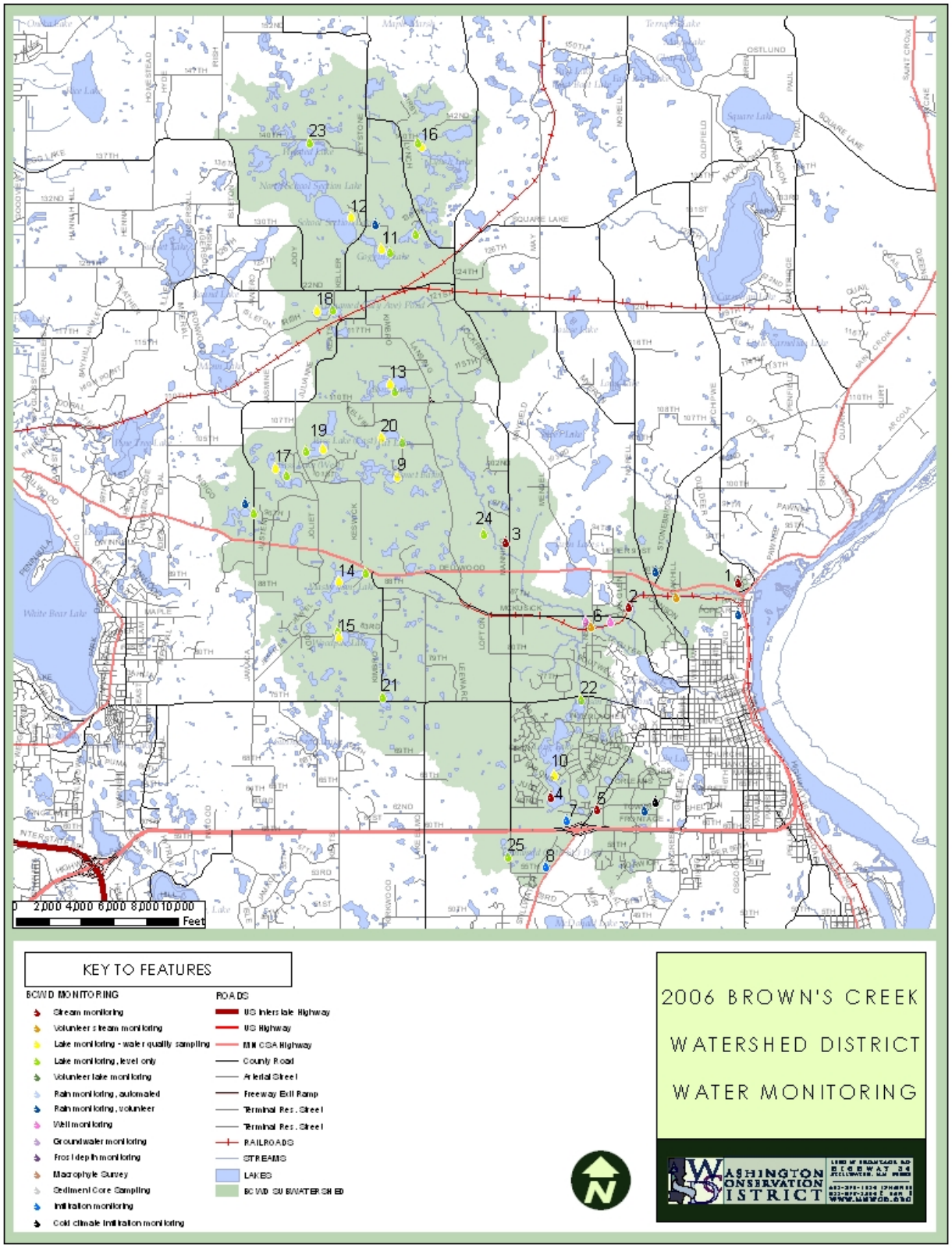


Figure 1: Sampling Location Map

II. LAKES

A. METHODS, RESULTS AND DISCUSSION

In 2006, water quality data was collected bimonthly 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, and total chloride ions concentrations (on 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). 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 annual averages for each parameter.

Table 2: Ecoregion Values and Average 2006 Parameters

2006 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	*0.025-0.050*	*5.00-22.00*	*4.9-10.5*	*0.60-1.20*
Goggins	0.114	34.56	1.9	2.36
Kismet	0.075	26.08	5.6	1.31
South School Section	0.058	40.11	4.3	1.61
Long	0.098	29.89	3.3	2.23
Benz	0.262	62.75	1.8	4.89
Bass East	0.070	13.28	6.2	1.23
Bass West	0.031	4.48	10.1	0.76
July Ave	0.291	224.20	0.9	7.88
Lynch	0.218	201.00	0.8	4.90
Masterman	0.067	22.11	5.3	1.15
Pat	0.117	27.20	4.5	1.11
Wood Pile	0.080	18.80	4.3	1.26

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 2006 study period, was 3.3 feet in Long Lake, 1.9 feet in Goggin's Lake, 5.6 feet in Kismet Basin, 1.8 feet in Benz Lake, 4.3 feet in South School Section Lake, 6.2 feet in Bass Lake East, 10.1 in Bass Lake West, 0.9 feet in July Avenue Wetland, 0.8 feet in Lynch Lake, 5.3 feet in Masterman Lake, 4.5 feet in Pat Lake, and 4.3 feet in Wood Pile Lake (Figure 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, Lynch Lake, Pat Lake, and Wood Pile Lake had Secchi disk readings less (worse) than the ecoregion range, while

Kismet Basin, Bass Lake East, Bass Lake West, and Masterman Lake were within the ecoregion range.

2. CHLOROPHYLL-*a*

Chlorophyll-*a* is a photosynthetic component found in algae and aquatic plants. It is also an indication of algal productivity. The 2006 summer average chlorophyll-*a* concentrations of BCWD lakes can be seen in Figure 3. 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, Lynch Lake, and Pat Lake exceeded (were poorer than) the ecoregion values for chlorophyll-*a*, Bass Lake East, Masterman Lake, and Wood Pile Lake were within the ecoregion range, and Bass Lake West 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 2006 were 0.072 mg/L in Kismet Basin, 0.114 mg/l in Goggin's Lake, 0.098 mg/L in Long Lake, 0.262 mg/L in Benz Lake, 0.058 in South School Section Lake, 0.070 mg/L in Bass Lake East, 0.031 mg/L in Bass Lake West, 0.291 mg/L in July Avenue Wetland, 0.218 mg/L in Lynch Lake, 0.067 mg/L in Masterman Lake, 0.117 mg/L in Pat Lake, and 0.080 mg/L in Wood Pile Lake (Figure 4). The typical range of the ecoregion values for total phosphorous is 0.025 – 0.050 mg/L. All lakes except Bass Lake West (within the ecoregion range) exceeded (were poorer than) the ecoregion value in 2006.

4. NITROGEN

Several forms of nitrogen are responsible for health problems and increase the rate of lake eutrophication. In 2006, average total Kjeldahl nitrogen (TKN) concentrations were 2.23 mg/L in Long Lake, 2.31 mg/l in Goggin's Lake, 4.77 mg/L in Benz Lake, 1.59 in South School Section Lake, , 1.31 mg/L in Kismet Basin, 1.23 mg/L in Bass Lake East, 0.76 mg/L in Bass Lake East, 7.88 mg/L in July Avenue Wetland, 4.90 in Lynch Lake, 1.20 in Masterman Lake, 1.11 mg/L in Pat Lake, and 1.26 mg/L in Wood Pile Lake (Figure 5). The ecoregion value range for total Kjeldahl nitrogen is 0.60-1.20 mg/L. Bass Lake West, Masterman Lake, and Pat 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

Temperature and dissolved oxygen readings were taken during each sampling event. In addition to surface water measurements, a temperature and dissolved oxygen profile was taken at each lake during each sampling event. These profiles were done at one-meter increments from the surface down to the lake bottom. The data collected from these profiles are contained in Appendix A. 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, Long, Goggin's, Bass East, Bass West, and Wood Pile Lakes exhibited thermal stratification during the summer months. This shows that these lakes are less likely to completely mix during the summer months; whereas, Kismet Basin, July Avenue Wetland, Lynch, Masterman, Pat, and Benz Lakes may mix throughout the summer allowing for some internal loading.

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 nearby Square Lake, located in Section 23 of May 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 2006 data and utilizing the Carlson's Trophic State Index (Table 3), Goggin's Lake, Long Lake, Benz Lake, July Avenue Wetland, and Lynch Lake are classified as hypereutrophic; Kismet Basin, South School Section Lake, Bass Lake East, Masterman Lake, Pat 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 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 2006; 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: Lake Grades, Trophic State Index, and Trophic Status

Lake	Summer TP Grade & TSI	Summer CLA Grade & TSI	Summer Secchi Grade & TSI	Summer Average Grade & TSI	Trophic Status
Goggins	D	C	F	**D**	Hypereutrophic
	72	65	68	**68**	
Kismet	D	C	C	**C-**	Eutrophic
	66	63	52	**60**	
Long	D	C	D	**D+**	Hypereutrophic
	70	64	60	**65**	
S School Sec	C	C	C	**C**	Eutrophic
	63	67	56	**62**	
Benz	F	D	F	**F+**	Hypereutrophic
	84	71	69	**75**	
Bass East	D	B	C	**C**	Eutrophic
	65	56	51	**57**	
Bass West	B	A	A	**A-**	Mesotrophic
	54	45	44	**48**	
July Ave	F	F	F	**F**	Hypereutrophic
	86	84	79	**83**	
Lynch	F	F	F	**F**	Hypereutrophic
	82	83	80	**82**	
Masterman	D	C	C	**C-**	Eutrophic
	65	61	53	**60**	
Pat	D	C	C	**C-**	Eutrophic
	73	63	55	**64**	
Wood Pile	D	B	C	**C**	Eutrophic
	67	59	56	**61**	

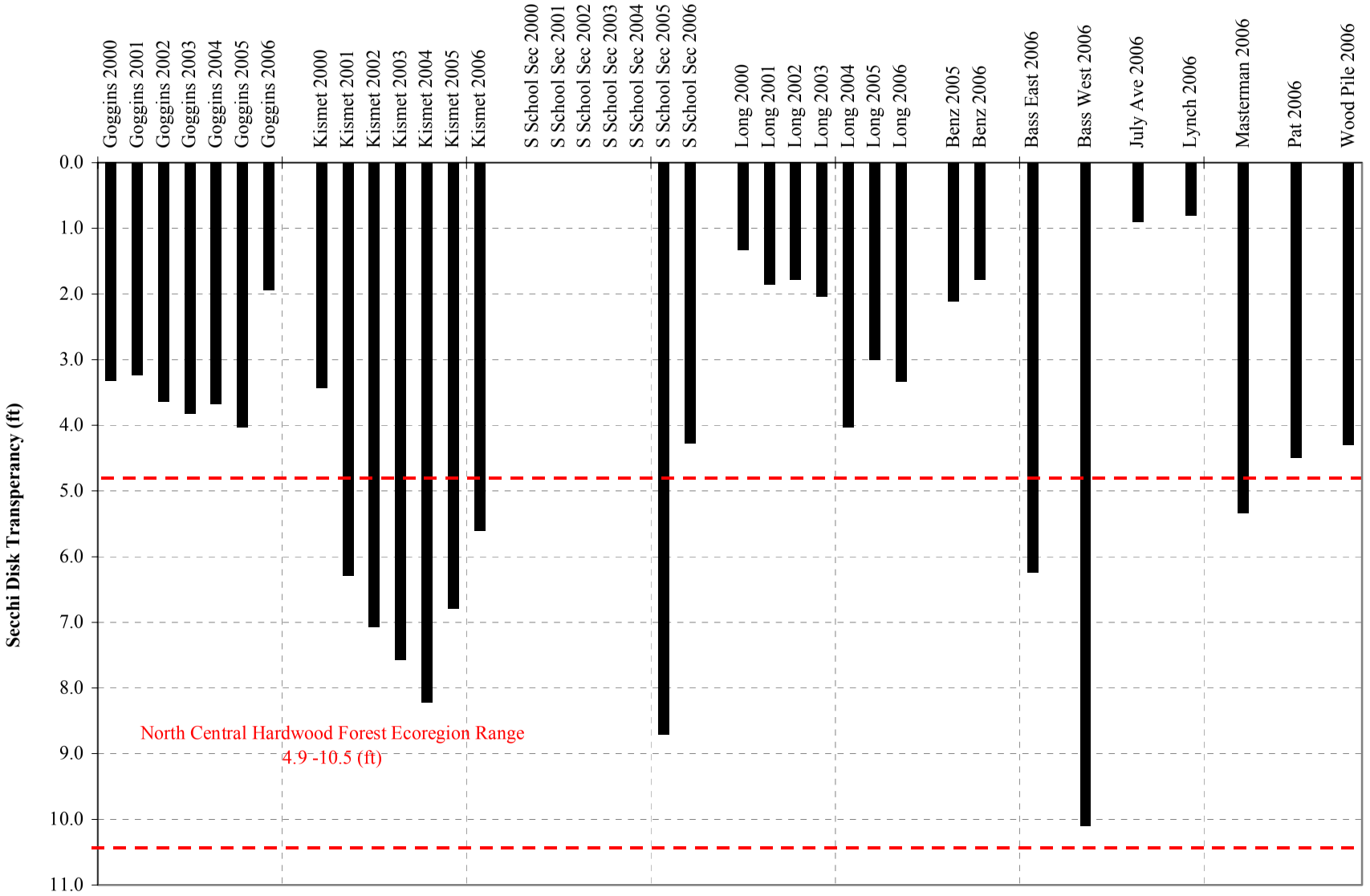


Figure 2: 2006 and Historic Secchi Records

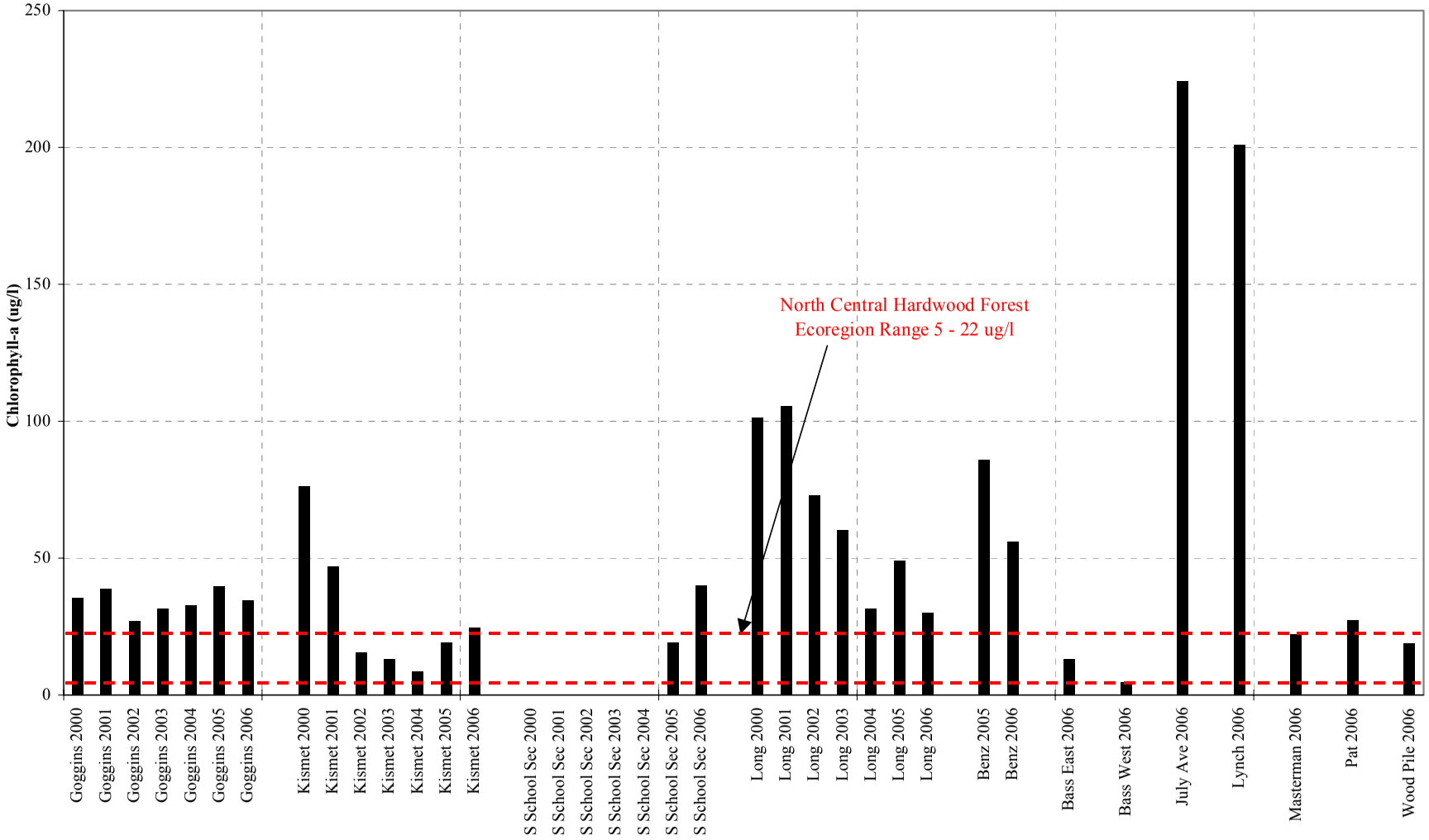


Figure 3: 2006 and Historic Chlorophyll-*a* Data

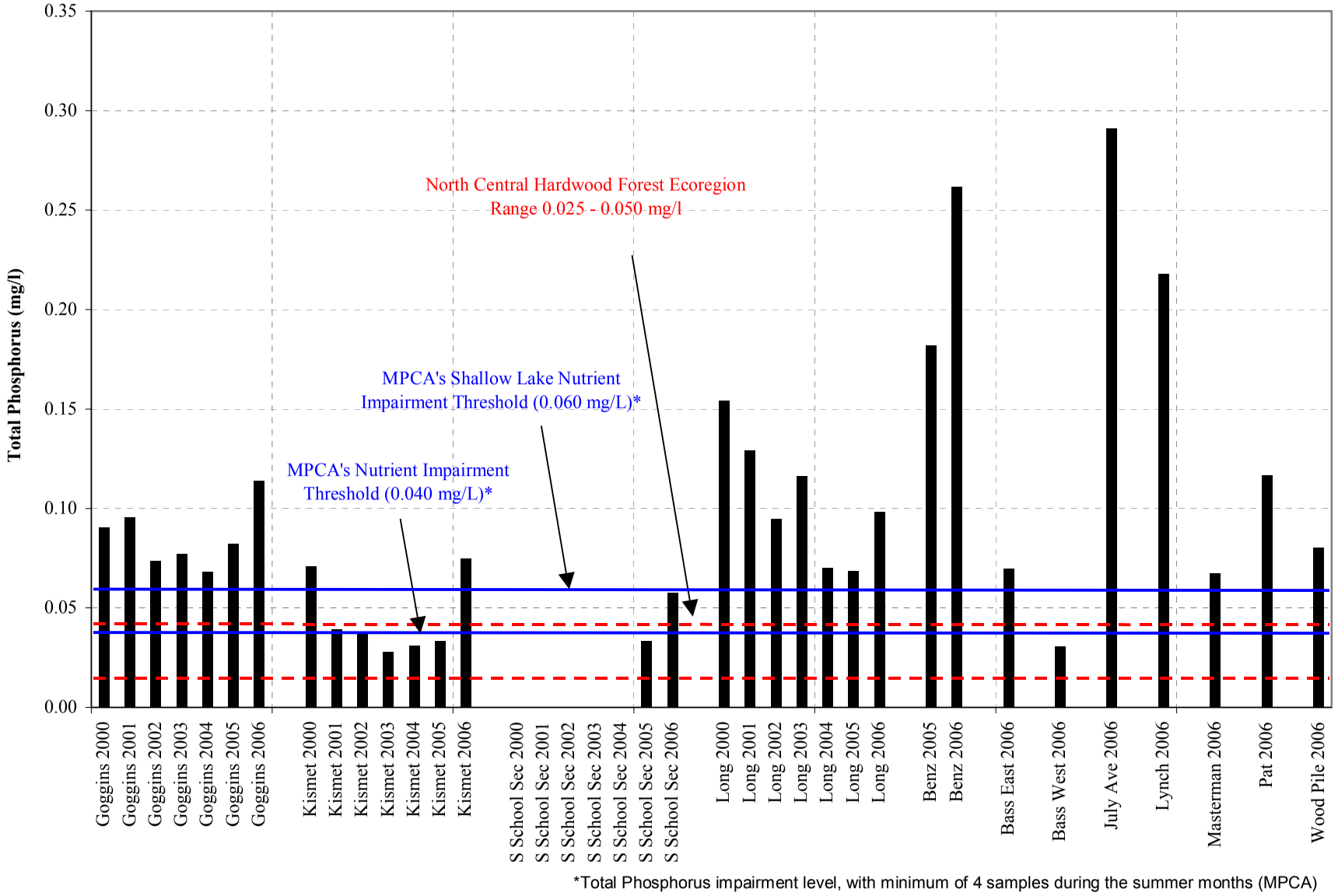


Figure 4: 2006 and Historic Total Phosphorus Data

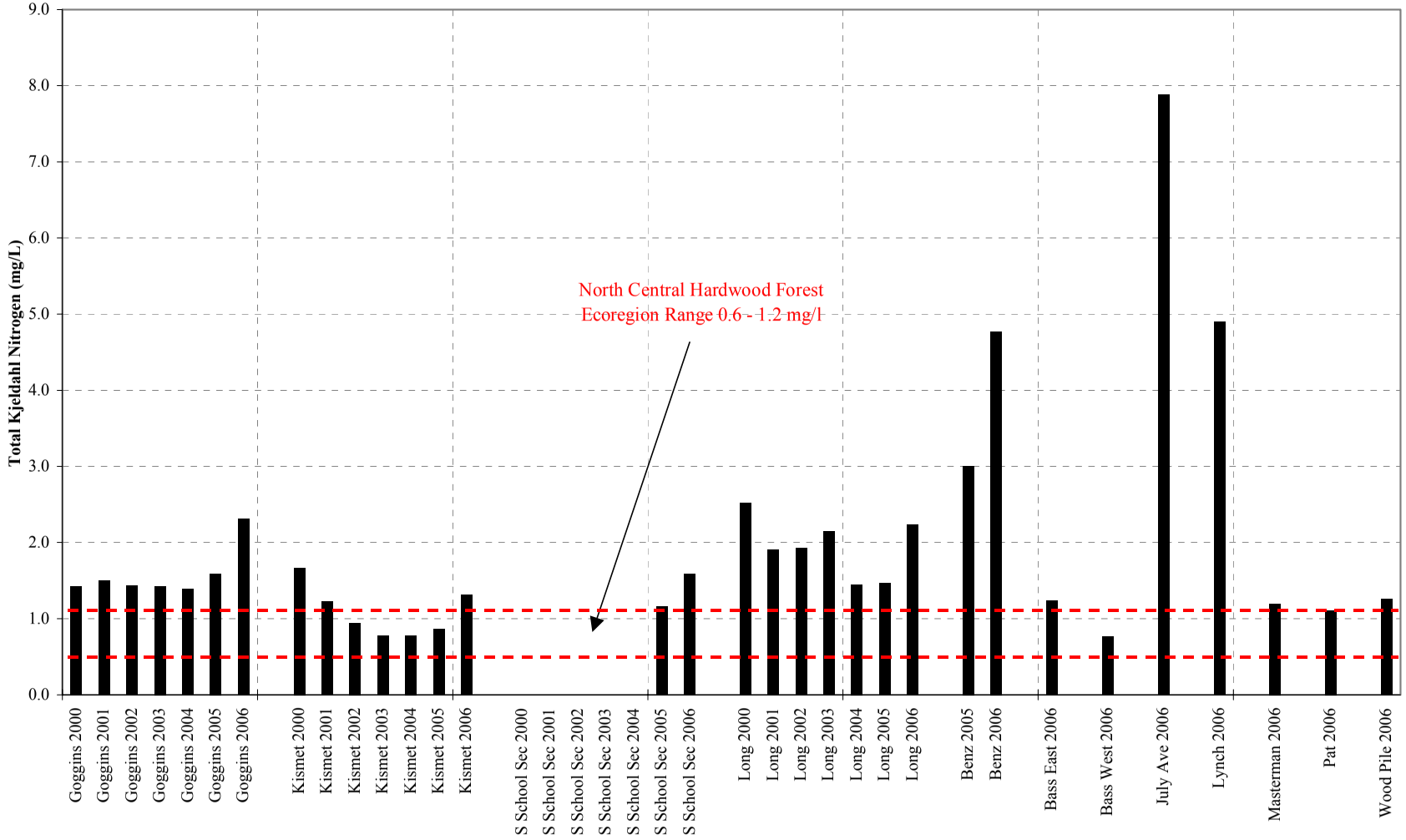


Figure 5: 2006 and Historic Total Kjeldahl Nitrogen Data

7. LAKE ELEVATIONS

Lake elevation gages are located on seventeen lakes and wetlands throughout BCWD and are monitored by both WCD staff and volunteers. Complete lake elevation data for 2006 can be found in Figure 7.

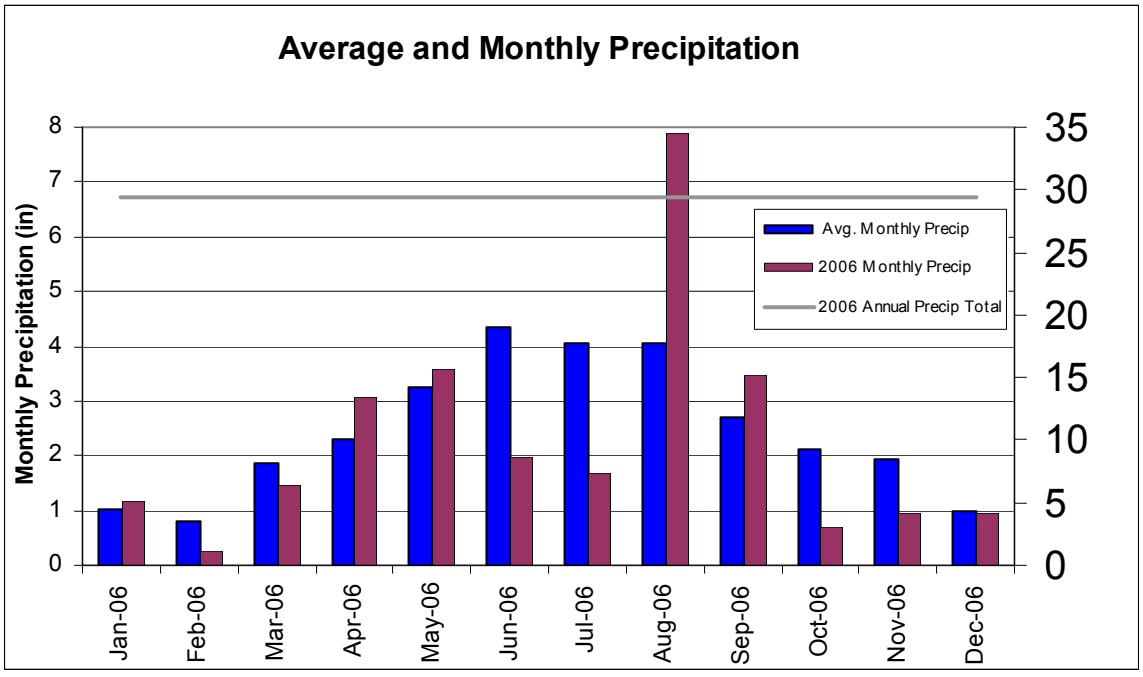
Brown's Creek Watershed District Hydrologic/Hydraulic Study November 1998 (H&H) developed an issues matrix to quantify and summarize flooding impacts. Impacts due to water elevations were determined relative to land that is normally not inundated such as septic systems, wells, residential structures, 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, 2004, 2005, and 2006, 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, and Woodpile Lake were within the low impact range for the entire year of 2006. Goggin's Lake was within the low impact range for about half of the year, dropping below the low impact range from late-July to late-October when monitoring was discontinued for the year. Kismet Basin remained in the moderate impact range for all of 2006. Long Lake and Jackson WMA remained below the high impact range for all of 2006.

Table 6: 2006 Water Elevation Flooding Impacts

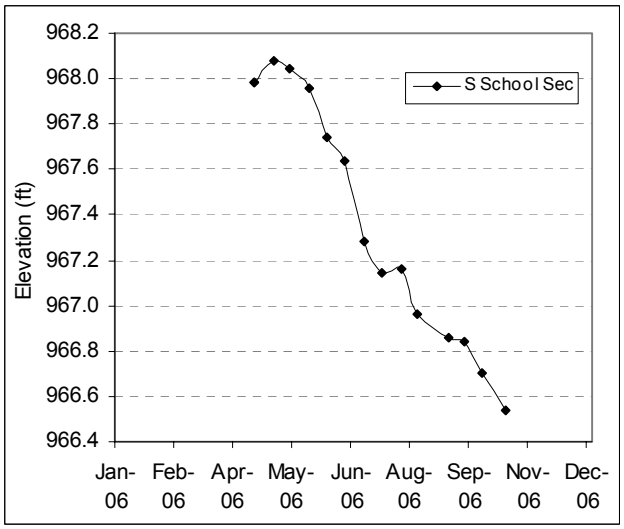
LAKE/WATERBODY	Average Elevation for 2006	Highest Elevation for 2006	Low Impact*	Moderate Impact*	High Impact*
Plaisted	967.57	967.86	*966.0-970.5*	*970.5-971.7*	*>971.7*
School Section	967.39	968.08	*965.3-971.0*	*971-977.2*	*>977.2*
Lynch	1004.83	1005.50	NA	NA	NA
Goggins	966.64	967.69	*966.5-968.2*	----	*>968.2*
July Avenue	971.84	973.23	NA	NA	NA
Benz	953.75	954.38	NA	NA	NA
Bass (West)	951.90	952.67	NA	NA	NA
Unnamed (Bass {East})	956.76	957.16	NA	NA	NA
Pat	940.92	941.47	NA	NA	NA
Kismet	941.41	942.11	*<940.6*	*940.6-946.6*	*>946.6*
BC at Gateway Trail	908.05	908.33	NA	NA	NA
Unnamed 82-0128	979.92	980.89	NA	NA	NA
Masterman	954.19	954.63	NA	NA	NA
Woodpile	965.82	966.29	*<968.5*	NA	NA
Kimbro and Hwy 12	926.94	927.65	NA	NA	NA
Jackson WMA	889.20	889.62	NA	NA	>893.4
Long	889.66	889.96	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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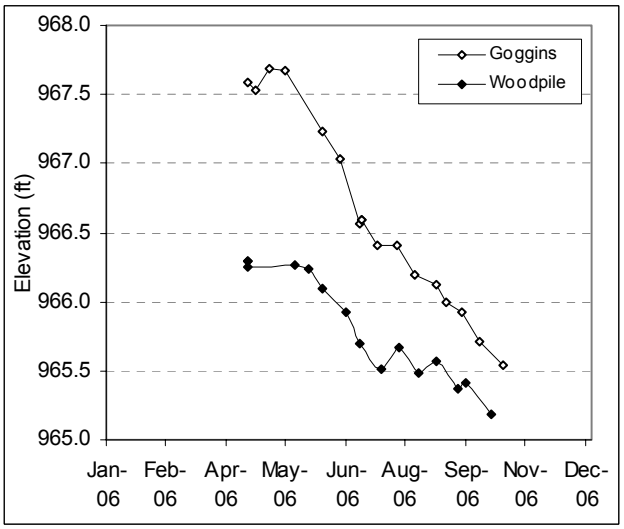
968.0
967.8
967.6
967.4
967.2
967.0
966.8
966.6
966.4
Jan-06 Feb-06 Apr-06 May-06 Jun-06 Aug-06 Sep-06 Nov-06 Dec-06


Goggins
Woodpile
Elevation (ft)
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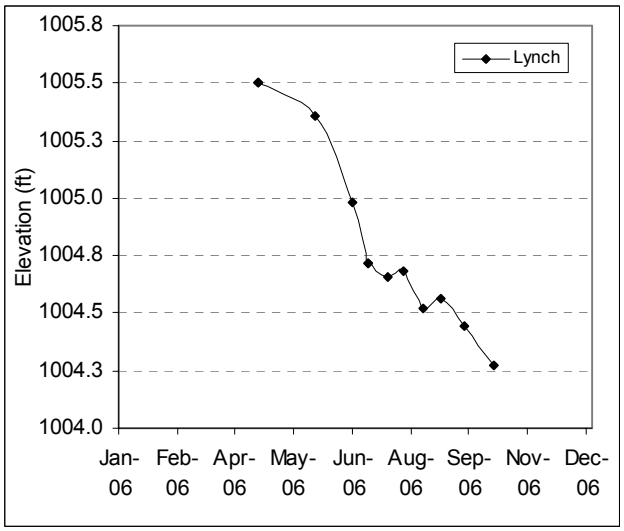
967.5
967.0
966.5
966.0
965.5
965.0
Jan-06 Feb-06 Apr-06 May-06 Jun-06 Aug-06 Sep-06 Nov-06 Dec-06


Lynch
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1005.5
1005.3
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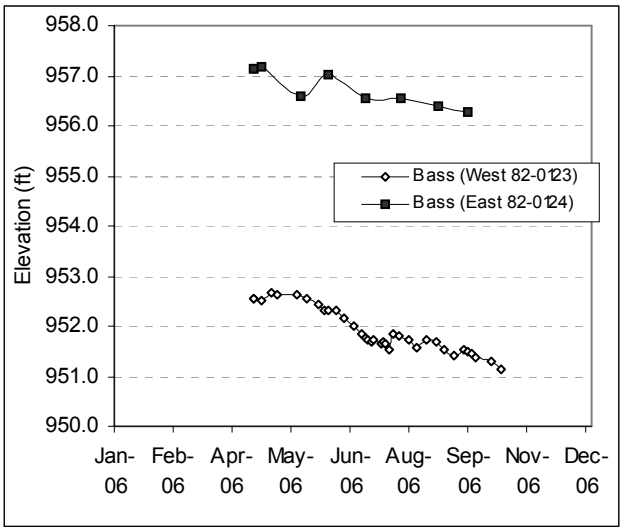
1004.8
1004.5
1004.3
1004.0
Jan-06 Feb-06 Apr-06 May-06 Jun-06 Aug-06 Sep-06 Nov-06 Dec-06


Bass (West 82-0123)
Bass (East 82-0124)
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952.0
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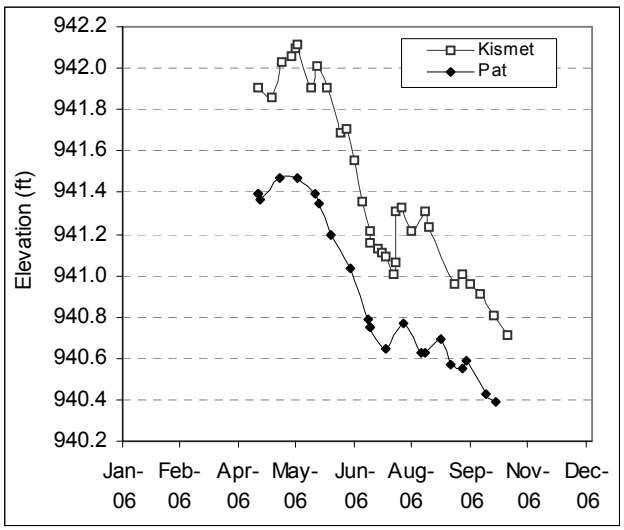
950.0
Jan-06 Feb-06 Apr-06 May-06 Jun-06 Aug-06 Sep-06 Nov-06 Dec-06


Kismet
Pat
Elevation (ft)
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941.6
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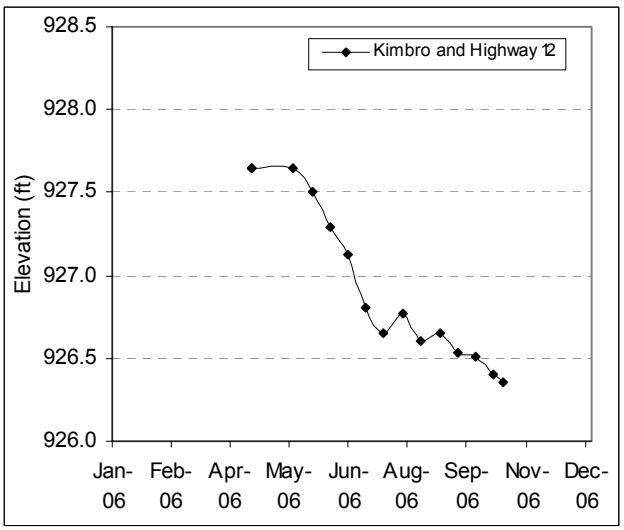
940.4
940.2
Jan-06 Feb-06 Apr-06 May-06 Jun-06 Aug-06 Sep-06 Nov-06 Dec-06


Kimbro and Highway 12
Elevation (ft)
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Jan-06 Feb-06 Apr-06 May-06 Jun-06 Aug-06 Sep-06 Nov-06 Dec-06

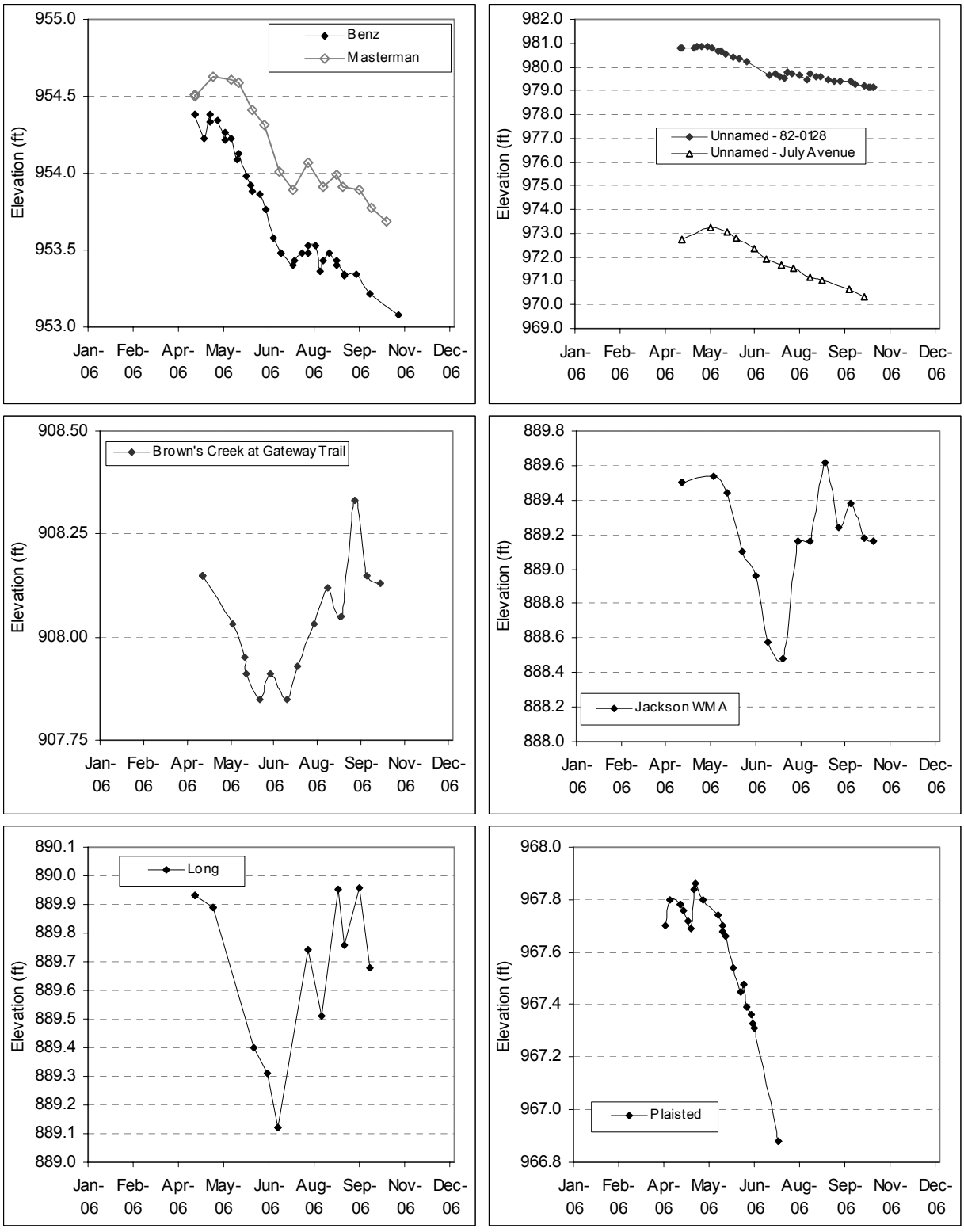


Figure 7: 2006 Lake Levels

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 2006, the 12 lakes monitored had good to very poor water quality ratings and were classified as mesotrophic (Bass Lake West), eutrophic (Kismet, South School Section, Bass East, Long, Masterman, Pat, and Wood Pile) and hypereutrophic (Benz, Goggin's, July Avenue Wetland, and Lynch). The overall 2006 lake grades for BCWD lakes were: Bass Lake East -- C, Bass Lake West -- A-, July Avenue Wetland -- F, Lynch Lake -- F, Wood Pile Lake – C, Masterman Lake – C-, Pat Lake – C-, South School Section Lake -- C, Kismet Basin – C-, Goggin's Lake -- D, Long Lake -- D+, and Benz Lake – F+. Of the lakes with historical data available (Long, South School Section, Googin's, Kismet, and Benz), one lake showed a slight deterioration in water quality for the 2006 season (Kismet Basin), two lakes maintained their water quality (Goggin's and South School Section), and two lakes improved in water quality (Benz and Long). Goggin's, Long, and Benz Lakes were considered worse than the ecoregion range for total phosphorus, total Kjeldahl nitrogen, chlorophyll-*a,* and Secchi disk transparency. Kismet Basin and South School Section Lake were within the ecoregion range for total phosphorus, total Kjeldahl nitrogen, and chlorophyll-*a*. Kismet Basin was within the range for Secchi transparency.

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 2006, 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 in-turn dissolving more nutrients from the sediments. The possibility exists in some lakes with invasive/exotic macrophytes present, for these macrophytes to dieback early in the season releasing a flux of 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. The Minnesota Pollution Control Agency currently monitors statistically significant trends in water quality throughout the state.

The thirteen lakes and four wetlands monitored for water elevation showed peaks from late April to early and mid-May of 2006 and then steadily declined until the end of the monitoring season. 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 following lake-by-lake discussion of the water monitoring data will include 2006 data as well as data from previous monitoring years, which in some cases is several years. This data is found in Appendix A. 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 excerpts from Carlson and Simpson (1986) describe how TSI is calculated and what information the TSI values will provide.

Table 7: Trophic State Index Equations

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

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

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

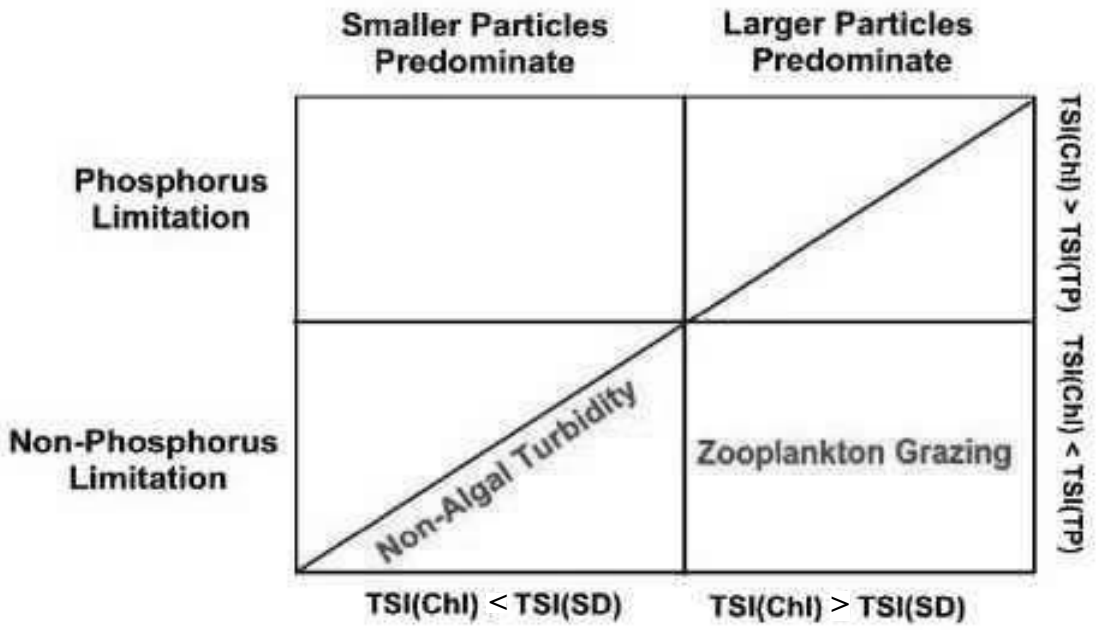
Table 8: Trophic State Gradient

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

Goggin's Lake

Summertime (June-September) Secchi disk transparency, total phosphorus, and chlorophyll-*a* averages have remained relatively consistent in Goggin's Lake (D to D+) in the seven years it has been monitored for water quality. In 2006, summer average TP and Secchi transparency deteriorated slightly when compared to 2005. CLA concentrations appeared to decrease slightly when when compared to 2005. In 2005, an increase in CLA concentration was seen and was considered out of the normal trend for this lake. The 2006 CLA data shows CLA concentrations returning to their normal concentration range. In 2006, the water level was at its highest in April and May and steadily declined until October when monitoring was discontinued for the season. As in previous years, Goggin's Lake's TSI values indicate that the transparency is better than the amount of TP would indicate. In past years, the TSI values indicated that the transparency was better than the amount of TP and CLA, but 2006 data indicates that CLA values match closely with transparency values. Therefore, this may show that the lake's algal population is limited by some component of nitrogen, zooplankton grazing, or other toxic factors. Due to this data differing from past years, it is possible that 2006 is an odd year and that it may return to its normal trend in future years of monitoring. It should be noted that in 2006, Curlyleaf pondweed (invasive species of macrophyte) was discovered within Goggin's Lake. This plant has the capacity to out compete native species and form dense stands within the lake. The macrophyte also dies early in the year releasing nutrients into the water column. It is recommended that at least monthly if not bi-weekly water quality samples, lake level readings, and observations to track the dissemination of this macrophyte continue to be taken to monitor this situation.

Kismet Basin

After peaking in mid-May, Kismet Basin's elevation declined until monitoring was discontinued. The basin remained below the ordinary high water mark for the entire monitoring season. The water quality of Kismet Basin worsened in 2006, dropping the lake grade to a C-, compared to a C+ in 2005. Kismet Basin was within the ecoregion ranges for Secchi disk transparency but exceeded the ranges for total phosphorus, chlorophyll-*a,* or total Kjeldahl nitrogen. Total chloride ion was collected again in 2006,

and lower summer average concentrations were seen in 2006 than in the previous three years, which is below the MPCA warning levels. The TSI values in 2006 became poorer for all parameters. The TSI values indicate that chlorophyll-*a* is being limited mainly by phosphorus and low Secchi disk readings are due to algal turbidity that dominates light attenuation. Some zooplankton grazing may be present as well leading to a transparency TSI values better than the TSI values for TP and CLA. Continued monthly or bi-weekly water quality and level monitoring are recommended.

Long Lake

In 2005 the lake's elevation was well below the OHW throughout the year, with its lowest elevation reached in early July. The average elevation in 2006 is the lowest it has been in the last six years. The water quality in Long Lake has remained consistently poor in the years the lake has been monitored. The Minnesota Pollution Control Agency determined the presence of a statistically significant negative trend in 2002 for Secchi disk transparency over the period of record. Since this trend was identified, further data gathering and analysis has lead to rescinding that trend and indicating that no current trend exists. The last time a trend computation was completed by the MPCA was in 2005. Current data has not been fully compiled and processed by the MPCA to determine if the same lack in trend exists or if a trend has returned. In 2006, TP concentrations increased slightly from 2005. Average Secchi disk transparency increased from 2005 to 2006 and CLA concentrations decreased by half from 2005. The TSI values indicate that chlorophyll-*a* is being limited by phosphorus and low Secchi disk readings are due to algal turbidity. Continued monthly or bi-weekly water quality and level monitoring are recommended to determine what these results may conclude.

Benz Lake

The 2006 monitoring season was the second year for water quality monitoring on Benz Lake. Lake elevations continued to be monitored for the tenth consecutive year by Washington Conservation District. The overall elevation average was the lowest it has been since 2001 and maintained a level that is below the OHW mark. Lake levels were highest in late April to early May, after that point elevation declined until the end of the

monitoring season. Summer average concentrations on Benz Lake were the worst amongst lakes monitored in Brown's Creek Watershed in 2005, but have since been moved up the list due to others in the watershed found in 2006 to have worse water quality. It is tough to tell any kind of trends on this lake due to lack of prior water quality records. Benz received an F in its first year of monitoring and an F+ in its second year. As with summer average concentrations, TSI values reflected poor water quality. Land use practices around Benz Lake might be a cause for such low water quality. The depth of the lake allows nutrients in sediments to mix throughout the water. Continued bi-weekly water quality and level monitoring are recommended to determine what these results may further conclude.

South School Section Lake

Lake elevations were recorded again as in 2005. Average levels dropped from 2005, but still remained above the OHW mark. This continued a declining trend started in 2000. Currently, South School Section Lake is the lowest it has been since it was first monitored for elevation in 1995. Elevations in 2006 were steady until May, after which the lake level continued to drop until monitoring was discontinued in late October. Summer average concentrations of all water quality parameters were worse in 2006 than in 2005. South School Section received a C lake grade for the second year in a row. Large algal particles appear to dominate the water column and algae production appears to be limited by the amount of phosphorus present. With gaps in the historical data set previous to 2005, it is difficult to establish long-term trends. Continued bi-weekly water quality and level monitoring are recommended to determine better long-term trends and also to determine what these results may further conclude.

Bass Lake (East)

Minnesota DNR identified water body Unnamed 82-0124, also known as Bass Lake East at the WCD, had lake elevations and water quality sampling conducted for the first time in 2006. Lake elevations were the highest in April and early May and continued to drop until October when monitoring was discontinued. Bass Lake East remained well below the OHW throughout the season. The lake received a C lake grade for the first year of

monitoring and is considered a eutrophic lake. Based on the lake's TSI, it appears that CLA concentrations and secchi transparencies are better than what is expected from the TP concentrations present. This may indicate that there is zooplankton grazing within the water body reducing the amount of algae and increasing the transparency. With no water quality data previous to 2006, it is not possible to establish a long-term trend. Continued bi-weekly water quality and level monitoring are recommended to determine better long-term trends and also to determine what these results may further conclude.

Bass Lake (West)

Bass Lake West (82-0123) had lake water quality sampling conducted for the first time in 2006. Volunteers have read the lake gage for many years and a good elevations data set exists for this lake. Lake elevations were at their highest in early May and then continued to drop during the season until late October when monitoring was discontinued. The lake was above the OHW for the first few weeks of May, but then dropped below the OHW for the remainder of the season. For its first year of monitoring, the lake received an A-lake grade and is considered mesotrophic, the best within the BCWD. Similar to Bass Lake East, Bass Lake West seems to have better transparency and CLA concentrations than would be expected considering the TP concentrations present. Again, this may indicate that zooplankton grazing may be occurring controlling the algae growth and increasing transparency within the lake. Continued bi-weekly water quality and level monitoring are recommended to determine better long-term trends and also to determine what these results may further conclude. Macrophyte surveys and/or zooplankton surveys are also recommended to determine why there is such a difference in water quality between Bass Lake East and Bass Lake West.

July Avenue Wetland

Unnamed wetland (82-0318) or the July Ave Wetland, as it is known at the WCD, was monitored for water quality for the first time in 2006. A historical elevation record is present and is continuing to be monitored by the WCD. In 2006, the elevation peaked in mid-May and continued to decline for the remainder of the monitoring season. The water quality at the July Avenue Wetland is the overall worst lake/wetland monitored in the

BCWD. In 2006, it received an F lake grade and is considered to be hypereutrophic. Because of its very shallow nature, it is understandable for nutrients to be stirred and utilized by algae throughout the monitoring season. Other lakes within BCWD are also shallow and do not exhibit this poor of water quality which points to a contributing pollutant(s). Either past external loads contributing to its current internal load were a severe problem or the wetland is currently receiving a large amount of runoff. Agriculture is present in the area and may be contributing to runoff to the wetland. The TSI indicates that TP is the limiting nutrient to the poor transparency and high CLA concentrations. Continued bi-weekly water quality and level monitoring are recommended to determine better long-term trends.

Lynch Lake

Lynch Lake was monitored for water quality for the first time in 2006. The WCD currently records and has a historical record of lake elevations for Lynch Lake. The elevation in Lynch Lake peaked in mid-April and declined until the end of the monitoring season. The elevation remained above the OHW until early June and then fell below the OHW for the remainder of the monitoring season. The water quality at Lynch Lake is the second worst lake/wetland monitored in the BCWD. In 2006, it received an F lake grade and is considered to be hypereutrophic. Because of its very shallow nature, it is understandable for nutrients to be stirred and utilized by algae throughout the monitoring season. With a history of agricultural practices in proximity of the lake, there is most likely a significant internal load as well as the current runoff from the adjacent agricultural land contributing to the poor water quality. The TSI for Lynch Lake indicates that algae growth (CLA) and transparency are heavily dependent on TP present. The TSI also indicates that larger algal particles dominate the water column leading. Continued bi-weekly water quality and level monitoring are recommended to determine better long-term trends.

Pat Lake

Pat Lake was monitored for water quality for the first time in 2006. The WCD currently records and has a historical record of lake elevations for Pat Lake. The elevation in Pat

Lake peaked in early to mid-May and declined until the end of the monitoring season. The elevation remained below the OHW for the entire monitoring season. Pat Lake received a C- lake grade for its first year of monitoring and is considered eutrophic. Agricultural practices are know to exist near or adjacent to Pat Lake and may be contributing to its average to poor water quality. The TSI indicates that some zooplankton grazing may exist which allows the secchi transparency and CLA concentrations to be lower than expected considering the TP concentrations. Continued bi-weekly water quality and level monitoring are recommended to determine better long-term trends.

Woodpile Lake

Woodpile Lake was monitored for water quality for the first time in 2006. The WCD currently records and has a historical record of lake elevations for Woodpile Lake. The elevation in Woodpile Lake peaked in mid-April and declined until the end of the monitoring season. The elevation remained below the OHW for the entire monitoring season. Woodpile Lake received a C lake grade for its first year of monitoring and is considered eutrophic. Agricultural practices are know to exist near or adjacent to Pat Lake and may be contributing to its average to poor water quality. A gravel road also runs within the riparian zone of the lake and may be contributing runoff without any room for a buffer to be placed in-between the road and the water. The TSI indicates that algae are dominating light attenuation, but zooplankton grazing may contribute to the discrepancies seen in the different TSI values. Continued bi-weekly water quality and level monitoring and an analysis of options for moving the road away from the riparian zone of lake are recommended.

Masterman Lake

Masterman Lake was monitored for water quality for the first time in 2006. The WCD currently records and has a historical record of lake elevations for Masterman Lake. The elevation in Masterman Lake peaked in early May and declined until the end of the monitoring season. The elevation remained below the OHW for the entire monitoring season. Masterman Lake received a C- lake grade for its first year of monitoring and is

considered eutrophic. No known development of agricultural activity are know to exist within the lake's subwatershed that may be contributing to its average to poor water quality. Runoff from the hard, gravel parking lot on the northeast corner and Hwy 96 may be contributing some runoff into Masterman Lake. The TSI indicates that algae (CLA) and transparency are limited by TP concentrations. Buffer considerations should be looked at between the lake and the adjacent parking lot for possible sources to reduce nutrient runoff. Continued bi-weekly water quality and level monitoring are recommended to determine better long-term trends.

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. Cold 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 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 2006, the WCD took grab samples and flow-weighted samples during both baseflow and storm event conditions at 6 locations within the watershed. Six automated samplers continuously monitored stream flow and collected storm and baseflow composite samples from March through November. Brown's Creek was monitored at 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 (Hwy 15, McKusick Road, Hwy 96, Diversion Structure Drainage), precipitation, conductivity (Hwy 96 and McKusick Road), dissolved oxygen (McKusick Road only), and analytical analysis (Table 1). A list of WCD standard operating procedures can be found at http://www.mnwcd.org/id27.html. All stream flow and chemistry data from 2006 can be found on pages 34-71. Historical ranges for water quality samples collected on Brown's Creek during the growing season (June through September) and during the monitored season (typically April through October) can be seen starting with Figure 18. All historical data (2000-2005) 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 three sites. In 2003, 2004, 2005, and 2006, 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, 2004, 2005, and 2006 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, and 2005-06 and the dry summers of 2003, 2004, 2005, and 2006 primarily caused the runoff reduction experienced in 2003, 2004, 2005, and 2006.

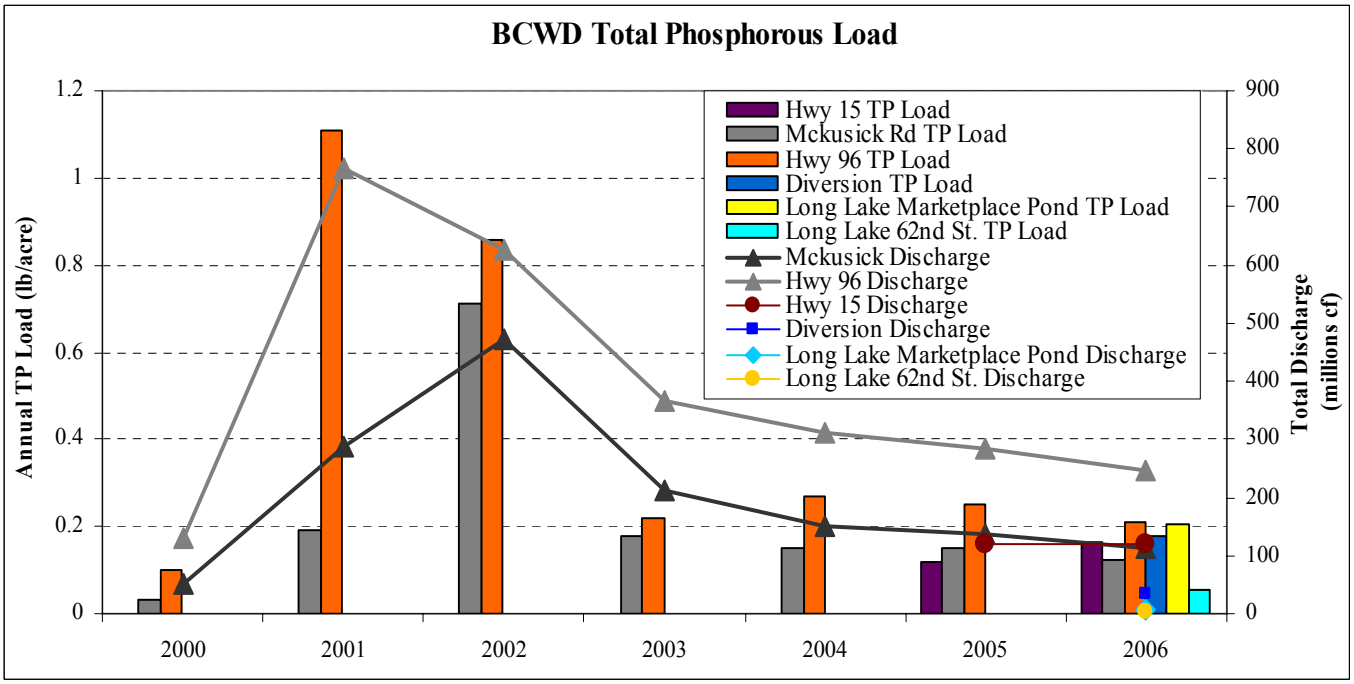


Figure 9: BCWD Annual Total Phosphorous Loads

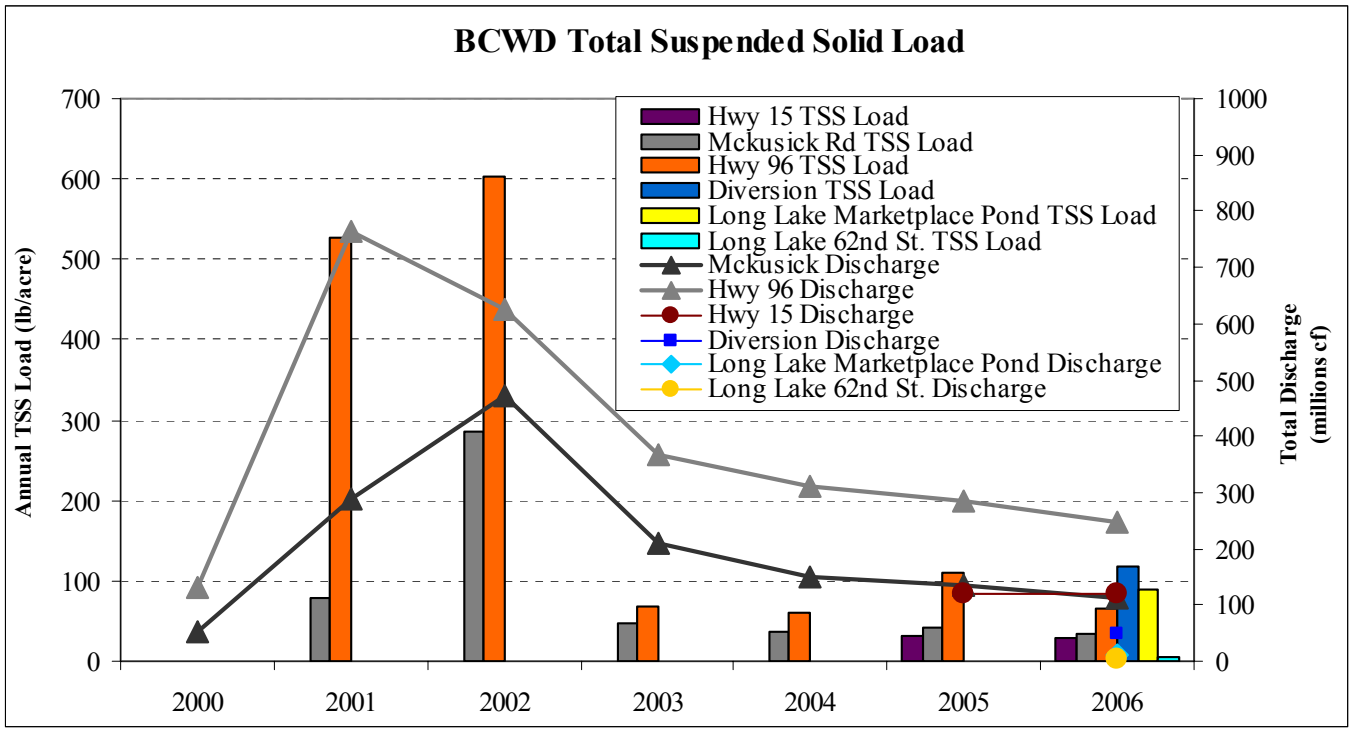


Figure 10: BCWD Annual Total Suspended Solids Loads

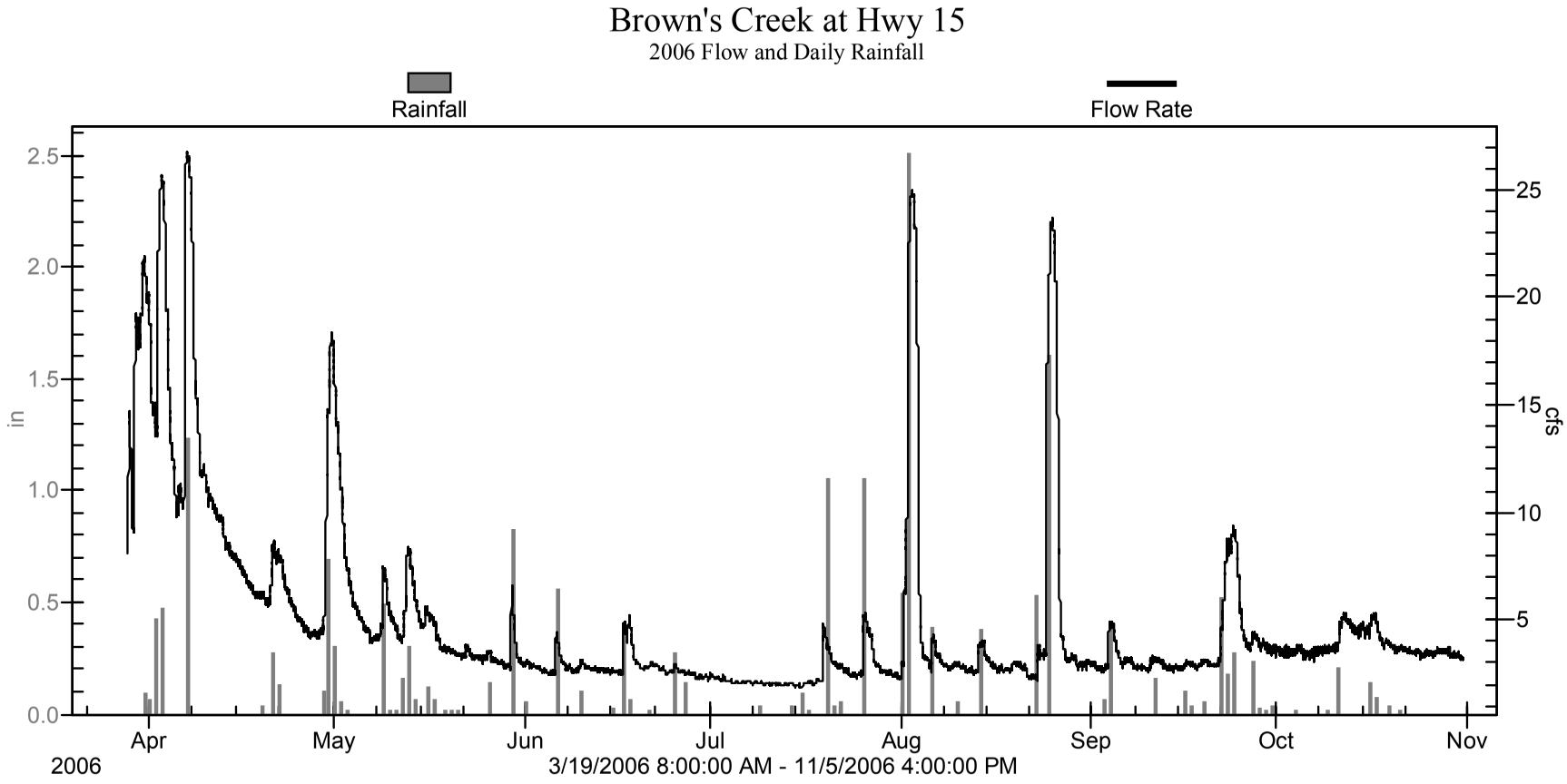


Figure 11. Brown's Creek at Hwy 15 2006 Flow and Daily Rainfall

Table 10. Brown's Creek at Hwy 15 2006 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			*10*	*0.104*	*1/1/2006 0:00*	*3/22/2006 2:00*	*13,838,400*	*89.41*	*8,466*
Snowmelt Grab	3/22/06 13:30	3/22/06 13:30	24	0.107	3/22/2006 2:00	3/24/2006 1:00	1,692,000	11.30	2,535
Base			*10*	*0.104*	*3/24/2006 1:00*	*3/28/2006 14:00*	*1,569,600*	*10.14*	*960*
Snowmelt			*51*	*0.234*	*3/28/2006 14:00*	*3/29/2006 10:00*	*868,040*	*12.66*	*2,764*
Snowmelt Composite	3/29/06 14:50	3/31/06 0:48	96	0.353	3/29/2006 10:00	3/31/2006 2:00	2,586,009	56.99	15,498
Snowmelt Grab	3/31/06 10:30	3/31/06 10:30	33	0.241	3/31/2006 2:00	4/1/2006 6:00	2,035,835	30.63	4,194
Base			*10*	*0.104*	*4/1/2006 6:00*	*4/2/2006 3:00*	*1,133,043*	*7.32*	*693*
Storm			*53*	*0.245*	*4/2/2006 3:00*	*4/3/2006 11:00*	*2,613,381*	*39.97*	*8,701*
Base			*10*	*0.104*	*4/3/2006 11:00*	*4/6/2006 14:00*	*3,654,268*	*23.61*	*2,236*
Storm Composite	4/6/06 17:48	4/8/06 16:52	52	0.21	4/6/2006 14:00	4/8/2006 13:00	3,838,236	50.32	12,460
Base			*10*	*0.104*	*4/8/2006 13:00*	*4/20/2006 12:00*	*8,910,602*	*57.57*	*5,451*
Storm			*53*	*0.245*	*4/20/2006 12:00*	*4/23/2006 6:00*	*1,787,770*	*27.34*	*5,952*
Base			*10*	*0.104*	*4/23/2006 6:00*	*4/29/2006 6:00*	*2,549,210*	*16.47*	*1,560*
Storm			*53*	*0.245*	*4/29/2006 6:00*	*5/2/2006 20:00*	*3,936,022*	*60.20*	*13,105*
Base			*10*	*0.104*	*5/2/2006 20:00*	*5/8/2006 6:00*	*2,446,935*	*15.81*	*1,497*
Storm			*53*	*0.245*	*5/8/2006 6:00*	*5/10/2006 3:00*	*927,642*	*14.19*	*3,088*
Base			*10*	*0.104*	*5/10/2006 3:00*	*5/12/2006 1:00*	*762,505*	*4.93*	*466*
Storm			*53*	*0.245*	*5/12/2006 1:00*	*5/14/2006 13:00*	*1,406,833*	*21.52*	*4,684*
Base			*10*	*0.104*	*5/14/2006 13:00*	*5/15/2006 15:00*	*462,468*	*2.99*	*283*
Storm Grab	5/16/06 14:00	5/16/06 14:00	8	0.098	5/15/2006 15:00	5/17/2006 18:00	930,524	5.69	465
Base			*10*	*0.104*	*5/17/2006 18:00*	*5/25/2006 19:00*	*2,412,776*	*15.59*	*1,476*
Storm			*53*	*0.245*	*5/25/2006 19:00*	*5/26/2006 17:00*	*271,985*	*4.16*	*906*
Base			*10*	*0.104*	*5/26/2006 17:00*	*5/29/2006 18:00*	*781,496*	*5.05*	*478*
Storm			*53*	*0.245*	*5/29/2006 18:00*	*5/30/2006 21:00*	*447,252*	*6.84*	*1,489*
Base Composite	5/31/06 7:19	6/1/06 13:05	15	0.17	5/30/2006 21:00	7/3/2006 0:00	8,019,543	85.11	7,509
Base Composite	7/3/06 8:58	7/5/06 11:17	8	0.104	7/3/2006 0:00	7/16/2006 0:00	2,320,201	14.99	1,159
Base Composite	7/17/06 15:22	7/18/06 7:49	4	0.072	7/16/2006 0:00	7/19/2006 7:00	589,358	2.65	147
Storm Composite	7/19/06 10:38	7/19/06 16:22	22	0.166	7/19/2006 7:00	7/20/06 20:00	508,877	5.27	699
Base			*10*	*0.104*	*7/20/2006 20:00*	*7/25/06 21:00*	*1,163,211*	*7.52*	*712*
Storm			*53*	*0.245*	*7/25/2006 21:00*	*7/27/06 10:00*	*618,823*	*9.46*	*2,060*
Base			*10*	*0.104*	*7/27/2006 10:00*	*8/1/06 0:00*	*1,046,820*	*6.76*	*640*
Storm Composite	8/1/06 16:17	8/2/06 19:08	152	0.571	8/1/2006 0:00	8/4/06 11:00	4,270,593	152.23	40,523
Base			*10*	*0.104*	*8/4/2006 11:00*	*8/6/06 1:00*	*438,208*	*2.83*	*268*
Storm			*53*	*0.245*	*8/6/2006 1:00*	*8/6/06 18:00*	*241,448*	*3.69*	*804*
Base			*10*	*0.104*	*8/6/2006 18:00*	*8/13/06 10:00*	*1,642,311*	*10.61*	*1,005*
Storm			*53*	*0.245*	*8/13/2006 10:00*	*8/14/06 21:00*	*462,551*	*7.07*	*1,540*
Base			*10*	*0.104*	*8/14/2006 21:00*	*8/23/06 1:00*	*1,937,108*	*12.52*	*1,185*
Storm			*53*	*0.245*	*8/23/2006 1:00*	*8/23/06 17:00*	*194,547*	*2.98*	*648*
Base			*10*	*0.104*	*8/23/2006 17:00*	*8/24/06 14:00*	*255,850*	*1.65*	*157*
Storm Composite	8/24/06 17:57	8/25/06 12:18	62	0.28	8/24/2006 14:00	8/26/06 19:00	3,526,235	61.64	13,648
Base			*10*	*0.104*	*8/26/2006 19:00*	*9/3/06 16:00*	*2,137,047*	*13.81*	*1,307*
Storm			*53*	*0.245*	*9/3/2006 16:00*	*9/5/06 6:00*	*592,926*	*9.07*	*1,974*
Base			*10*	*0.104*	*9/5/2006 6:00*	*9/10/06 11:00*	*1,321,061*	*8.54*	*808*
Storm			*53*	*0.245*	*9/10/2006 11:00*	*9/12/06 6:00*	*482,182*	*7.37*	*1,605*
Base Composite	9/12/06 13:27	9/13/06 14:31	18	0.106	9/12/2006 6:00	9/21/06 14:00	2,329,018	15.41	2,617
Storm Composite	9/22/06 13:13	9/24/06 8:41	24	0.145	9/21/2006 14:00	9/25/06 2:00	2,172,970	19.67	3,256
Base			*10*	*0.104*	*9/25/2006 2:00*	*9/26/06 22:00*	*670,431*	*4.33*	*410*
Storm			*53*	*0.245*	*9/26/2006 22:00*	*9/28/06 4:00*	*453,585*	*6.94*	*1,510*
Base			*10*	*0.104*	*9/28/2006 4:00*	*10/11/06 3:00*	*4,087,325*	*26.41*	*2,501*
Storm			*53*	*0.245*	*10/11/2006 3:00*	*10/12/06 22:00*	*765,751*	*11.71*	*2,549*
Base			*10*	*0.104*	*10/12/2006 22:00*	*10/16/06 5:00*	*1,309,395*	*8.46*	*801*
Storm			*53*	*0.245*	*10/16/2006 5:00*	*10/17/06 18:00*	*654,618*	*10.01*	*2,179*
Base Grab	10/23/06 14:24	10/23/06 14:24	4	0.066	10/17/2006 18:00	10/31/06 9:30	4,205,446	17.33	1,050
Base			*10*	*0.104*	*10/31/2006 9:30*	*1/1/07 0:00*	*10,645,200*	*68.78*	*6,512*
Storm Average			53	0.245					
Base Average			10	0.104					
Snowmelt Average			51	0.234					
All Average			40	0.202					
Total							**120,925,470**	1,206	201,190
Brown's Creek Major Subwatershed Total Acres							7,193		
Total TP/TSS(lb/ac/yr)								0.17	27.97
Total TP/TSS (kg/ha/yr)								0.19	31.35

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

** Interval volumes from 1/1/06 to 3/28/06 and 10/31/06 to 1/1/07 were estimated using base flow

Table 11. Brown's Creek at Hwy 15 2006 Primary Chemistry Result Averages

Parameter	Storm Flow Average	Base Flow Average	Average (all samples)
TSS (mg/L)	53	10	40
VSS (mg/L)	32	6	25
TKN (mg/L)	1.77	0.50	1.43
TP (mg/L)	0.25	0.10	0.20
Fecal Coliform (#/100 mL)	--	--	602

Of the parameters sampled at Hwy 15 (Table 12), three lead samples exceeded the MPCA Rule 7050 Water Quality Chronic Standard.

Table 12. Hwy 15 2006 Chemical Parameters Which Exceeded MPCA 7050 Water Quality Standards

Sample Type	Copper (mg/L)	Nickel (mg/L)	Lead (mg/L)	Zinc (mg/L)	Cadmium (mg/L)	Chromium (mg/L)	Chloride (mg/L)
Chronic Standard	**0.0064**	**0.088**	**0.0013**	**0.0590**	**0.00066**	**0.117**	**230**
# of Exceedences/# of Samples	0/14	0/14	3/14	0/14	0/14	0/14	0/14
Maximum Standard	**0.0092**	**0.789**	**0.0340**	**0.0650**	**0.01500**	**0.984**	**860**
# of Exceedences/# of Samples	0/14	0/14	0/14	0/14	0/14	0/14	0/14

*All water quality standards listed are the most stringent based on the use of varied levels of total hardness within MPCA 7050 water quality standards

Table 13: Brown's Creek at Hwy 15 2006 Primary Chemistry Results

Sample Type	Start	End	TSS (mg/L)	VSS (mg/L)	TKN (mg/L)	TP (mg/L)	Dissolved P (mg/L)	Fecal Coliform (#/100 mL)
Snowmelt Grab	3/22/06 13:30	3/22/06 13:30	~24	~18	0.78	0.107	~0.031	
Snowmelt Composite	3/29/06 14:50	3/31/06 0:48	~96	~64	2.50	0.353	0.073	
Snowmelt Grab	3/31/06 10:30	3/31/06 10:30	33	19	1.60	0.241	0.069	
Storm Composite	4/6/06 17:48	4/8/06 16:52	52	28	1.70	0.210	0.075	
Storm Grab	5/16/06 14:00	5/16/06 14:00	8	~4	0.62	0.098	~0.048	
Base Composite	5/31/06 7:19	6/1/06 13:05	15	9	0.82	0.170	0.059	
E. Coli Grab	6/14/06 10:50	6/14/06 10:50						770
Base Composite	7/3/06 8:58	7/5/06 11:17	8	5			~0.041	
Base Composite	7/17/06 15:22	7/18/06 7:49	4	4	0.29	0.072	~0.042	
Storm Composite	7/19/06 10:38	7/19/06 16:22	22	14	0.89	0.166	0.052	
E. Coli Grab	7/24/06 11:15	7/24/06 11:15						772
Storm Composite	8/1/06 16:17	8/2/06 19:08	152	98	4.40	0.571	0.089	
E. Coli Grab	8/10/06 8:14	8/10/06 8:14						866
Storm Composite	8/24/06 17:57	8/25/06 12:18	62	37	1.90	0.280	0.092	
E. Coli Grab	9/6/06 10:45	9/6/06 10:45						236
Base Composite	9/12/06 13:27	9/13/06 14:31	18	~11	0.50	0.106	~0.039	
Storm Composite	9/22/06 13:13	9/24/06 8:41	24	15	1.10	0.145	0.060	
E. Coli Grab	10/10/06 8:30	10/10/06 8:30						365
Base Grab	10/23/06 14:24	10/23/06 14:24	4	3	0.40	0.066	~0.039	
Average			**37**	**24**	**1.35**	**0.199**	**0.058**	**602**

Table 14: Brown's Creek at Hwy 15 2006 Secondary Chemistry 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)
Snowmelt Grab	3/22/06 13:30	3/22/06 13:30	0.0011	0.0018	0.0004	0.0037	0.00050	0.0009	11
Snowmelt Compos	3/29/06 14:50	3/31/06 0:48	0.0100	0.0022	0.0017	0.0146	0.00010	0.0029	9
Snowmelt Grab	3/31/06 10:30	3/31/06 10:30	0.0009	0.0016	0.0007	0.0047	<.00004	0.0012	10
Storm Composite	4/6/06 17:48	4/8/06 16:52	0.0023	0.0017	0.0009	0.0057	0.00007	0.0016	11
Base Grab	5/16/06 14:00	5/16/06 14:00	0.0048	0.0015	0.0002	0.0022	<.00004	0.0007	13
Base Composite	5/31/06 7:19	6/1/06 13:05	0.0010	0.0019	0.0003	0.0057	0.00020	0.0006	13
E. Coli Grab	6/14/06 10:50	6/14/06 10:50							
Base Composite	7/3/06 8:58	7/5/06 11:17	0.0010	0.0019	0.0002	0.0035	0.00060	0.0008	12
Base Composite	7/17/06 15:22	7/18/06 7:49	0.0008	0.0017	0.0001	0.0037	0.00060	0.0006	12
Storm Composite	7/19/06 10:38	7/19/06 16:22	0.0013	0.0017	0.0006	0.0037	0.00010	0.0012	11
E. Coli Grab	7/24/06 11:15	7/24/06 11:15							
Storm Composite	8/1/06 16:17	8/2/06 19:08	0.0030	0.0028	0.0025	0.0125	0.00020	0.0045	8
E. Coli Grab	8/10/06 8:14	8/10/06 8:14							
Storm Composite	8/24/06 17:57	8/25/06 12:18	0.0019	0.0021	0.0013	0.0066	0.00010	0.0018	7
E. Coli Grab	9/6/06 10:45	9/6/06 10:45							
Base Composite	9/12/06 13:27	9/13/06 14:31	0.0005	0.0017	0.0002	0.0005	0.00010	0.0006	12
Storm Composite	9/22/06 13:13	9/24/06 8:41	0.0009	0.0019	0.0005	0.0021	0.00009	0.0011	15
E. Coli Grab	10/10/06 8:30	10/10/06 8:30							
Base Grab	10/23/06 14:24	10/23/06 14:24	0.0005	0.0013	0.0001	0.0005	<.00004	0.0005	13
Average			**0.0021**	**0.0018**	**0.0007**	**0.0050**	**0.00020**	**0.0014**	**11**

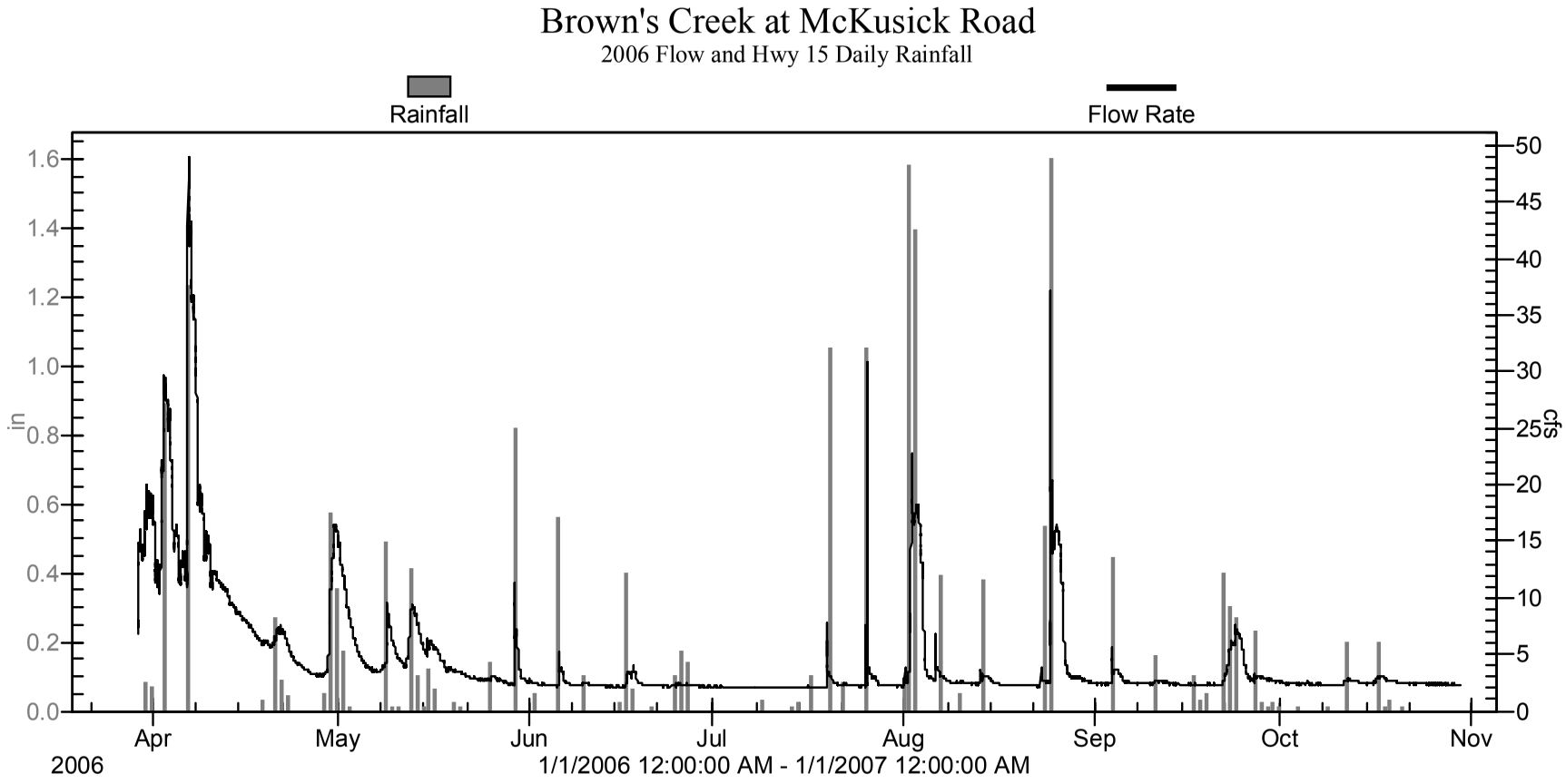


Figure 12. Brown' s Creek at McKusick Road 2006 Flow and Hwy 15 Daily Rainfall

Table 15. Brown's Creek at McKusick Road 2006 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)
Base			*12*	*0.127*	*1/1/2006 0:00*	*3/22/2006 14:00*	*13,924,800*	*9997*	*110.54*
Snowmelt Grab	3/22/06 15:45	3/22/06 15:45	6	0.078	3/22/2006 14:00	3/24/2006 1:00	1,260,000	472	6.14
Base			*12*	*0.127*	*3/24/2006 1:00*	*3/29/2006 12:30*	*2,367,000*	*1699*	*18.79*
Snowmelt Composite	3/29/06 16:42	3/31/06 18:26	88	0.333	3/29/2006 12:30	3/31/2006 4:30	2,111,083	11597	43.88
Snowmelt Grab	3/31/06 9:45	3/31/06 9:45	72	0.305	3/31/2006 4:30	4/1/2006 10:30	1,910,971	8589	36.38
Base			*12*	*0.127*	*4/1/2006 10:30*	*4/2/2006 3:30*	*758,386*	*544*	*6.02*
Storm			*164*	*0.425*	*4/2/2006 3:30*	*4/4/2006 9:30*	*4,472,740*	*45745*	*118.71*
Base			*12*	*0.127*	*4/4/2006 9:30*	*4/6/2006 13:30*	*2,559,530*	*1837*	*20.32*
Storm Composite	4/6/06 17:46	4/8/06 7:15	236	0.381	4/6/2006 13:30	4/8/2006 10:30	5,481,437	80756	130.37
Base			*12*	*0.127*	*4/8/2006 10:30*	*4/18/2006 21:30*	*9,391,062*	*6742*	*74.55*
Storm			*164*	*0.425*	*4/18/2006 21:30*	*4/19/2006 17:30*	*438,854*	*4488*	*11.65*
Base			*12*	*0.127*	*4/19/2006 17:30*	*4/20/2006 13:30*	*410,660*	*295*	*3.26*
Storm			*164*	*0.425*	*4/20/2006 13:30*	*4/22/2006 22:30*	*1,382,683*	*14141*	*36.70*
Base			*12*	*0.127*	*4/22/2006 22:30*	*4/29/2006 9:30*	*2,132,966*	*1531*	*16.93*
Storm			*164*	*0.425*	*4/29/2006 9:30*	*5/3/2006 0:30*	*3,722,402*	*38071*	*98.80*
Base			*12*	*0.127*	*5/3/2006 0:30*	*5/8/2006 21:30*	*2,300,241*	*1651*	*18.26*
Storm			*164*	*0.425*	*5/8/2006 21:30*	*5/9/2006 21:30*	*659,766*	*6748*	*17.51*
Base			*12*	*0.127*	*5/9/2006 21:30*	*5/12/2006 3:30*	*925,676*	*665*	*7.35*
Storm			*164*	*0.425*	*5/12/2006 3:30*	*5/15/2006 2:30*	*1,824,711*	*18662*	*48.43*
Base			*12*	*0.127*	*5/15/2006 2:30*	*5/15/2006 16:30*	*255,393*	*183*	*2.03*
Storm			*164*	*0.425*	*5/15/2006 16:30*	*5/17/2006 8:30*	*819,691*	*8383*	*21.76*
Base Grab	5/17/06 9:15	5/17/06 9:15	5	0.077	5/17/2006 8:30	5/25/2006 20:30	2,455,832	767	11.80
Storm			*164*	*0.425*	*5/25/2006 20:30*	*5/26/2006 20:30*	*259,840*	*2658*	*6.90*
Base			*12*	*0.127*	*5/26/2006 20:30*	*5/29/2006 17:30*	*635,099*	*456*	*5.04*
Storm			*164*	*0.425*	*5/29/2006 17:30*	*5/30/2006 11:30*	*388,635*	*3975*	*10.31*
Base Composite	5/30/06 12:13	6/2/06 13:06	22	0.189	5/30/2006 11:30	6/5/2006 22:30	1,394,415	1915	16.45
Storm			*164*	*0.425*	*6/5/2006 22:30*	*6/6/2006 17:30*	*244,549*	*2501*	*6.49*
Base			*12*	*0.127*	*6/6/2006 17:30*	*6/9/2006 14:30*	*584,562*	*420*	*4.64*
Storm			*164*	*0.425*	*6/9/2006 14:30*	*6/10/2006 19:30*	*251,900*	*2576*	*6.69*
Base			*12*	*0.127*	*6/10/2006 19:30*	*6/16/2006 20:30*	*1,149,803*	*825*	*9.13*
Storm			*164*	*0.425*	*6/16/2006 20:30*	*6/17/2006 18:30*	*247,521*	*2532*	*6.57*
Storm			*164*	*0.425*	*6/17/2006 18:30*	*6/18/2006 19:30*	*292,882*	*2995*	*7.77*
Base			*12*	*0.127*	*6/18/2006 19:30*	*6/24/2006 9:30*	*1,093,008*	*785*	*8.68*
Storm			*164*	*0.425*	*6/24/2006 9:30*	*6/25/2006 17:30*	*262,965*	*2689*	*6.98*
Base			*12*	*0.127*	*6/25/2006 17:30*	*6/26/2006 16:30*	*188,896*	*136*	*1.50*
Storm			*164*	*0.425*	*6/26/2006 16:30*	*6/26/2006 19:30*	*24,726*	*253*	*0.66*
Base Composite	7/3/06 12:09	7/5/06 15:59	9	0.115	6/26/2006 19:30	7/16/2006 7:30	3,594,262	2019	25.80
Storm			*164*	*0.425*	*7/16/2006 7:30*	*7/17/2006 12:30*	*222,717*	*2278*	*5.91*
Base Composite	7/17/06 15:38	7/18/06 10:20	12	0.127	7/17/2006 12:30	7/19/2006 9:30	341,495	245	2.71
Storm Composite	7/19/06 10:05	7/19/06 13:02	140	0.420	7/19/2006 9:30	7/19/2006 14:30	74,721	653	1.96
Base			*12*	*0.127*	*7/19/2006 14:30*	*7/25/2006 16:30*	*1,252,968*	*900*	*9.95*
Storm Composite	7/25/06 22:32	7/26/06 1:52	348	0.883	7/25/2006 16:30	7/26/2006 1:30	218,596	4749	12.05
Base			*12*	*0.127*	*7/26/2006 1:30*	*8/1/2006 0:30*	*1,281,197*	*920*	*10.17*
Storm Composite	8/1/06 19:51	8/3/06 13:20	128	0.400	8/1/2006 0:30	8/4/2006 8:30	3,348,112	26753	83.60
Base			*12*	*0.127*	*8/4/2006 8:30*	*8/6/2006 1:30*	*455,048*	*327*	*3.61*
Storm			*164*	*0.425*	*8/6/2006 1:30*	*8/6/2006 5:30*	*60,126*	*615*	*1.60*
Base			*12*	*0.127*	*8/6/2006 5:30*	*8/13/2006 11:30*	*1,643,889*	*1180*	*13.05*
Storm			*164*	*0.425*	*8/13/2006 11:30*	*8/15/2006 1:30*	*403,807*	*4130*	*10.72*
Base			*12*	*0.127*	*8/15/2006 1:30*	*8/23/2006 3:30*	*1,597,630*	*1147*	*12.68*
Storm			*164*	*0.425*	*8/23/2006 3:30*	*8/23/2006 11:30*	*81,447*	*833*	*2.16*
Base			*12*	*0.127*	*8/23/2006 11:30*	*8/24/2006 14:30*	*249,969*	*179*	*1.98*
Storm Composite	8/24/06 15:38	8/26/06 2:03	100	0.328	8/24/2006 14:30	8/27/2006 22:30	3,171,235	19797	64.93
Base			*12*	*0.127*	*8/27/2006 22:30*	*9/3/2006 15:30*	*1,519,205*	*1091*	*12.06*
Storm			*164*	*0.425*	*9/3/2006 15:30*	*9/5/2006 16:30*	*593,622*	*6071*	*15.76*
Base			*12*	*0.127*	*9/5/2006 16:30*	*9/10/2006 12:30*	*1,034,087*	*742*	*8.21*
Storm			*164*	*0.425*	*9/10/2006 12:30*	*9/12/2006 14:30*	*468,262*	*4789*	*12.43*
Base Composite	9/12/06 14:46	9/13/06 10:51	15	0.161	9/12/2006 14:30	9/21/2006 15:30	1,827,841	1712	18.37
Storm			*164*	*0.425*	*9/21/2006 15:30*	*9/23/2006 13:30*	*739,466*	*7563*	*19.63*
Storm Composite	9/23/06 16:55	9/24/06 7:38	31	0.139	9/23/2006 13:30	9/25/2006 9:30	962,830	1863	8.35
Base			*12*	*0.127*	*9/25/2006 9:30*	*9/26/2006 18:30*	*354,597*	*255*	*2.81*
Storm			*164*	*0.425*	*9/26/2006 18:30*	*9/27/2006 20:30*	*278,533*	*2849*	*7.39*
Base			*12*	*0.127*	*9/27/2006 20:30*	*10/11/2006 2:30*	*2,814,307*	*2020*	*22.34*
Storm			*164*	*0.425*	*10/11/2006 2:30*	*10/13/2006 13:30*	*567,204*	*5801*	*15.05*
Base			*12*	*0.127*	*10/13/2006 13:30*	*10/16/2006 5:30*	*561,792*	*403*	*4.46*
Storm			*164*	*0.425*	*10/16/2006 5:30*	*10/18/2006 9:30*	*536,353*	*5486*	*14.24*
Base Grab	10/23/06 14:10	10/23/06 14:10	5	0.063	10/18/2006 9:30	10/30/2006 11:45	2,536,565	792	9.98
Base			*12*	*0.127*	*10/30/2006 11:45*	*1/1/2007 0:00*	*10,801,800*	*7755*	*85.75*
Storm Average			164	0.425					
Base Average			11	0.122					
Snowmelt Average			55	0.239					
All Average			87	0.281					
Total							**112,178,365**	404,195	1,478
Brown's Creek Major Subwatershed Total Acres							11,877		
Total TP/TSS(lb/ac/yr)								34.03	0.12
Total TP/TSS (kg/ha/yr)								38.14	0.14

*Italics indicate estimated concentrations based on average base and storm flow concentrations
** Interval volumes from 1/1/06 to 3/29/06 and 10/30/06 to 1/1/07 were estimated using base flow

Table 16. Brown's Creek at McKusick Road 2006 Primary Chemistry Result Averages

Parameter	Storm Flow Average	Base Flow Average	Average (all samples)
TSS (mg/L)	164	11	87
VSS (mg/L)	54	2	30
TKN (mg/L)	2.33	0.59	1.53
TP (mg/L)	0.43	0.12	0.28
Fecal Coliform (#/100 mL)	--	--	240

Of the parameters sampled at McKusick Road (Table 17), copper, lead, and cadmium exceeded the MPCA Rule 7050 Water Quality Chronic Standard. There were four samples in which copper exceeded the MPCA Rule 7050 Water Quality Maximum Standard.

Table 17. Brown's Creek at McKusick Road Chemical Parameters Which Exceeded MPCA 7050 Water Quality Standards

Sample Type	Copper (mg/L)	Nickel (mg/L)	Lead (mg/L)	Zinc (mg/L)	Cadmium (mg/L)	Chromium (mg/L)	Chloride (mg/L)
Chronic Standard	**0.0064**	**0.088**	**0.0013**	**0.0590**	**0.00066**	**0.117**	**230**
# of Exceedences/# of Samples	1/15	0/15	6/15	0/15	2/15	0/15	0/15
Maximum Standard	**0.0092**	**0.789**	**0.0340**	**0.0650**	**0.01500**	**0.984**	**860**
# of Exceedences/# of Samples	0/15	0/15	0/15	0/15	0/15	0/15	0/15

*All water quality standards listed are the most stringent based on the use of varied levels of total hardness within MPCA 7050 water quality standards

Table 18: Brown's Creek at McKusick Road 2006 Primary Chemistry Results

Sample Type	Start	End	TSS (mg/L)	VSS (mg/L)	TKN (mg/L)	TP (mg/L)	Dissolved P (mg/L)	Fecal Coliform (#/100 mL)
Snowmelt Grab	3/22/06 15:45	3/22/06 15:45	~6	~3	1.40	0.078	0.051	
Snowmelt Composite	3/29/06 16:42	3/31/06 18:26	~88	~48	2.10	0.333	0.084	
Snowmelt Grab	3/31/06 9:45	3/31/06 9:45	~72	<40	2.00	0.305	0.086	
Storm Composite	4/6/06 17:46	4/8/06 7:15	236	66	2.60	0.381	0.079	
Base Grab	5/17/06 9:15	5/17/06 9:15	5	~2	0.71	0.077	0.052	
Base Composite	5/30/06 12:13	6/2/06 13:06	22	12	0.91	0.189	0.062	
E. Coli Sample	6/14/06 10:15	6/14/06 10:15						318
Base Composite	7/3/06 12:09	7/5/06 15:59	9	6	0.49	0.115	0.066	
Base Composite	7/17/06 15:38	7/18/06 10:20	13	~6	0.50	0.158	~0.038	
Storm Composite	7/19/06 10:05	7/19/06 13:02	140	45	2.10	0.420	0.096	
E. Coli Sample	7/24/06 11:30	7/24/06 11:30						226
Storm Composite	7/25/06 22:32	7/26/06 1:52	348	100	4.10	0.883	0.084	
Storm Composite	8/1/06 19:51	8/3/06 13:20	128	62	2.40	0.400	0.096	
E. Coli Sample	8/10/06 8:28	8/10/06 8:28						249
Storm Composite	8/24/06 15:38	8/26/06 2:03	100	39	1.80	0.328	0.083	
E. Coli Sample	9/6/06 11:00	9/6/06 11:00						299
Base Composite	9/12/06 14:46	9/13/06 10:51	15	7	0.50	0.161	~0.041	
Storm Composite	9/23/06 16:55	9/24/06 7:38	31	13	0.98	0.139	0.062	
E. Coli Sample	10/10/06 9:30	10/10/06 9:30						107
Base Grab	10/23/06 14:10	10/23/06 14:10	5	3	0.43	0.063	~0.040	
Average			**81**	**30**	**1.53**	**0.269**	**0.068**	**240**

Table 19: Brown's Creek at McKusick Road 2006 Secondary Chemistry Results

Sample Type	Start	End	Copper (mg/L)	Nickel (mg/L)	Lead (mg/L)	Zinc (mg/L)	Cadmium (mg/L)	Chromium (mg/L)	Chloride (mg/L)
Snowmelt Grab	3/22/06 15:45	3/22/06 15:45	0.0032	0.0017	0.0002	0.0032	<.00004	0.0006	21
Storm Composite	3/29/06 16:42	3/31/06 18:26	0.0123	0.0027	0.0018	0.0121	0.00010	0.0030	11
Snowmelt Grab	3/31/06 9:45	3/31/06 9:45	0.0016	0.0020	0.0011	0.0062	<.00004	0.0019	10
Storm Composite	4/6/06 17:46	4/8/06 7:15	0.0063	0.0032	0.0026	0.0133	0.00010	0.0041	11
Base Grab	5/17/06 9:15	5/17/06 9:15	0.0032	0.0018	0.0001	0.0034	<.00004	0.0007	15
Base Composite	5/30/06 12:13	6/2/06 13:06	0.0014	0.0021	0.0005	0.0060	0.00030	0.0011	17
E. Coli Sample	6/14/06 10:15	6/14/06 10:15							
Base Composite	7/3/06 12:09	7/5/06 15:59	0.0016	0.0022	0.0006	0.0059	0.00030	0.0014	17
Base Composite	7/17/06 15:38	7/18/06 10:20	0.0010	0.0022	0.0005	0.0042	<.00004	0.0013	17
Storm Composite	7/19/06 10:05	7/19/06 13:02	0.0051	0.0033	0.0021	0.0158	0.00140	0.0037	12
E. Coli Sample	7/24/06 11:30	7/24/06 11:30							
Storm Composite	7/25/06 22:32	7/26/06 1:52	0.0075	0.0055	0.0055	0.0270	0.00110	0.0074	10
Storm Composite	8/1/06 19:51	8/3/06 13:20	0.0030	0.0028	0.0019	0.0119	0.00010	0.0036	14
E. Coli Sample	8/10/06 8:28	8/10/06 8:28							
Storm Composite	8/24/06 15:38	8/26/06 2:03	0.0025	0.0026	0.0015	0.0084	0.00007	0.0024	13
E. Coli Sample	9/6/06 11:00	9/6/06 11:00							
Base Composite	9/12/06 14:46	9/13/06 10:51	0.0022	0.0020	0.0005	0.0020	0.00040	0.0009	15
Storm Composite	9/23/06 16:55	9/24/06 7:38	0.0010	0.0020	0.0005	0.0029	0.00007	0.0011	18
E. Coli Sample	10/10/06 9:30	10/10/06 9:30							
Base Grab	10/23/06 14:10	10/23/06 14:10	0.0005	0.0014	0.0001	0.0006	<.00004	0.0006	17
Average			**0.0035**	**0.0025**	**0.0013**	**0.0082**	**0.00028**	**0.0023**	**11**

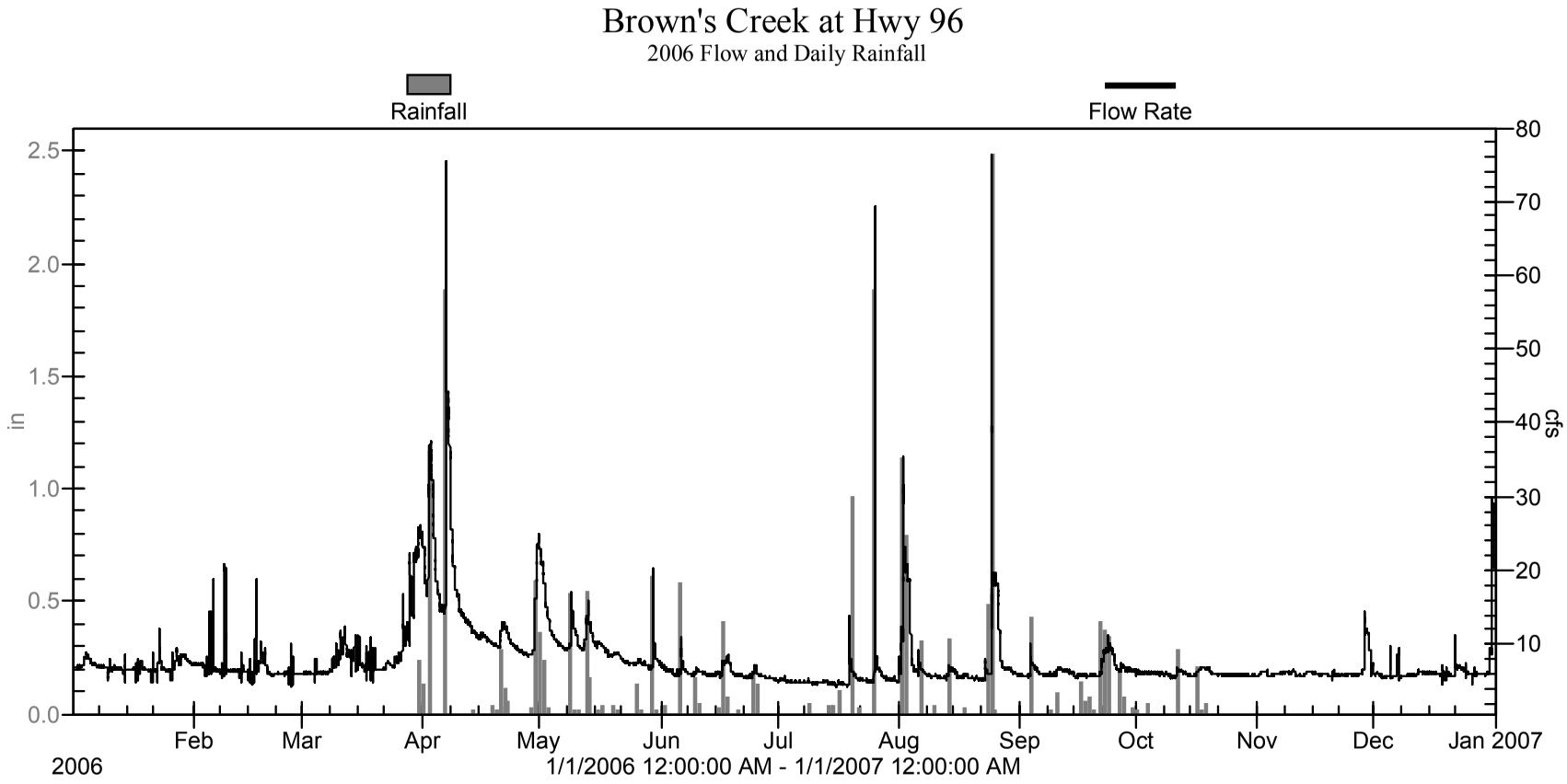


Figure 13. Brown's Creek at Hwy 96 2006 Flow and Daily Rainfall

Table 20. Brown's Creek at Hwy 96 2006 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)
Base			*12*	*0.092*	*1/1/2006 0:00*	*1/3/2006 20:00*	*1,701,912*	*1,264*	*9.79*
Snowmelt			*23*	*0.081*	*1/3/2006 20:00*	*1/5/2006 20:00*	*1,406,910*	*2,020*	*7.11*
Base			*12*	*0.092*	*1/5/2006 20:00*	*1/23/2006 1:00*	*9,992,225*	*7,423*	*57.45*
Snowmelt			*23*	*0.081*	*1/23/2006 1:00*	*1/23/2006 20:00*	*590,644*	*848*	*2.99*
Base			*12*	*0.092*	*1/23/2006 20:00*	*1/26/2006 22:00*	*1,745,153*	*1,296*	*10.03*
Snowmelt Grab	1/27/06 13:30	1/27/06 13:30	16	0.078	1/26/2006 22:00	1/28/2006 16:00	1,194,359	1,193	5.82
Base			*12*	*0.092*	*1/28/2006 16:00*	*2/4/2006 8:00*	*4,349,381*	*3,231*	*25.01*
Snowmelt			*23*	*0.081*	*2/4/2006 8:00*	*2/4/2006 20:00*	*307,604*	*442*	*1.56*
Base			*12*	*0.092*	*2/4/2006 20:00*	*2/5/2006 3:00*	*157,179*	*117*	*0.90*
Snowmelt			*23*	*0.081*	*2/5/2006 3:00*	*2/5/2006 11:00*	*329,581*	*473*	*1.67*
Base			*12*	*0.092*	*2/5/2006 11:00*	*2/6/2006 4:00*	*412,516*	*306*	*2.37*
Snowmelt			*23*	*0.081*	*2/6/2006 4:00*	*2/6/2006 12:00*	*344,684*	*495*	*1.74*
Base			*12*	*0.092*	*2/6/2006 12:00*	*2/8/2006 23:00*	*1,366,098*	*1,015*	*7.85*
Snowmelt			*23*	*0.081*	*2/8/2006 23:00*	*2/9/2006 11:00*	*697,158*	*1,001*	*3.33*
Base			*12*	*0.092*	*2/9/2006 11:00*	*2/16/2006 22:00*	*4,096,037*	*3,043*	*23.55*
Snowmelt			*23*	*0.081*	*2/16/2006 22:00*	*2/17/2006 13:00*	*717,918*	*1,031*	*3.63*
Base			*12*	*0.092*	*2/17/2006 13:00*	*2/18/2006 8:00*	*499,573*	*371*	*2.87*
Snowmelt			*23*	*0.081*	*2/18/2006 8:00*	*2/18/2006 12:00*	*145,753*	*209*	*0.74*
Base			*12*	*0.092*	*2/18/2006 12:00*	*2/25/2006 8:00*	*3,821,605*	*2,839*	*21.97*
Snowmelt			*23*	*0.081*	*2/25/2006 8:00*	*2/26/2006 20:00*	*862,026*	*1,238*	*4.36*
Base Grab	2/28/06 16:00	2/28/06 16:00	7	0.044	2/26/2006 20:00	3/8/2006 9:00	5,049,230	2,206	13.87
Snowmelt			*23*	*0.081*	*3/8/2006 9:00*	*3/15/2006 19:00*	*5,634,988*	*8,091*	*28.49*
Base			*12*	*0.092*	*3/15/2006 19:00*	*3/17/2006 5:00*	*876,473*	*651*	*5.04*
Snowmelt			*23*	*0.081*	*3/17/2006 5:00*	*3/19/2006 15:00*	*1,551,163*	*2,227*	*7.84*
Base			*12*	*0.092*	*3/19/2006 15:00*	*3/22/2006 10:00*	*1,602,602*	*1,191*	*9.21*
Snowmelt Grab	3/22/06 15:30	3/22/06 15:30	30	0.084	3/22/2006 10:00	3/23/2006 10:00	629,617	1,179	3.30
Base			*12*	*0.092*	*3/23/2006 10:00*	*3/26/2006 11:00*	*2,022,843*	*1,503*	*11.63*
Storm Grab	3/31/06 12:15	3/31/06 12:15	110	0.236	3/26/2006 11:00	4/1/2006 11:00	9,355,017	64,240	137.82
Base			*12*	*0.092*	*4/1/2006 11:00*	*4/2/2006 4:00*	*1,085,318*	*806*	*6.24*
Storm			*187*	*0.474*	*4/2/2006 4:00*	*4/4/2006 4:00*	*5,089,986*	*59,419*	*150.53*
Base			*12*	*0.092*	*4/4/2006 4:00*	*4/6/2006 16:00*	*3,484,962*	*2,589*	*20.04*
Storm			*187*	*0.474*	*4/6/2006 16:00*	*4/8/2006 13:00*	*6,218,448*	*72,592*	*183.91*
Base	4/10/06 11:00	4/10/06 11:00	26	0.105	4/8/2006 13:00	4/20/2006 13:00	13,062,630	21,202	85.62
Storm			*187*	*0.474*	*4/20/2006 13:00*	*4/22/2006 23:00*	*2,472,940*	*28,868*	*73.14*
Base			*12*	*0.092*	*4/22/2006 23:00*	*4/29/2006 7:00*	*5,100,146*	*3,789*	*29.32*
Storm			*187*	*0.474*	*4/29/2006 7:00*	*5/3/2006 19:00*	*6,769,247*	*79,022*	*200.20*
Base			*12*	*0.092*	*5/3/2006 19:00*	*5/8/2006 22:00*	*4,480,592*	*3,329*	*25.76*
Storm			*187*	*0.474*	*5/8/2006 22:00*	*5/10/2006 7:00*	*1,545,398*	*18,040*	*45.70*
Base			*12*	*0.092*	*5/10/2006 7:00*	*5/12/2006 5:00*	*1,599,095*	*1,188*	*9.19*
Storm			*187*	*0.474*	*5/12/2006 5:00*	*5/14/2006 14:00*	*2,498,705*	*29,169*	*73.90*
Base Grab	5/16/06 15:15	5/16/06 15:15	8	0.066	5/14/2006 14:00	5/29/2006 18:00	10,893,020	5,440	44.88
Storm			*187*	*0.474*	*5/29/2006 18:00*	*5/30/2006 21:00*	*1,005,781*	*11,741*	*29.75*
Base Composite	5/30/06 16:09	6/1/06 14:47	36	0.202	5/30/2006 21:00	6/5/2006 23:00	3,493,363	7,851	44.05
Storm			*187*	*0.474*	*6/5/2006 23:00*	*6/6/2006 23:00*	*685,166*	*7,998*	*20.26*
Base			*12*	*0.092*	*6/6/2006 23:00*	*6/9/2006 15:00*	*1,409,190*	*1,047*	*8.10*
Storm			*187*	*0.474*	*6/9/2006 15:00*	*6/10/2006 15:00*	*557,115*	*6,504*	*16.48*
Base			*12*	*0.092*	*6/10/2006 15:00*	*6/16/2006 21:00*	*3,231,782*	*2,401*	*18.58*
Storm			*187*	*0.474*	*6/16/2006 21:00*	*6/19/2006 3:00*	*1,468,482*	*17,143*	*43.43*
Base			*12*	*0.092*	*6/19/2006 3:00*	*6/24/2006 2:00*	*2,482,272*	*1,844*	*14.27*
Storm			*187*	*0.474*	*6/24/2006 2:00*	*6/26/2006 0:00*	*1,029,446*	*12,017*	*30.45*
Base Grab	7/5/06 15:41	7/5/06 15:41	6	0.082	6/26/2006 0:00	7/7/2006 0:00	4,993,735	1,870	25.56
Base Composite	7/18/06 8:08	7/18/06 16:24	10	0.106	7/7/2006 0:00	7/19/2006 9:00	5,126,498	3,200	33.92
Storm Composite	7/19/06 10:08	7/19/06 14:53	266	0.750	7/19/2006 9:00	7/20/2006 15:00	758,485	12,595	35.51
Base			*12*	*0.092*	*7/20/2006 15:00*	*7/25/2006 17:00*	*2,299,980*	*1,709*	*13.22*
Storm			*187*	*0.474*	*7/25/2006 17:00*	*7/25/2006 22:00*	*146,968*	*1,716*	*4.35*
Storm			*187*	*0.474*	*7/25/2006 22:00*	*7/26/2006 3:00*	*500,345*	*5,841*	*14.80*
Base Grab	7/26/06 11:45	7/26/06 11:45	14	0.132	7/26/2006 3:00	8/1/2006 1:00	2,942,662	2,572	24.25
Storm Composite	8/2/06 3:27	8/3/06 15:49	93	0.371	8/1/2006 1:00	8/4/2006 10:00	4,498,713	26,118	104.19
Base			*12*	*0.092*	*8/4/2006 10:00*	*8/6/2006 2:00*	*942,622*	*700*	*5.42*
Storm			*187*	*0.474*	*8/6/2006 2:00*	*8/6/2006 8:00*	*168,802*	*1,971*	*4.99*
Base			*12*	*0.092*	*8/6/2006 8:00*	*8/13/2006 12:00*	*3,631,952*	*2,698*	*20.88*
Storm			*187*	*0.474*	*8/13/2006 12:00*	*8/16/2006 1:00*	*1,420,347*	*16,583*	*42.01*
Base			*12*	*0.092*	*8/16/2006 1:00*	*8/23/2006 4:00*	*3,413,287*	*2,536*	*19.62*
Storm			*187*	*0.474*	*8/23/2006 4:00*	*8/23/2006 15:00*	*269,106*	*3,141*	*7.96*
Base			*12*	*0.092*	*8/23/2006 15:00*	*8/24/2006 15:00*	*325,530*	*390*	*3.02*
Storm Composite	8/24/06 19:20	8/26/06 3:24	279	0.538	8/24/2006 15:00	8/27/2006 3:00	4,027,048	70,139	135.25
Base			*12*	*0.092*	*8/27/2006 3:00*	*9/3/2006 16:00*	*4,100,701*	*3,046*	*23.58*
Storm			*187*	*0.474*	*9/3/2006 16:00*	*9/5/2006 22:00*	*1,364,764*	*15,932*	*40.36*
Base Grab	9/13/06 12:35	9/13/06 12:35	3	0.074	9/5/2006 22:00	9/21/2006 16:00	8,185,190	1,533	37.81
Storm			*187*	*0.474*	*9/21/2006 16:00*	*9/25/2006 7:00*	*2,743,332*	*32,025*	*81.13*
Base			*12*	*0.092*	*9/25/2006 7:00*	*9/26/06 19:00*	*897,704*	*667*	*5.16*
Storm			*187*	*0.474*	*9/26/2006 19:00*	*9/27/06 7:00*	*299,223*	*3,493*	*8.85*
Base			*12*	*0.092*	*9/27/2006 7:00*	*10/11/06 3:00*	*7,150,375*	*5,312*	*41.11*
Storm			*187*	*0.474*	*10/11/2006 3:00*	*10/12/06 15:00*	*820,284*	*9,576*	*24.26*
Base			*12*	*0.092*	*10/12/2006 15:00*	*10/16/06 5:00*	*1,853,098*	*1,377*	*10.65*
Storm			*187*	*0.474*	*10/16/2006 5:00*	*10/19/06 21:00*	*2,117,758*	*24,722*	*62.63*
Base Grab	10/23/06 14:01	10/23/06 14:01	2	0.036	10/19/2006 21:00	11/28/06 2:00	20,237,320	2,527	45.48
Storm			*187*	*0.474*	*11/28/2006 2:00*	*11/30/06 2:00*	*1,761,941*	*20,568*	*52.11*
Base			*12*	*0.092*	*11/30/2006 2:00*	*11/30/06 7:00*	*109,096*	*81*	*0.63*
Storm			*187*	*0.474*	*11/30/2006 7:00*	*11/30/06 23:00*	*403,050*	*4,705*	*11.92*
Base			*12*	*0.092*	*11/30/2006 23:00*	*12/3/06 0:00*	*2,016,999*	*1,498*	*11.60*
Storm			*187*	*0.474*	*12/5/2006 0:00*	*12/5/06 8:00*	*235,121*	*2,745*	*6.95*
Base			*12*	*0.092*	*12/5/2006 8:00*	*12/6/06 23:00*	*797,414*	*592*	*4.58*
Storm			*187*	*0.474*	*12/6/2006 23:00*	*12/7/06 12:00*	*374,060*	*4,367*	*11.06*
Base Grab	12/13/06 10:22	12/13/06 10:22	7	0.074	12/7/2006 12:00	12/18/06 10:00	5,625,834	2,458	25.99
Storm			*187*	*0.474*	*12/18/2006 10:00*	*12/19/06 20:00*	*706,880*	*8,252*	*20.91*
Base			*12*	*0.092*	*12/19/2006 20:00*	*12/21/06 13:00*	*858,823*	*638*	*4.94*
Storm			*187*	*0.474*	*12/21/2006 13:00*	*12/21/06 21:00*	*240,948*	*2,813*	*7.13*
Base			*12*	*0.092*	*12/21/2006 21:00*	*12/30/06 13:00*	*4,685,445*	*3,481*	*26.94*
Storm			*187*	*0.474*	*12/30/2006 13:00*	*1/1/07 0:00*	*2,016,188*	*23,336*	*59.63*
Storm Average			187	0.474					
Base Average			12	0.092					
Snowmelt Average			23	0.081					
All Average			57	0.186					
Total							**246,391,160**	834,863	2,706
Brown's Creek Major Subwatershed Total Acres							12,864		
Total TP/TSS (lb/ac/yr)								64.90	0.21
Total TP/TSS (kg/ha/yr)								*72.74*	0.24

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

Table 21. Brown's Creek at Hwy 96 (WOMP) 2006 Primary Chemistry Result Averages

Parameter	Storm Flow Average	Base Flow Average	Average (all samples)
TSS (mg/L)	187	12	57
VSS (mg/L)	59	4	18
TKN (mg/L)	2.43	0.41	0.92
TP (mg/L)	0.47	0.09	0.19
Fecal Coliform (#/100 mL)	--	--	166
COD (mg/L)	92	24	58
Alkalinity (mg/L)	109	166	196
Hardness (mg/L)	125	196	178

Of the parameters sampled at Hwy 96 (Table 22), copper exceeded both the MPCA Rule 7050 Water Quality Chronic and Maximum Standard on two samples. Copper, Lead, and Ammonia Nitrogen all exceeded the MPCA Rule 7050 Chronic Standard. Lead exceeded the MPCA Rule 7050 Chronic Standard in all samples taken in 2006. All other sampled parameters were below the Chronic Standard.

Table 22. Hwy 96 Chemical Parameters Which Exceeded MPCA 7050 Water Quality Standards

Sample Type	Copper (mg/L)	Nickel (mg/L)	Lead (mg/L)	Zinc (mg/L)	Cadmium (mg/L)	Chromium (mg/L)	Chloride (mg/L)	Ammonia Nitrogen (mg/L)
Chronic Standard	**0.0064**	**0.088**	**0.0013**	**0.0590**	**0.00066**	**0.117**	**230**	**0.04**
# of Exceedences/# of Samples	2/16	0/16	16/16	0/16	0/16	0/16	0/16	3/16
Maximum Standard	**0.0092**	**0.789**	**0.0340**	**0.0650**	**0.01500**	**0.984**	**860**	**No Standard**
# of Exceedences/# of Samples	2/16	0/16	0/16	0/16	0/16	0/16	0/16	NA

*All water quality standards listed are the most stringent based on the use of varied levels of total hardness within MPCA 7050 water quality standards

Table 23: Brown's Creek at Mouth (Highway 96) 2006 Primary Water Quality Results

Sample Type	Start	End	TSS (mg/L)	VSS (mg/L)	TKN (mg/L)	TP (mg/L)	Dissolved P (mg/L)	Fecal Coliform (#/100 mL)	COD (mg/L)	Alkalinity (mg/L)	Hardness (mg/L)
Snowmelt Grab	1/27/06 13:30	1/27/06 13:30	16	~5	0.41	0.078	0.030		~8	167	194
Base Grab	2/28/06 16:00	2/28/06 16:00	7	~1	0.18	~0.044	0.023		~5	175	208
Snowmelt Grab	3/22/06 15:30	3/22/06 15:30	30	6	0.44	0.084	0.020		~11	179	196
Storm Grab	3/31/06 12:15	3/31/06 12:15	110	~28	1.50	0.236	0.068		51	96	102
Base Grab	4/10/06 11:00	4/10/06 11:00	26	~8	0.83	0.105	0.052		28	109	130
Base Grab	5/16/06 15:15	5/16/06 15:15	8	~4	0.57	0.066	0.039		16	136	165
Base Composite	5/30/06 16:09	6/1/06 14:47	36	12	0.92	0.202	0.067		35	156	204
E. Coli Sample	6/14/06 9:00	6/14/06 9:00						236			
Base Grab	7/5/06 15:41	7/5/06 15:41	6	~3	0.15	0.082	0.058		~9	185	222
Base Composite	7/18/06 8:08	7/18/06 16:24	10	4	0.25	0.106	0.058		~12	202	218
Storm Composite	7/19/06 10:08	7/19/06 14:53	266	92	3.40	0.750	0.081		128	134	162
E. Coli Sample	7/25/06 8:30	7/25/06 8:30						156			
Base Grab	7/26/06 11:45	7/26/06 11:45	14	4	0.44	0.132	0.103		18	154	184
Storm Composite	8/2/06 3:27	8/3/06 15:49	93	44	2.20	0.371	0.205		84	104	124
E. Coli Sample	8/10/06 9:50	8/10/06 9:50						137			
Storm Composite	8/24/06 19:20	8/26/06 3:24	279	72	2.60	0.538	0.116		103	100	112
E. Coli Sample	9/6/06 10:25	9/6/06 10:25						276			
Base Grab	9/13/06 12:35	9/13/06 12:35	3	~2	0.31	0.074	~0.036		~5	188	215
E. Coli Sample	10/10/06 9:10	10/10/06 9:10						27			
Base Grab	10/23/06 14:01	10/23/06 14:01	~2	~2	0.20	~0.036	~0.046		~7	183	210
Base Grab	12/13/06 10:22	12/13/06 10:22	7	3	0.24	0.074	~0.027		~10	175	202
Average			57	18	0.92	0.186	0.064	166	33	153	178

Table 24: Brown's Creek at Mouth (Highway 96) 2006 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)	Turbidity (NTU)	Toc (mg/L)	Tbod (mg/L)
Snowmelt Grab	1/27/06 13:30	1/27/06 13:30	0.0008	0.0002	0.0013	0.0070	<0.00004	0.0012	23	<0.03	1.12	<0.02	5.8	2.5	<1.0
Base Grab	2/28/06 16:00	2/28/06 16:00	0.0006	0.0001	0.0014	0.0037	<0.00004	0.0008	19	<0.03	1.25	<0.02	3.3	1.3	<1.0
Snowmelt Grab	3/22/06 15:30	3/22/06 15:30	0.0016	0.0004	0.0022	0.0050	<0.00004	0.0013	23	0.04	1.14	<0.02	10	2.5	1
Storm Grab	3/31/06 12:15	3/31/06 12:15	0.0024	0.0012	0.0026	0.0071	0.00004	0.0026	12	<0.03	0.41	0.15	13	8.8	2.9
Storm Grab	4/10/06 11:00	4/10/06 11:00	0.0009	0.0004	0.0017	0.0030	<0.00004	0.0011	18	<0.03	0.58	~0.04	8.9	9.5	1.3
Base Grab	5/16/06 15:15	5/16/06 15:15	0.0007	0.0001	0.0018	0.0022	<0.00004	0.0008	18	<0.03	0.46	<0.02	33	7.1	1.2
Base Composite	5/30/06 16:09	6/1/06 14:47	0.0173	0.0006	0.0025	0.0074	0.00005	0.0013	20	<0.03	0.77	<0.02	17	6.5	
E. Coli Sample	6/14/06 9:00	6/14/06 9:00													
Base Grab	7/5/06 15:41	7/5/06 15:41	0.0007	0.0001	0.0022	0.0039	<0.00004	0.0010	20			<0.02	4	2.1	
Base Composite	7/18/06 8:08	7/18/06 16:24	0.0050	0.0002	0.0021	0.0029	0.00050	0.0011	22	<0.03	1.07	<0.02	5	2.4	
Storm Composite	7/19/06 10:08	7/19/06 14:53	0.0126	0.0061	0.0069	0.0250	0.00005	0.0132	18	<0.03	0.92	~0.03	130	5.5	
E. Coli Sample	7/25/06 8:30	7/25/06 8:30													
Storm Grab	7/26/06 11:45	7/26/06 11:45	0.0011	0.0004	0.0019	0.0083	0.00005	0.0010	19	<0.03	0.79	<0.02	8	3.8	1.2
Storm Composite	8/2/06 3:27	8/3/06 15:49	0.0059	0.0019	0.0030	0.0101	0.00030	0.0035	16	<0.03	0.25	<0.02	45	14	
E. Coli Sample	8/10/06 9:50	8/10/06 9:50													
Storm Composite	8/24/06 19:20	8/26/06 3:24	0.0107	0.0037	0.0046	0.0159	0.00008	0.0061	13	0.05	0.37	~0.03	84	11	
E. Coli Sample	9/6/06 10:25	9/6/06 10:25													
Base Grab	9/13/06 12:35	9/13/06 12:35	0.0005	0.0001	0.0018	<0.0004	<0.00004	0.0007	18	<0.03	0.76	<0.02	4	2.6	<1.0
E. Coli Sample	10/10/06 9:10	10/10/06 9:10													
Base Grab	10/23/06 14:01	10/23/06 14:01	<0.0005	0.0001	0.0014	0.0005	<0.00004	0.0007	20	<0.03	1.42	<0.02	4	2.8	<1.0
Base Grab	12/13/06 10:22	12/13/06 10:22	0.0005	0.0002	0.0017	0.0014	<0.00004	0.0008	20	<0.03	1.53	~0.05	5	1.8	<1.0
Average			0.0039	0.0010	0.0024	0.0065	0.00009	0.0023	19	0.03	0.86	0.03	24	5.3	1.3

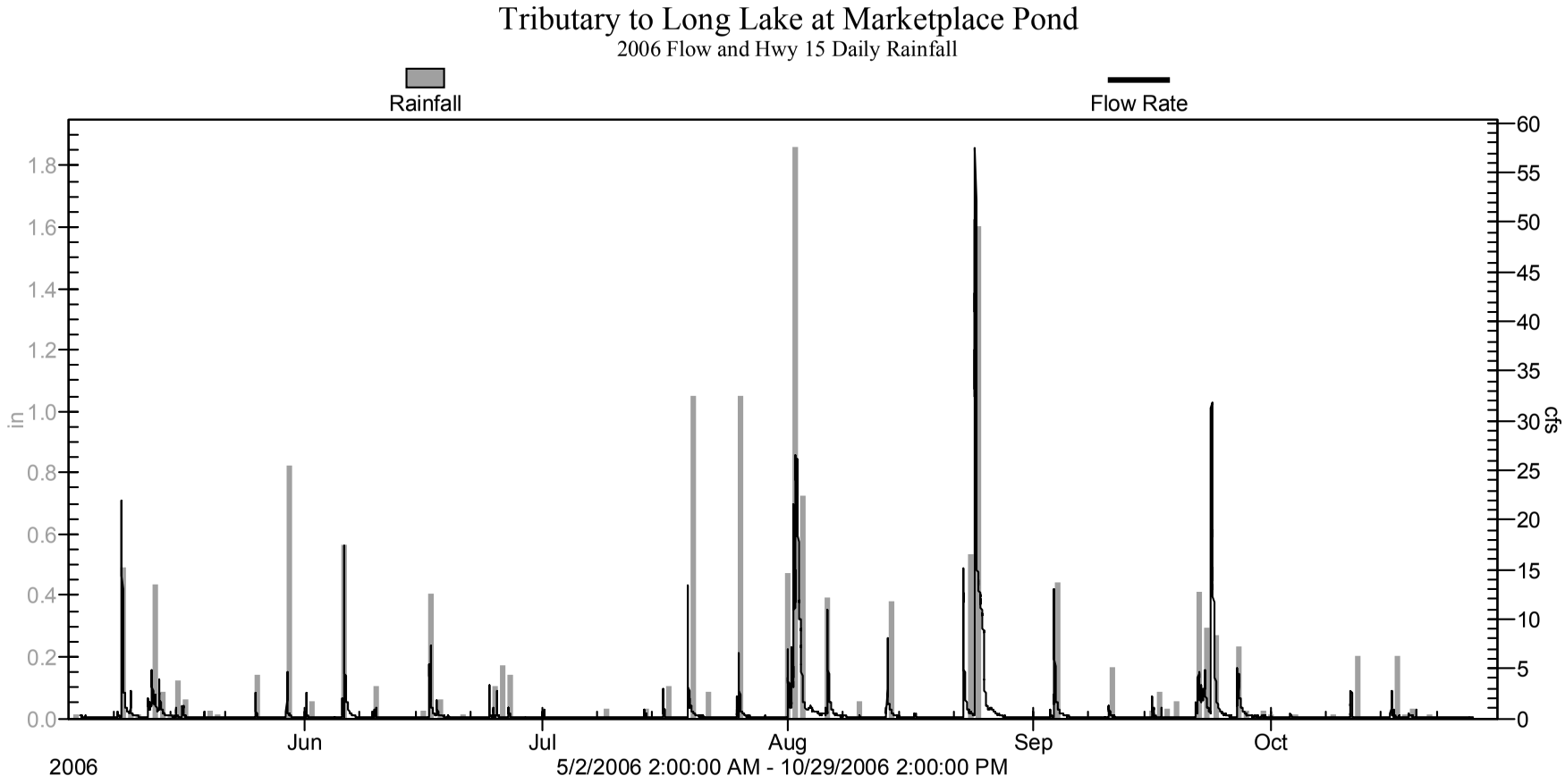


Figure 14. Tributary to Long Lake at Marketplace Pond 2006 Flow and Hwy 15 Daily Rainfall

Table 25. Tributary to Long Lake at Marketplace Pond 2006 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			*7*	*0.171*	*1/1/2006 0:00*	*5/3/2006 15:00*	*317,844*	*3.38*	*129*
Base			*7*	*0.171*	*5/3/2006 15:00*	*5/8/2006 10:00*	*22,633*	*0.24*	*9*
Storm			*108*	*0.185*	*5/8/2006 10:00*	*5/8/2006 15:00*	*3,807*	*0.04*	*26*
Base			*7*	*0.171*	*5/8/2006 15:00*	*5/8/2006 21:00*	*770*	*0.01*	*0*
Storm			*108*	*0.185*	*5/8/2006 21:00*	*5/9/2006 12:00*	*273,624*	*3.16*	*1,837*
Base			*7*	*0.171*	*5/9/2006 12:00*	*5/9/2006 22:00*	*25,143*	*0.27*	*10*
Storm			*108*	*0.185*	*5/9/2006 22:00*	*5/10/2006 3:00*	*15,404*	*0.18*	*103*
Base			*7*	*0.171*	*5/10/2006 3:00*	*5/12/2006 2:00*	*29,314*	*0.31*	*12*
Storm			*108*	*0.185*	*5/12/2006 2:00*	*5/13/2006 7:00*	*191,656*	*2.22*	*1,287*
Base			*7*	*0.171*	*5/13/2006 7:00*	*5/13/2006 12:00*	*15,522*	*0.17*	*6*
Storm			*108*	*0.185*	*5/13/2006 12:00*	*5/14/2006 1:00*	*63,747*	*0.74*	*428*
Base			*7*	*0.171*	*5/14/2006 1:00*	*5/15/2006 15:00*	*42,412*	*0.45*	*17*
Storm			*108*	*0.185*	*5/15/2006 15:00*	*5/15/2006 22:00*	*8,264*	*0.10*	*55*
Base			*7*	*0.171*	*5/15/2006 22:00*	*5/16/2006 14:00*	*9,679*	*0.10*	*4*
Storm			*108*	*0.185*	*5/16/2006 14:00*	*5/16/2006 22:00*	*10,683*	*0.12*	*72*
Base			*7*	*0.171*	*5/16/2006 22:00*	*5/18/2006 6:00*	*13,261*	*0.14*	*5*
Storm			*108*	*0.185*	*5/18/2006 6:00*	*5/18/2006 9:00*	*773*	*0.01*	*5*
Base			*7*	*0.171*	*5/18/2006 9:00*	*5/19/2006 8:00*	*3,924*	*0.04*	*2*
Storm			*108*	*0.185*	*5/19/2006 8:00*	*5/19/2006 14:00*	*3,132*	*0.04*	*21*
Base			*7*	*0.171*	*5/19/2006 14:00*	*5/20/2006 13:00*	*1,427*	*0.02*	*1*
Storm			*108*	*0.185*	*5/20/2006 13:00*	*5/20/2006 17:00*	*441*	*0.01*	*3*
Base			*7*	*0.171*	*5/20/2006 17:00*	*5/25/2006 20:00*	*9,171*	*0.10*	*4*
Storm			*108*	*0.185*	*5/25/2006 20:00*	*5/26/2006 7:00*	*15,628*	*0.18*	*105*
Base			*7*	*0.171*	*5/26/2006 7:00*	*5/29/06 17:00*	*1,942*	*0.02*	*1*
Storm			*108*	*0.185*	*5/29/2006 17:00*	*5/30/06 10:00*	*46,155*	*0.53*	*310*
Base Composite	5/30/06 12:18	5/31/06 9:50	10	0.255	5/30/2006 10:00	6/1/06 4:00	10,004	0.16	6
Storm			*108*	*0.185*	*6/1/2006 4:00*	*6/1/06 13:00*	*13,774*	*0.16*	*92*
Base			*7*	*0.171*	*6/1/2006 13:00*	*6/5/06 18:00*	*12,250*	*0.13*	*5*
Storm			*108*	*0.185*	*6/5/2006 18:00*	*6/6/06 6:00*	*209,944*	*2.43*	*1,410*
Base Grab	6/6/06 15:29	6/6/06 15:29	3	0.086	6/6/2006 6:00	6/9/06 14:00	86,478	0.46	16
Storm			*108*	*0.185*	*6/9/2006 14:00*	*6/10/06 6:00*	*20,338*	*0.24*	*137*
Base			*7*	*0.171*	*6/10/2006 6:00*	*6/16/06 19:00*	*13,229*	*0.14*	*5*
Storm Composite	6/16/06 20:06	6/16/06 22:11	290	0.314	6/16/2006 19:00	6/17/06 6:00	80,743	1.58	1,462
Base			*7*	*0.171*	*6/17/2006 6:00*	*6/17/06 17:00*	*16,360*	*0.17*	*7*
Storm			*108*	*0.185*	*6/17/2006 17:00*	*6/17/06 23:00*	*15,348*	*0.18*	*103*
Base			*7*	*0.171*	*6/17/2006 23:00*	*6/24/06 8:00*	*45,996*	*0.49*	*19*
Storm			*108*	*0.185*	*6/24/2006 8:00*	*6/25/06 13:00*	*43,067*	*0.50*	*289*
Base			*7*	*0.171*	*6/25/2006 13:00*	*6/26/06 19:00*	*10,847*	*0.12*	*4*
Storm			*108*	*0.185*	*6/26/2006 19:00*	*6/27/06 4:00*	*10,706*	*0.12*	*72*
Base			*7*	*0.171*	*6/27/2006 4:00*	*7/13/06 21:00*	*38,522*	*0.41*	*16*
Storm			*108*	*0.185*	*7/13/2006 21:00*	*7/14/06 12:00*	*11,451*	*0.13*	*77*
Base			*7*	*0.171*	*7/14/2006 12:00*	*7/16/06 6:00*	*1,993*	*0.02*	*1*
Storm			*108*	*0.185*	*7/16/2006 6:00*	*7/16/06 15:00*	*23,618*	*0.27*	*159*
Base			*7*	*0.171*	*7/16/2006 15:00*	*7/19/06 8:00*	*7,580*	*0.08*	*3*
Storm Composite	7/19/06 9:07	7/19/06 11:27	187	0.248	7/19/2006 8:00	7/20/06 12:00	172,560	2.67	2,014
Base			*7*	*0.171*	*7/20/2006 12:00*	*7/25/06 14:00*	*44,544*	*0.47*	*18*
Storm Composite	7/25/06 22:08	7/25/06 22:33	1660	0.415	7/25/2006 14:00	7/26/06 9:00	62,501	1.62	6,477
Base			*7*	*0.171*	*7/26/2006 9:00*	*8/1/06 0:00*	*56,862*	*0.61*	*23*
Storm Composite	8/1/06 0:59	8/1/06 21:45	37	0.170	8/1/2006 0:00	8/3/06 6:00	1,616,316	17.15	3,733
Base			*7*	*0.171*	*8/3/2006 6:00*	*8/6/06 1:00*	*160,891*	*1.71*	*65*
Storm			*108*	*0.185*	*8/6/2006 1:00*	*8/6/06 20:00*	*155,983*	*1.80*	*1,047*
Base			*7*	*0.171*	*8/6/2006 20:00*	*8/13/06 10:00*	*73,854*	*0.79*	*30*
Storm			*108*	*0.185*	*8/13/2006 10:00*	*8/14/06 9:00*	*117,166*	*1.36*	*787*
Base			*7*	*0.171*	*8/14/2006 9:00*	*8/23/06 3:00*	*64,476*	*0.69*	*26*
Storm Composite	8/23/06 3:18	8/23/06 11:02	32	0.115	8/23/2006 3:00	8/23/2006 17:00	249,572	1.79	499
Base			*7*	*0.171*	*8/23/2006 17:00*	*8/24/2006 14:00*	*42,032*	*0.45*	*17*
Storm Composite	8/24/06 14:31	8/24/06 18:21	79	0.171	8/24/2006 14:00	8/26/2006 8:00	2,019,991	21.56	9,962
Base			*7*	*0.171*	*8/26/2006 8:00*	*9/3/2006 4:00*	*135,167*	*1.44*	*55*
Storm Composite	9/3/06 15:26	9/3/06 19:11	80	0.144	9/3/2006 4:00	9/4/2006 18:00	250,435	2.25	1,251
Base			*7*	*0.171*	*9/4/2006 18:00*	*9/10/2006 11:00*	*38,783*	*0.41*	*16*
Storm			*108*	*0.185*	*9/10/2006 11:00*	*9/10/2006 22:00*	*23,003*	*0.27*	*154*
Base			*7*	*0.171*	*9/10/2006 22:00*	*9/16/2006 2:00*	*27,392*	*0.29*	*11*
Storm			*108*	*0.185*	*9/16/2006 2:00*	*9/16/2006 9:00*	*16,190*	*0.19*	*109*
Base			*7*	*0.171*	*9/16/2006 9:00*	*9/17/2006 5:00*	*8,781*	*0.09*	*4*
Storm			*108*	*0.185*	*9/17/2006 5:00*	*9/17/2006 10:00*	*7,100*	*0.08*	*48*
Base			*7*	*0.171*	*9/17/2006 10:00*	*9/21/2006 14:00*	*13,954*	*0.15*	*6*
Storm			*108*	*0.185*	*9/21/2006 14:00*	*9/23/2006 0:00*	*295,951*	*3.42*	*1,987*
Base			*7*	*0.171*	*9/23/2006 0:00*	*9/23/2006 13:00*	*35,122*	*0.37*	*14*
Storm Composite	9/23/06 15:26	9/23/06 23:44	48	0.135	9/23/2006 13:00	9/24/2006 17:00	653,118	5.50	1,957
Base			*7*	*0.171*	*9/24/2006 17:00*	*9/26/2006 17:00*	*49,051*	*0.52*	*20*
Storm			*108*	*0.185*	*9/26/2006 17:00*	*9/27/2006 21:00*	*152,951*	*1.77*	*1,027*
Base			*7*	*0.171*	*9/27/2006 21:00*	*10/11/2006 2:00*	*88,241*	*0.94*	*36*
Storm			*108*	*0.185*	*10/11/2006 2:00*	*10/11/2006 14:00*	*26,767*	*0.31*	*180*
Base			*7*	*0.171*	*10/11/2006 14:00*	*10/16/2006 5:00*	*3,436*	*0.04*	*1*
Storm			*108*	*0.185*	*10/16/2006 5:00*	*10/16/2006 21:00*	*31,926*	*0.37*	*214*
Base			*7*	*0.171*	*10/16/2006 21:00*	*10/18/2006 11:00*	*18,941*	*0.20*	*8*
Storm			*108*	*0.185*	*10/18/2006 11:00*	*10/18/2006 22:00*	*10,502*	*0.12*	*71*
Base			*7*	*0.171*	*10/18/2006 22:00*	*10/19/2006 10:00*	*6,403*	*0.07*	*3*
Storm			*108*	*0.185*	*10/19/2006 10:00*	*10/19/2006 14:00*	*3,998*	*0.05*	*27*
Base			*7*	*0.171*	*10/19/2006 14:00*	*10/26/2006 13:15*	*18,979*	*0.20*	*8*
Base			*7*	*0.171*	*10/26/2006 13:15*	*1/1/2007 0:00*	*172,233*	*1.83*	*70*
Storm Average			108	0.185					
Base Average			7	0.171					
All Average			243	0.205					
Total							**8,723,774**	94	40,309
Brown's Creek Major Subwatershed Total Acres							448		
Total TP/TSS(lb/ac/yr)								0.21	89.98
Total TP/TSS (kg/ha/yr)								0.24	100.85

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

** Interval volumes from 1/1/06 to 5/3/06 and 10/26/06 to 1/1/07 were estimated using base flow

Table 26. Tributary to Long Lake at Marketplace Pond 2006 Primary Chemistry Result Averages

Parameter	Storm Flow Average	Base Flow Average	Average (all samples)
TSS (mg/L)	108	7	243
VSS (mg/L)	54	3	44
TKN (mg/L)	1.25	.83	1.25
TP (mg/L)	0.19	0.17	0.21
Fecal Coliform (#/100 mL)	--	--	461

Of the parameters sampled at the Tributary to Long Lake at Marketplace Pond (Table 27), copper exceeded both the MPCA Rule 7050 Water Quality Chronic and Maximum Standard all six samples. Copper, Lead, Zinc, and Cadmium all exceeded the MPCA Rule 7050 Chronic Standard. All other sampled parameters were below the Chronic Standard.

Table 27. Tributary to Long Lake at Marketplace Pond Chemical Parameters Which Exceeded MPCA 7050 Water Quality Standards

Sample Type	Copper (mg/L)	Nickel (mg/L)	Lead (mg/L)	Zinc (mg/L)	Cadmium (mg/L)	Chromium (mg/L)	Chloride (mg/L)
Chronic Standard	**0.0064**	**0.088**	**0.0013**	**0.0590**	**0.00066**	**0.117**	**230**
# of Exceedences/# of Samples	6/6	0/6	5/6	1/6	1/6	0/6	0/6
Maximum Standard	**0.0092**	**0.789**	**0.0340**	**0.0650**	**0.01500**	**0.984**	**860**
# of Exceedences/# of Samples	6/6	0/6	0/6	0/6	0/6	0/6	0/6

*All water quality standards listed are the most stringent based on the use of varied levels of total hardness within MPCA 7050 water quality standards

Table 28: Tributary to Long Lake at Marketplace Pond 2006 Primary Water Quality Results

Sample Type	Start	End	TSS (mg/L)	VSS (mg/L)	TKN (mg/L)	TP (mg/L)	Dissolved P (mg/L)	Fecal Coliform (#/100 mL)
Base Composite	5/30/06 12:18	5/31/06 9:50	10	~6	1.50	0.255	0.111	
Base Grab	6/6/06 15:29	6/6/06 15:29	~3	~2	1.00	0.086	~0.024	
Storm Composite	6/16/06 20:06	6/16/06 22:11	290	51	2.30	0.314	0.051	
Storm Composite	7/19/06 9:07	7/19/06 11:27	187	~26	1.60	0.248	~0.025	
Storm Composite	7/25/06 22:08	7/25/06 22:33	1660	312	1.60	0.415		
Storm Composite	8/1/06 0:59	8/1/06 21:45	37	~8	0.95	0.170	0.072	
E. Coli Sample	8/10/06 8:41	8/10/06 8:41						461
Storm Composite	8/23/06 3:18	8/23/06 11:02	32	7	0.91	0.115	0.052	
Storm Composite	8/24/06 14:31	8/24/06 18:21	79	~10	1.00	0.171	0.051	
Storm Composite	9/3/06 15:26	9/3/06 19:11	80	~11	0.84	0.144	~0.030	
Storm Composite	9/23/06 15:26	9/23/06 23:44	48	~8	0.78	0.135	~0.044	
Average			**243**	**44**	**1.25**	**0.205**	**0.051**	**461**

Table 29: Tributary to Long Lake at Marketplace Pond 2006 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)
Base Composite	5/30/06 12:18	5/31/06 9:50							
Base Grab	6/6/06 15:29	6/6/06 15:29							
Storm Composite	6/16/06 20:06	6/16/06 22:11							
Storm Composite	7/19/06 9:07	7/19/06 11:27	0.0230	0.0043	0.0052	0.0640	0.00070	0.0085	
Storm Composite	7/25/06 22:08	7/25/06 22:33							
Storm Composite	8/1/06 0:59	8/1/06 21:45	0.0150	0.0024	0.0018	0.0230	0.00010	0.0034	116
E. Coli Sample	8/10/06 8:41	8/10/06 8:41							
Storm Composite	8/23/06 3:18	8/23/06 11:02	0.0107	0.0018	0.0012	0.0192	<.00004	0.0017	79
Storm Composite	8/24/06 14:31	8/24/06 18:21	0.0118	0.0031	0.0028	0.0290	0.00020	0.0072	19
Storm Composite	9/3/06 15:26	9/3/06 19:11	0.0127	0.0027	0.0026	0.0430	0.00010	0.0042	26
Storm Composite	9/23/06 15:26	9/23/06 23:44	0.0111	0.0028	0.0024	0.0210	0.00007	0.0052	31
Average			**0.0141**	**0.0029**	**0.0027**	**0.0332**	**0.00020**	**0.0050**	**54**

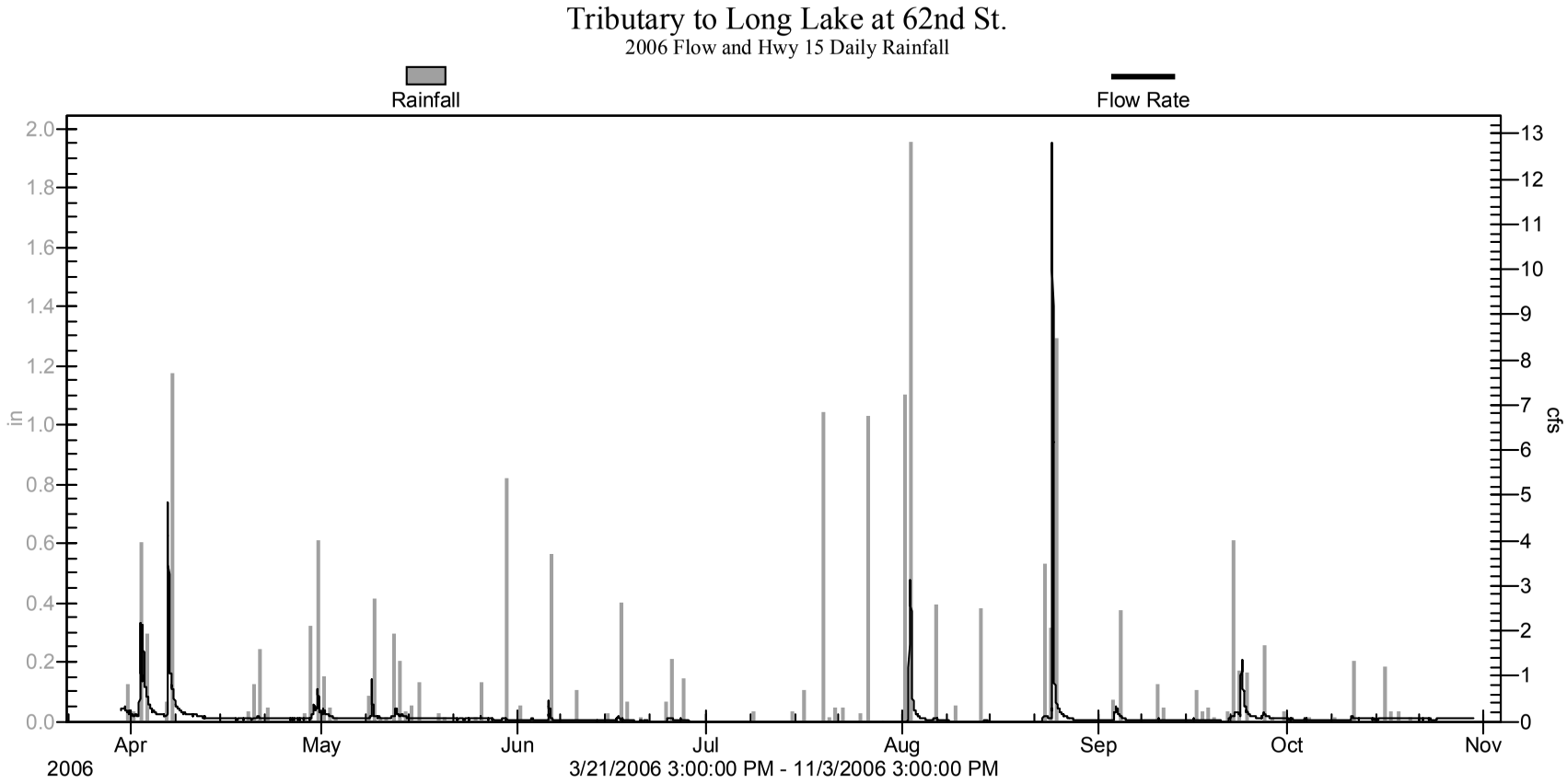


Figure 15. Tributary to Long Lake at 62nd St. 2006 Flow and Hwy 15 Daily Rainfall

Table 30. Tributary to Long Lake at 62nd St. 2006 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*	*0.052*	*1/1/2006 0:00*	*3/10/2006 0:00*	*29,376*	*0.10*	*7*
Base Grab	3/10/06 13:00	3/10/06 13:00	5	0.005	3/10/2006 0:00	3/30/2006 10:00	176,400	0.06	55
Base			*4*	*0.052*	*3/30/2006 10:00*	*3/31/2006 9:00*	*21,026*	*0.07*	*5*
Snowmelt Grab	3/31/06 9:30	3/31/06 9:30	6	0.152	3/31/2006 9:00	3/31/2006 23:00	10,360	0.10	4
Base			*4*	*0.052*	*3/31/2006 23:00*	*4/2/2006 4:00*	*13,848*	*0.05*	*3*
Storm			*41*	*0.459*	*4/2/2006 4:00*	*4/2/2006 17:00*	*49,678*	*1.42*	*127*
Storm			*41*	*0.459*	*4/2/2006 17:00*	*4/3/2006 5:00*	*56,965*	*1.63*	*145*
Base			*4*	*0.052*	*4/3/2006 5:00*	*4/6/2006 16:00*	*72,822*	*0.24*	*17*
Storm			*41*	*0.459*	*4/6/2006 16:00*	*4/7/2006 5:00*	*102,367*	*2.93*	*261*
Base Grab	4/7/06 11:15	4/7/06 11:15	8	0.219	4/7/2006 5:00	4/20/2006 12:00	153,286	2.10	77
Storm			*41*	*0.459*	*4/20/2006 12:00*	*4/21/2006 7:00*	*5,762*	*0.16*	*15*
Base			*5*	*0.141*	*4/21/2006 7:00*	*4/29/2006 8:00*	*39,309*	*0.35*	*12*
Storm			*41*	*0.459*	*4/29/2006 8:00*	*4/30/2006 4:00*	*13,856*	*0.40*	*35*
Storm			*41*	*0.459*	*4/30/2006 4:00*	*5/1/2006 4:00*	*28,094*	*0.80*	*72*
Storm			*41*	*0.459*	*5/1/2006 4:00*	*5/1/2006 18:00*	*10,459*	*0.30*	*27*
Base			*5*	*0.141*	*5/1/2006 18:00*	*5/8/2006 21:00*	*40,902*	*0.36*	*13*
Storm			*41*	*0.459*	*5/8/2006 21:00*	*5/9/2006 11:00*	*20,995*	*0.60*	*53*
Base			*5*	*0.141*	*5/9/2006 11:00*	*5/12/2006 4:00*	*17,398*	*0.15*	*5*
Storm			*41*	*0.459*	*5/12/2006 4:00*	*5/13/2006 4:00*	*12,887*	*0.37*	*33*
Base			*5*	*0.141*	*5/13/2006 4:00*	*5/13/2006 16:00*	*5,457*	*0.05*	*2*
Storm			*41*	*0.459*	*5/13/2006 16:00*	*5/14/2006 5:00*	*6,697*	*0.19*	*17*
Base Grab	5/17/06 9:52	5/17/06 9:52	6	0.175	5/14/2006 5:00	5/29/2006 17:00	75,317	0.82	28
Storm Grab	5/30/06 13:36	5/30/06 13:36	27	0.392	5/29/2006 17:00	5/30/2006 16:00	3,503	0.09	6
Base			*5*	*0.141*	*5/30/2006 16:00*	*6/5/2006 22:00*	*8,415*	*0.07*	*3*
Storm Composite***			41	0.459	6/5/2006 22:00	6/6/2006 17:00	12,310	0.35	31
Base			*5*	*0.141*	*6/6/2006 17:00*	*6/16/2006 19:00*	*11,069*	*0.10*	*3*
Storm			*41*	*0.459*	*6/16/2006 19:00*	*6/17/2006 17:00*	*3,856*	*0.11*	*10*
Storm			*41*	*0.459*	*6/17/2006 17:00*	*6/18/2006 12:00*	*1,928*	*0.06*	*5*
Base			*5*	*0.141*	*6/18/2006 12:00*	*6/24/2006 20:00*	*1,702*	*0.02*	*1*
Storm			*41*	*0.459*	*6/24/2006 20:00*	*6/26/06 19:00*	*5,788*	*0.17*	*15*
Storm			*41*	*0.459*	*6/26/2006 19:00*	*6/27/06 16:00*	*2,528*	*0.07*	*6*
Base			*5*	*0.141*	*6/27/2006 16:00*	*8/1/06 19:00*	*488*	*0.00*	*0*
Storm Composite	8/2/06 3:52	8/3/06 4:50	85	0.547	8/1/2006 19:00	8/3/06 5:00	126,015	4.30	669
Base			*5*	*0.141*	*8/3/2006 5:00*	*8/13/06 22:00*	*19,667*	*0.17*	*6*
Storm			*41*	*0.459*	*8/13/2006 22:00*	*8/14/06 16:00*	*997*	*0.03*	*3*
Storm			*41*	*0.459*	*8/14/2006 16:00*	*8/23/06 19:00*	*4,647*	*0.13*	*12*
Base			*5*	*0.141*	*8/23/2006 19:00*	*8/24/06 14:00*	*5,890*	*0.05*	*2*
Storm Composite	8/24/06 14:54	8/24/06 17:57	25	0.391	8/24/2006 14:00	8/25/06 0:00	211,388	5.16	330
Base			*5*	*0.141*	*8/25/2006 0:00*	*9/3/06 13:00*	*81,319*	*0.72*	*25*
Storm Composite	9/3/06 18:31	9/4/06 2:46	34	0.381	9/3/2006 13:00	9/5/06 2:00	21,268	0.51	45
Base			*5*	*0.141*	*9/5/2006 2:00*	*9/21/06 17:00*	*33,759*	*0.30*	*11*
Storm			*41*	*0.459*	*9/21/2006 17:00*	*9/23/06 13:00*	*21,163*	*0.61*	*54*
Storm Composite	9/23/06 15:18	9/24/06 14:26	33	0.582	9/23/2006 13:00	9/24/06 12:00	55,503	2.02	114
Base			*5*	*0.141*	*9/24/2006 12:00*	*9/26/06 18:00*	*19,356*	*0.17*	*6*
Storm			*41*	*0.459*	*9/26/2006 18:00*	*9/27/06 19:00*	*12,531*	*0.36*	*32*
Base			*5*	*0.141*	*9/27/2006 19:00*	*10/10/06 7:00*	*41,508*	*0.37*	*13*
Storm			*41*	*0.459*	*10/10/2006 7:00*	*10/12/06 6:00*	*8,923*	*0.26*	*23*
Base			*5*	*0.141*	*10/12/2006 6:00*	*10/16/06 4:00*	*15,174*	*0.13*	*5*
Storm			*41*	*0.459*	*10/16/2006 4:00*	*10/18/06 9:00*	*11,868*	*0.34*	*30*
Base Grab	10/23/06 14:37	10/23/06 14:37	1	0.030	10/18/2006 9:00	10/30/06 9:30	49,662	0.09	3
Base			*5*	*0.141*	*10/30/2006 9:30*	*1/1/07 0:00*	*27,045*	*0.24*	*8*
Storm Average			41	0.459					
Base Average			5	0.141					
Snowmelt Average			4	0.052					
All Average			23	0.287					
	No Flow								
	Start	End							
	6/28/2006 8:45	8/1/2006 19:15							
	8/8/2006 11:30	8/13/2006 22:45							
	8/14/2006 15:45	8/23/2006 7:15							
Total							**1,782,528**	30	2,481
Brown's Creek Major Subwatershed Total Acres							561		
Total TP/TSS(lb/ac/yr)								0.05	4.42
Total TP/TSS (kg/ha/yr)								0.06	4.96

*Italics indicate estimated concentrations based on average base and storm flow concentrations
** Interval volumes from 1/1/06 to 3/30/06 and 10/30/06 to 1/1/07 were estimated using base flow
***Storm composite results left out of calculation because of invalid results

Table 31. Tributary to Long Lake at 62nd St. 2006 Primary Chemistry Result Averages

Parameter	Storm Flow Average	Base Flow Average	Average (all samples)
TSS (mg/L)	41	5	23
VSS (mg/L)	13	2	8
TKN (mg/L)	1.38	1.32	1.18
TP (mg/L)	0.46	0.14	0.29
Fecal Coliform (#/100 mL)	--	--	1221

Of the parameters sampled at the Tributary to Long Lake at 62nd St. (Table 32), copper exceeded both the MPCA Rule 7050 Water Quality Chronic and Maximum Standard in three samples. Copper, Lead, Cadmium, and Chromium all exceeded the MPCA Rule 7050 Chronic Standard. All other sampled parameters were below the Chronic Standard.

Table 32. Tributary to Long Lake at 62nd St. Chemical Parameters Which Exceeded MPCA 7050 Water Quality Standards

Sample Type	Copper (mg/L)	Nickel (mg/L)	Lead (mg/L)	Zinc (mg/L)	Cadmium (mg/L)	Chromium (mg/L)	Chloride (mg/L)
Chronic Standard	**0.0064**	**0.088**	**0.0013**	**0.0590**	**0.00066**	**0.117**	**230**
# of Exceedences/# of Samples	3/6	0/6	5/6	0/6	1/6	1/6	0/6
Maximum Standard	**0.0092**	**0.789**	**0.0340**	**0.0650**	**0.01500**	**0.984**	**860**
# of Exceedences/# of Samples	3/6	0/6	0/6	0/6	0/6	0/6	0/6

*All water quality standards listed are the most stringent based on the use of varied levels of total hardness within MPCA 7050 water quality standards

Table 33: Tributary to Long Lake at 62nd St. 2006 Primary Water Quality Results

Sample Type	Start	End	TSS (mg/L)	VSS (mg/L)	TKN (mg/L)	TP (mg/L)	Dissolved P (mg/L)	Fecal Coliform (#/100 mL)
Submitted Sample	3/10/06 13:00	3/10/06 13:00	~5	~5	0.26	0.005	0.121	
Snowmelt Grab	3/31/06 9:30	3/31/06 9:30	6	~3	0.71	0.152	0.067	
Base Grab	4/7/06 11:15	4/7/06 11:15	~8	<3	1.80	0.219		
Base Grab	5/17/06 9:52	5/17/06 9:52	6	~2	0.86	0.175	~0.029	
Storm Grab	5/30/06 13:36	5/30/06 13:36	27	~15	1.50	0.392	~0.011	
E. Coli Sample	6/14/06 10:30	6/14/06 10:30						21
Storm Composite	8/2/06 3:52	8/3/06 4:50	85	~24	1.40	0.547	0.334	
Storm Composite	8/24/06 14:54	8/24/06 17:57	25	~5	1.20	0.391	0.314	
Storm Composite	9/3/06 18:31	9/4/06 2:46	34	~11	1.20	0.381	0.099	
E. Coli Sample	9/6/06 10:45	9/6/06 10:45						>2420
Storm Composite	9/23/06 15:18	9/24/06 14:26	33	~11	1.60	0.582	0.251	
Base Grab	10/23/06 14:37	10/23/06 14:37	<1	~1	1.30	~0.030	~0.029	
Average			**23**	**8**	**1.18**	**0.287**	**0.139**	**1221**

Table 34: Tributary to Long Lake at 62nd St. 2006 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)
Submitted Sample	3/10/06 13:00	3/10/06 13:00	0.0030	0.0004	0.0237	<.00004	0.00050	0.6200	192
Snowmelt Grab	3/31/06 9:30	3/31/06 9:30							78
Base Grab	4/7/06 11:15	4/7/06 11:15							
Base Grab	5/17/06 9:52	5/17/06 9:52							
Storm Grab	5/30/06 13:36	5/30/06 13:36							
E. Coli Sample	6/14/06 10:30	6/14/06 10:30							
Storm Composite	8/2/06 3:52	8/3/06 4:50	0.0164	0.0032	0.0018	0.03000	0.00100	0.0020	35
Storm Composite	8/24/06 14:54	8/24/06 17:57	0.0205	0.0026	0.0019	0.02100	0.00010	0.0032	22
Storm Composite	9/3/06 18:31	9/4/06 2:46	0.0057	0.0041	0.0013	0.02700	0.00060	0.0014	112
E. Coli Sample	9/6/06 10:45	9/6/06 10:45							
Storm Composite	9/23/06 15:18	9/24/06 14:26	0.0106	0.0030	0.0022	0.02100	0.00007	0.0027	50
Base Grab	10/23/06 14:37	10/23/06 14:37	0.0008	0.0027	<.00007	0.00320	<.00004	0.0003	207
Average			**0.0095**	**0.0027**	**0.0052**	**0.01704**	**0.00039**	**0.1049**	**99**

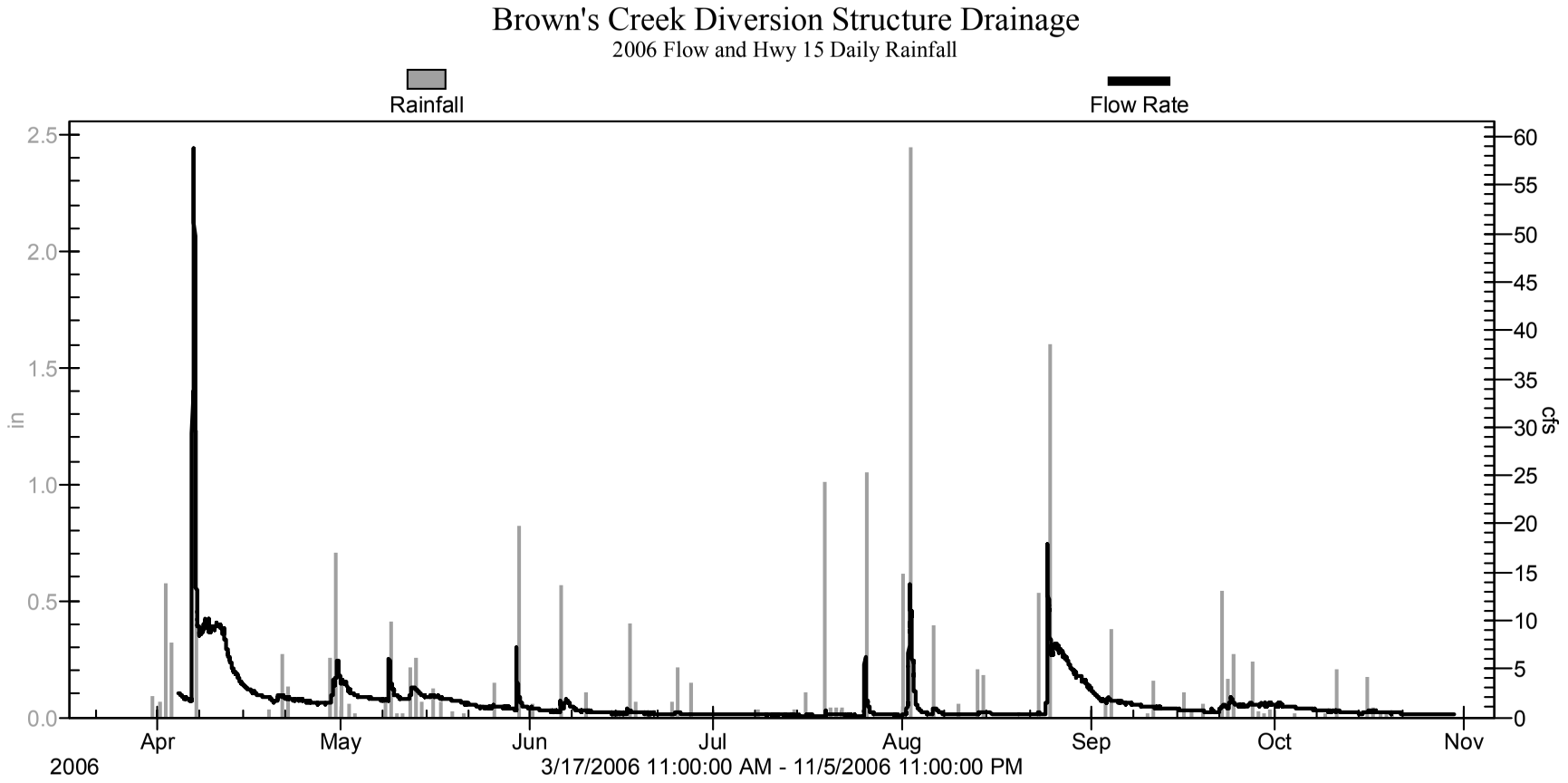


Figure 16. Brown's Creek Diversion Structure Drainage 2006 Flow and Hwy 15 Daily Rainfall

Table 35. Brown's Creek Diversion Structure Drainage 2006 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			*15*	*0.144*	*1/1/2006 0:00*	*3/10/2006 0:00*	*1,175,040*	*10.59*	*1,088*
Base			*15*	*0.144*	*3/10/2006 0:00*	*4/4/2006 12:00*	*4,406,400*	*39.70*	*4,080*
Base			*15*	*0.144*	*4/4/2006 12:00*	*4/6/2006 18:00*	*374,094*	*3.37*	*346*
Storm Composite	4/6/06 18:33	4/7/06 3:38	188	0.588	4/6/2006 18:00	4/7/2006 7:00	1,764,567	64.77	20,709
Base			*15*	*0.144*	*4/7/2006 7:00*	*4/29/2006 10:00*	*7,726,031*	*69.61*	*7,154*
Storm			*390*	*0.933*	*4/29/2006 10:00*	*5/2/2006 17:00*	*1,016,670*	*59.18*	*24,720*
Base			*15*	*0.144*	*5/2/2006 17:00*	*5/8/2006 22:00*	*1,080,111*	*9.73*	*1,000*
Storm			*390*	*0.933*	*5/8/2006 22:00*	*5/9/2006 15:00*	*238,527*	*13.89*	*5,800*
Base			*15*	*0.144*	*5/9/2006 15:00*	*5/12/2006 5:00*	*457,351*	*4.12*	*424*
Storm			*390*	*0.933*	*5/12/2006 5:00*	*5/14/2006 7:00*	*476,698*	*27.75*	*11,591*
Base Grab	*5/17/06 9:34*	*5/17/06 9:34*	*4*	*0.057*	*5/14/2006 7:00*	*5/29/2006 19:00*	*1,957,220*	*6.96*	*489*
Storm Composite	5/29/06 20:26	5/29/06 23:40	438	0.931	5/29/2006 19:00	5/30/2006 4:00	125,939	7.32	3,443
Base Composite	5/31/06 7:08	6/1/06 15:25	40	0.141	5/30/2006 4:00	6/5/2006 23:00	517,863	4.56	1,293
Storm			*390*	*0.933*	*6/5/2006 23:00*	*6/8/2006 20:00*	*290,886*	*16.93*	*7,073*
Base			*15*	*0.144*	*6/8/2006 20:00*	*6/16/2006 21:00*	*345,310*	*3.11*	*320*
Storm			*390*	*0.933*	*6/16/2006 21:00*	*6/17/2006 18:00*	*47,013*	*2.74*	*1,143*
Base			*15*	*0.144*	*6/17/2006 18:00*	*6/24/2006 21:00*	*239,256*	*2.16*	*222*
Storm			*390*	*0.933*	*6/24/2006 21:00*	*6/25/2006 21:00*	*34,936*	*2.03*	*849*
Base Grab	7/3/06 11:11	7/3/06 11:11	15	0.144	6/25/2006 21:00	7/5/2006 0:00	233,335	2.10	216
Base Grab	7/17/06 14:52	7/17/06 14:52	13	0.159	7/5/2006 0:00	7/19/2006 10:00	255,807	2.54	208
Storm			*390*	*0.933*	*7/19/2006 10:00*	*7/19/2006 22:00*	*17,767*	*1.03*	*432*
Base			*15*	*0.144*	*7/19/2006 22:00*	*7/25/2006 17:00*	*105,101*	*0.95*	*97*
Storm Composite	7/25/06 22:34	7/26/06 13:15	530	1.33	7/25/2006 17:00	7/26/2006 7:00	111,501	9.26	3,689
Base			*15*	*0.144*	*7/26/2006 7:00*	*8/1/2006 1:00*	*172,689*	*1.56*	*160*
Storm Composite	8/1/06 22:31	8/3/06 8:45	402	0.881	8/1/2006 1:00	8/3/2006 9:00	758,976	41.74	19,047
Base			*15*	*0.144*	*8/3/2006 9:00*	*8/6/06 2:00*	*126,405*	*1.14*	*117*
Storm			*390*	*0.933*	*8/6/2006 2:00*	*8/7/06 8:00*	*75,395*	*4.39*	*1,833*
Base			*15*	*0.144*	*8/7/2006 8:00*	*8/13/06 12:00*	*147,000*	*1.32*	*136*
Storm			*390*	*0.933*	*8/13/2006 12:00*	*8/15/06 9:00*	*79,371*	*4.62*	*1,930*
Base			*15*	*0.144*	*8/15/2006 9:00*	*8/23/06 4:00*	*208,202*	*1.88*	*193*
Storm			*390*	*0.933*	*8/23/2006 4:00*	*8/23/06 15:00*	*17,854*	*1.04*	*434*
Base			*15*	*0.144*	*8/23/2006 15:00*	*8/24/06 15:00*	*31,512*	*0.28*	*29*
Storm Composite	8/24/06 17:16	8/26/06 10:39	3920	1.77	8/24/2006 15:00	8/26/06 11:00	1,283,703	141.84	314,136
Base			*15*	*0.144*	*8/26/2006 11:00*	*9/3/06 16:00*	*2,852,288*	*25.70*	*2,641*
Storm			*390*	*0.933*	*9/3/2006 16:00*	*9/4/06 7:00*	*101,635*	*5.92*	*2,471*
Base Composite	9/12/06 13:58	9/13/06 12:03	12	0.259	9/4/2006 7:00	9/21/06 20:00	1,512,299	24.45	1,133
Storm			*390*	*0.933*	*9/21/2006 20:00*	*9/23/06 3:00*	*108,730*	*6.33*	*2,644*
Base			*15*	*0.144*	*9/23/2006 3:00*	*9/23/06 15:00*	*40,484*	*0.36*	*37*
Storm			*390*	*0.933*	*9/23/2006 15:00*	*9/24/06 12:00*	*124,071*	*7.22*	*3,017*
Base			*15*	*0.144*	*9/24/2006 12:00*	*9/26/06 19:00*	*236,746*	*2.13*	*219*
Storm			*390*	*0.933*	*9/26/2006 19:00*	*9/28/06 2:00*	*149,083*	*8.68*	*3,625*
Base			*15*	*0.144*	*9/28/2006 2:00*	*10/11/06 5:00*	*1,119,126*	*10.08*	*1,036*
Storm			*390*	*0.933*	*10/11/2006 5:00*	*10/11/06 21:00*	*38,821*	*2.26*	*944*
Base			*15*	*0.144*	*10/11/2006 21:00*	*10/16/06 7:00*	*175,231*	*1.58*	*162*
Storm			*390*	*0.933*	*10/16/2006 7:00*	*10/18/06 6:00*	*98,280*	*5.72*	*2,390*
Base Grab	10/23/06 14:21	10/23/06 14:21	3	0.07	10/18/2006 6:00	10/30/06 11:15	380,502	1.66	71
Base			*15*	*0.144*	*10/30/2006 11:15*	*1/1/07 0:00*	*1,080,540*	*9.74*	*1,001*
Storm Average			390	0.933					
Base Average			14	0.138					
Snowmelt Average									
All Average			182	0.499					
Total							**33,916,362**	676	455,793
Brown's Creek Major Subwatershed Total Acres							3,837		
Total TP/TSS(lb/ac/yr)								0.18	118.79
Total TP/TSS (kg/ha/yr)								0.20	133.14

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

** Interval volumes from 1/1/06 to 4/4/06 and 10/30/06 to 1/1/07 where estimated based upon base flow

Table 36. Brown's Creek Diversion Structure Drainage 2006 Primary Chemistry Result Averages

Parameter	Storm Flow Average	Base Flow Average	Average (all samples)
TSS (mg/L)	390	14	182
VSS (mg/L)	707	6	300
TKN (mg/L)	8.63	0.73	3.96
TP (mg/L)	0.93	0.14	0.50
Fecal Coliform (#/100 mL)	--	--	305

Of the parameters sampled at the Brown's Creek Diversion Structure Drainage (Table 37), copper exceeded both the MPCA Rule 7050 Water Quality Chronic and Maximum Standard in three samples. Copper, Lead, Zinc, and Cadmium all exceeded the MPCA Rule 7050 Chronic Standard. All other sampled parameters were below the Chronic Standard.

Table 37. Brown's Creek Diversion Structure Drainage 2006 Chemical Parameters Which Exceeded MPCA 7050 Water Quality Standards

Sample Type	Copper (mg/L)	Nickel (mg/L)	Lead (mg/L)	Zinc (mg/L)	Cadmium (mg/L)	Chromium (mg/L)	Chloride (mg/L)
Chronic Standard	**0.0064**	**0.088**	**0.0013**	**0.0590**	**0.00066**	**0.117**	**230**
# of Exceedences/# of Samples	3/7	0/7	3/7	1/7	1/7	0/7	0/7
Maximum Standard	**0.0092**	**0.789**	**0.0340**	**0.0650**	**0.01500**	**0.984**	**860**
# of Exceedences/# of Samples	2/7	0/7	0/7	1/7	0/7	0/7	0/7

*All water quality standards listed are the most stringent based on the use of varied levels of total hardness within MPCA 7050 water quality standards

Table 38: Brown's Creek Diversion Structure Drainage 2006 Primary Water Quality Results

Sample Type	Start	End	TSS (mg/L)	VSS (mg/L)	TKN (mg/L)	TP (mg/L)	Dissolved P (mg/L)	Fecal Coliform (#/100 mL)
Storm Composite	4/6/06 18:33	4/7/06 3:38	188	~68	2.70	0.588	0.061	
Base Grab	5/17/06 9:34	5/17/06 9:34	~4	~2	0.72	0.057	~0.028	
Storm Composite	5/29/06 20:26	5/29/06 23:40	438	164	4.70	0.931	~0.042	
Base Composite	5/31/06 7:08	6/1/06 15:25	40	14	1.00	0.141	~0.037	
E. Coli Sample	6/14/06 10:00	6/14/06 10:00						86
Base Grab	7/3/06 11:11	7/3/06 11:11	17	6	0.60	0.180	0.074	
Base Grab	7/17/06 14:52	7/17/06 14:52	13	~5	0.52	0.159	0.067	
E. Coli Sample	7/24/06 11:30	7/24/06 11:30						488
Storm Composite	7/25/06 22:34	7/26/06 13:15	530	200	5.80	1.330	0.082	
Storm Composite	8/1/06 22:31	8/3/06 8:45	402	168	5.00	0.881	0.089	
E. Coli Sample	8/10/06 8:23	8/10/06 8:23						770
Storm Composite	8/24/06 17:16	8/26/06 10:39	3920	2390	21.00	1.770	0.080	
E. Coli Sample	9/6/06 10:45	9/6/06 10:45						84
Base Composite	9/12/06 13:58	9/13/06 12:03	12	~5	1.10	0.259	~0.035	
E. Coli Sample	10/10/06 9:35	10/10/06 9:35						96
Base Grab	10/23/06 14:21	10/23/06 14:21	3	~2	0.44	0.070	~0.047	
Average			**506**	**275**	**3.96**	**0.579**	**0.058**	**305**

Table 39: Brown's Creek Diversion Structure Drainage 2006 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)
Storm Composite	4/6/06 18:33	4/7/06 3:38							
Base Grab	5/17/06 9:34	5/17/06 9:34							
Storm Composite	5/29/06 20:26	5/29/06 23:40							
Base Composite	5/31/06 7:08	6/1/06 15:25							
E. Coli Sample	6/14/06 10:00	6/14/06 10:00							
Base Grab	7/3/06 11:11	7/3/06 11:11	0.0013	0.0025	0.0005	0.0044	<.00004	0.0013	25
Base Grab	7/17/06 14:52	7/17/06 14:52	0.0017	0.0025	0.0005	0.0059	0.00070	0.0013	29
E. Coli Sample	7/24/06 11:30	7/24/06 11:30							
Storm Composite	7/25/06 22:34	7/26/06 13:15	0.0139	0.0106	0.0089	0.0480	0.00030	0.0113	30
Storm Composite	8/1/06 22:31	8/3/06 8:45	0.0081	0.0093	0.0052	0.0270	0.00030	0.0065	21
E. Coli Sample	8/10/06 8:23	8/10/06 8:23							
Storm Composite	8/24/06 17:16	8/26/06 10:39	0.0270	0.0420	0.0168	0.1550	0.00300	0.0205	39
E. Coli Sample	9/6/06 10:45	9/6/06 10:45							
Base Composite	9/12/06 13:58	9/13/06 12:03	0.0015	0.0013	0.0008	0.0036	0.00040	0.0009	80
E. Coli Sample	10/10/06 9:35	10/10/06 9:35							
Base Grab	10/23/06 14:21	10/23/06 14:21	0.0007	0.0015	0.0002	0.0007	<.00004	0.0006	39
Average			**0.0077**	**0.0100**	**0.0047**	**0.0349**	**0.00068**	**0.0061**	**38**

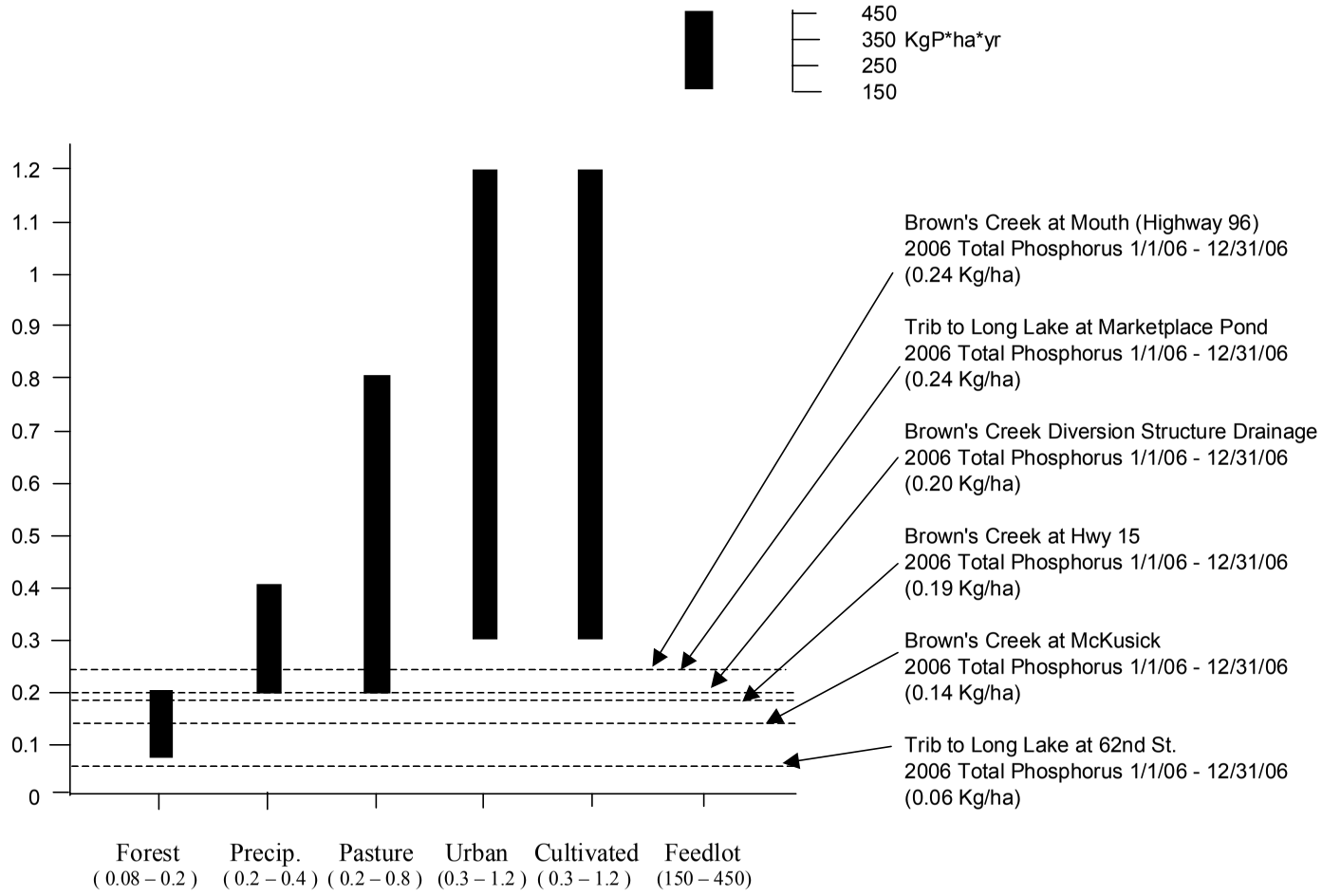


Figure 17: Total Phosphorus Export Coefficients: Brown's Creek and Estimated Range by Land Use (literature estimates)

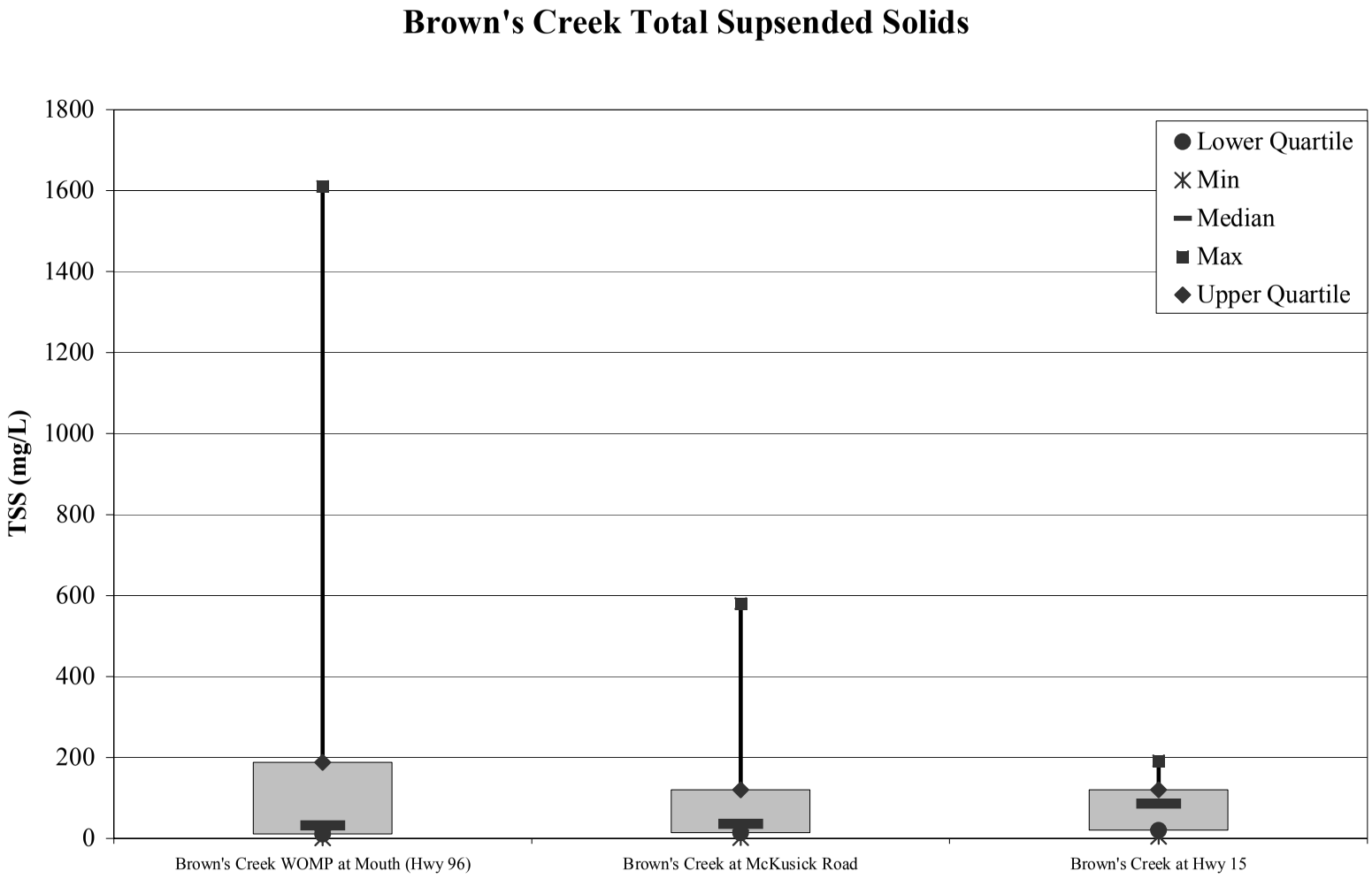


Figure 18. Brown's Creek Monitoring Sites' Historical Period of Record Monitoring Season Total Suspended Solids Box and Whisker Plot

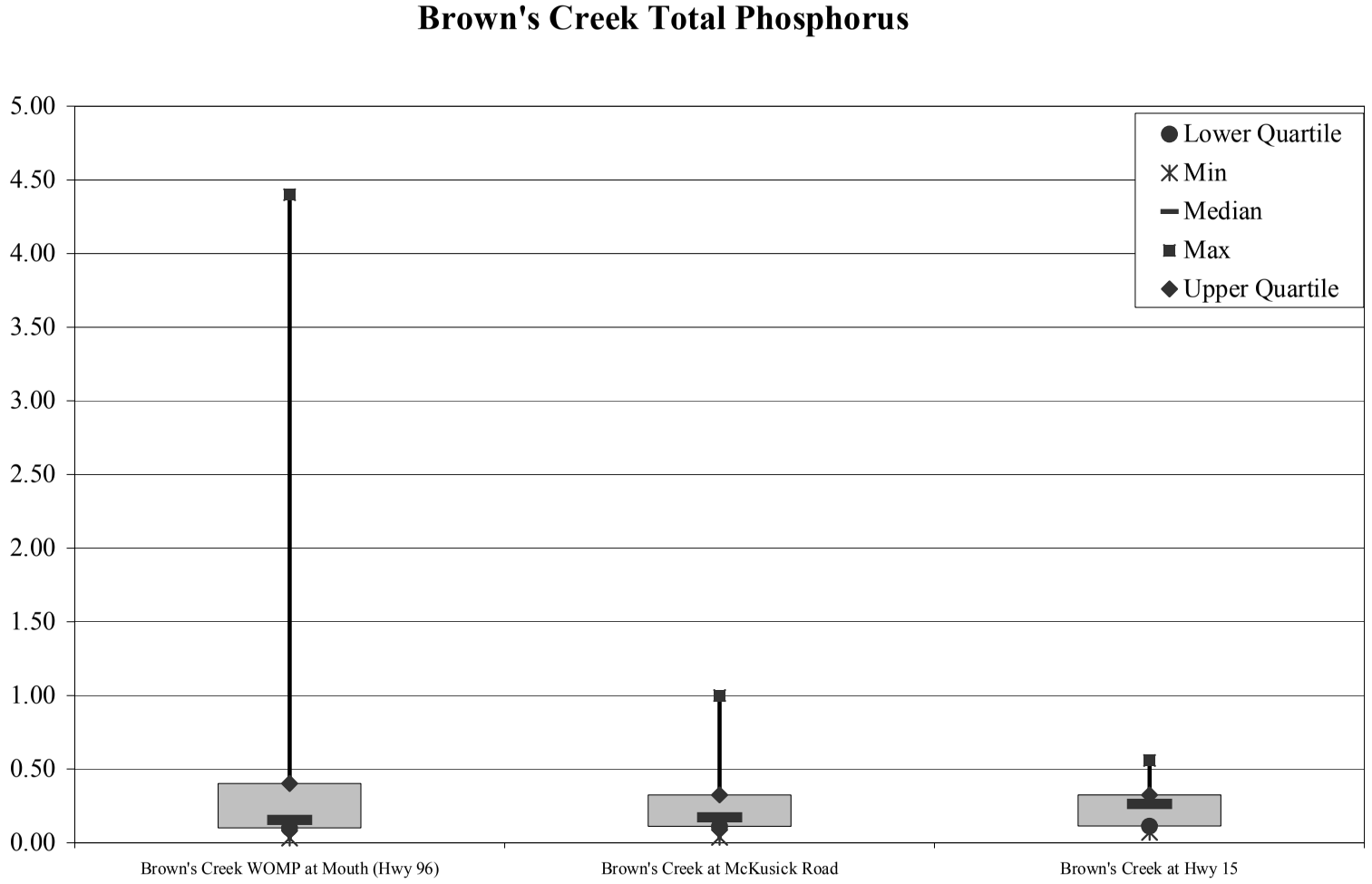


Figure 19. Brown's Creek Monitoring Sites' Historical Period of Record Monitoring Season Total Phosphorus Box and Whisker Plot

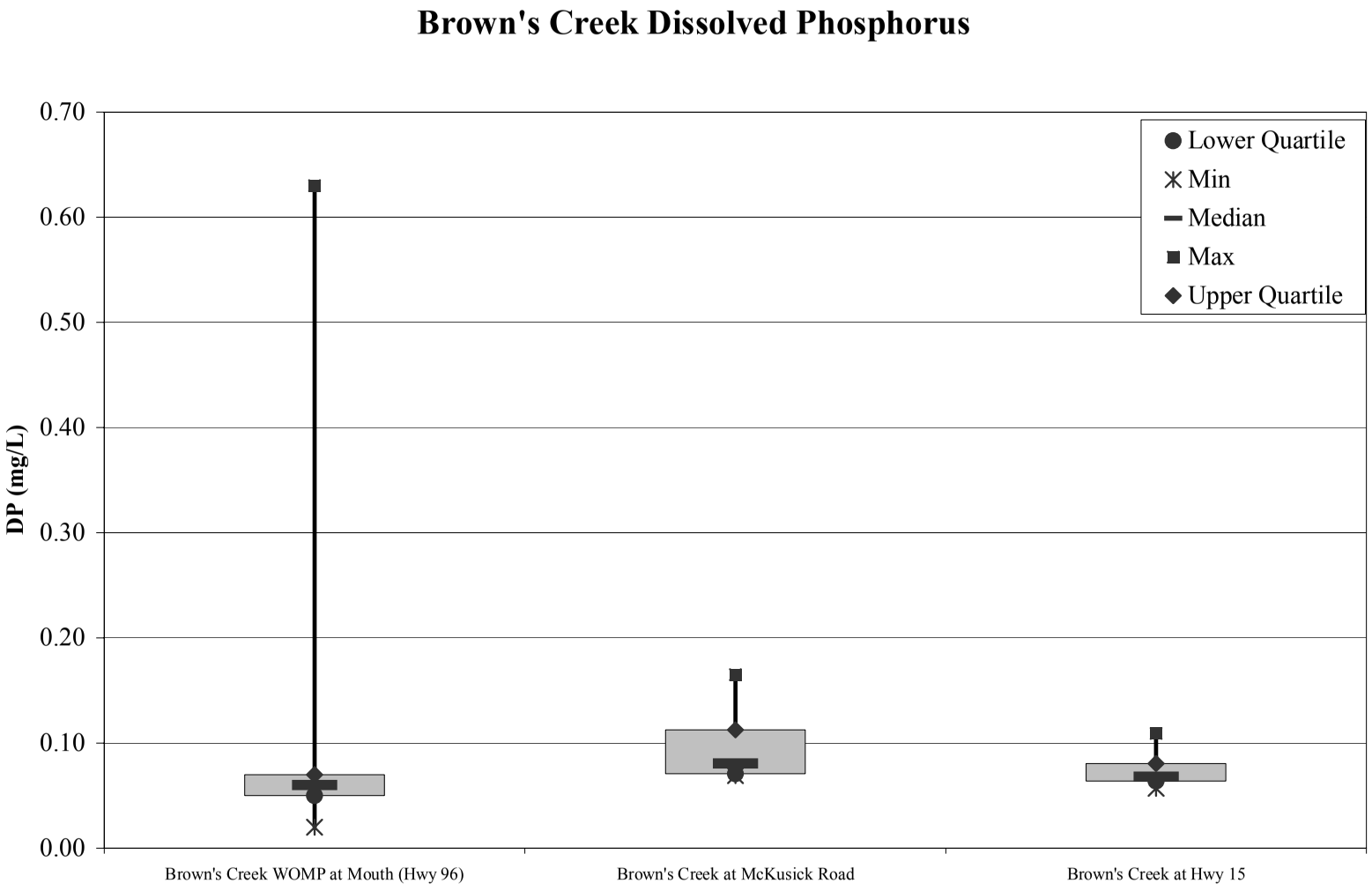


Figure 20. Brown's Creek Monitoring Sites' Historical Period of Record Monitoring Season Dissolved Phosphorus Box and Whisker Plot

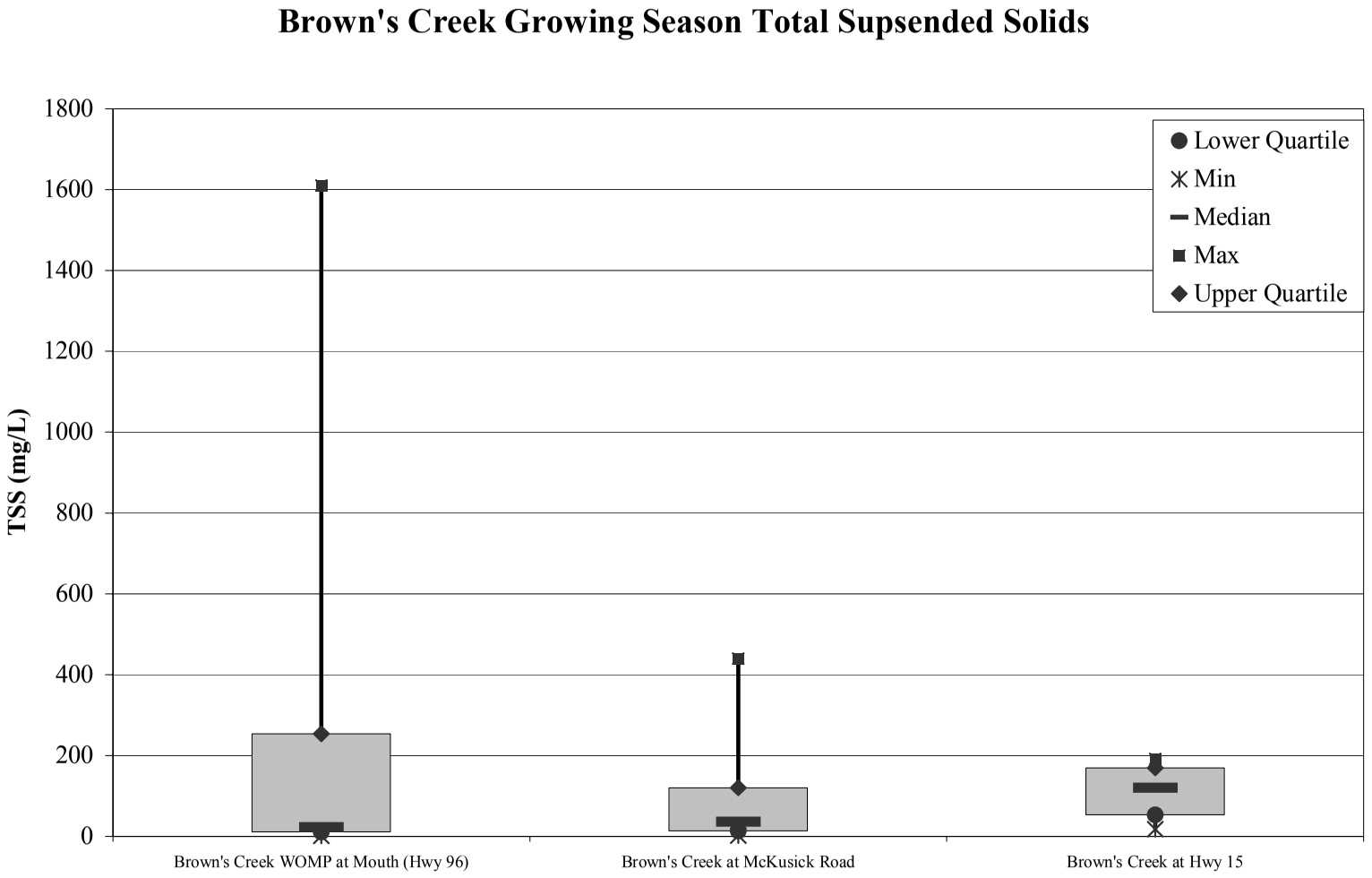


Figure 21. Brown's Creek Monitoring Sites' Historical Period of Record Growing Season (June-September) Total Suspended Solids Box and Whisker Plot

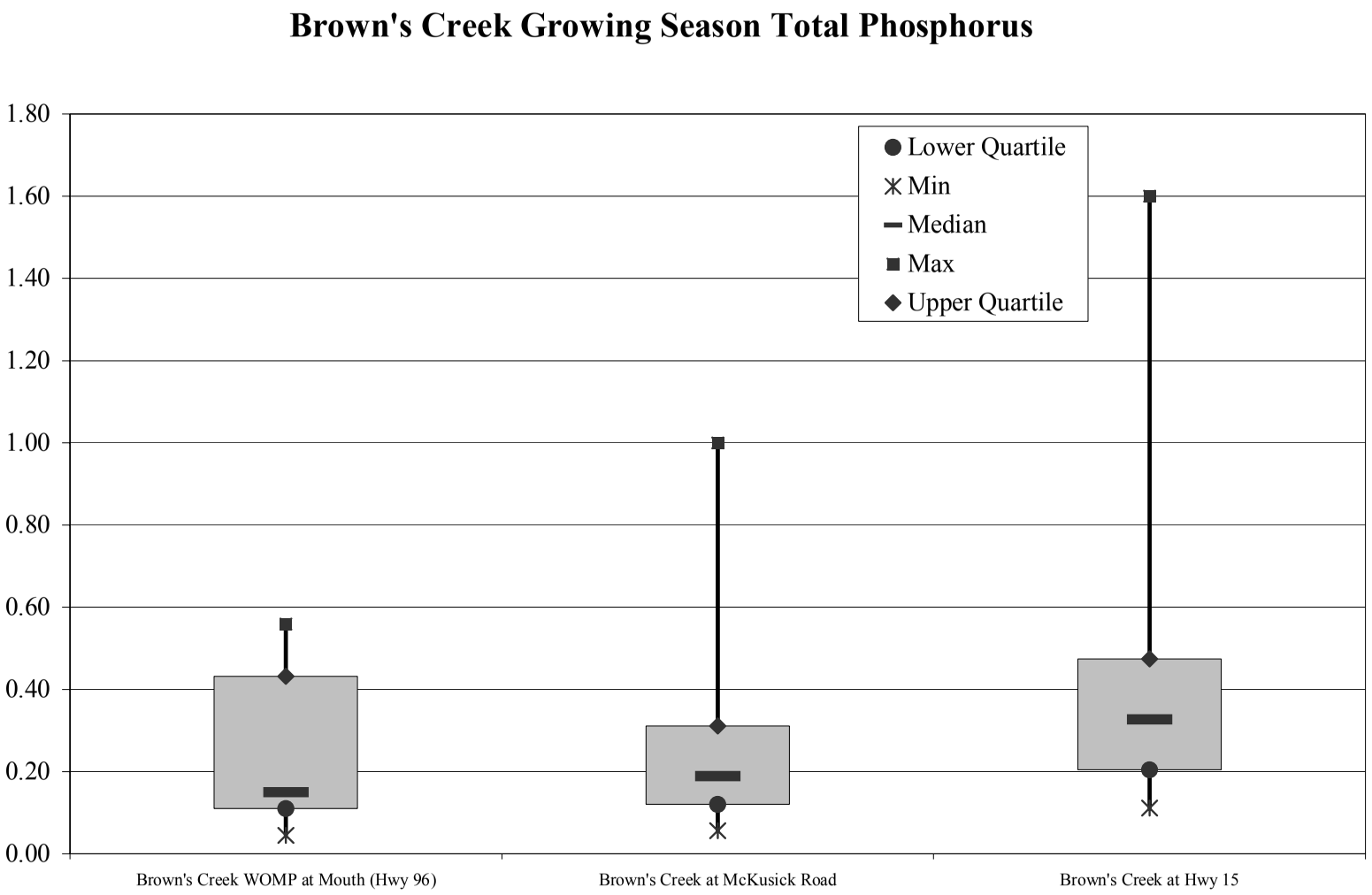


Figure 22. Brown's Creek Monitoring Sites' Historical Period of Record Growing Season (June-September) Total Phsophorus Box and Whisker Plot

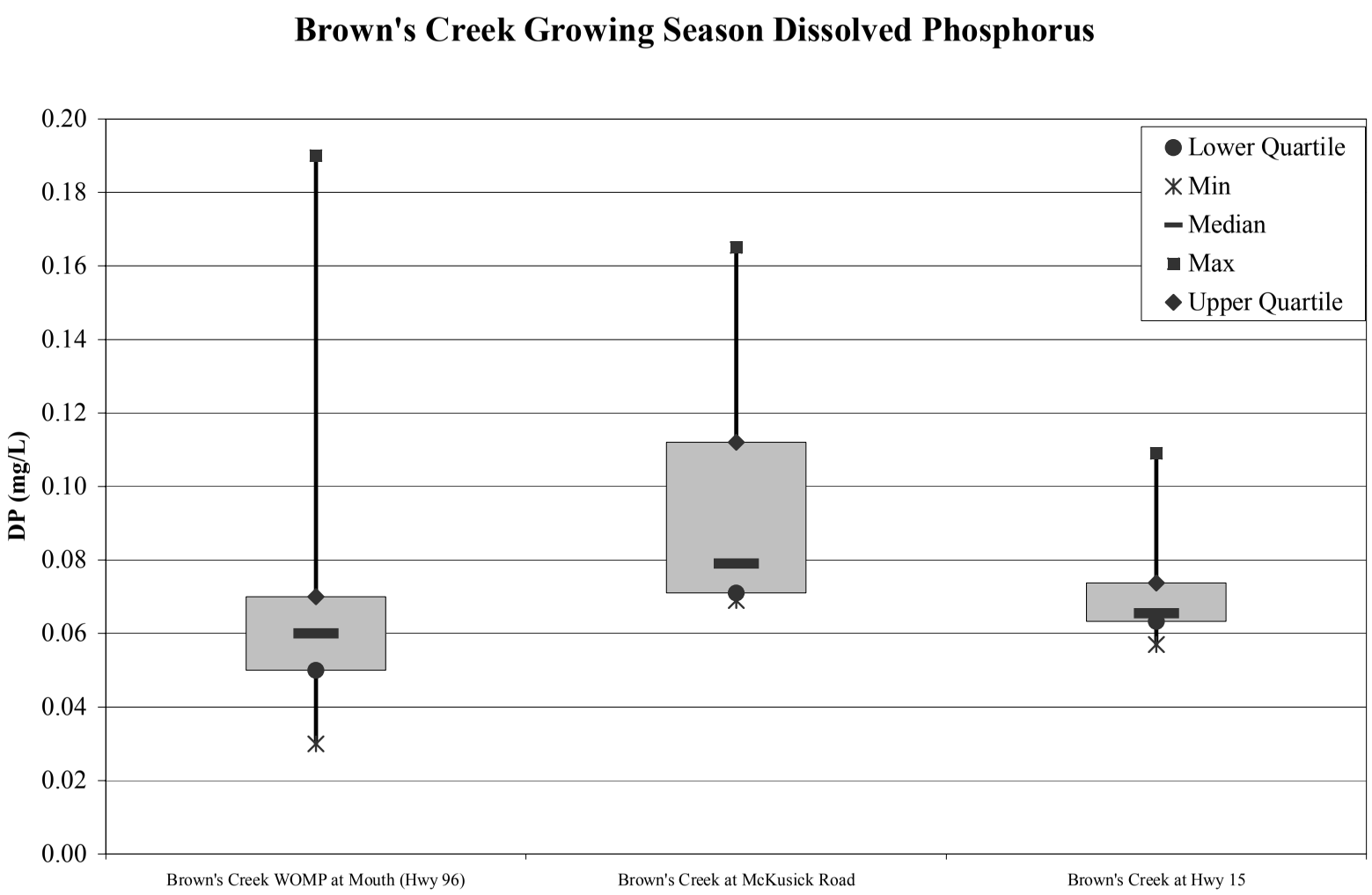


Figure 23. Brown's Creek Monitoring Sites' Historical Period of Record Growing Season (June-September) Dissolved Phosphorus Box and Whisker Plot

2. FISHERIES DATA

Brown's Creek is a designated trout stream managed by The Minnesota Department of Natural Resources, Division of Fisheries. It's one of the few trout streams in the Twin Cities Metropolitan area that support a fishable trout population. Compared to other fish species, trout need colder and cleaner water to survive. They also need a variety of stream habitats, including deep pools with overhead cover. The DNR has actively managed Brown's Creek since 1951 (Table 40).

Table 40: Fish Stocking in Brown's Creek

Year	Number	Rate	Species/Strain	Size
1951	495	Total	Brook Trout	fingerling
1955-56	566-567	Total/year	Brown Trout	yearling
1956-57	99-103	Total/year	Brook Trout	yearling
1957-66	168-940	Total/year	Brown Trout	yearling
1967-73	1086-1274	Total/year	Brown Trout	yearling
1970	1086	Total	Brown Trout	adult
1974-83	572-800	Total/year	Brown Trout	yearling
1984	1100	Total	Brown Trout	fingerling
1985	800	Total	Brown Trout	yearling
1986	800	Total	Brown Trout	yearling
1987	800	Total	Brown Trout	yearling
1988	800	Total	Brown Trout	yearling
1989	800	Total	Brown Trout	yearling
1990	800	Total	Brown Trout	yearling
1991	800	Total	Brown Trout	yearling
1992	800	Total	Brown Trout	yearling
1993	800	Total	Brown Trout	yearling
1994	800	Total	Brown Trout	yearling
1995	800	Total	Brown Trout	yearling
1996	1600	Total	Brown Trout	yearling
1997	800	Total	Brown Trout	yearling
1998	800	Total	Brown Trout	yearling
1999	800	Total	Brown Trout	yearling
2000	1300	Total	Brown Trout	yearling
2001	800	Total	Brown Trout	yearling
2002	800	Total	Brown Trout	yearling
2003	1000	Total	Brown Trout	yearling
2004	800	Total	Brown Trout	yearling
2005	1000	Total	Brown Trout	yearling
2006	1000	Total	Brown Trout	yearling

Population assessments help the DNR track the health of the stream and manage the recreational fishery. Fishing pressure in Brown's Creek is fairly strong at the season opener and tapers off as the season progresses. DNR Fisheries acquired an angler easement ten feet on either side of the stream up to the first house below the stone bridge. Brown's Creek was first stocked with brown trout in 1955 and then annually from 1958 to present. Current management plans call for 1,000 fingerling brown trout to be stocked each spring. Stocked fish typically average about 5 to 6 inches in length, although some can be as large as 12 inches. Brown trout stocked in Brown's Creek fare quite well, growing at fairly rapid rates. Fall electrofishing surveys by the DNR typically find many fish in the 8- to 9-inch. Survey data also show that in many years' adult trout successfully spawn and the young fish survive and grow to be part of the fishable population. This is known as natural reproduction. In some years, however, eggs and young fish do not survive, or survival is poor.

Recent years have been some of the best recorded for the brown trout population in Brown's Creek. Figure 24 gives an indication of changes in the trout population since 1966. This graph represents the number of trout captured during fall surveys and includes all sizes of trout; the actual number of trout in the stream is higher, since not all fish are captured during surveys. The areas sampled varied from year to year, but would typically coincide with the sections of stream where trout were found. In some years, the area was not very far upstream from the intersection of Highways 95 and 96. Some years were sampled twice, only fall samples are shown. Part of the variation in surveys was due to the fact that the DNR historically did not find trout upstream of the Highway 5 bridge and therefore did not survey beyond the bridge. However, they now find trout over a mile upstream of the bridge. Sampling has been extended to include this upstream habitat. This upstream expansion is directly linked to habitat improvement projects

that are described later in this summary. The upstream expansion and overall increase in trout numbers is viewed by the DNR as a positive sign for Brown's Creek.

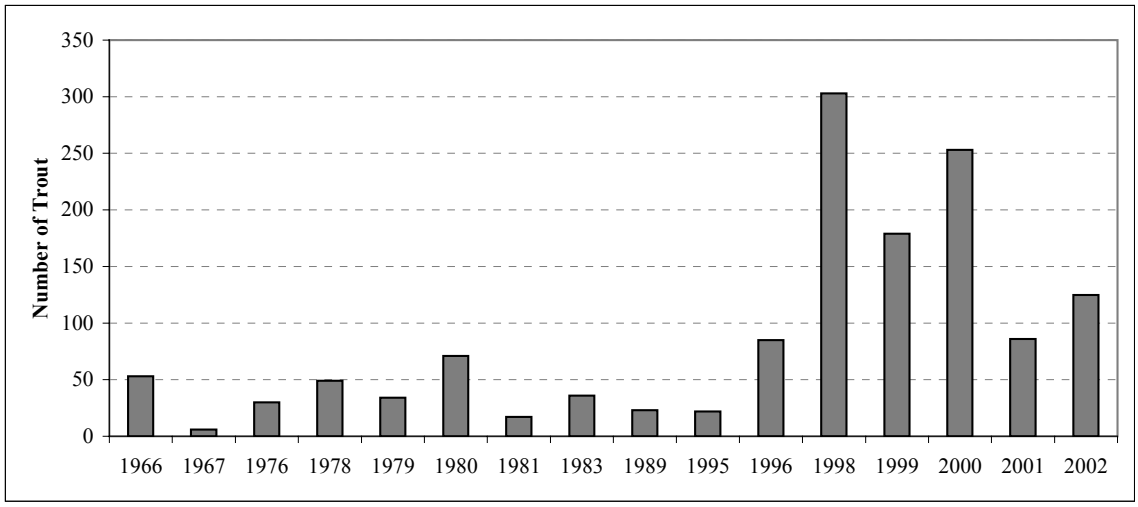


Figure 24: Historical electrofishing data (Source: DNR Fisheries)

The long-term outlook for natural reproduction is less clear. Historically, brown trout have reproduced in Brown's Creek in fairly limited numbers. However, since the DNR did not survey Brown's Creek every year until the late 1990's, it is difficult to know what happened in the years that they did not survey the stream. Natural reproduction is indicated by the presence of small brown trout, typically 4 or 5 inches at the time of fall surveys (see photo on the right). Fish biologists often refer to these small trout as 'young-of-the-year', because they haven't lived a full year. Stream surveys confirmed natural reproduction in 1966, 1976, 1989, 1998, 1999, 2000, 2001, 2003, and 2004. It is evident from the survey that 1998 was the best year for 'young-of-the-year trout', with 1999 and 2004 not far behind. However, in 2001 and 2002, there was a noticeable lack of smaller fish, although the numbers of larger fish continued to be fairly high. Figure 25 shows more detailed information from the past seven years of surveying conducted by the trout specialists and crew at the MN DNR. Note fewer numbers of young-of-the-year trout in 2001 and 2002. Because they are smaller than the size of trout stocked, the presence of young-of-the-year trout indicates successful natural reproduction.

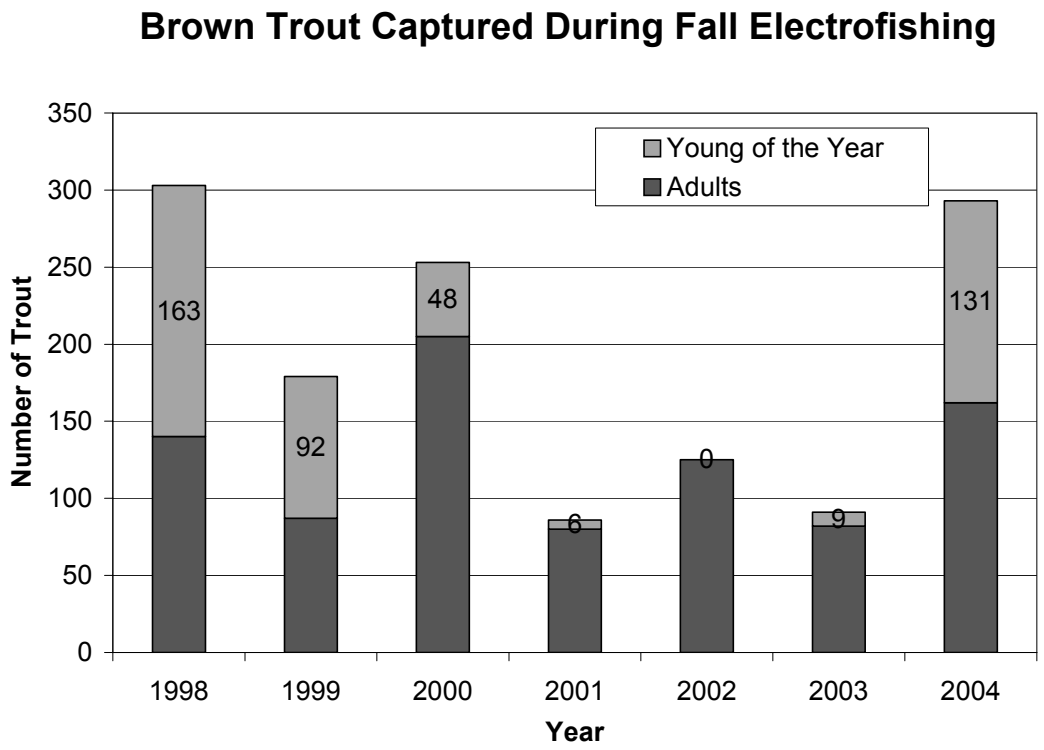


Figure 25: Electrofishing Results 1998-2004: Young of Year & Adult Brown Trout

Water quality, habitat quality and food availability are all factors that determine how well trout survive, grow, and reproduce. These factors vary from stream to stream, with each stream having a unique composition. Some streams are more subject to floods, others more prone to warm temperatures. In all trout streams, repeated periods of high stream flow and elevated water temperatures will take a toll on trout survival and reproduction. Year to year variability will result in a "bad" year now and then, but repeated bad years can indicate a negative trend in trout populations. Brown trout spawn in the fall by burying their eggs in gravel. The eggs develop slowly over the winter and typically hatch in March and April. At these early stages in their life, trout are not very effective swimmers. Some fish will simply die or be consumed by larger trout or other predators. High stream flows from snowmelt and rainfall can quickly sweep these small fry downstream and into the St. Croix River, essentially removing them from the population. In Brown's Creek, the spring of 2001 and 2002 both had high stream flows (Figure 48, Figure 49, Figure 55, and Figure 56), which may have contributed to poor egg and/ or fry survival.

As discussed in the following section, sustained periods of increased water temperatures can also be stressful and even lethal to trout, particularly smaller fish. Warm temperatures affect small fish more easily than larger ones.

3. TEMPERATURE DATA

Temperature in Brown's Creek has been monitored by several organizations since 1998 and summarized in a report by the Minnesota Department of Natural Resources. 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 26), which replaces a 5,130-foot long section that flowed through the wetland just north of McKusick Lake and across the golf course (Figure 27). 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 are now 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 26: New channel along the golf course. This photo shows the much-improved habitat, with many native shrubs and trees growing along the banks.

Figure 27: 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, 2004, 2005, and 2006 even during the night and early morning hours when water temperatures are usually coolest (Figure 35). 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 29 and Figure 30). 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 record the

average number of days at or above 90º F in Twin Cities is about 17.7 days a year. Figure 28-Figure 31 show the correlation between the number of warm days and warm stream temperatures. 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 31). 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. Recent data from the Hwy 15 site has proven to show otherwise. Figure 32, Figure 35-Figure 36, and Figure 41-Figure 43 show the differences between each of the three sites on Brown's Creek. Although the groundwater inputs near and downstream of Hwy 5 appear to be maintaining the cooler water at Hwy 96, the McKusick Road site and Hwy 15 site show much more interesting temperature differentiation. Based on the data collected, the Hwy 15 site appears to have higher maximum daily temperatures and higher average daily temperatures, but lower minimum daily temperatures than at McKusick Road. This phenomenon is difficult to explain considering the changes in temperature at each site.

A couple possible explanations exist that could explain this phenomenon. First, because Brown's Creek flows through a large wetland complex previous to the Hwy 15 site, the channel may be less defined in these areas. Due to this lack of confinement, ambient temperatures, both hot and cold, as well as sunlight may have more impact on water that is spread over greater surface area than within a confined channel. Secondly, the riparian vegetation work that has been done near McKusick Road as well as undisturbed riparian vegetation along the banks of Brown's Creek upstream of McKusick Road and downstream of Hwy 15 may be shading the creek from sunlight during the warmest hours of the day, but minimum temperatures may be affected from runoff due to irrigation systems operating during evening hours and warming on the landscape prior to entering the stream. These explanations are solely hypothesized for why this phenomenon exists, but no concurrent data collection efforts, if any, can confirm nor deny these hypotheses or offer any other explanations to why this phenomenon exists.

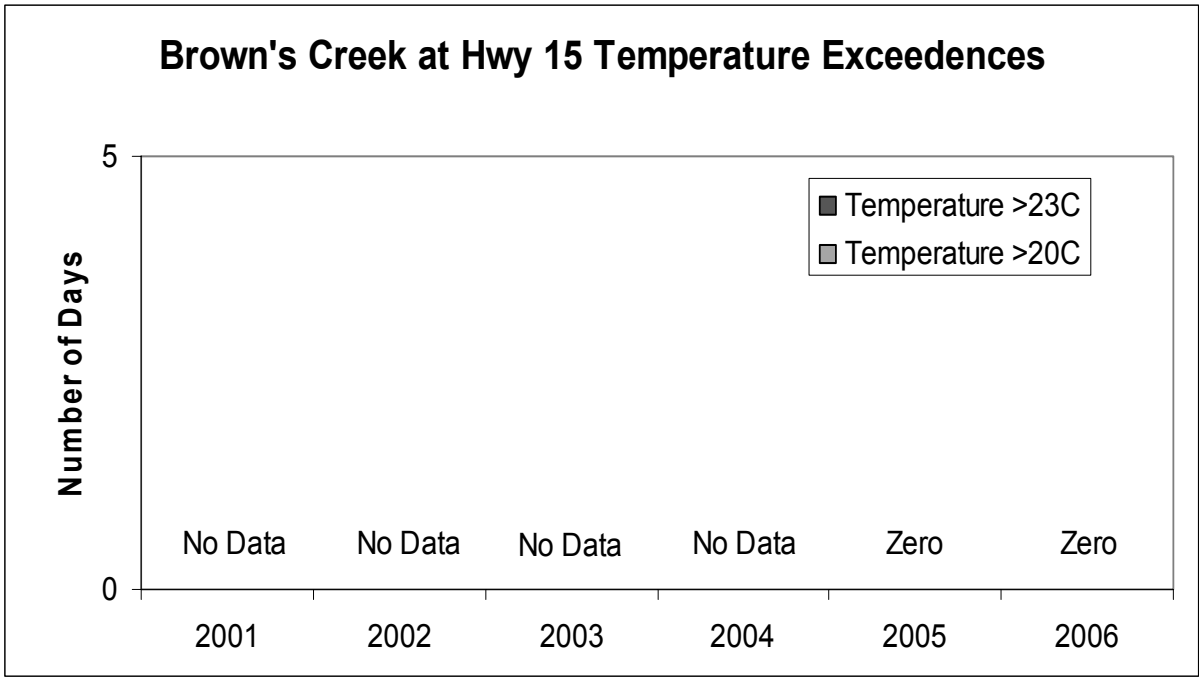


Figure 28. Occurrences of Brown's Creek Daily Minimum Water Temperature Greater than 20 and 23 degrees Celsius at Hwy 15

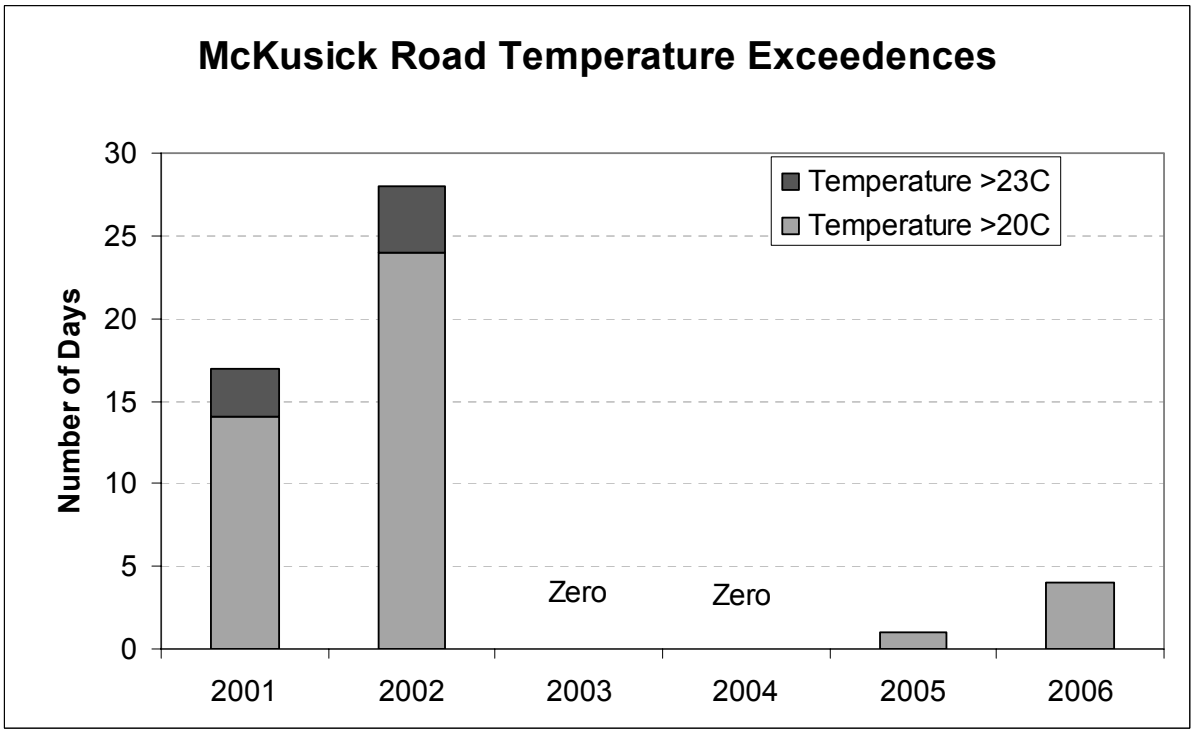


Figure 29: Occurrences of Brown's Creek Daily Minimum Water Temperature Greater than 20 and 23 degrees Celsius at McKusick Road

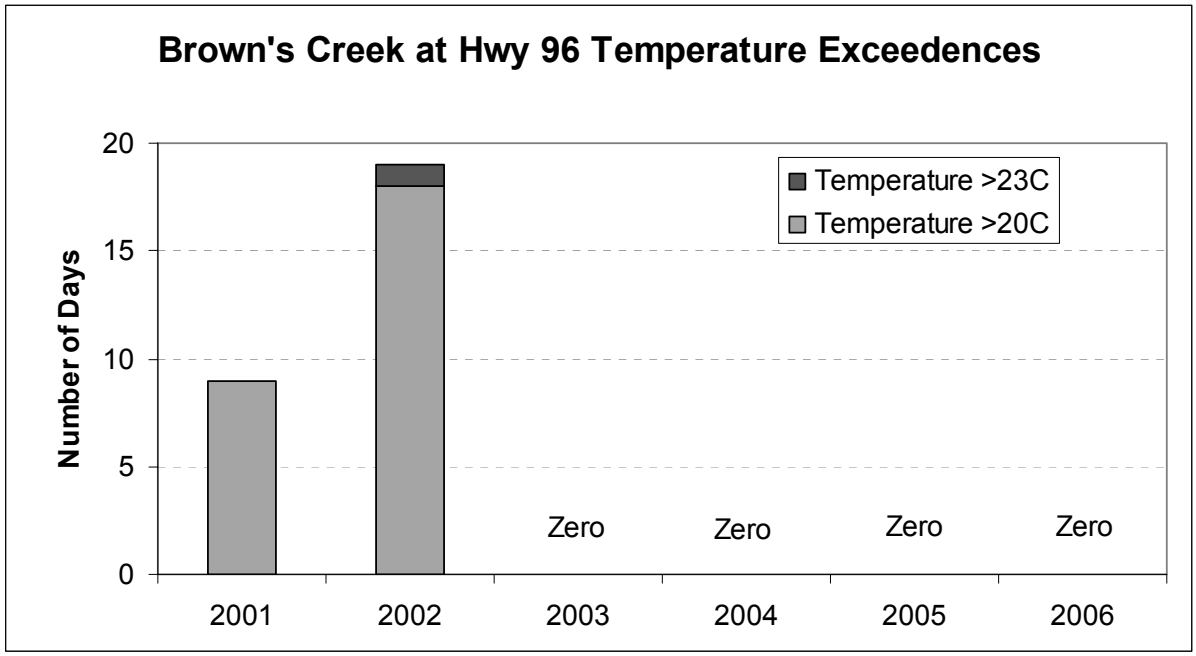


Figure 30: Occurrences of Brown's Creek Daily Minimum Water Temperature Greater than 20 and 23 degrees Celsius at Hwy 96

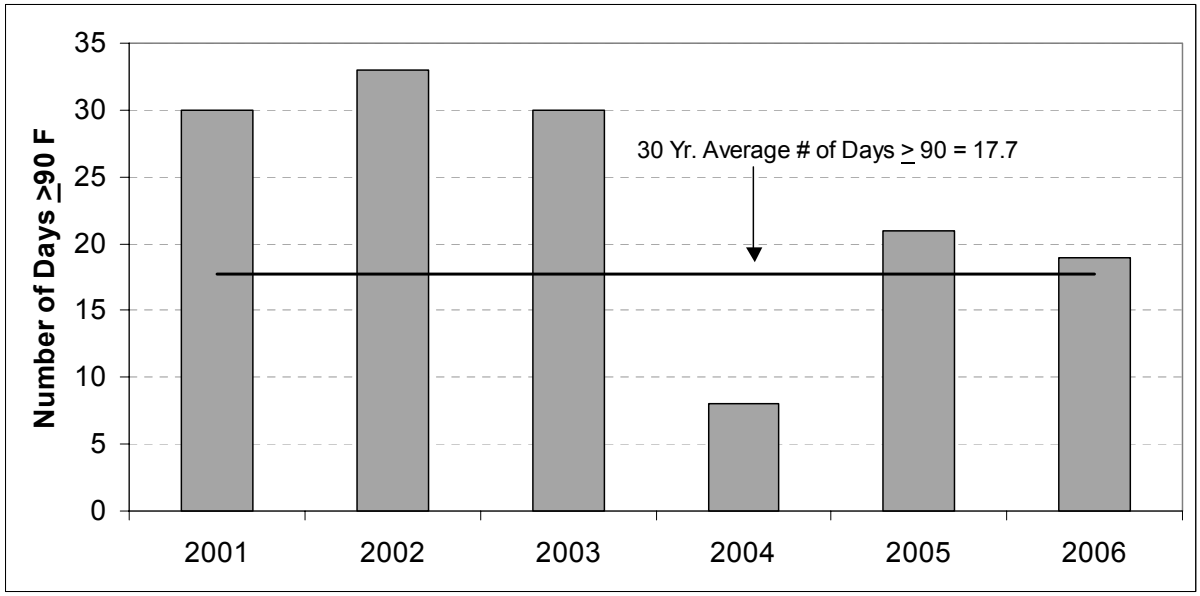


Figure 31: Days With Air Temperatures Over 90 Degrees Fahrenheit, Stillwater, MN (Source: National Weather Service {Stillwater 30N, 20W, S34})

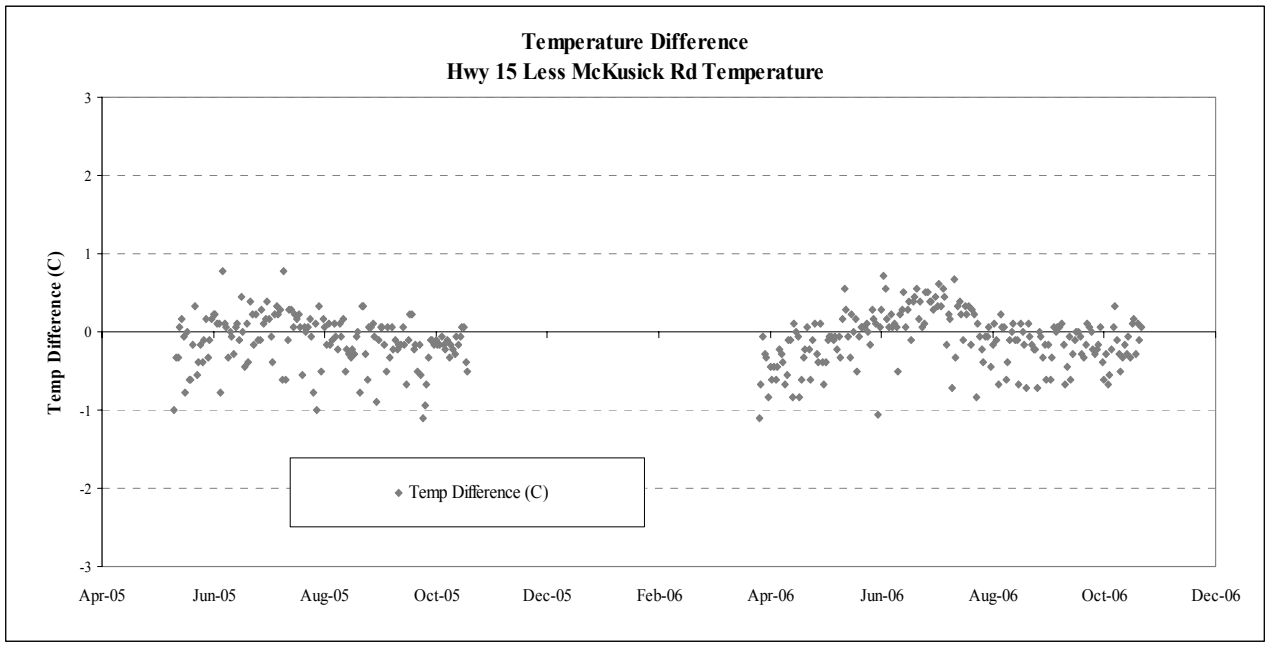


Figure 32: Temperature Differences Between Hwy 15 & McKusick Rd

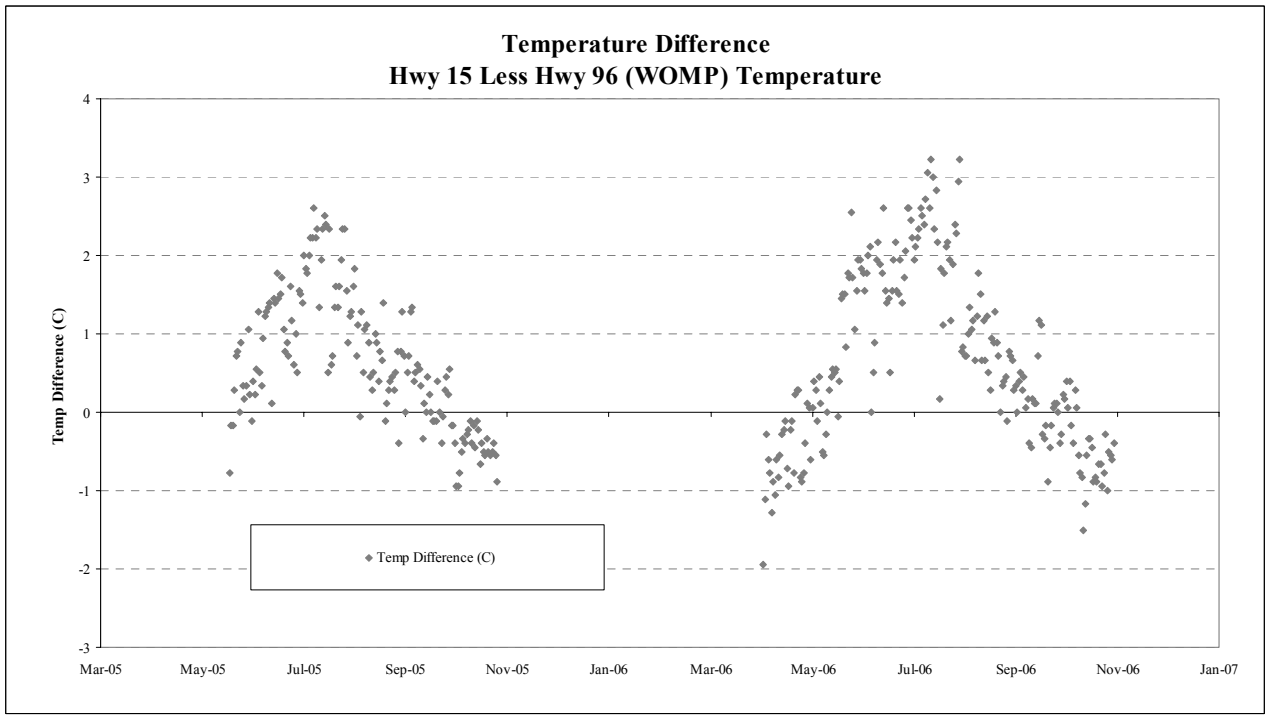


Figure 33: Temperature Differences Between Hwy 15 & Hwy 96 (WOMP) Sites

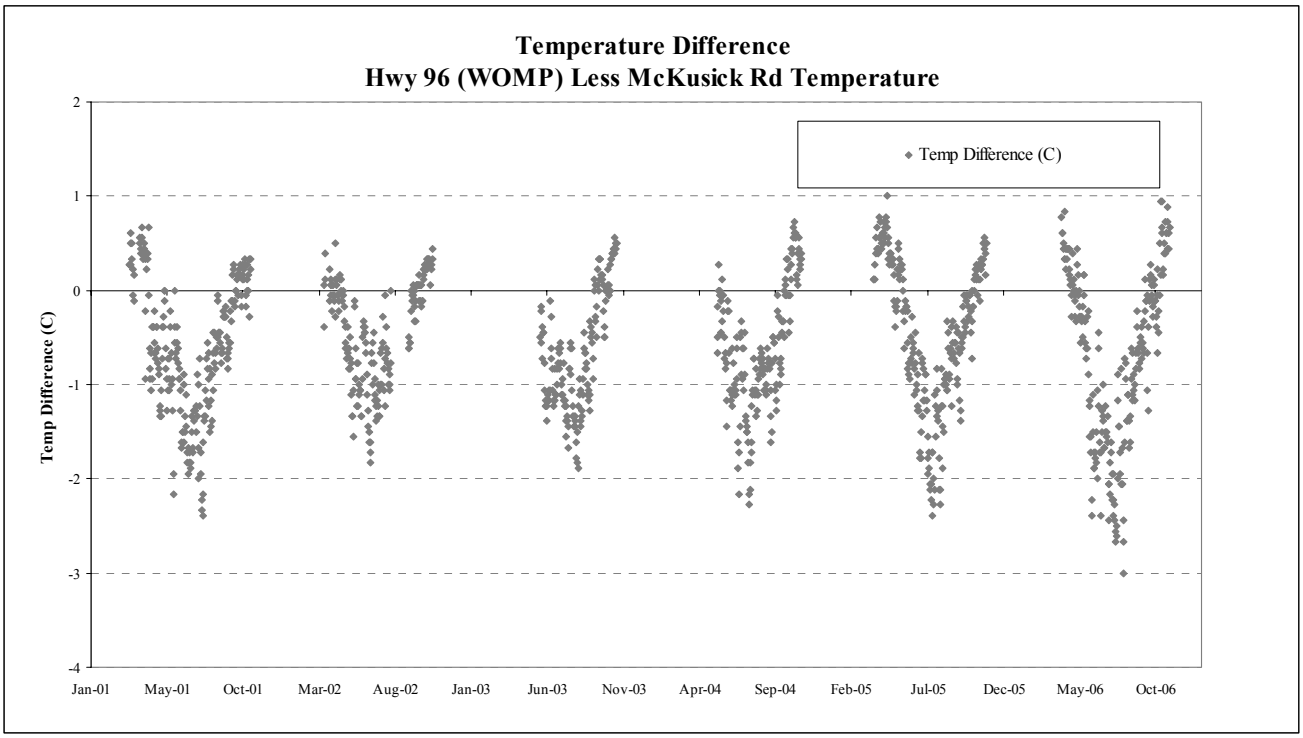


Figure 34: Temperature Differences Between McKusick Rd & Hwy 96 (WOMP) Sites

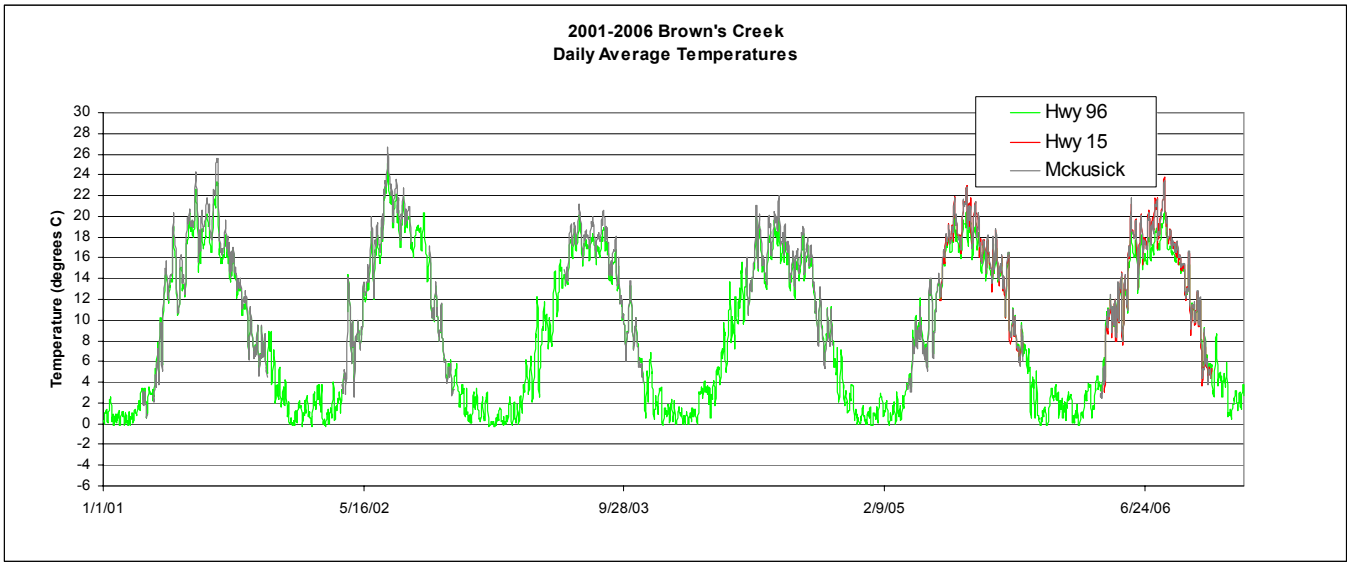


Figure 35: 2000-2006 Daily Average Temperatures

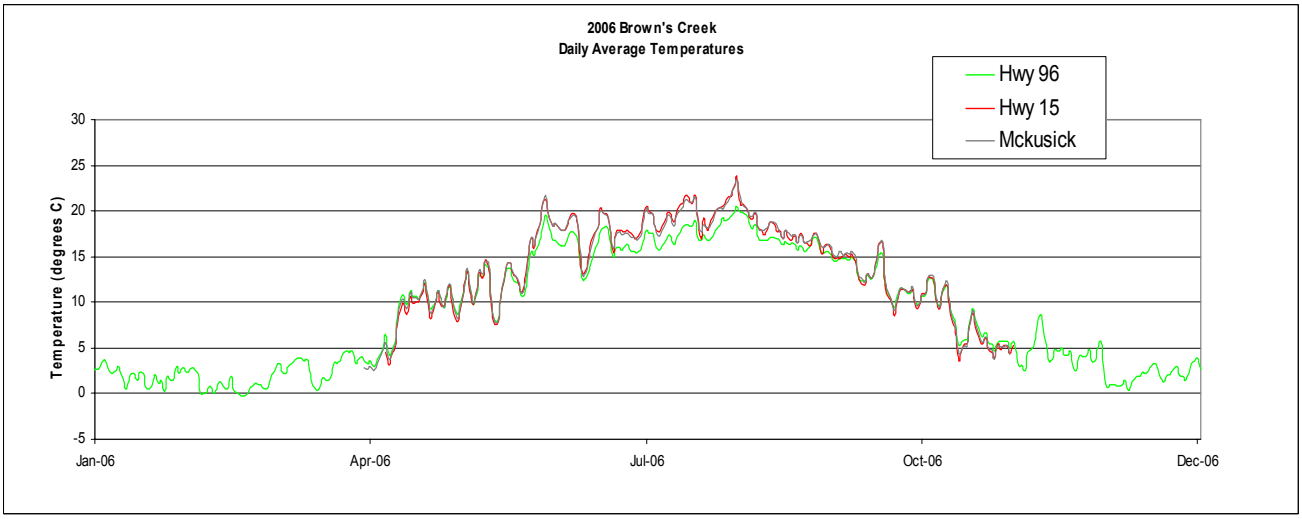


Figure 36: 2006 Daily Average Temperatures

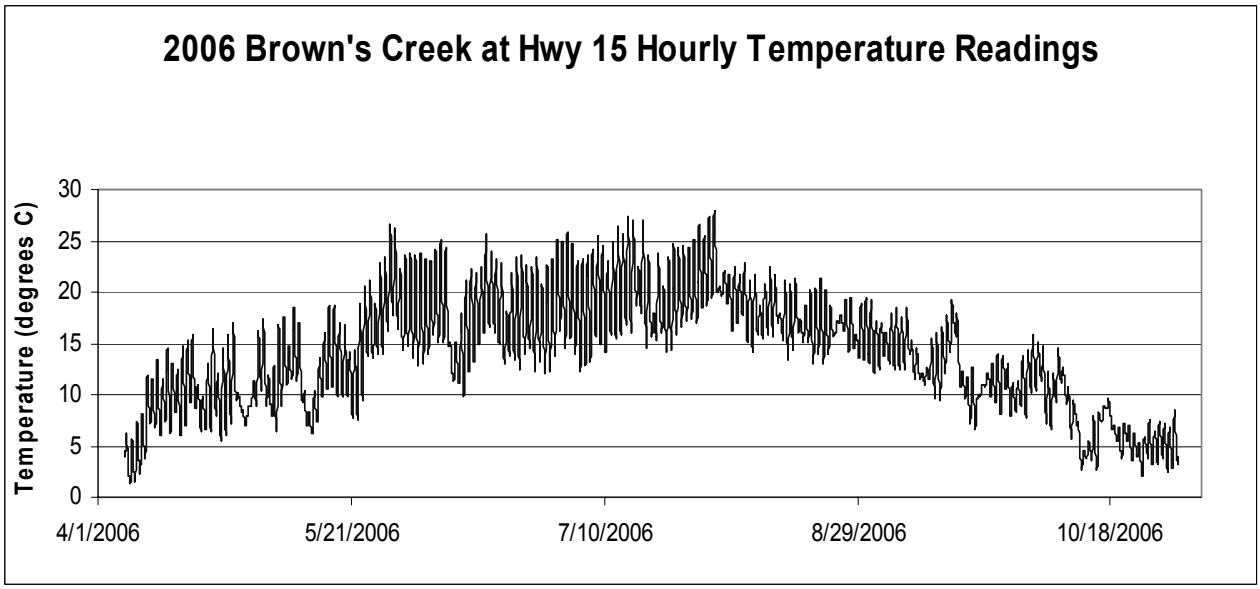


Figure 37: 2006 Hwy 15 Temperatures

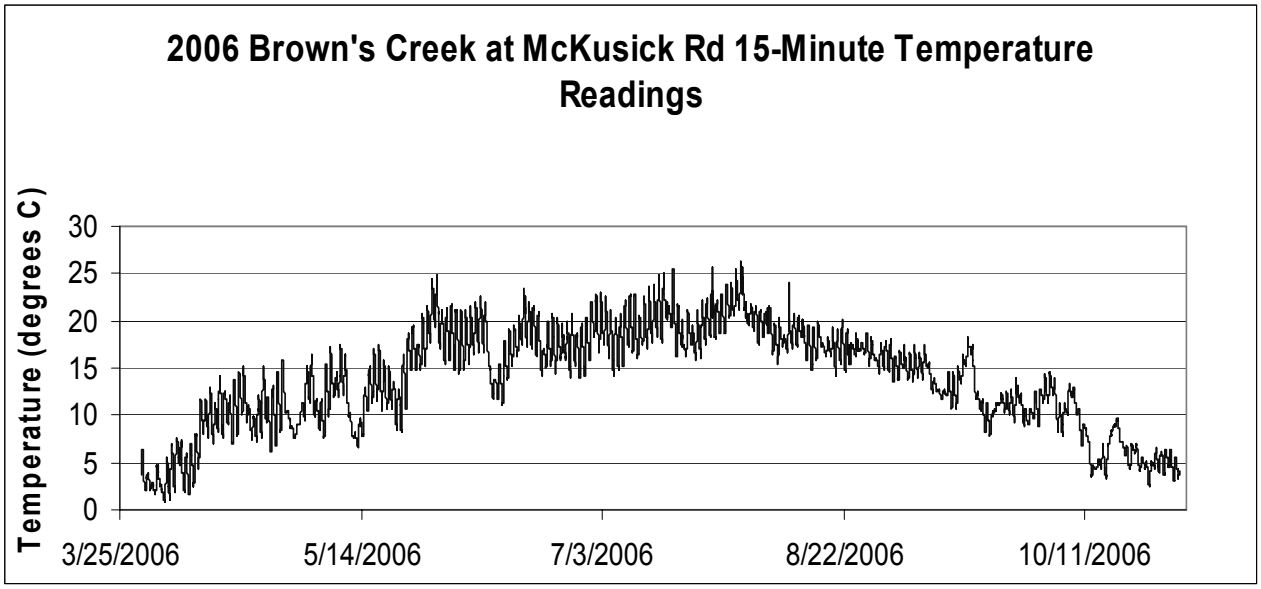


Figure 38: 2006 McKusick Road Temperatures

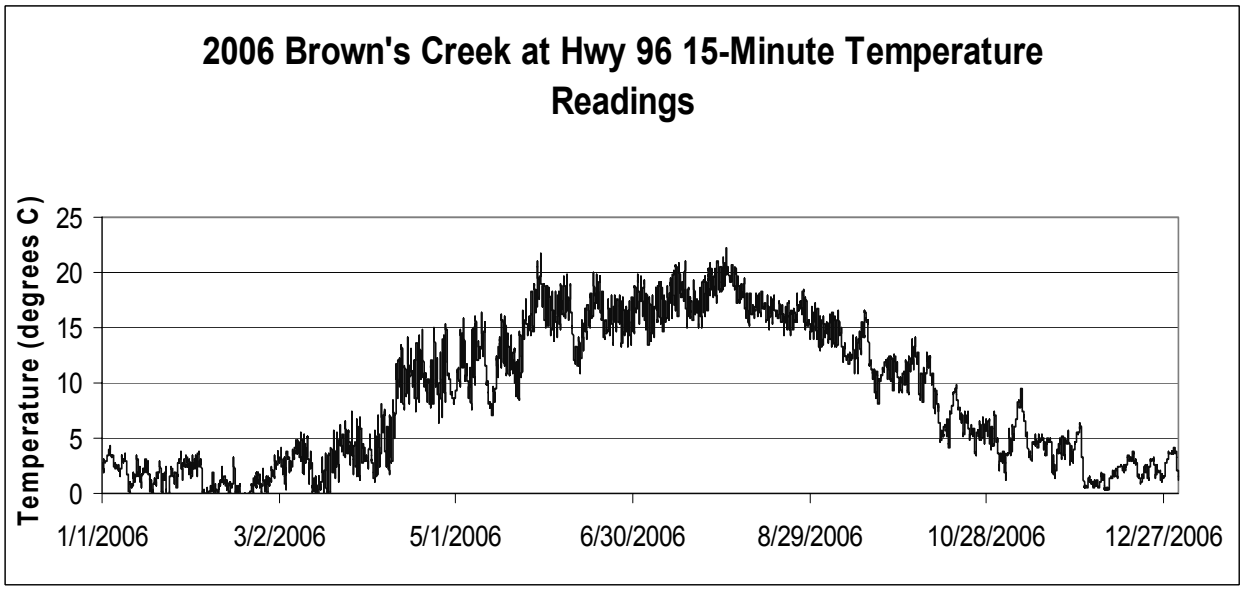


Figure 39: 2006 Hwy 96 (WOMP) Temperatures

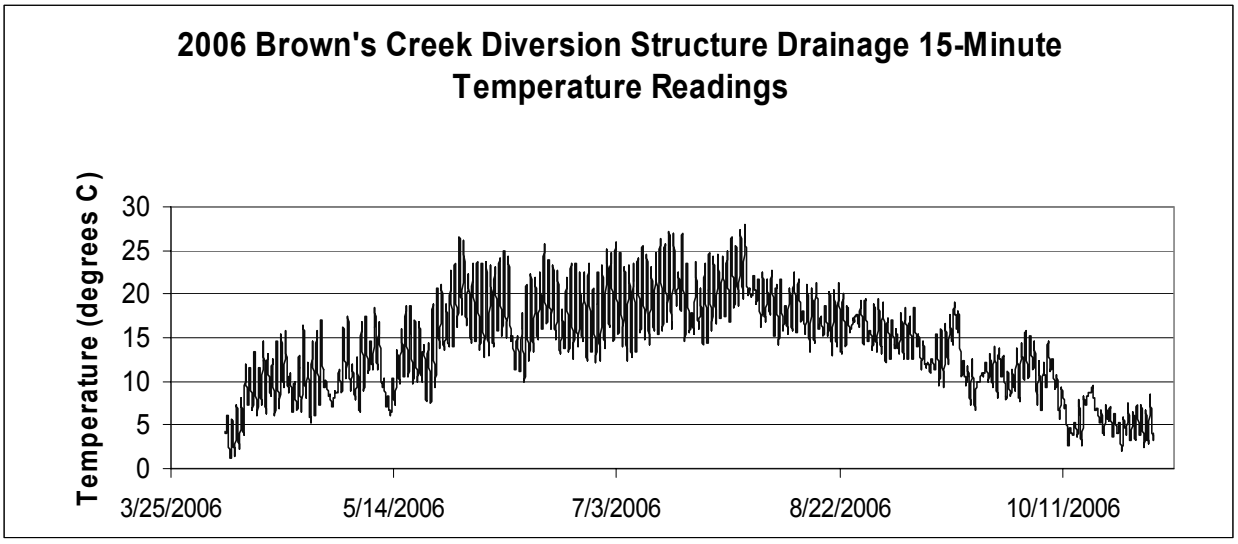


Figure 40: 2006 Brown's Creek Diversion Structure Drainage Temperatures

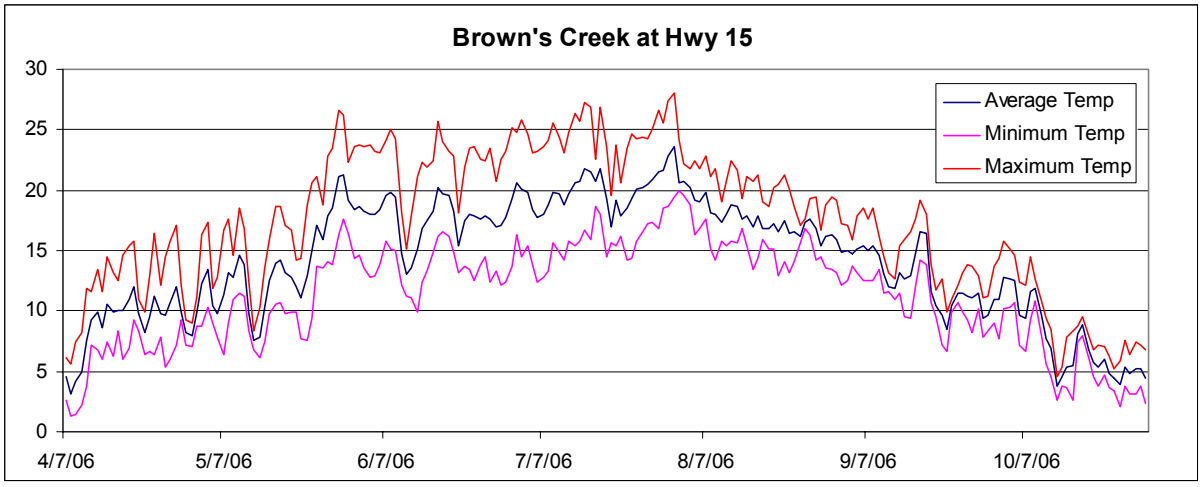


Figure 41. 2006 Brown's Creek at Hwy 15 Daily Average, Minimum, and Maximum Temperatures

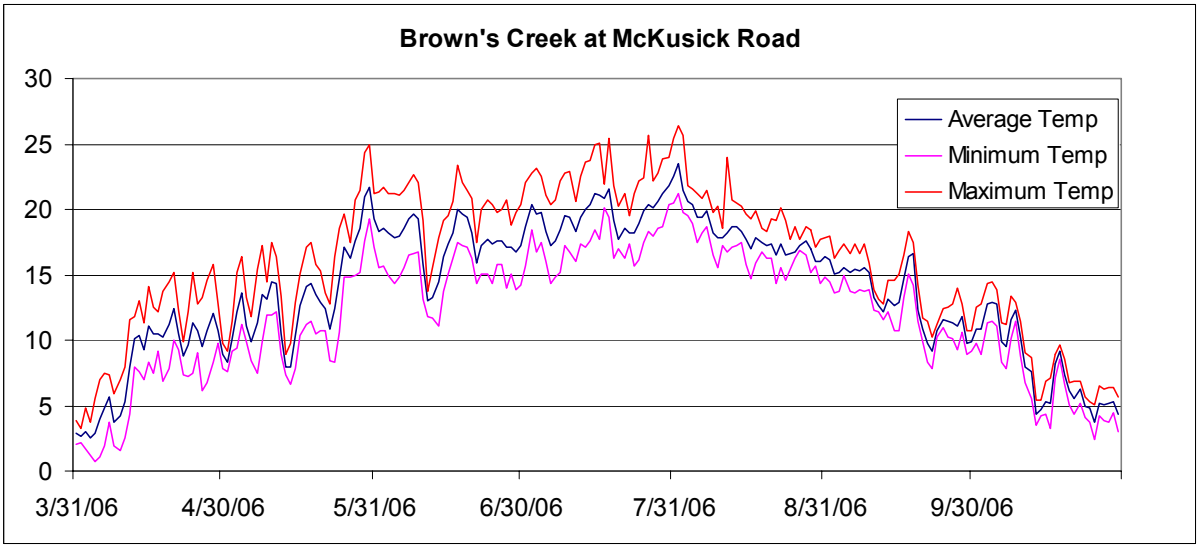


Figure 42. 2006 Brown's Creek at McKusick Road Daily Average, Minimum, and Maximum Temperatures

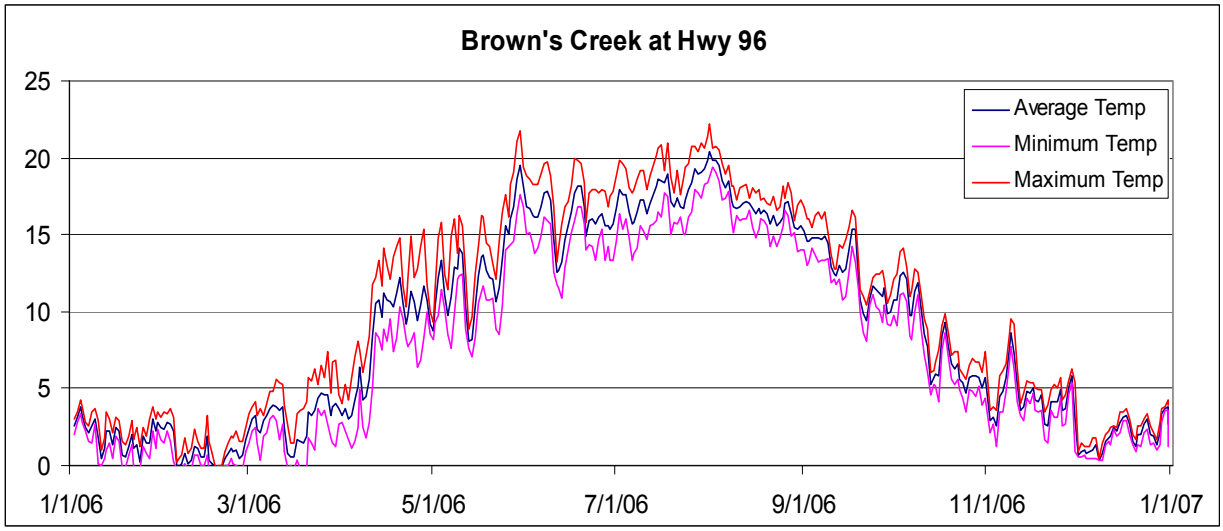


Figure 43. 2006 Brown's Creek at Hwy 96 Daily Average, Minimum, and Maximum Temperatures

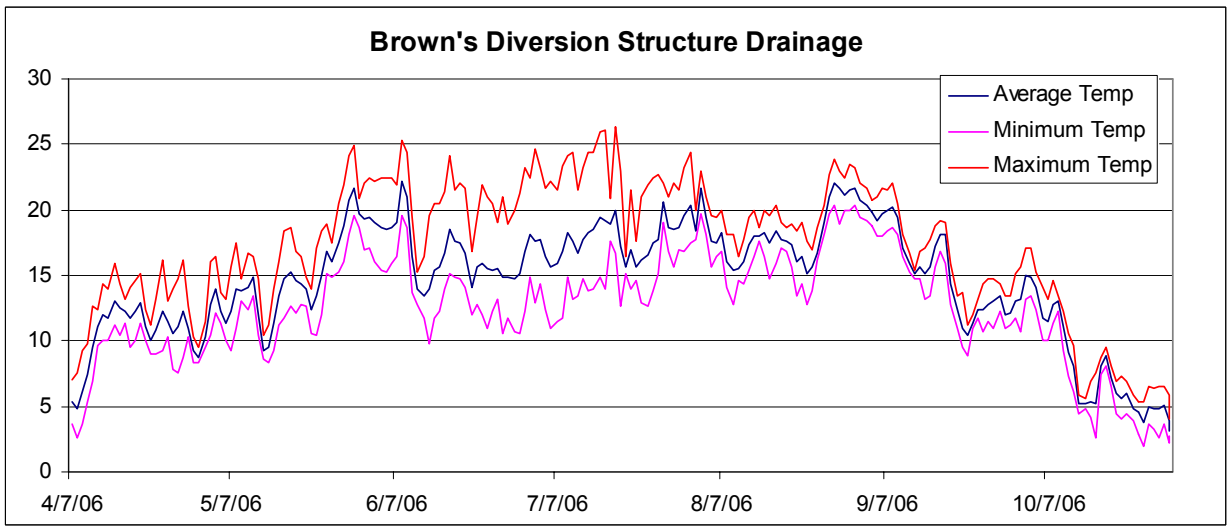


Figure 44. 2006 Brown's Creek Diversion Structure Drainage Daily Average, Minimum, and Maximum Temperatures

4. MACROINVERTEBRATE DATA

Aquatic macroinvertebrate insects are small animal organisms that live their larval stage in a lake or stream. By identifying the types of macroinvertebrates present and their relative abundance, much can be revealed about water quality. Not all macroinvertebrates are equally affected by pollution. For example, stoneflies require clean, oxygenated water; whereas leeches and blackflies do not. Therefore, observed changes in macroinvertebrate communities can give information about changes in overall water quality.

Brown's Creek has been monitored by volunteers in two locations for macroinvertebrates and physical habitat from spring 1998. The volunteer-collected data will establish a long-term record about the stream's capacity to support various life forms, including trout. Site W3 is just over a mile from the mouth of Brown's Creek. Site W4 is near the mouth of Brown's Creek at Hwy 96. Both sites were monitored by students at Stillwater Area High School and led by teacher Andy Weaver. Site W4 could not be monitored in the spring of 2001 due to the flooding of Brown's Creek and tail water from the St. Croix River. A third sampling site (Site W8) at the creek crossing with Neal Avenue was added in spring of 2003 and is sampled by SAHS biology teacher Doug Long and his biology class. The Washington Conservation District collected macroinvertebrates at Hwy 15 beginning in 2005 in response to this reach of stream being listed as impaired on the MPCA's 303d impaired waters list. All sites are sampled using the multi-habitat sampling protocol. In the spring and fall of 2006, the WCD collected macroinvertebrates using the MPCA's protocols for the Index of Biological Integrity in order to track the listed impairment. The results from the collected organisms were sent to the MPCA in order to attain an IBI (index of biological integrity) score. IBI is the ability to support and maintain a balanced, integrated adaptive assemblage of organisms having species composition, diversity, and functional organization comparable to that of natural habitat of the region. A portion of the analyzed results were not identified to genus by the outside consultant which skewed the results and indicates a much poorer IBI than would normally be seen. The results of the spring and fall samples at Hwy 15 can be seen in

Figure 45. The WCD plans to have the organisms lacking genus identification further analyzed to better assess the IBI score. Although further analysis is needed, the scores were significantly different between the fall sampling and spring sampling, which may indicate that a large change is occurring in the ecology of the stream between these two time periods. Further in-depth macroinvertebrate collection at this site will show whether this large difference in fall and spring species and numbers is a normal yearly occurrence at this locations or if another factor was affecting what was observed in 2006.

The volunteers collect stream data in the spring and fall including macroinvertebrate densities and diversity, physical characteristics of the stream, and observations about land use in the watershed. All volunteer teams use methods outlined in the National River Watch Network Benthic Macroinvertebrate Monitoring Manual, which includes using kick nets to collect samples. These groups kick and scrub the rocks upstream from their nets for two minutes and collect everything that washes into the nets. The procedure is repeated so that at least one replicate is collected. The National River Watch protocol recommends at least 100 insects collected per sample. All the teams observe and monitor the habitat surrounding the stream and score it for changes. After collection, stream teams preserve, sort and identify samples to the family taxonomic level. Once identification is complete, the samples are sent to the WCD for minor quality control and then sent to an outside consultant for the final enumeration and identification.

The data from each site is analyzed by a number of criteria. The EPT represents the number of mayfly (Ephemeroptera), stonefly (Plecoptera), and caddisfly (Trichoptera) families in each sample. These families represent the pollution intolerant macroinvertebrates. A higher EPT score reflects better water quality than a lower one. Another analytical tool is Hilsenhoff's Biotic Index, shown in Table 41. The biotic index summarizes the various pollution tolerance values of all families in a sample. Table 42 lists macroinvertebrate sampling results for sites W3, W4, and W8 for 1998-2006. The results from spring of 2001 for site W3 look unusual due to both the low number of organisms identified and the low biotic index, and should be viewed with the information

that the river was flooded downstream during this time to the extent that sampling at site W4 was impossible.

Table 41: Evaluation of Water Quality Using Hilsenhoff's Biotic Index

Family Biotic Index	Water Quality	Degree of Organic Pollution
0.00-3.75	Excellent	Organic pollution unlikely
3.76-4.25	Very good	Possible slight organic pollution
4.26-5.00	Good	Some organic pollution probable
5.01-5.75	Fair	Fairly substantial pollution likely
5.76-6.50	Fairly poor	Substantial pollution likely
6.51-7.25	Poor	Very substantial pollution likely
7.26-10.0	Very poor	Severe organic pollution likely

The family biotic index (FBI) summarizes the various pollution tolerance values of all macroinvertebrate families in a sample; each macroinvertebrate family has a unique pollution tolerance value associated with it. FBI values range from 0 to 10, with lower values reflecting higher water quality. One important note for sites W3 and W4 is that the volunteer classes collecting these site's data were delayed in submitting macroinvertebrate samples for enumeration and classification. The results for fall samples at 2003 and 204 are currently absent due to late submittal. The FBI for W3 has ranged from 2.1 in 2001 to 5.3 in 2006, in the "Fair Water Quality" range of FBI values and also the poorest water quality year on record. The FBI for W4 ranges between 2.1 (excellent water quality) in 2000 to 4.9 (good water quality) in 2005. All data from this site indicates excellent to good water quality. Site W8's FBI ranges from 3.2 in 2004 to 5.1 in 2006. The majority of data from this site indicates very good to good water quality with a couple monitoring periods with excellent (2004) and Fair (2006) water quality. In 2006, the Hwy 15 site collected by the WCD showed good to very good water quality. EPT values in the fall indicate much higher pollution tolerant species present at the site as well.

Table 42: Macroinvertebrate Sampling Results

Site #	Date	# Organisms	EPT*	Hilsenhoff's Biotic Index*	Number of Families*	Dominant Family*	Dominant Family Tolerance Value*	Dominant Family %*
W3	May-98	195	8	3.2	17	Emidae	4	21.0
W3	Oct-98	194	7	3.7	10	Philoptomatidae	3	53.1
W3	May-99	218	7	3.9	11	Baetidae	4	38.1
W3	Oct-99	182	4	3.5	9	Philoptomatidae	3	34.5
W3	May-00	198	6	4.1	11	Chironomidae	6	31.6
W3	Oct-00	212	5	3.3	9	Philopotamidae	3	70.0
W3	May-01	75	6	2.1	9	Odontoceridae	0	41.3
W3	Oct-01	121	6	3.3	11	Baetidae	4	42.0
W3	May-02	116	4	3.9	9	Baetidae	4	28.4
W3	Oct-02	189	5	4.4	12	Baetidae	4	39.2
W3	May-03	122	5	4.4	9	Baetidae	4	28.7
W3	Oct-03	143	4	3.4	9	Philopotamidae	3	63.6
W3	May-04	96	6	3.9	11	Limnephilidae	4	31.3
W3	Oct-04	157	7	3.3	12	Philopotamidae	3	38.2
W3	May-05	315	5	4.8	14	Baetidae	4	27.3
W3	Oct-05	92	7	3.7	13	Elmidae	4	22.8
W3	Apr-06	229	6	5.3	10	Chironomidae	6	71.2
W3	Oct-06	79	6	3.7	10	Baetidae	4	31.3
W4	May-98	172	7	3.0	11	Baetidae	4	24.4
W4	Oct-98	188	6	2.4	12	Glossomatidae	0	36.7
W4	Apr-99	232	5	4.4	10	Baetidae	4	42.7
W4	Oct-99	111	5	3.3	11	Perlodidae	2	40.0
W4	May-00	242	4	2.8	8	Perlodidae	2	46.0
W4	Oct-00	149	6	2.1	11	Brachycentridae	1	57.0
W4	May-01	Site Flooded—No macroinvertebrates found.						
W4	Oct-01	200	6	3.0	12	Brachycentridae	1	28.5
W4	May-02	90*	4	4.1	8	Baetidae	4	64.4
W4	Oct-02	204	4	4.3	9	Baetidae	4	62.3
W4	May-03	105	6	4.2	10	Chironomidae	6	28.6
W4	Oct-03	246	4	2.7	11	Brachycentridae	1	39.8
W4	May-04	89	6	3.8	11	Baetidae	4	25.8
W4	Oct-04	126	6	4.8	13	Chironomidae	6	29.6
W4	May-05	149	6	4.9	14	Chironomidae	6	34.9
W4	Oct-05	111	7	2.7	13	Brachycentridae	1	36.0
W4	Apr-06	155	4	4.7	11	Chironomidae	6	54.2
W3	Oct-06	79.0	6	3.7	10	Baetidae	4	31.3
W8	May-03	106	2	4.4	7	Gammaridae	4	75.5
W8	Oct-03	107	4	3.8	6	Gammaridae	4	76.6
W8	May-04	119	4	4.2	10	Gammaridae	4	63.0
W8	Oct-04	72	2	3.2	6	Gammaridae	4	62.5
W8	May-05	129	5	4.9	12	Gammaridae	4	45.0
W8	Oct-05	101	1	4.5	6	Gammaridae	4	69.3
W8	May-06	97	4	5.1	9	Gammaridae	4	45.0
W8	Oct-06	98	4	3.8	8	Gammaridae	4	74.5
Hwy 15	Apr-05	154	4	4.9	8	Chironomidae	6	48.7
Hwy 15	Oct-05	112	5	4	9	Gammaridae	4	47.3
Hwy 15	Apr-06	249	2	4.2	9	Gammaridae	4	71.9
Hwy 15	Oct-06	431	6	4.7	20	Gammaridae	4	40.1

*Macroinvertebrate monitoring terms can be found in Appendix D

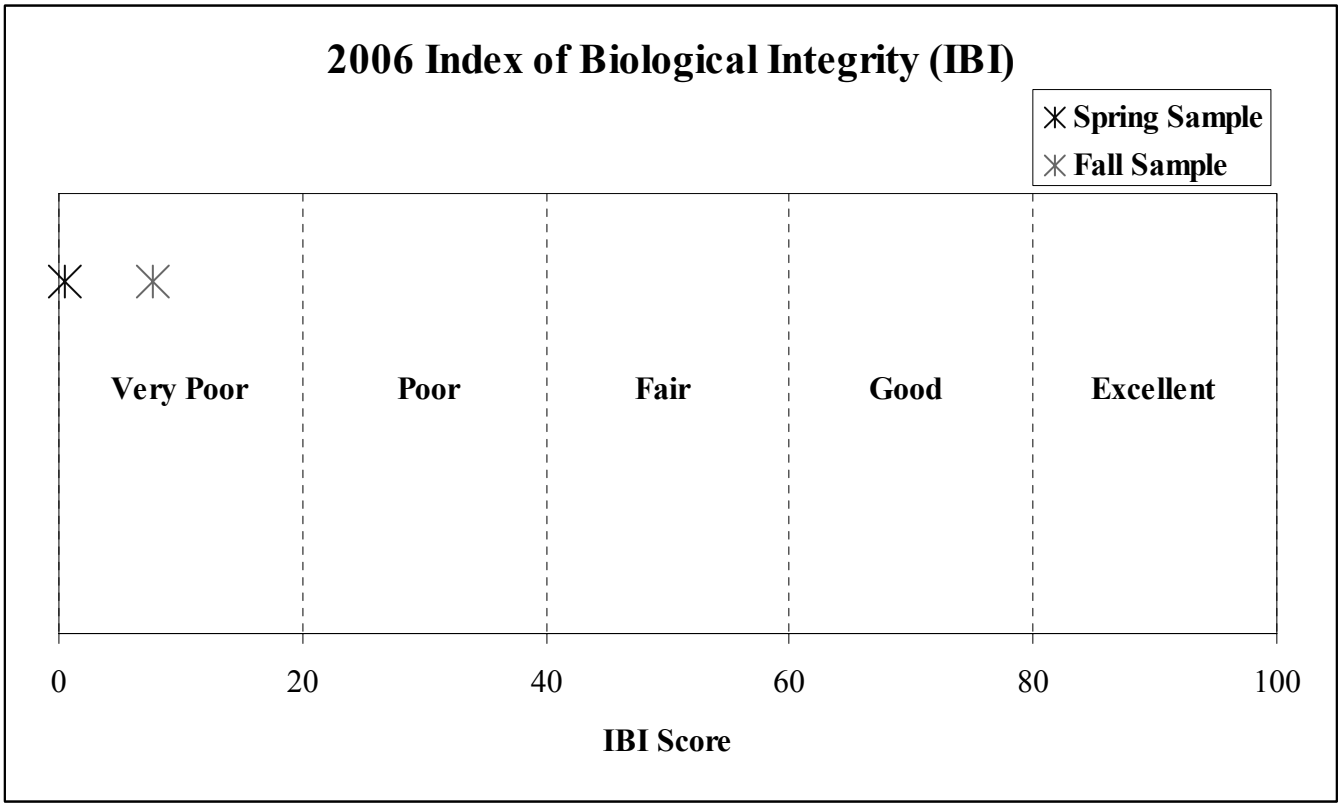


Figure 45. Brown's Creek at Hwy 15 2006 Index of Biological Integrity (IBI) Scores

The dominant family percentage reflects the diversity of habitats for various macroinvertebrates within the stream. A low dominant family percentage reflects a good mix of organisms without one family dominating the stream. The dominant family percentage in W3 consistently reflects a good diversity of habitats, except for the fall of 2000 sample, the fall of 2003 sample with greater than 60% Philopotamidae, and the spring and fall of 2006 sample with greater than 70% Chironomidae and 60% Baetidae respectively. This was also the result shown in W4, except for the 2002 samples containing greater than 60% Baetidae and the spring 2006 sample containing 54% Chironomidae. Site W8 consistently reflects greater than 60% Gammaridae, which suggests fewer habitats available for macroinvertebrates at this sampling site. The Hwy 15 site collected by the WCD indicates that the spring sample showed much less diversity of organisms than the fall sample with 71.9% of organisms in the spring sample classified in the Gammaridae family.

Appendix C shows all macroinvertebrate families collected in each sample. Perlodidae, a family of stonefly, Brachycentridae and Philoptamidae, families of caddisflies, seem to appear in greater numbers consistently in the fall and not in the spring at site W3. Chironamidae was present in large numbers in the spring of 2006 but only one organism in the fall 2006 sample. At site W4, Glossomatidae, which was the dominant family in the fall of 1998, had not been seen since the spring of 1999, but made a return in the fall of 2000 and 2001 and disappeared again in 2002 and 2003. It has returned, but the numbers are not strong in 2004 and 2005. In 2006, this family of macroinvertebrate was again absent in the spring but present in the fall. Similar to W3, the spring of 2006 showed more Chironomidae than any other year on record at W4, but this organism was absent in the fall. At site W8, Glossomatidae was present in 2006 for the first time but in relatively low numbers. This change in family presence may indicate that the habitat is becoming more tolerable for these macroinvertebrates. At Hwy 15, a very high presence of Gammaridae was collected. The fall sample had much less Gammaridae than the spring sample, which fell into the range previously seen in 2005, but was still the dominate family of organisms at this site.

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 averaged approximately 7 cfs in 2001, 10 cfs in 2002, 7 cfs in 2003, and 6.5 cfs in 2004, 6.5 in 2005, and 6.0 in 2006. This reflects the observations from the previous years' monitoring efforts. 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 compared to 2005.

In 2006, there were three large runoff events at the mouth: 75 cfs on April 6th, 69 cfs on July 25th, and 76 cfs on August 24th. All of these events were the result of high magnitude rainfall. These latter of the two storms dominated the hydrology of Brown's Creek in 2006, and the first storm may include runoff on some remaining frozen soils coupled with 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 2006, Brown's Creek at the mouth exhibited annual loading rates per unit area (Kg/ha) within the pasture land use range (Figure 17). In 2006, both the Hwy 15 and McKusick Road sites exhibited annual loading rates per unit area (Kg/ha), which were slightly less

than the outlet station. The average total phosphorus concentration in the stream at the mouth was 0.19 mg/L in 2006. This is consistent with the moderate impact range according to the H&H study (Table 43). The modeled condition for phosphorus concentration from the H&H Study was 0.125 mg/L for the 1.5-year (2") storm event. In The trend from 2000-2003 has been a steady increase in the average concentration of total phosphorus in Brown's Creek until 2004. This may be due to the completion of the Brown's Creek Diversion Structure and the removal on nutrient and sediment loaded water. This trend should be closely monitored to make sure that higher concentrations do not return. The Brown's Creek Diversion Structure drainage-loading rate per unit area was 0.20 Kg/ha in 2006 and was classified in the pasture land use range. Considering this drainage is heavily urban, this loading rate seems low when compared to urban loading rates. Though a fair amount of this drainage is urbanized, some remains undeveloped and management strategies should be implemented to maintain these or lower loading rates moving forward. Because this drainage discharges to McKusick Lake, water quality concerns will be an matter which will need to be addressed for residents concerned about future lake degradation. McKusick Lake is currently on the MPCA's 303d impaired waters list for excess nutrients. Based on this drainage alone, a reduction of at least 115 lbs would have to be met for McKusick Lake to meet the shallow lake water quality standard of 0.60 mg/L. Of course, this drainage is not the only drainage to McKusick Lake, but one that is a large water resource concern for the city and residents. The drainage sites to Long Lake, Marketplace Pond and 62nd St., showed loading rates of 0.24 and 0.06 Kg/ha respectively. The Marketplace Pond drainage is substantially higher than at 62nd St. and may need further BMP projects to reduce loading to Long Lake. 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 2006 at the mouth was 57 mg/L, McKusick Road was 81 mg/L, and Hwy 15 was 37 mg/L. This is within the modeled condition for the mouth from the H&H Study.

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 and the Marketplace pond drainage were in the high impact range of Table 43. The TSS values for the 62nd St. site remained 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 43: 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 threshold at the McKusick Road site. The Hwy 15 site and at the mouth have not exceeded any thresholds in 2006. Continued efforts to improve shade throughout critical areas will likely improve temperature conditions. In 2001 and 2002, stream temperatures reached levels above ideal conditions for trout habitat but showed no direct negative correlation to natural reproduction rates.

Trout have been stocked annually in Brown's Creek since 1958 from the Highway 96 culvert to the stone bridge. Recent fish surveys show not only an increase in the numbers of trout, but also an increase in the age of the trout. Scale samples taken in 1998-2000 suggest that about 10% of the trout captured are age three or older, and 2% are five or

older. This is typical of natural systems, and rare in the metro area. Possible factors contributing to the improving trout populations include improvements in habitat and water quality, and improvements in the genetic composition and diversity of the trout stocked.

Interpretation of macroinvertebrate sampling results in Brown's Creek shows the creek to have consistently fair to excellent water quality. Hilsenhoff's biotic index, which summarizes the pollution tolerance of the families, reflects fair to excellent water quality. Except in 2006, dominant family percentage has almost always been less than 50% at both downstream sampling locations, which shows that the stream has had a diverse habitat to support a variety of organisms. The upstream sampling location has shown to have a slightly less diverse habitat with more than 50% dominant family percentage but still indicating good water quality. This habitat diversity is also reflected in the number of families observed as well as the EPT ratio. With the changes seen in the dominant family percentages, there may be a concern for water quality degradation in this portion of the stream. With 2006 climatic conditions being abnormal, these trends may change with more typical conditions.

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, and Hwy 15 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 the headwaters of 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. This provides not only valuable baseline

information about the stream, but also education opportunities to residents of and around Brown's Creek Watershed District.

- 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.
- Continue to collect macroinvertebrate samples at Hwy 15 and look at establishing upstream sites for comparisons to the MPCA's IBI to determine further impairment or improvement.
- Investigate if stream temperatures in Brown's Creek near Hwy 15 can be reduced during the warmest hours of the day using practices to promote further shading to provide tolerable conditions for trout survival.

APPENDIX A - WATER QUALITY DATA – BY LAKE, DATE, AND ANNUAL AVERAGE

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)
City of Grant

Vital Statistics

DNR ID #: 82-0124
LOCATION: Section 10, T30N-R21W
MUNICIPALITY: Township of Grant
LAKE SIZE: 310.5 acres
MAXIMUM DEPTH: 14 Feet
ORDINARY HIGH WATER MARK: 960.20 Feet
100-YEAR HIGH WATER LEVEL: 960.40 Feet

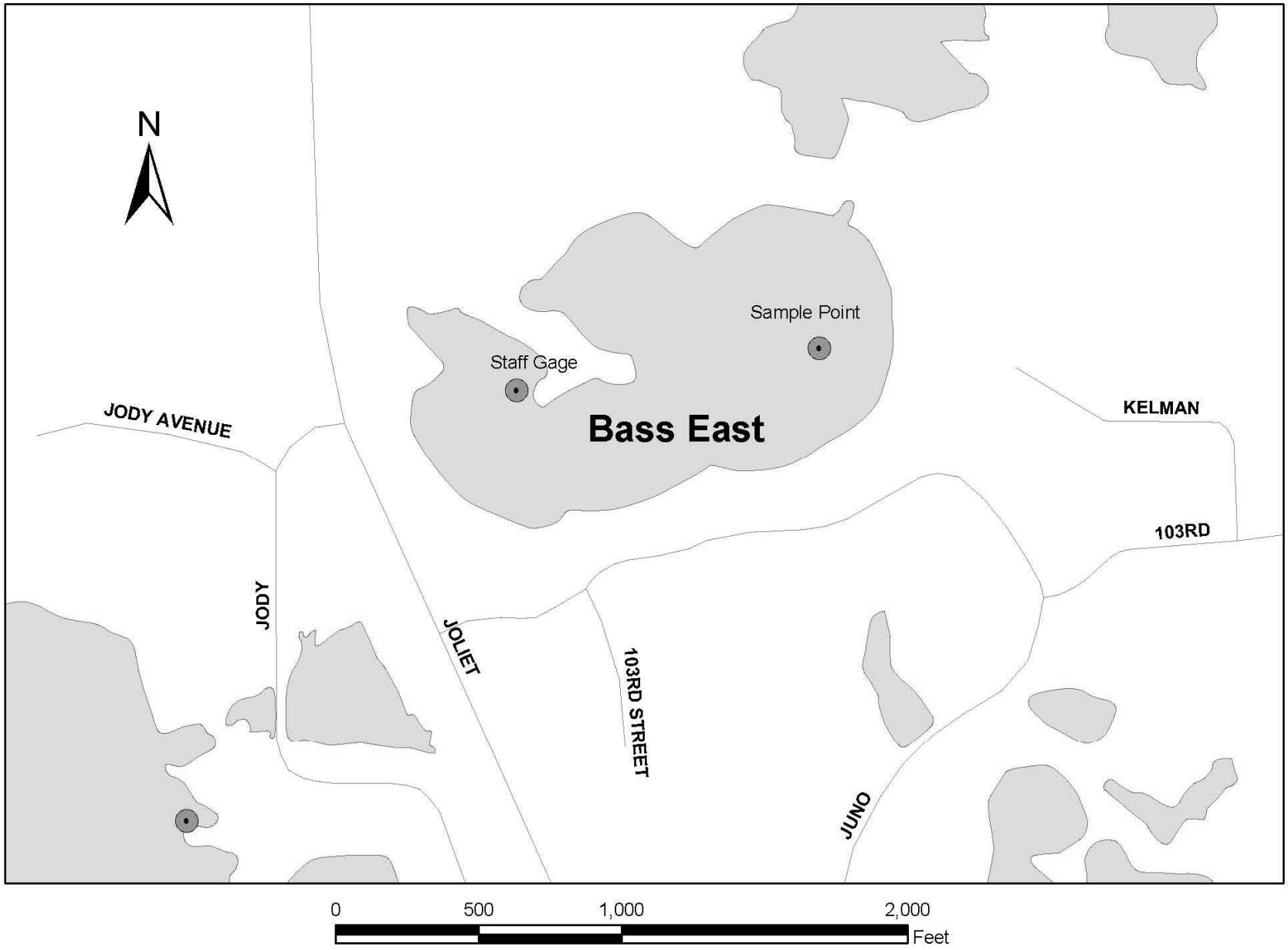
Date	Total Phosphorus (mg/L)	Chlorophyll-a (ug/L)	Secchi Disk Depths (m)	Surface Dissolved Oxygen Levels (mg/L)	Surface Temperature Levels (Celsius)
4/24/2006	0.022	4	2.90	7.46	16.2
5/23/2006	0.037	3	3.20	10.95	18.4
6/13/2006	0.039	13	2.29	9.24	22.2
7/12/2006	0.053	9	2.13	8.40	26.8
8/8/2006	0.095	17	0.82	8.76	26.3
9/6/2006	0.117	23	1.07	8.18	22.5
9/28/2006	0.045	4	3.20	7.86	14.9
2006 Average	0.058	10	2.23	8.69	21.0
2006 Summer Average	0.070	13	1.90	8.49	22.5

	High	High Date	Low	Low Date	Average
2006 Elevation (ft)	957.16	4/24/2006	956.28	9/28/2006	956.76

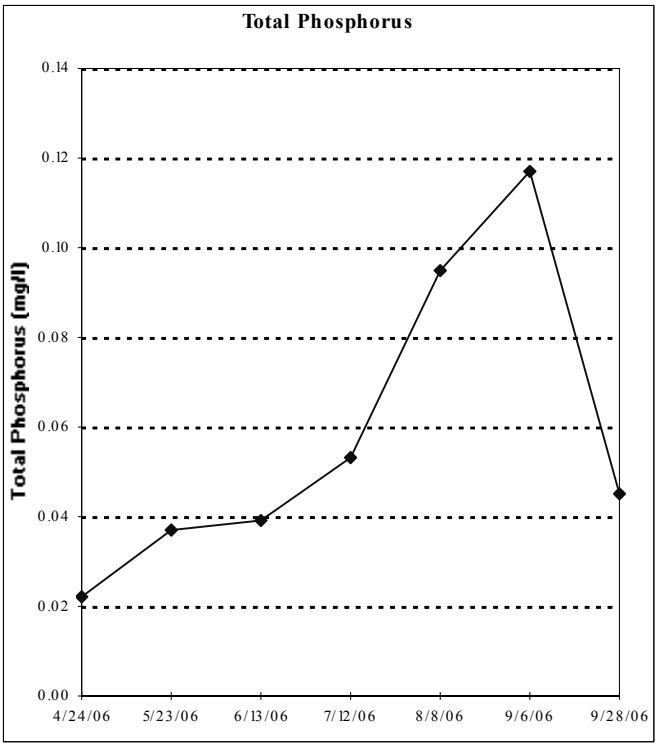
Lake Water Quality Summary

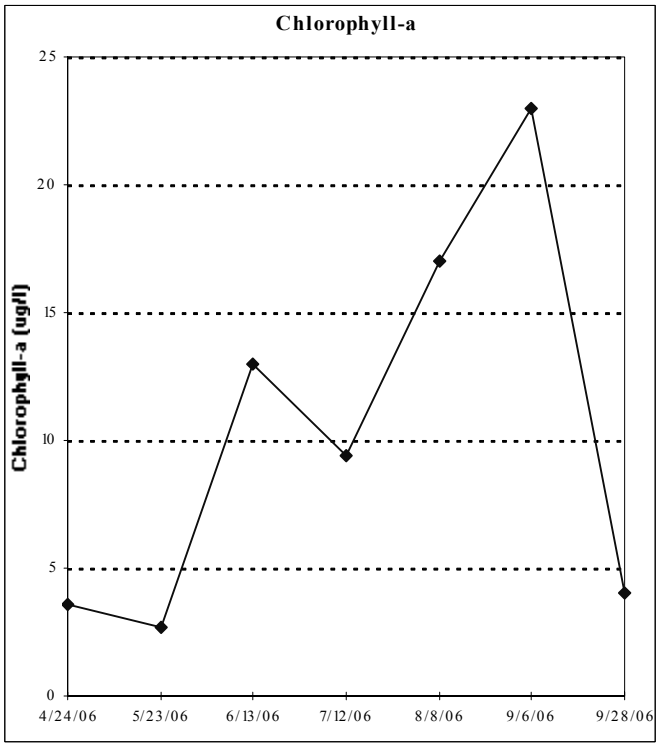
	Trophic Status	Summertime Lake Grades						
	2006	2006	2005	2004	2003	2002	2001	2000
Total Phosphorus (mg/l)	Hypereutrophic	D	NA	NA	NA	NA	NA	NA
Chlorophyll-*a* (ug/l)	Eutrophic	B	NA	NA	NA	NA	NA	NA
Secchi disk (ft)	Mesotrophic	C	NA	NA	NA	NA	NA	NA
Overall	Eutrophic	C	NA	NA	NA	NA	NA	NA

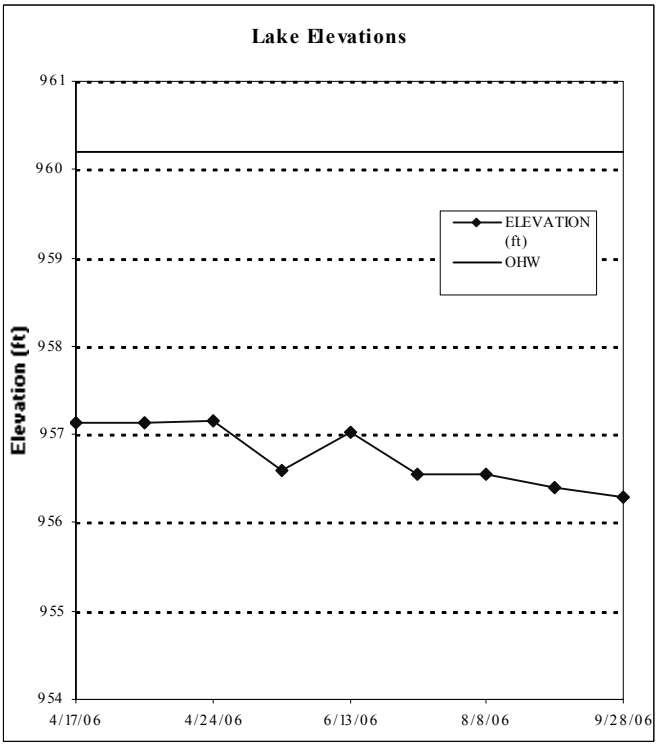
Bass East

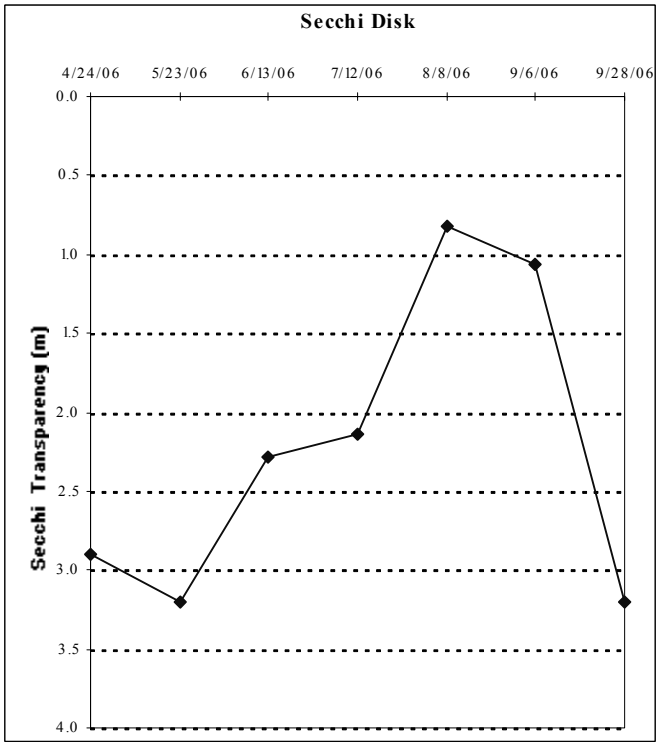

N
Sample Point
Staff Gage
Bass East
JODY AVENUE
KELMAN
103RD
JODY
JOLIET
103RD STREET
JUNO
0
500
1,000
2,000
Feet

Bass Lake (East)
City of Grant



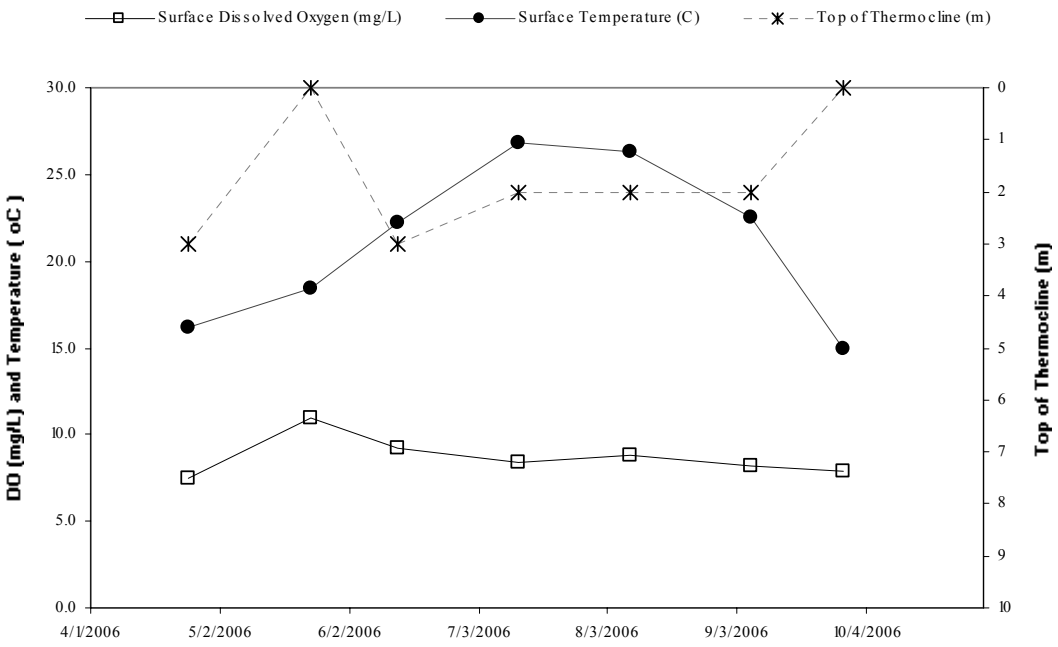






Bass Lake (East)
City of Grant

Dissolved Oxygen, Temperature, and Top of Thermocline by Sampling Date

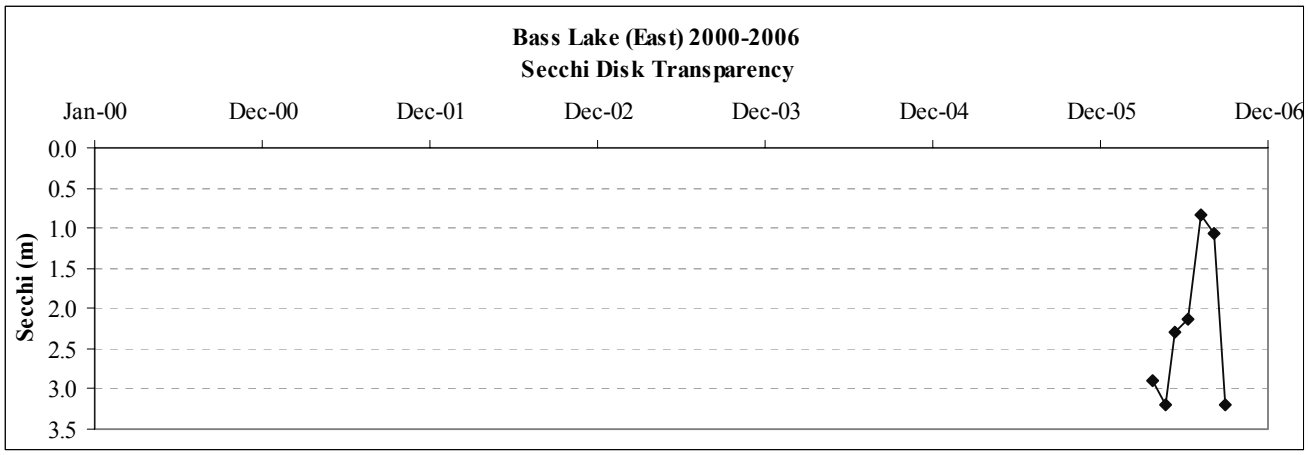


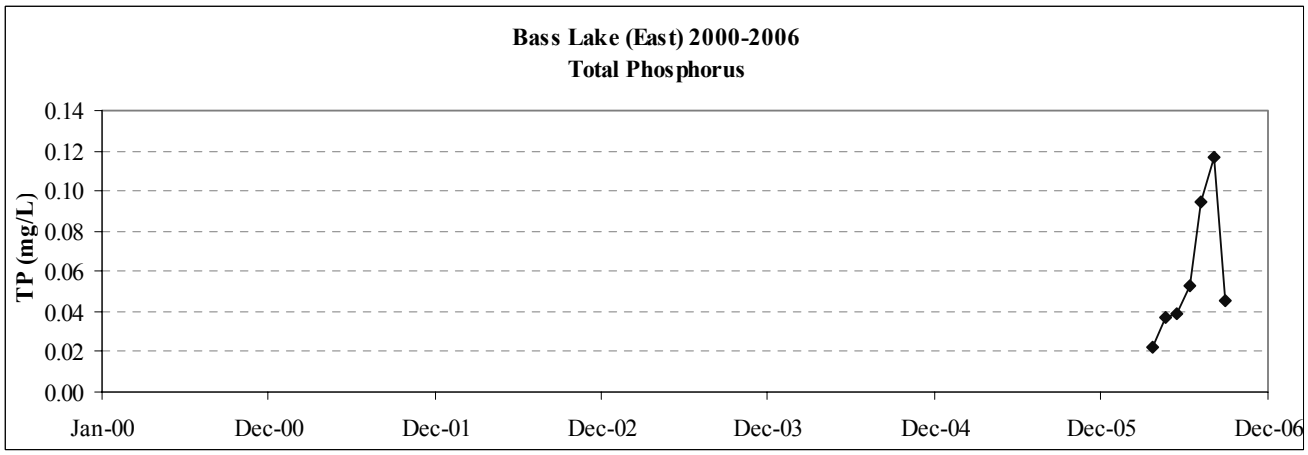
Dissolved Oxygen and Temperature Profile by Sampling Date and Depth

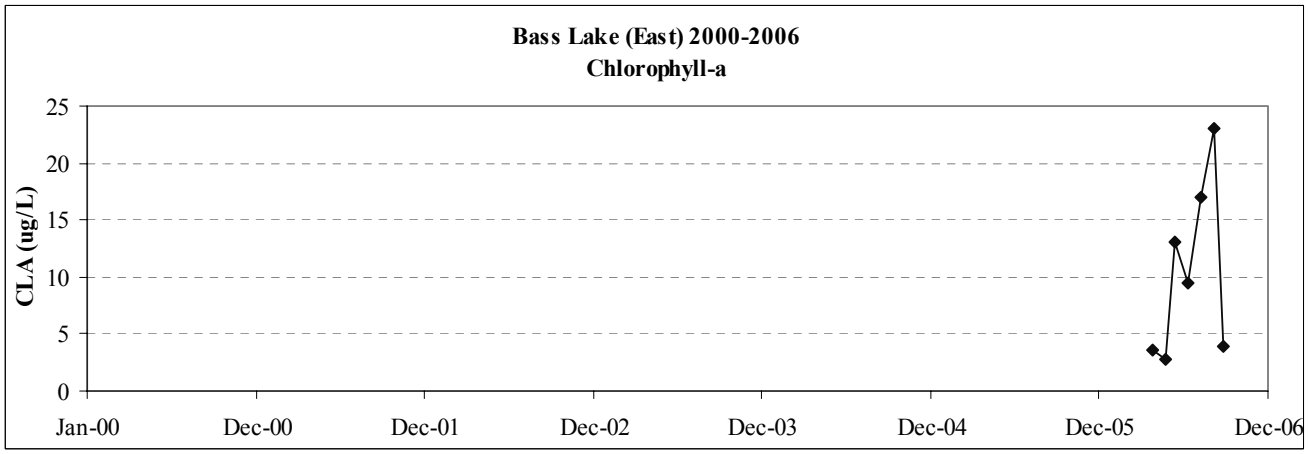
Sampling Date

	4/24/2006		5/23/2006		6/13/2006		7/12/2006		8/8/2006		9/6/2006		9/28/2006	
Depth (m)	D.O.	Temp	D.O.	Temp	D.O.	Temp	D.O.	Temp	D.O.	Temp	D.O.	Temp	D.O.	Temp
surface	7.46	16.2	10.95	18.4	9.24	22.2	8.40	26.8	8.76	26.3	8.18	22.5	7.86	14.9
1	7.20	16.2	11.08	18.4	9.43	21.8	7.67	26.8	8.29	26.0	7.61	22.3	7.81	14.8
2	7.16	16.2	11.42	18.2	7.88	20.7	2.84	24.9	0.11	25.3	0.21	21.4	8.34	14.8
3	9.03	11.3	11.57	16.6	0.16	18.9	0.14	22.2	0.17	21.5	0.05	20.1	8.05	14.7
4	6.63	8.6	8.85	15.7	0.08	17.9							0.10	14.8
5														
Top of Thermocline (m)	3				3		2		2		2			

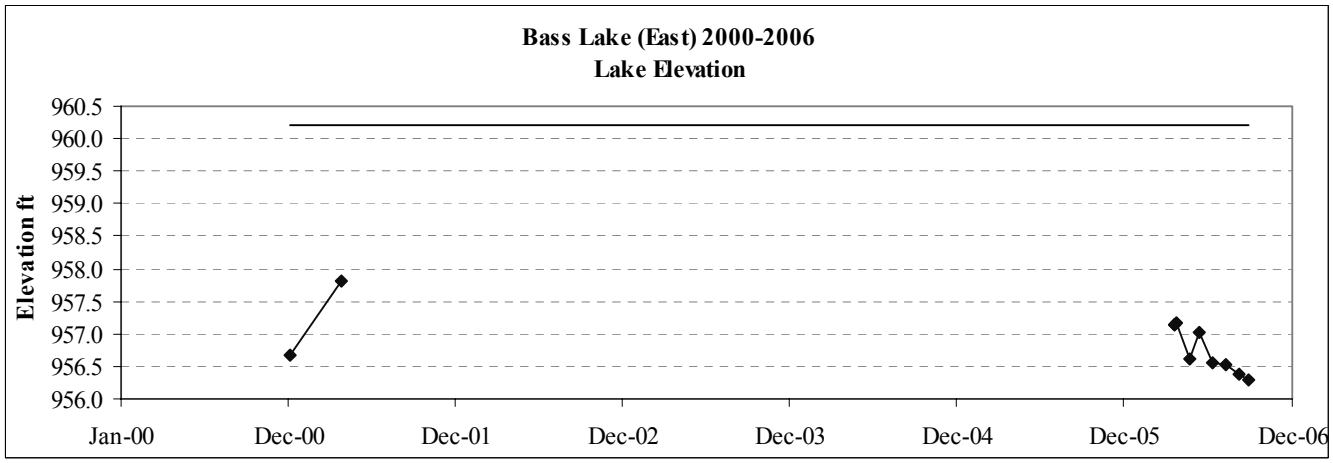
Bass Lake (East)
City of Grant

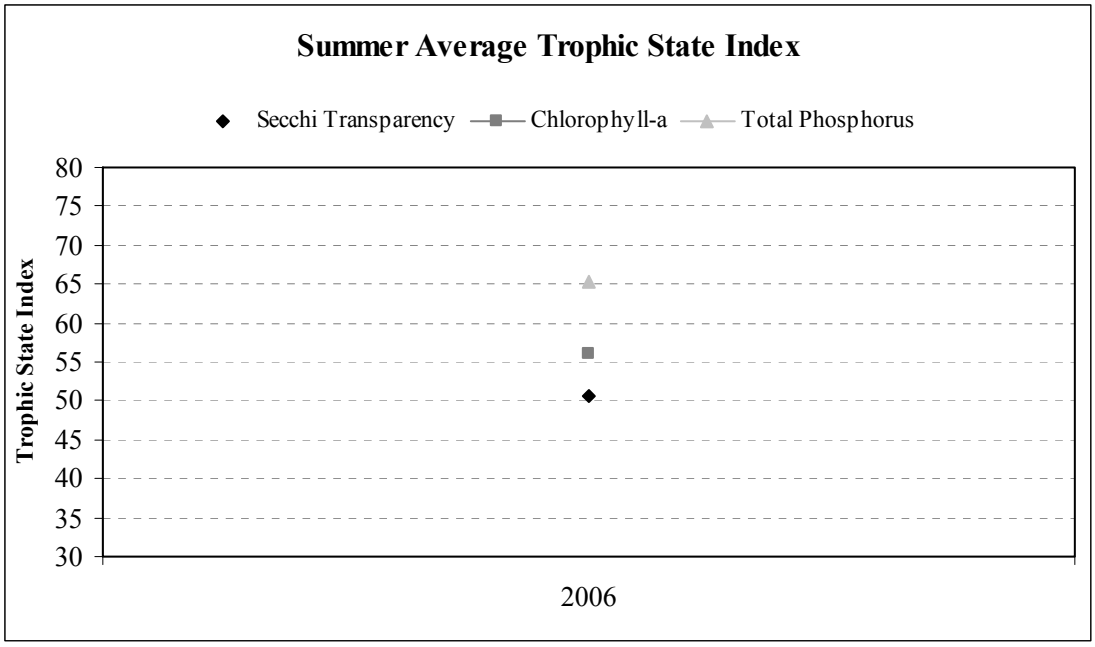






Bass Lake (East)
City of Grant





Bass Lake (West)
City of Grant

Vital Statistics

DNR ID #: 82-0123
LOCATION: Section 10, T30N-R21W
MUNICIPALITY: Township of Grant
LAKE SIZE: 776 acres
MAXIMUM DEPTH: 15 Feet
ORDINARY HIGH WATER MARK: 952.60 Feet
100-YEAR HIGH WATER LEVEL: 955.90 Feet

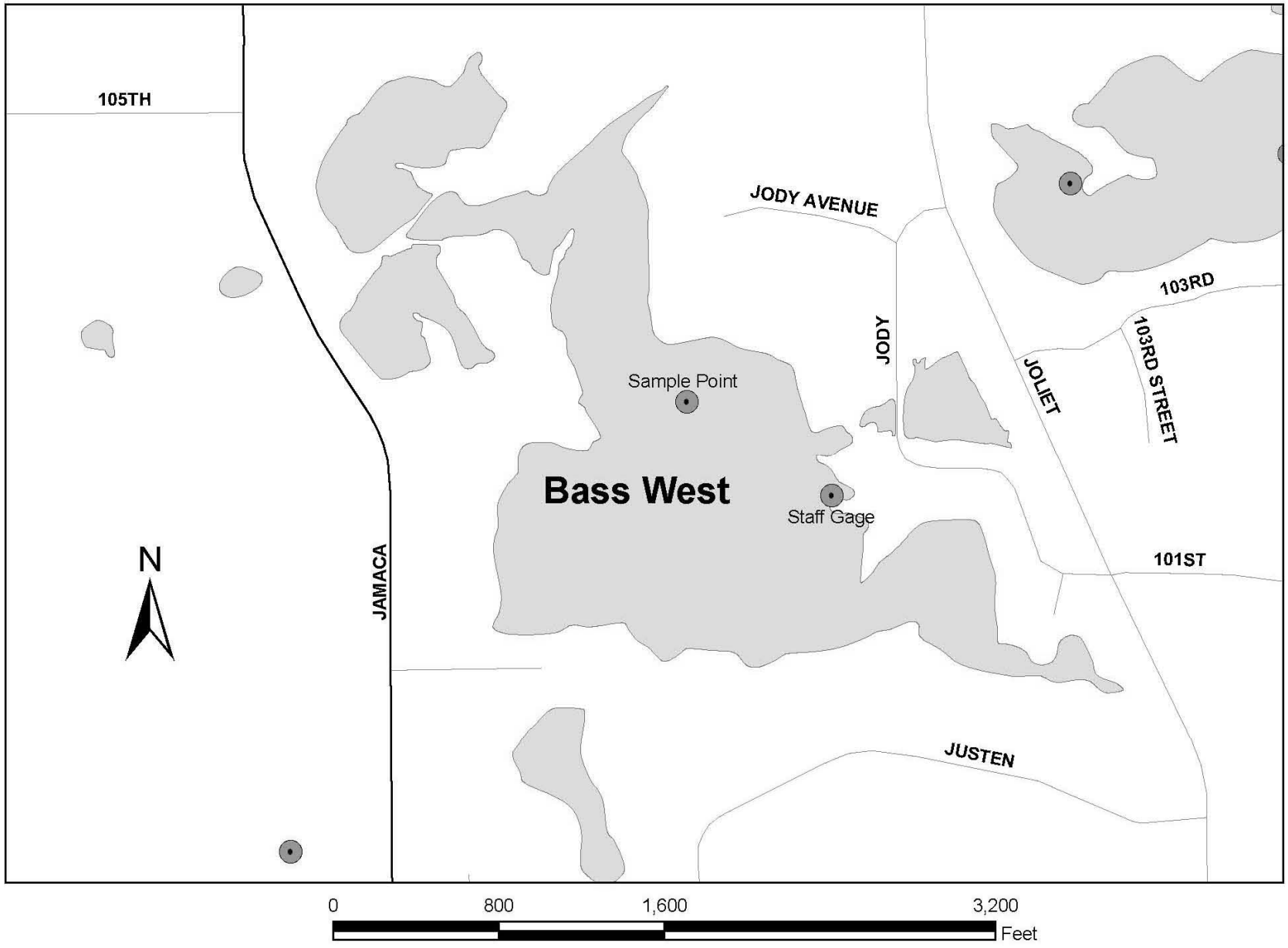
Date	Total Phosphorus (mg/L)	Chlorophyll-a (ug/L)	Secchi Disk Depths (m)	Surface Dissolved Oxygen Levels (mg/L)	Surface Temperature Levels (Celsius)
4/24/2006	0.018	2	3.96	7.38	15.5
5/23/2006	0.023	1	3.35	11.97	19.6
6/13/2006	0.017	3	3.35	7.60	22.3
7/12/2006	0.024	5	2.44	8.57	26.2
8/8/2006	0.039	6	2.74	5.94	26.3
9/6/2006	0.054	6	3.20	8.79	22.5
9/28/2006	0.020	2	3.66	8.95	14.8
2006 Average	0.028	4	3.24	8.46	21.0
2006 Summer Average	0.031	4	3.08	7.97	22.4

	High	High Date	Low	Low Date	Average
2006 Elevation (ft)	952.67	5/1/2006	951.13	10/24/2007	951.90

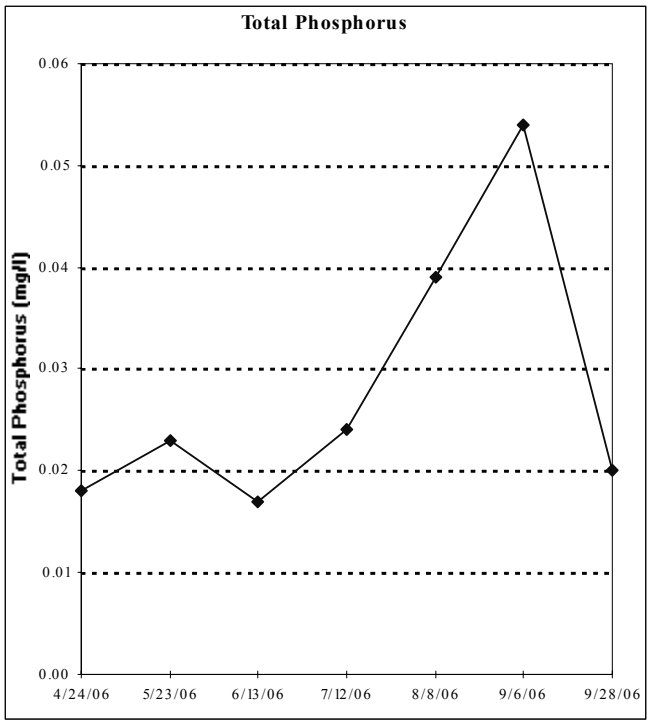
Lake Water Quality Summary

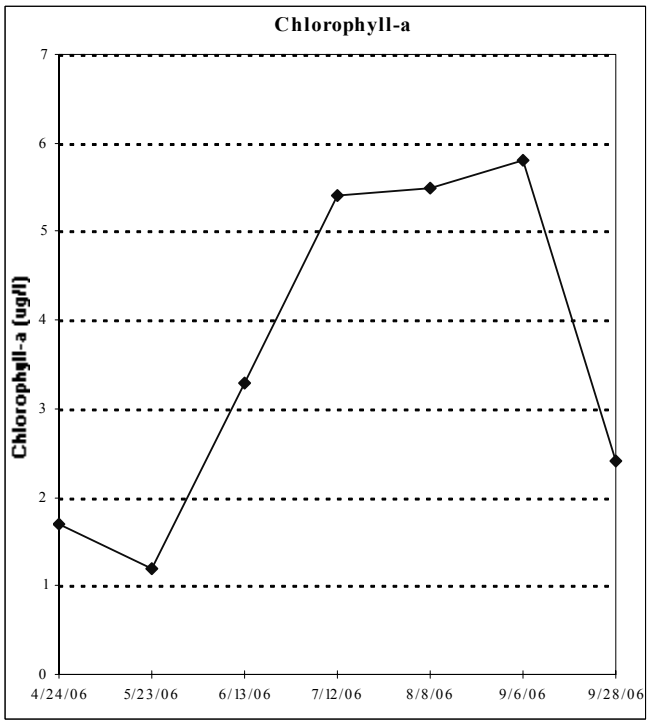
	Trophic Status	Summertime Lake Grades						
	2006	2006	2005	2004	2003	2002	2001	2000
Total Phosphorus (mg/l)	Eutrophic	B	NA	NA	NA	NA	NA	NA
Chlorophyll-*a* (ug/l)	Mesotrophic	A	NA	NA	NA	NA	NA	NA
Secchi disk (ft)	Mesotrophic	A	NA	NA	NA	NA	NA	NA
Overall	Mesotrophic	A-	NA	NA	NA	NA	NA	NA

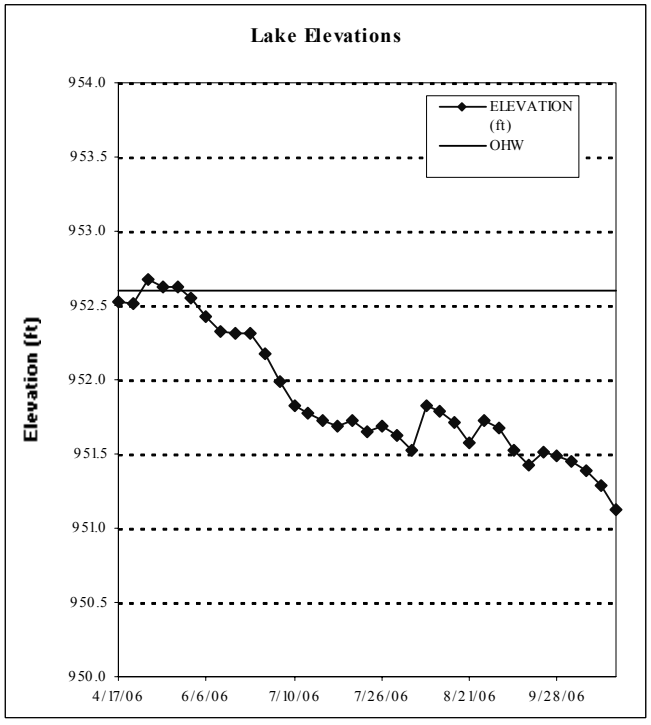
Bass West

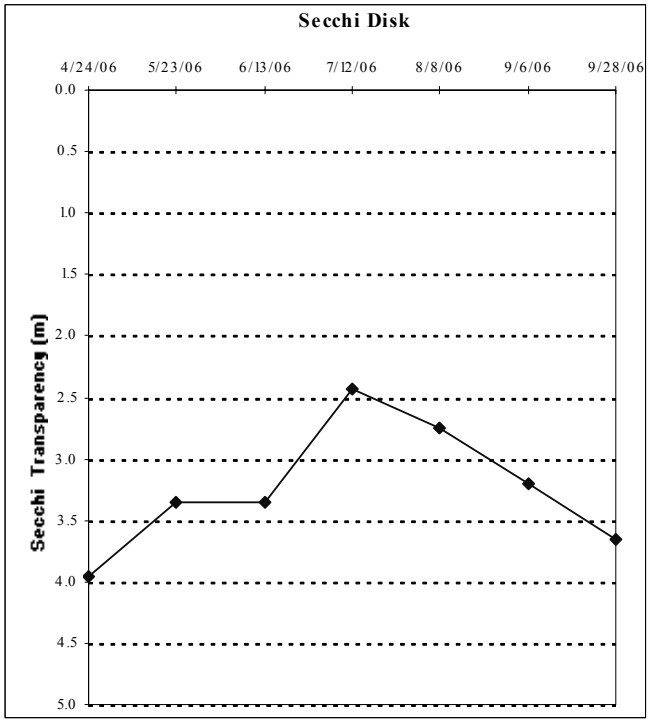

105TH
JODY AVENUE
103RD
JODY
103RD STREET
JOLIET
Sample Point
Bass West
Staff Gage
N
JAMACA
101ST
JUSTEN
0
800
1,600
3,200
Feet

Bass Lake (West)
City of Grant



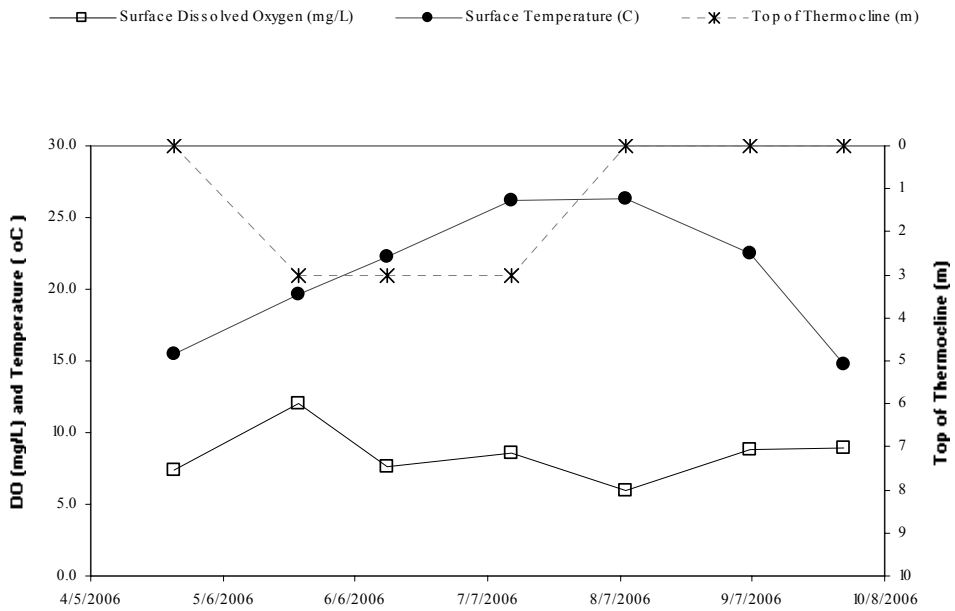






Bass Lake (West)
City of Grant

Dissolved Oxygen, Temperature, and Top of Thermocline by Sampling Date

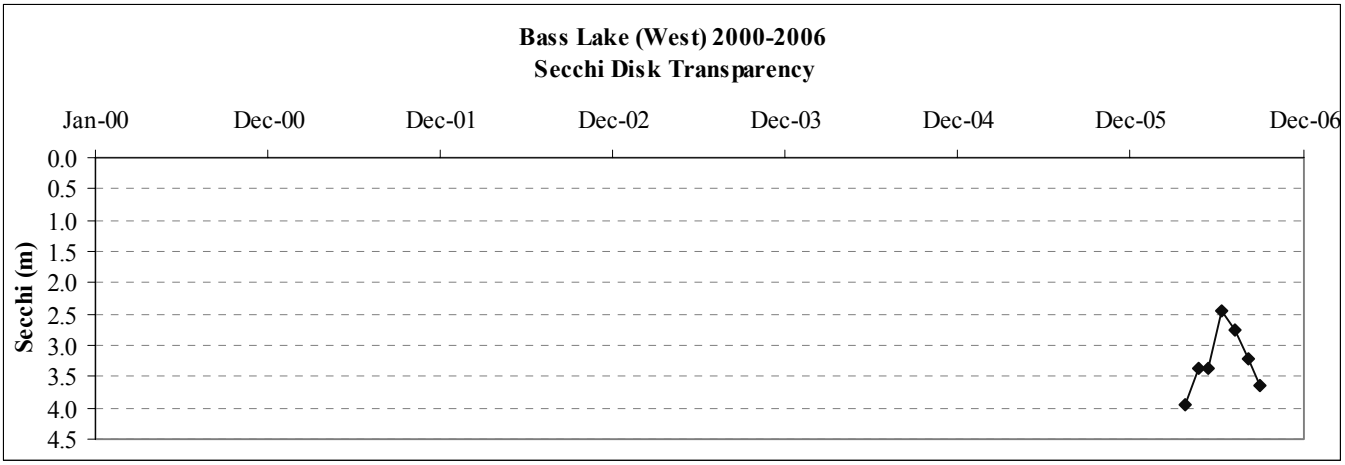


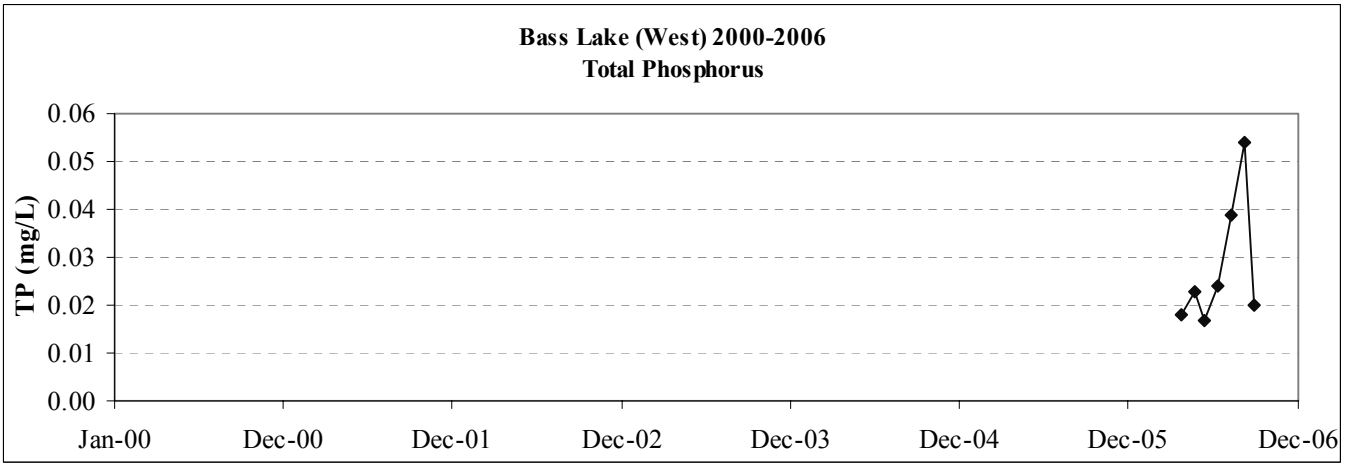
Dissolved Oxygen and Temperature Profile by Sampling Date and Depth

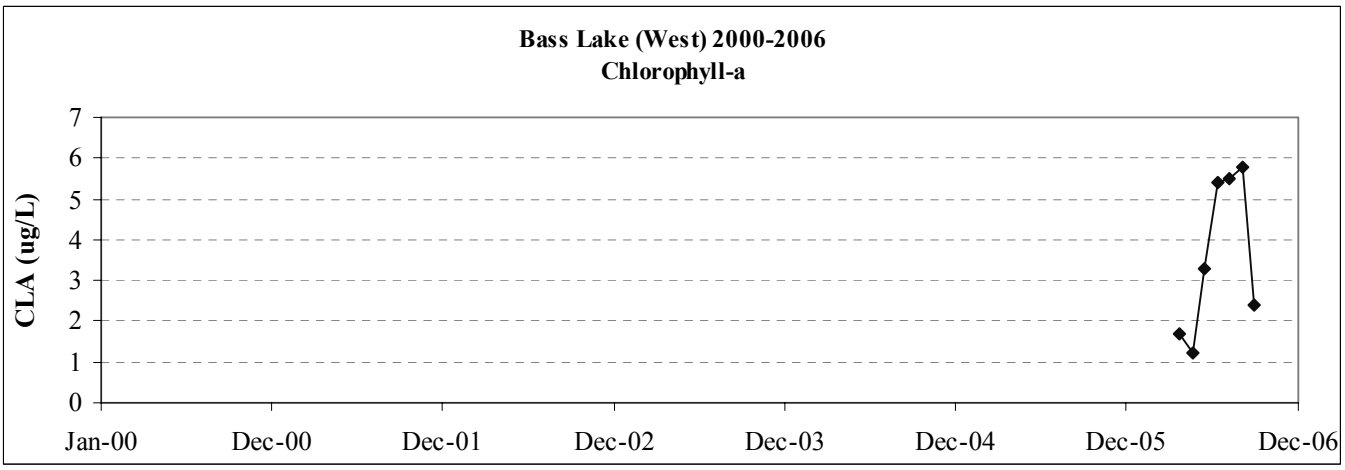
Sampling Date

	4/24/2006		5/23/2006		6/13/2006		7/12/2006		8/8/2006		9/6/2006		9/28/2006	
Depth (m)	D.O.	Temp	D.O.	Temp	D.O.	Temp	D.O.	Temp	D.O.	Temp	D.O.	Temp	D.O.	Temp
surface	7.38	15.5	11.97	19.6	7.60	22.3	8.57	26.2	5.94	26.3	8.79	22.5	8.95	14.8
1	6.98	15.5	11.84	18.2	7.83	21.8	8.56	26.1	6.22	26.2	7.80	22.2	8.93	14.8
2	7.07	15.3	10.84	17.7	7.00	21.1	7.69	26.1	6.00	26.0	7.09	22.1	8.83	14.8
3	7.17	15.2	4.56	14.8	6.28	20.7	4.24	25.4	0.07	24.4	4.58	21.8	0.14	14.8
4	4.66	13.4	4.80	13.7	0.08	19.7	0.27	24.6						
5			0.45	12.9										
Top of Thermocline (m)			3		3		3							

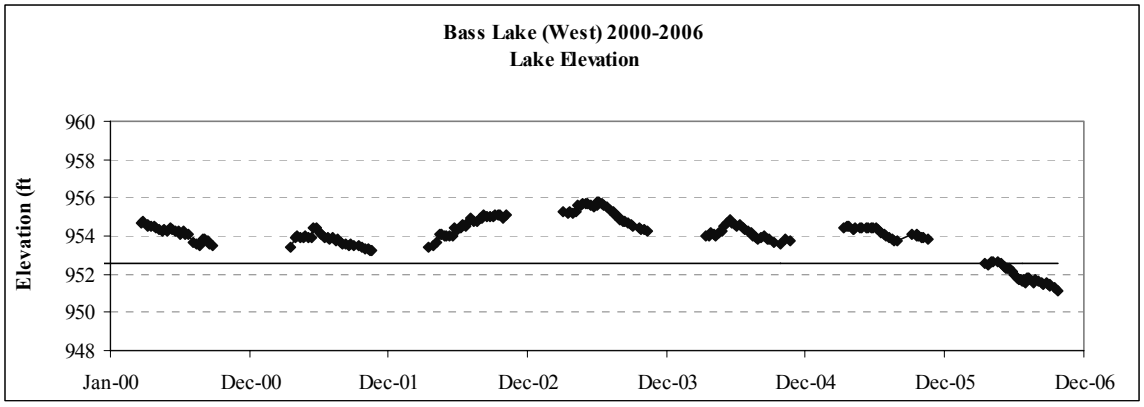
Bass Lake (West)
City of Grant

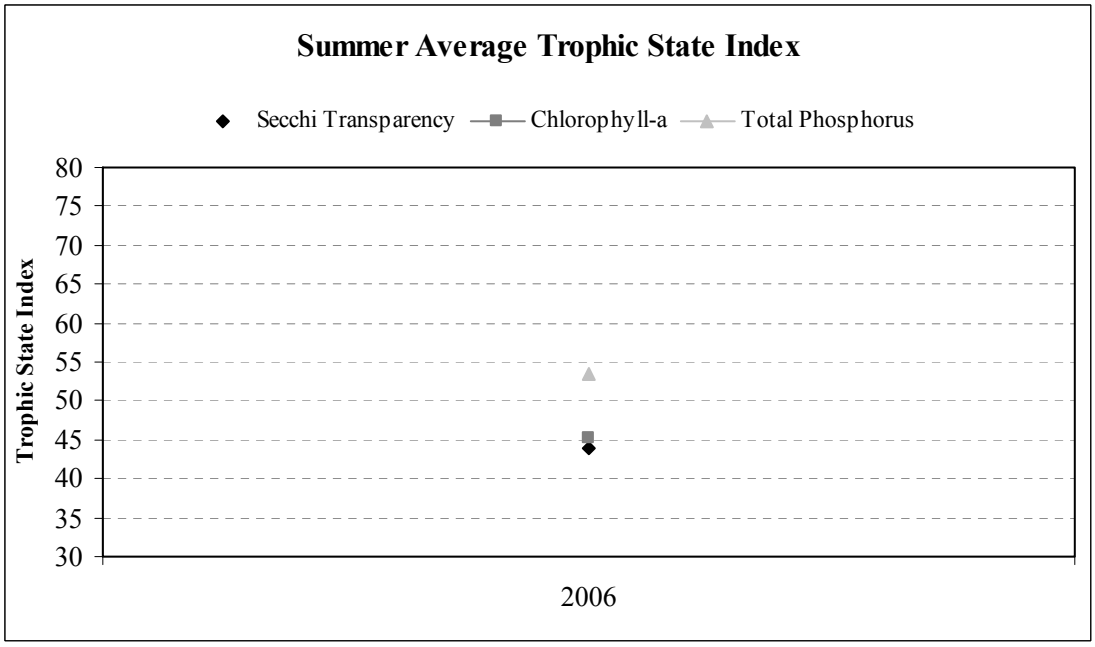






Bass Lake (West)
City of Grant





Benz Lake
City of Grant

Vital Statistics

DNR ID #: 82-0120
LOCATION: SE$^{1/4}$ Section 2, T30N-R21W
MUNICIPALITY: City of Withrow
LAKE SIZE: 37.6 Acres
MAXIMUM DEPTH: Not Available
ORDINARY HIGH WATER MARK: 954.07 Feet*
100-YEAR HIGH WATER LEVEL: 955.30 Feet
**Reduced by 4.84 feet due to benchmark error*

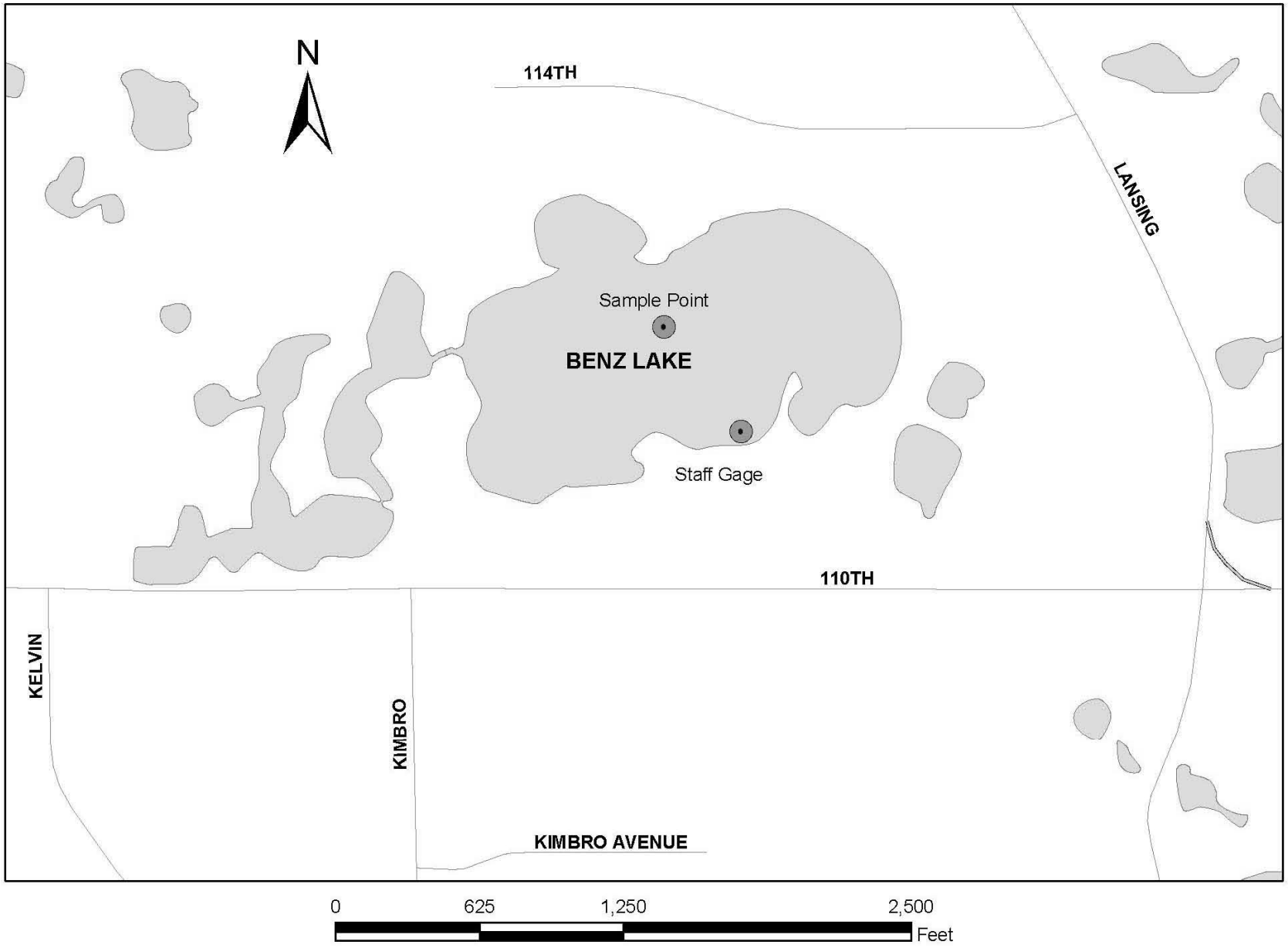
Date	Total Phosphorus (mg/L)	Chlorophyll-a (ug/L)	Secchi Disk Depths (m)	Surface Dissolved Oxygen Levels (mg/L)	Surface Temperature Levels (Celsius)
4/17/2006	0.196	17	1.83	6.53	15.9
5/3/2006	0.092	25	1.68	9.10	15.6
5/17/2006	0.085	22	1.68	10.34	18.5
5/30/2006	0.103	12	1.68	4.84	27.5
6/12/2006	0.181	18	1.22	4.59	21.3
6/27/2006	0.257	55	0.61	10.91	26.5
7/12/2006	0.542	57	0.61	4.28	25.8
7/24/2006	0.273	**NA**	0.46	9.71	27.0
8/8/2006	0.295	99	0.46	8.77	27.0
8/21/2006	0.117	84	0.46	8.93	24.7
9/6/2006	0.247	52	0.46	11.08	24.7
9/13/2006	0.226	65	0.30	12.18	18.0
9/25/2006	0.219	72	0.30	11.77	16.3
10/9/2006	0.176	67	0.46	9.08	14.1
2006 Average	0.215	50	0.87	8.72	21.6
2006 Summer Average	0.262	63	0.54	9.14	23.5

	High	High Date	Low	Low Date	Average
2006 Elevation (ft)	954.38	4/17/2006 5/3/2006	953.08	11/6/2006	953.75

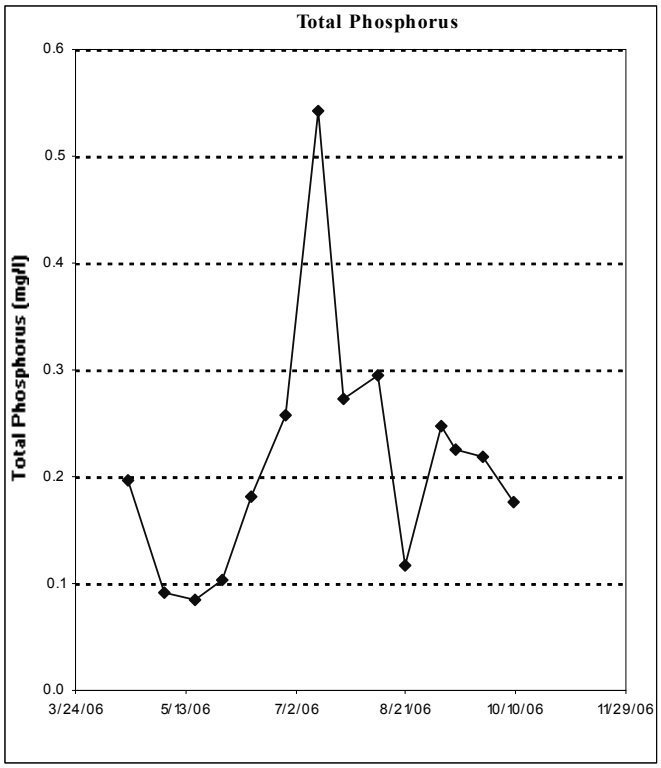
Lake Water Quality Summary

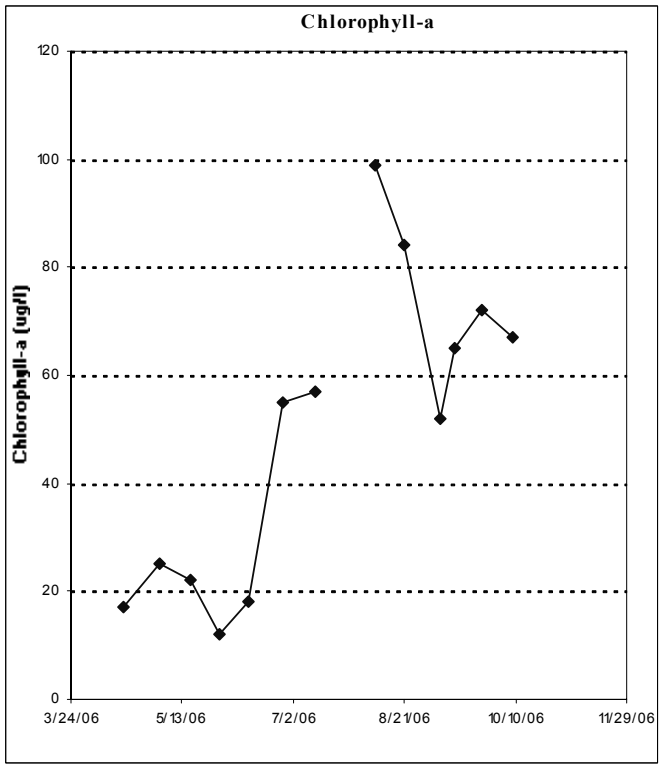
	Trophic Status	Summertime Lake Grades						
	2006	2006	2005	2004	2003	2002	2001	2000
Total Phosphorus (mg/l)	Hypereutrophic	F	F	NA	NA	NA	NA	NA
Chlorophyll-*a* (ug/l)	Hypereutrophic	D	F	NA	NA	NA	NA	NA
Secchi disk (ft)	Hypereutrophic	F	F	NA	NA	NA	NA	NA
Overall	Hypereutrophic	F+	F	NA	NA	NA	NA	NA

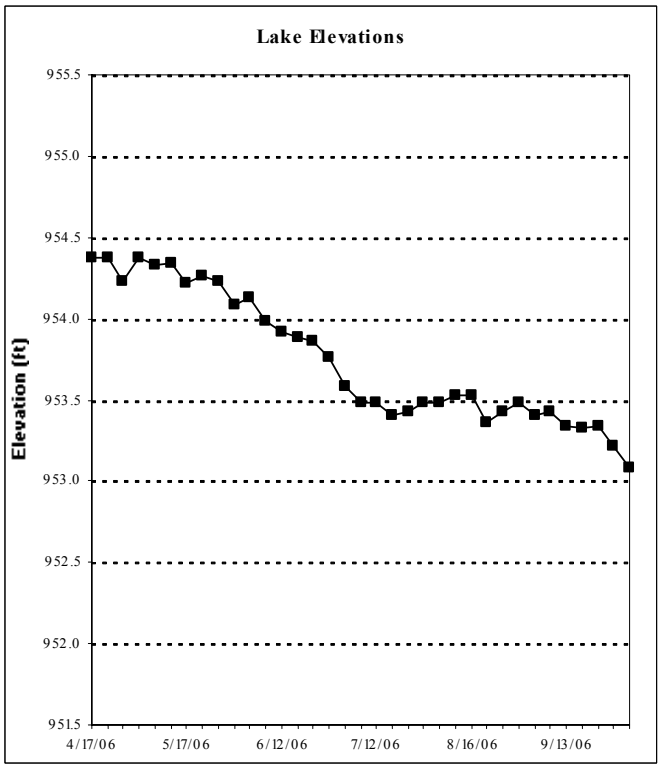
Benz Lake

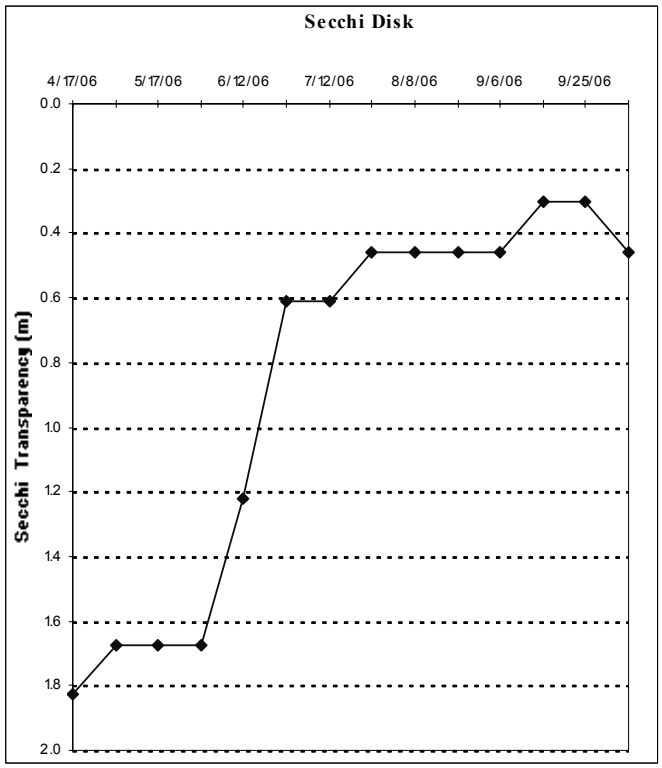

N
114TH
LANSING
Sample Point
BENZ LAKE
Staff Gage
110TH
KELVIN
KIMBRO
KIMBRO AVENUE
0
625
1,250
2,500
Feet

Benz Lake
City of Grant



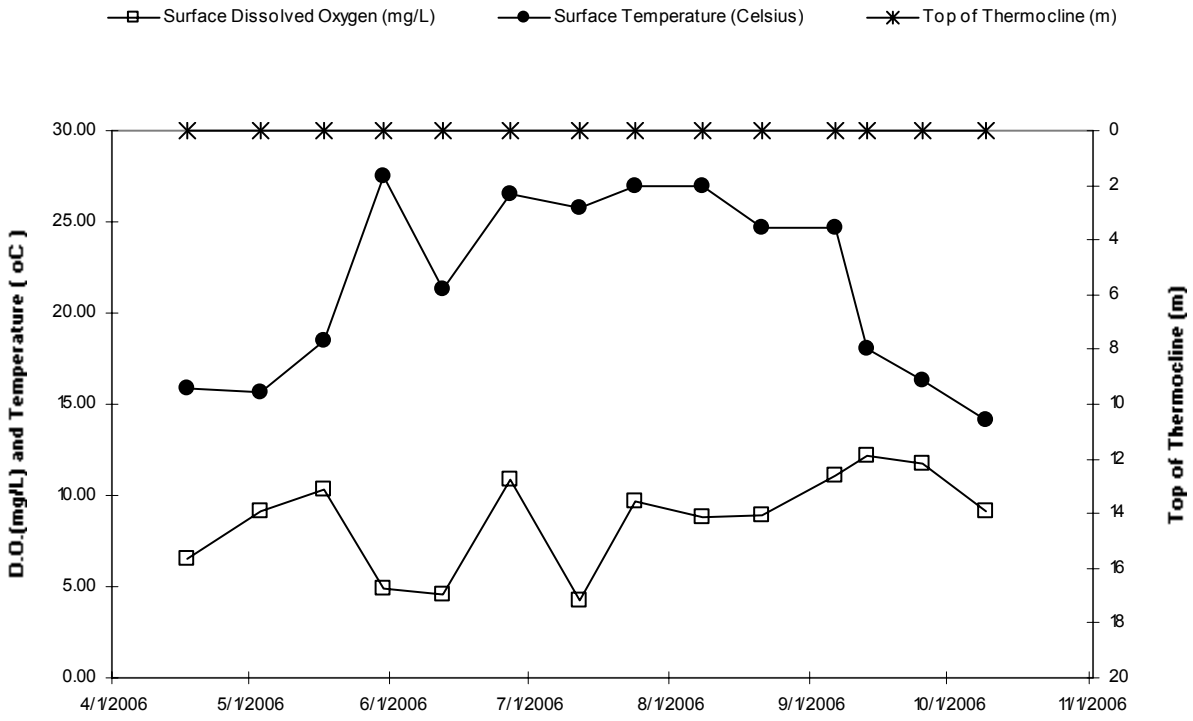






Benz Lake
City of Grant

Dissolved Oxygen, Temperature, and Top of Thermocline by Sampling Date

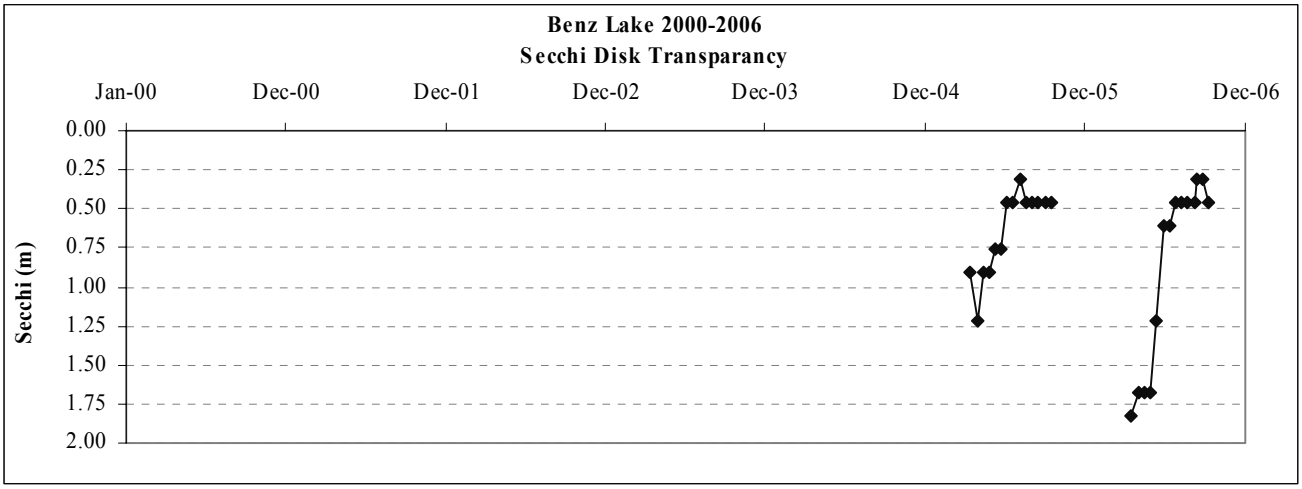


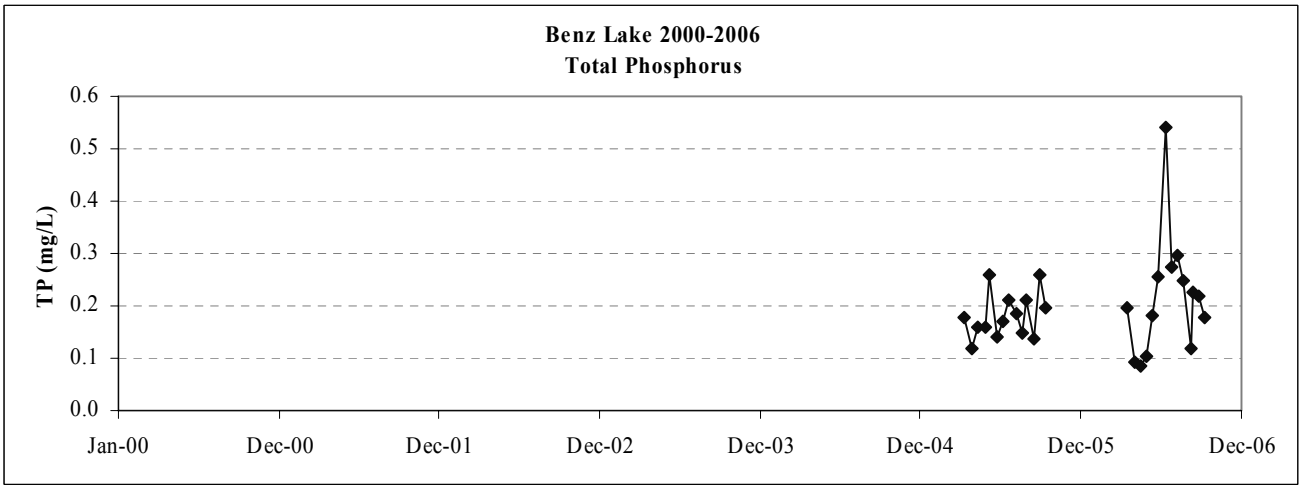
Dissolved Oxygen and Temperature Profile by Sampling Date and Depth

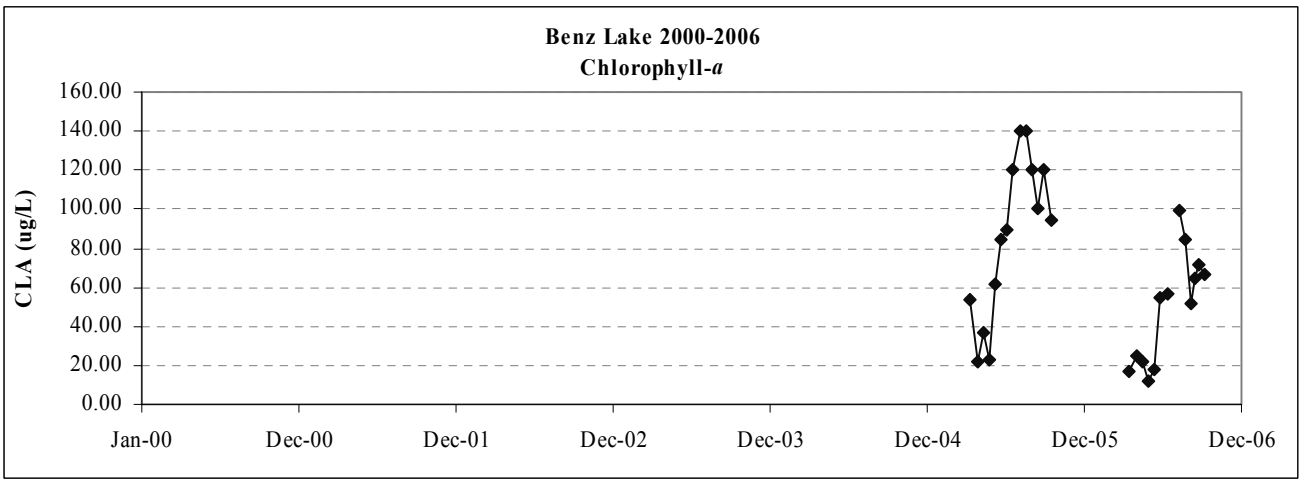
Sampling Date

Depth (m)	4/17/2006		5/3/2006		5/17/2006		5/30/2006		6/12/2006		6/27/2006		7/12/2006		7/24/2006		8/8/2006		8/21/2006		9/6/2006		9/13/2006		9/25/2006		10/9/2006	
	D.O.	Temp	D.O.	Temp	D.O.	Temp	D.O.	Temp	D.O.	Temp	D.O.	Temp	D.O.	Temp	D.O.	Temp	D.O.	Temp	D.O.	Temp	D.O.	Temp	D.O.	Temp	D.O.	Temp	D.O.	Temp
surface	6.53	15.9	9.10	15.6	10.34	18.5	4.84	27.5	4.59	21.3	10.91	26.5	4.28	25.8	9.71	27.0	8.77	27.0	8.93	24.7	11.08	24.7	12.18	18.0	11.77	16.3	9.08	14.1
1	6.54	15.8	9.12	15.5	10.52	17.2	5.26	26.3	4.07	20.3	10.38	24.9	2.90	25.8	9.12	26.8	8.26	26.7	7.70	24.2	5.69	22.0	9.66	17.5	9.09	14.4	8.68	13.9
2	6.60	15.1	8.96	15.5	10.54	14.1	6.00	20.7	2.22	20.1	1.21	24.0	0.09	25.1	0.12	25.2	0.07	25.6	1.05	23.6	3.53	21.6	0.16	17.3	6.95	14.2	4.36	13.8
3									0.09	20.2	0.06	23.7							0.08	23.4					0.10	14.3		
4																												
5																												
No Thermocline Present (m)																												

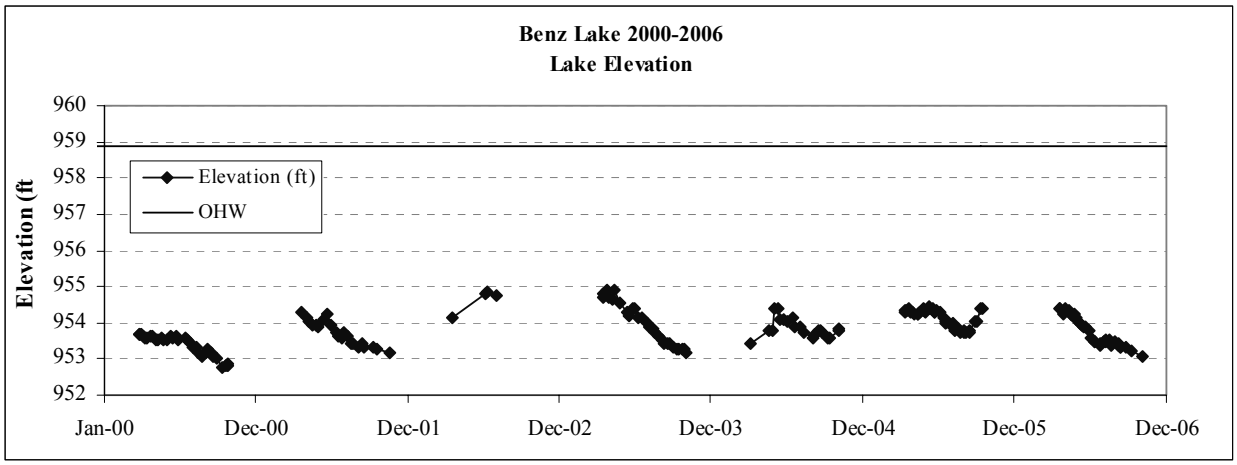
Benz Lake
City of Grant

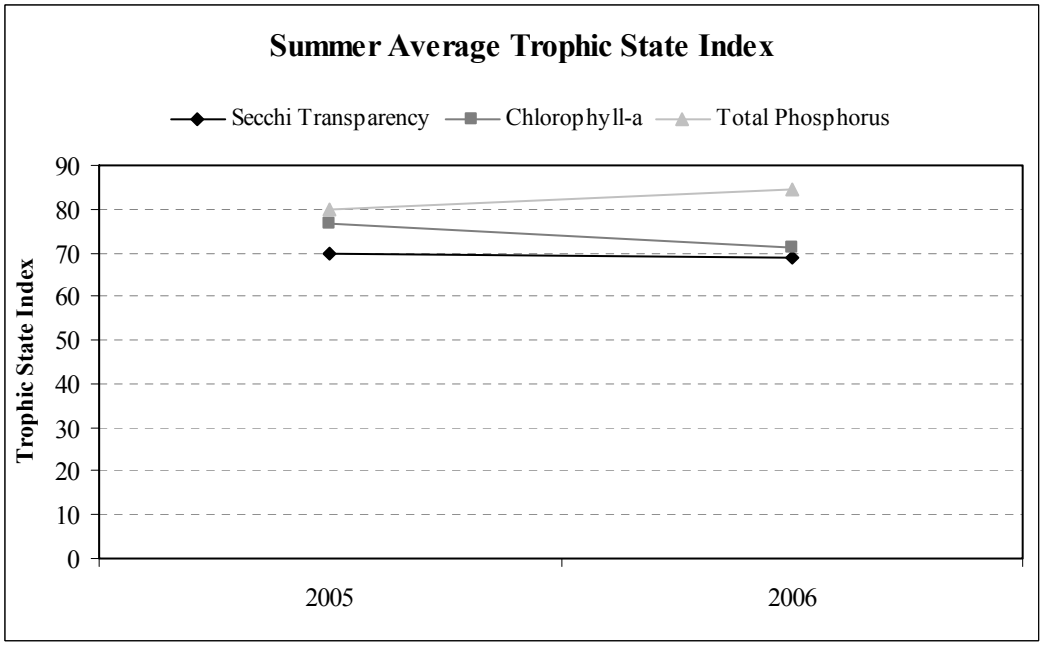






Benz Lake
City of Grant





Goggin's Lake
May Township

Vital Statistics

DNR ID #: 82-0077
LOCATION: NW$^{1/4}$ Section 31, T31N-R20W
MUNICIPALITY: May Township
LAKE SIZE: 41 Acres
MAXIMUM DEPTH: 15 Feet
ORDINARY HIGH WATER MARK: 966.50 Feet
100-YEAR HIGH WATER LEVEL: 972.20 Feet

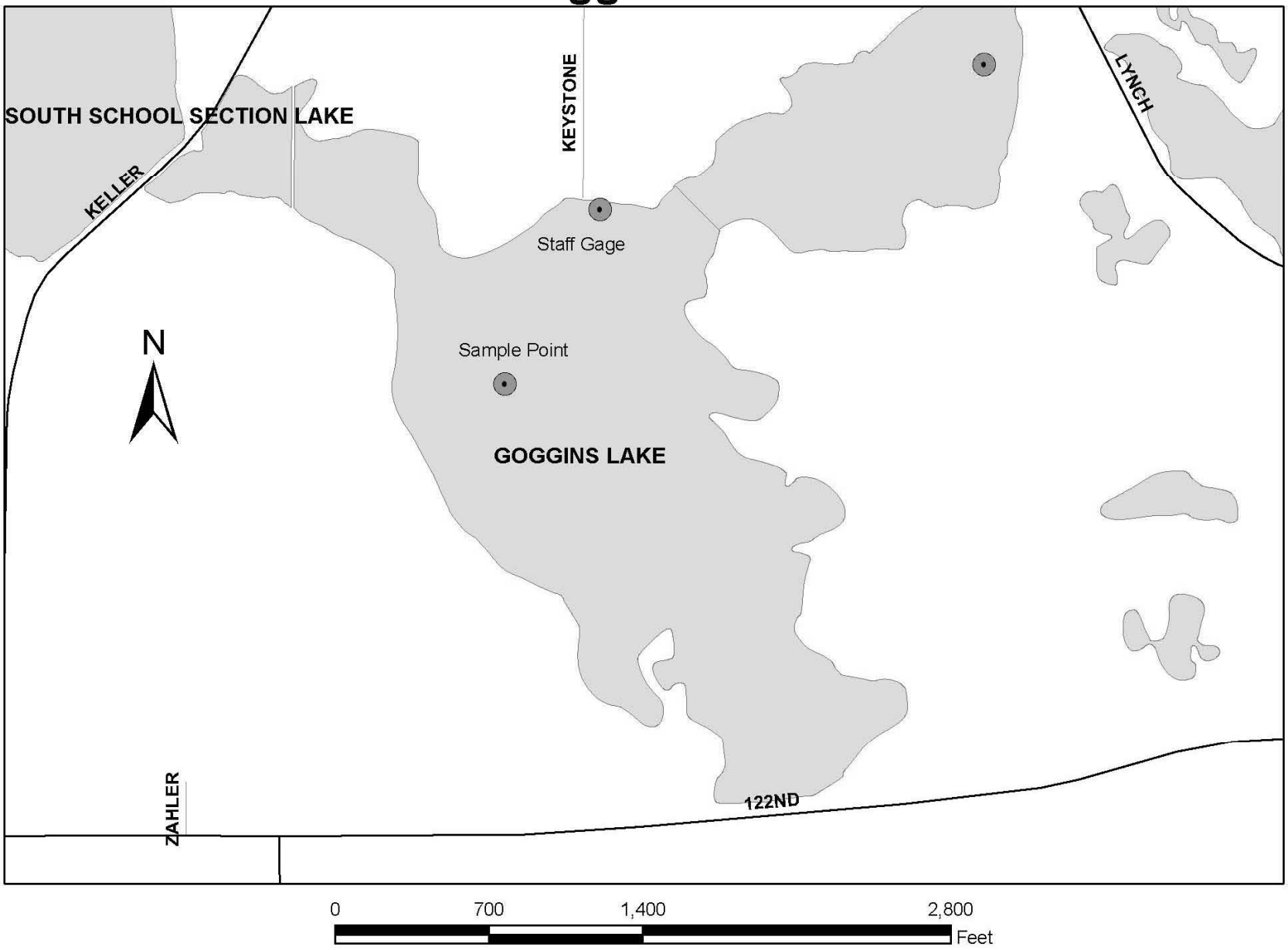
Date	Total Phosphorus (mg/L)	Chlorophyll-a (ug/L)	Secchi Disk Depths (m)	Surface Dissolved Oxygen Levels (mg/L)	Surface Temperature Levels (Celsius)
4/24/2006	0.052	30	1.37	10.25	15.2
5/3/2006	0.049	29	1.52	8.60	14.5
5/15/2006	0.071	31	1.68	8.98	13.2
5/30/2006	0.061	20	1.68	6.26	25.5
6/12/2006	0.106	22	0.91	6.65	19.4
6/26/2006	0.114	46	0.61	9.41	24.1
7/11/2006	0.118	31	0.61	12.19	27.3
7/24/2006	0.118	11	0.46	11.59	27.3
8/8/2006	0.197	34	0.61	9.60	25.4
8/21/2006	0.056	34	0.61	8.32	23.9
9/6/2006	0.095	43	0.61	13.45	21.9
9/13/2006	0.080	49	0.46	9.40	17.7
9/25/2006	0.141	41	0.46	10.81	14.3
10/9/2006	0.095	28	0.61	9.62	13.6
2006 Average	0.097	32	0.87	9.65	20.2
2006 Summer Average	0.114	35	0.59	10.16	22.4

	High	High Date	Low	Low Date	Average
2006 Elevation (ft)	967.69	5/3/2006	965.54	10/27/2006	966.66

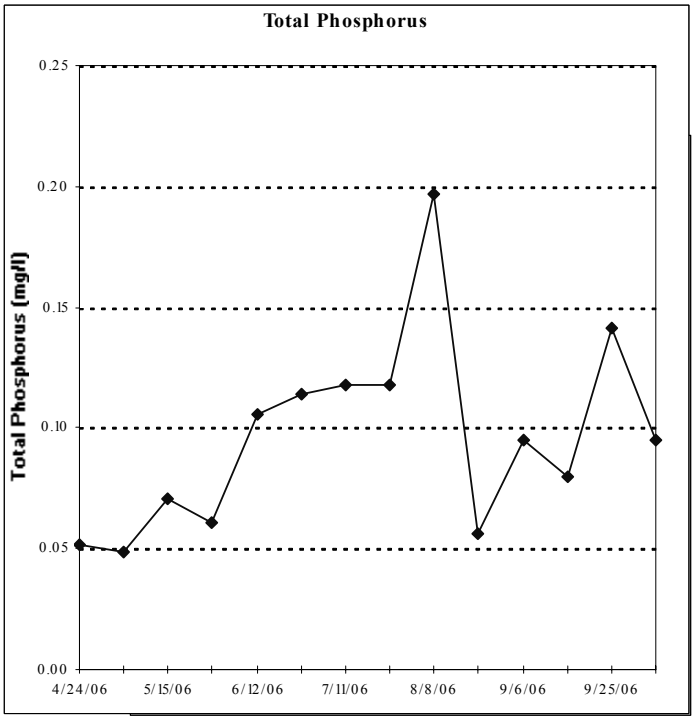
Lake Water Quality Summary

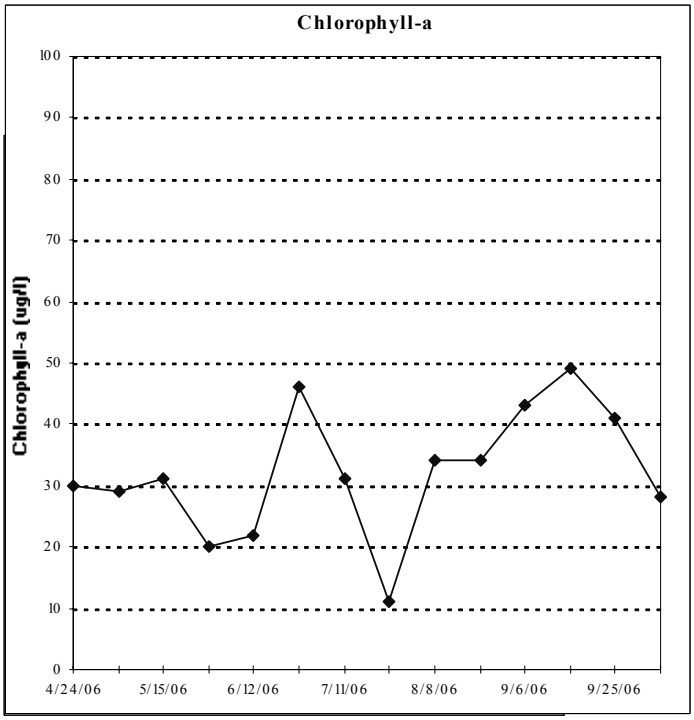
	Trophic Status	Summertime Lake Grades						
	2006	2006	2005	2004	2003	2002	2001	2000
Total Phosphorus (mg/l)	Hypereutrophic	D	D	D+	D+	D	D	D
Chlorophyll-*a* (ug/l)	Hypereutrophic	C	D+	C	C	C	C	C
Secchi disk (ft)	Hypereutrophic	F	D	D	D	D	D	D
Overall	Hypereutrophic	D	D	D+	D+	D+	D+	D+

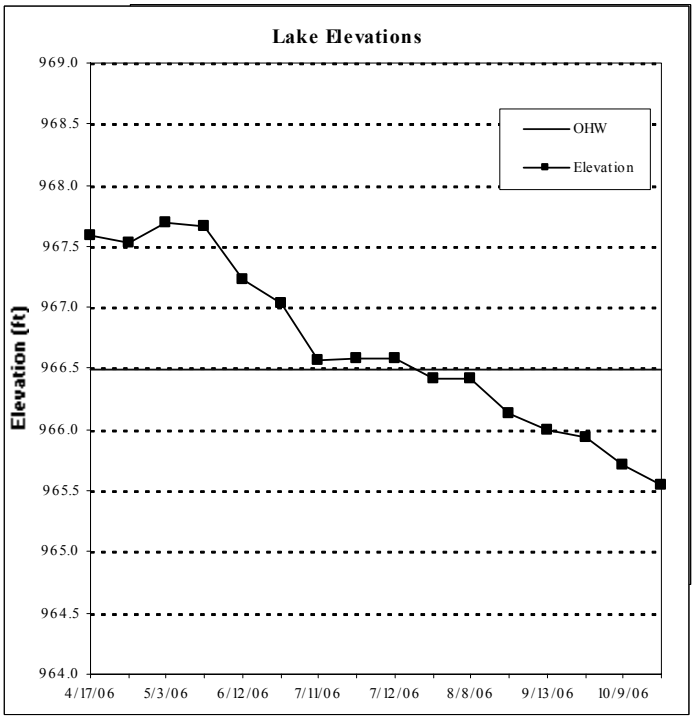
Goggin's Lake

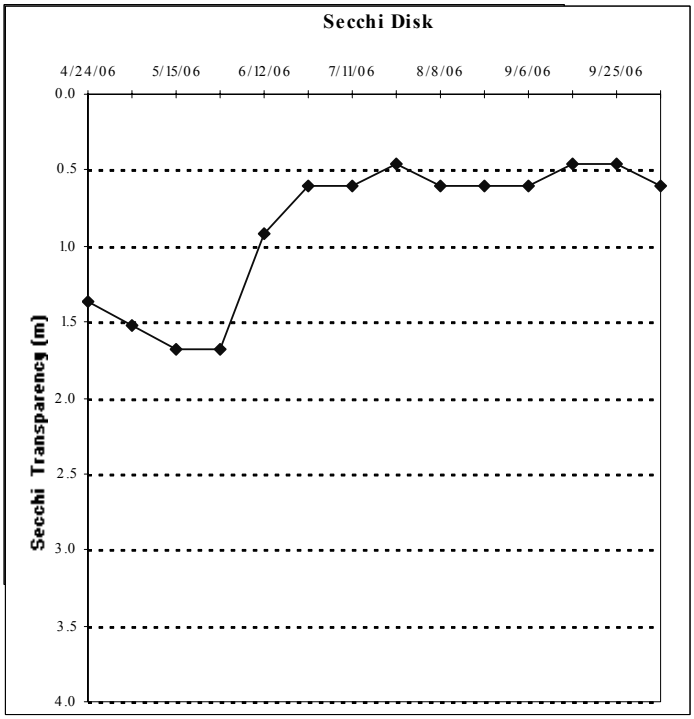


Goggin's Lake
May Township



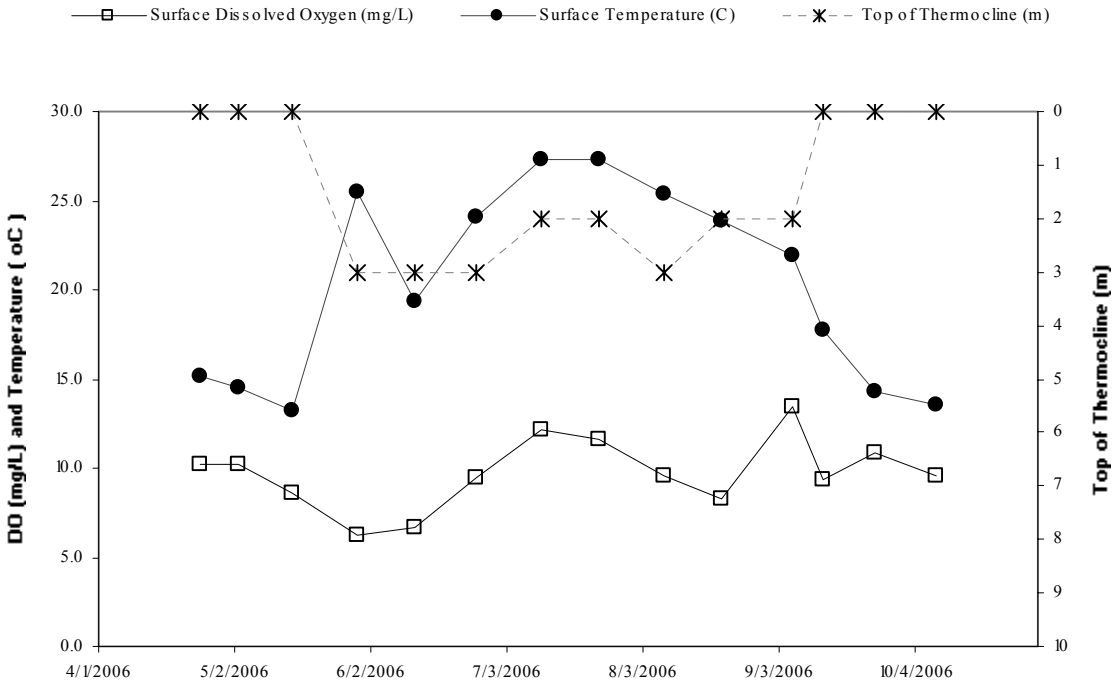






Goggin's Lake
May Township

Dissolved Oxygen, Temperature, and Top of Thermocline by Sampling Date

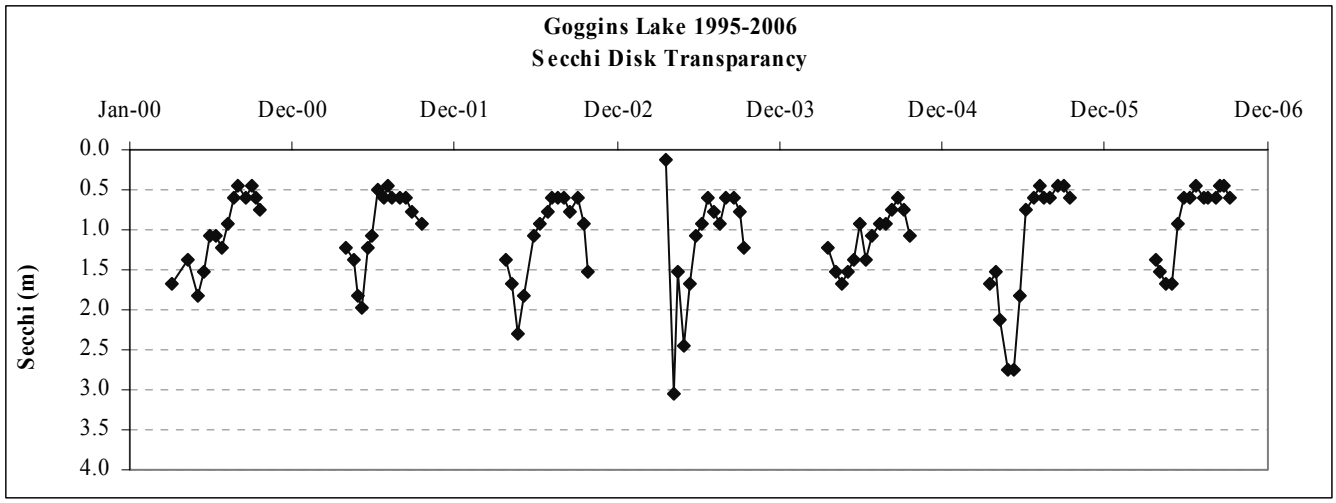


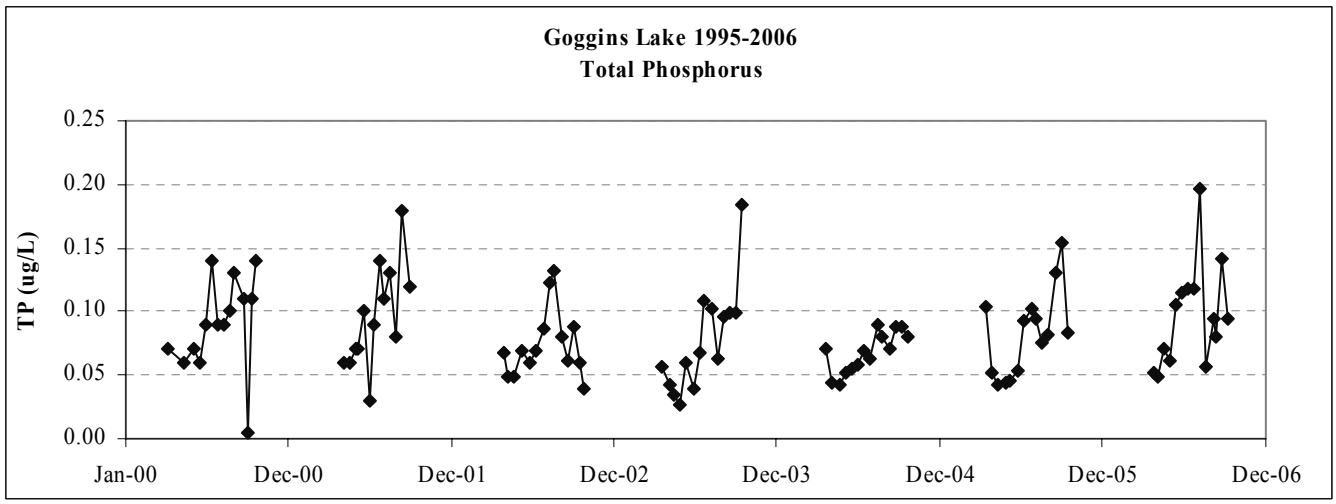
Dissolved Oxygen and Temperature Profile by Sampling Date and Depth

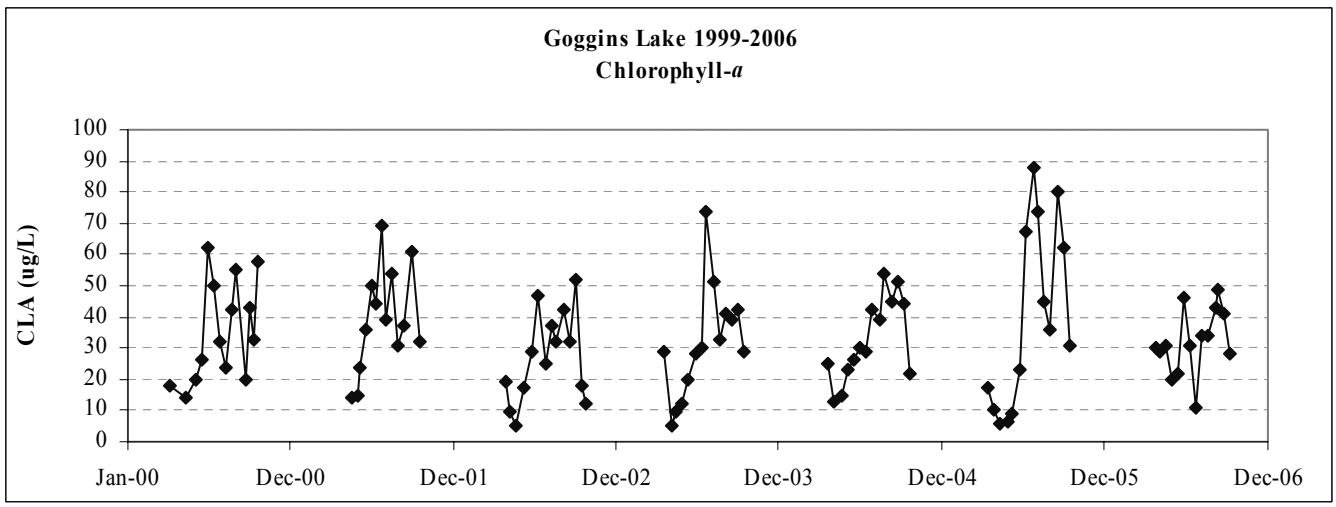
Sampling Date

Depth (m)	4/24/2006		5/3/2006		5/15/2006		5/30/2006		6/12/2006		6/26/2006		7/11/2006		7/24/2006		8/8/2006		8/21/2006		9/6/2006		9/13/2006		9/25/2006		10/9/2006	
	D.O.	Temp	D.O.	Temp	D.O.	Temp	D.O.	Temp	D.O.	Temp	D.O.	Temp	D.O.	Temp	D.O.	Temp	D.O.	Temp	D.O.	Temp	D.O.	Temp	D.O.	Temp	D.O.	Temp	D.O.	Temp
surface	10.25	15.2	10.25	14.5	8.60	13.2	6.26	25.5	6.65	19.4	9.41	24.1	12.19	27.3	11.59	27.3	9.60	25.4	8.32	23.9	13.45	21.9	9.40	17.7	10.81	14.3	9.62	13.6
1	9.75	15.1	9.75	14.4	6.20	13.1	5.81	25.6	6.07	19.4	9.13	23.4	11.56	26.3	12.24	26.8	9.24	25.4	8.17	23.7	12.13	21.9	8.80	17.5	10.78	14.3	9.60	13.6
2	9.22	14.2	9.22	13.4	6.30	12.9	5.29	24.9	5.56	19.4	6.84	23.0	5.56	24.5	6.17	24.4	8.31	25.4	4.38	22.9	7.85	21.1	8.70	17.3	10.76	14.3	9.18	13.6
3	8.40	13.5	8.40	13.1	6.28	12.8	3.72	17.3	3.69	19.4	1.19	22.1	0.81	23.3	0.22	23.1	0.17	24.2	0.56	22.4	4.02	20.8	9.13	17.2	9.41	14.1	9.35	13.6
4	6.13	13.0	6.13	12.8	5.67	12.4	0.48	14.6	0.19	19.4	0.04	15.9	0.13	15.9			0.07	18.4	0.07	19.0	0.07	19.9	8.15	17.0	8.49	13.9	0.13	13.6
5																							0.19	17.2	0.17	14.2		
Top of Thermocline (m)							3		3		3		2		2		3		2		2							

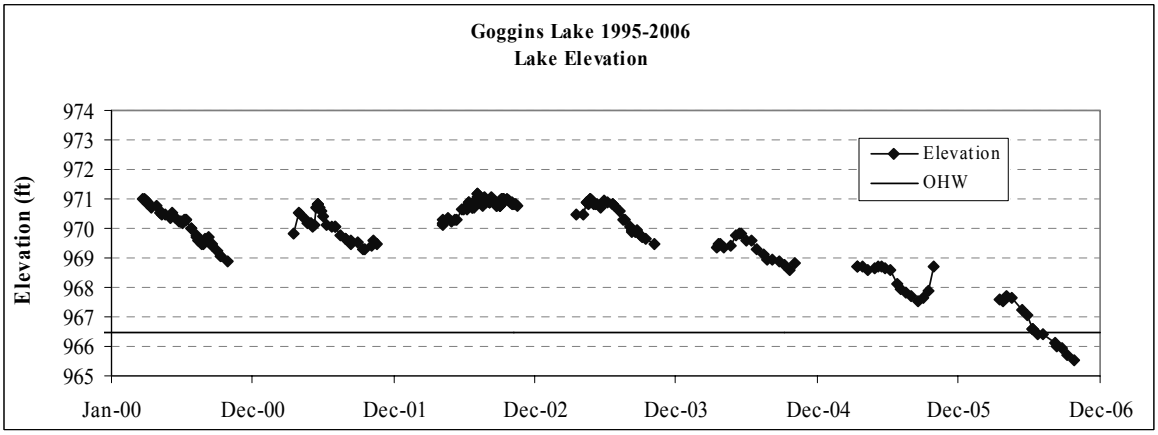
Goggin's Lake
May Township

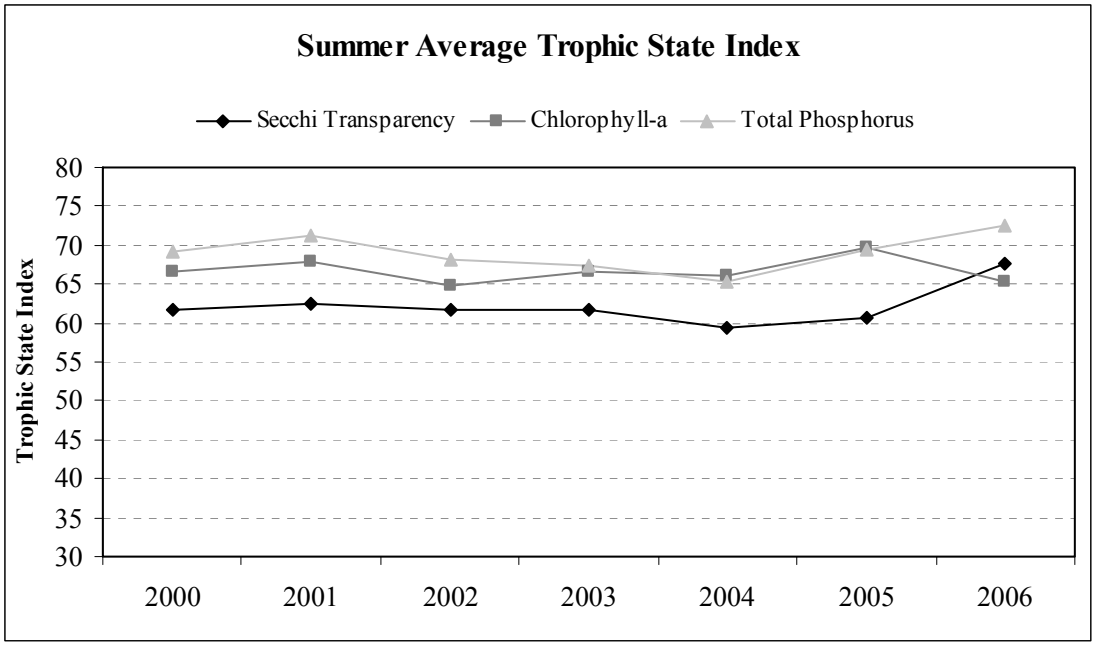






Goggin's Lake
May Township





July Avenue Pond
City of Hugo

Vital Statistics

DNR ID #: 82-0318
LOCATION: Section 23, T30N-R21W
MUNICIPALITY: Township of Grant
LAKE SIZE: 121.9 acres
MAXIMUM DEPTH: 7.5 Feet
ORDINARY HIGH WATER MARK: NA
100-YEAR HIGH WATER LEVEL: 979.2 Feet

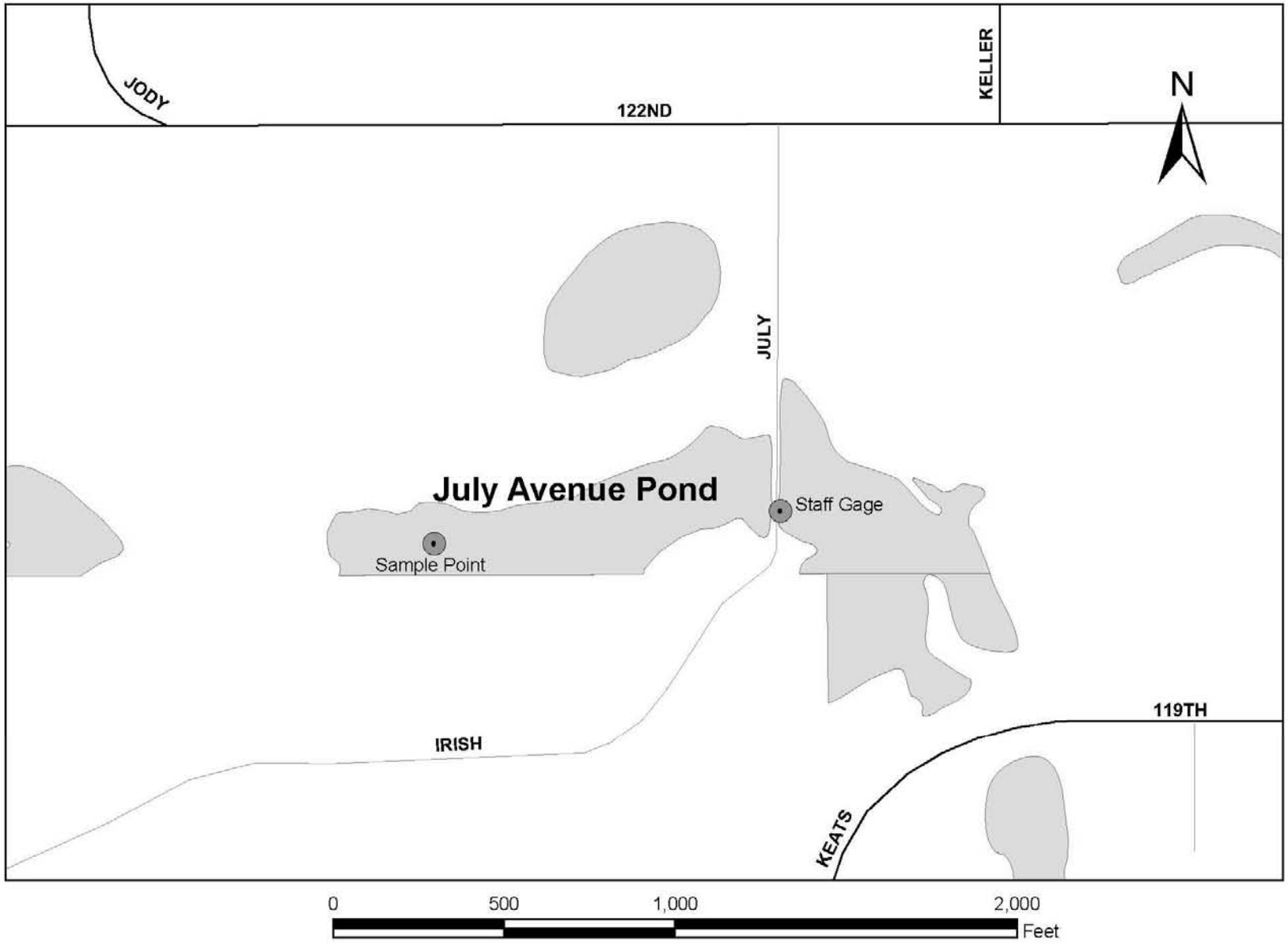
Date	Total Phosphorus (mg/L)	Chlorophyll-a (ug/L)	Secchi Disk Depths (m)	Surface Dissolved Oxygen Levels (mg/L)	Surface Temperature Levels (Celsius)
4/18/2006	0.127	150	0.46	11.53	13.9
5/17/2006	0.095	32	0.46	10.53	20.7
6/12/2006	0.067	51	0.61	5.15	19.4
7/11/2006	0.146	130	0.30	9.98	25.2
8/8/2006	0.248	280	0.15	9.06	24.9
9/6/2006	0.812	410	0.15	10.60	21.5
9/25/2006	0.183	250	0.15	9.08	14.0
2006 Average	0.240	186	0.33	9.42	19.9
2006 Summer Average	0.291	224	0.27	8.77	21.0

	High	High Date	Low	Low Date	Average
2006 Elevation (ft)	973.23	5/17/2006	970.35	10/18/2006	971.84

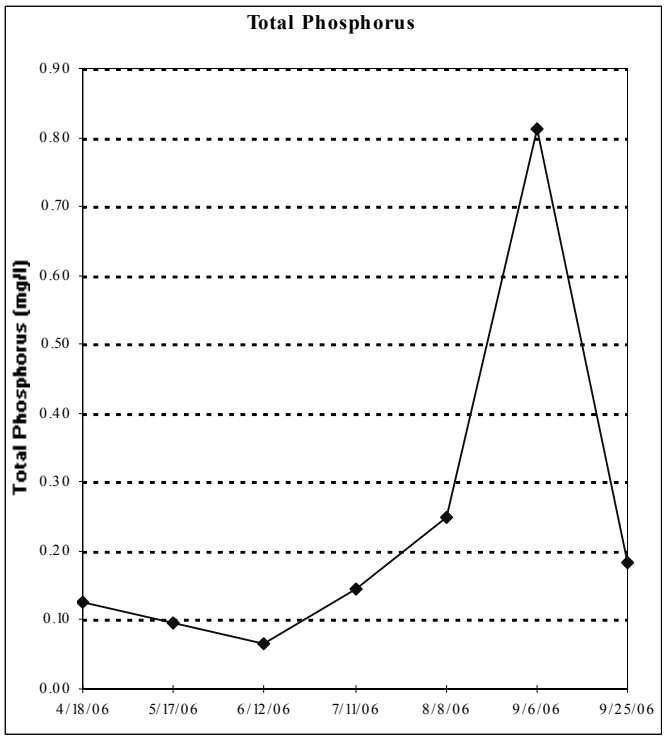
Lake Water Quality Summary

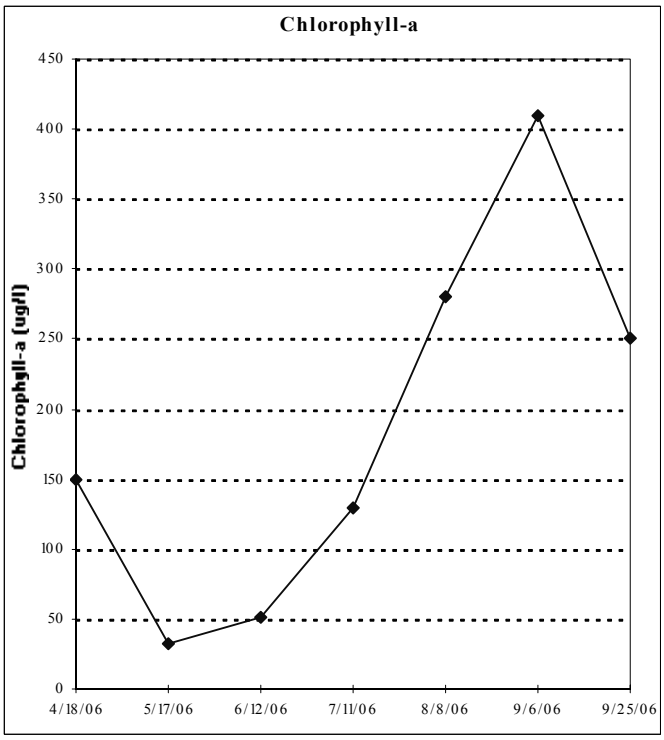
	Trophic Status	Summertime Lake Grades						
	2006	2006	2005	2004	2003	2002	2001	2000
Total Phosphorus (mg/l)	Hypereutrophic	F	NA	NA	NA	NA	NA	NA
Chlorophyll-*a* (ug/l)	Hypereutrophic	F	NA	NA	NA	NA	NA	NA
Secchi disk (ft)	Hypereutrophic	F	NA	NA	NA	NA	NA	NA
Overall	Hypereutrophic	F	NA	NA	NA	NA	NA	NA

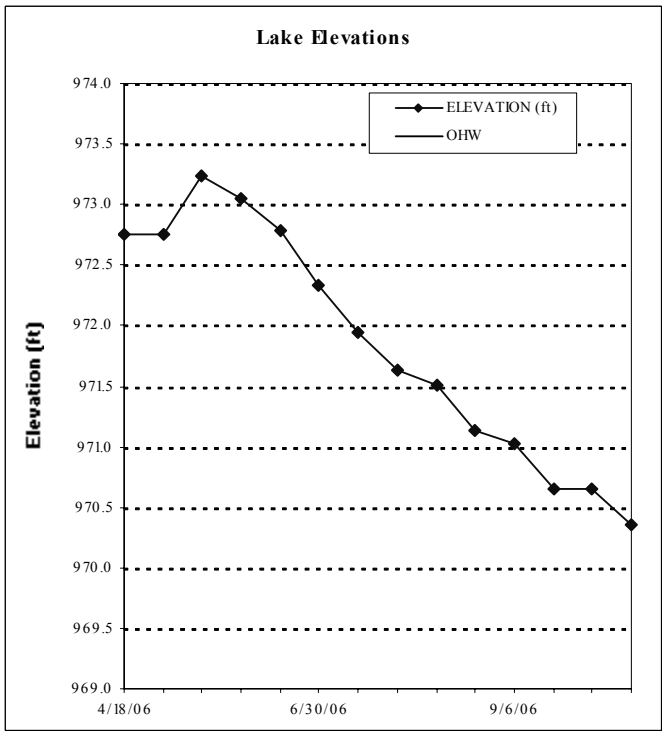
July Avenue Pond

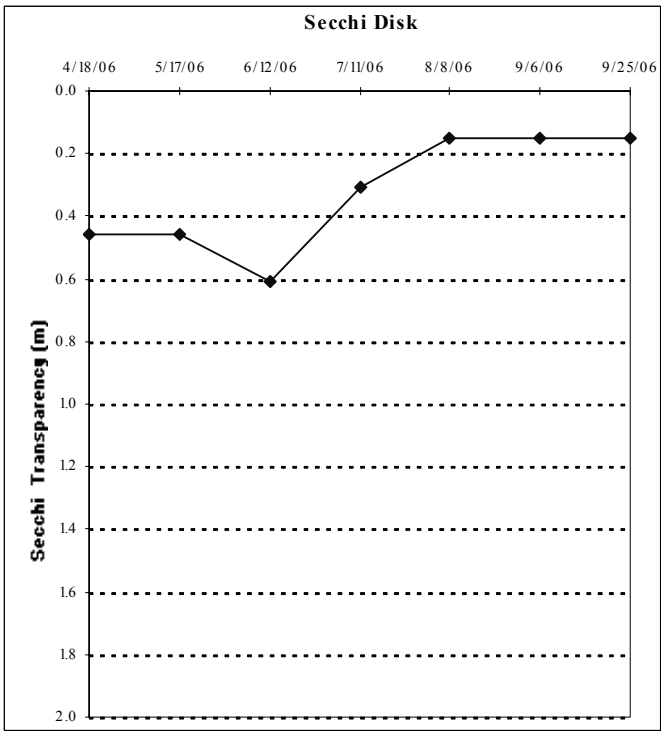


July Avenue Pond
City of Hugo



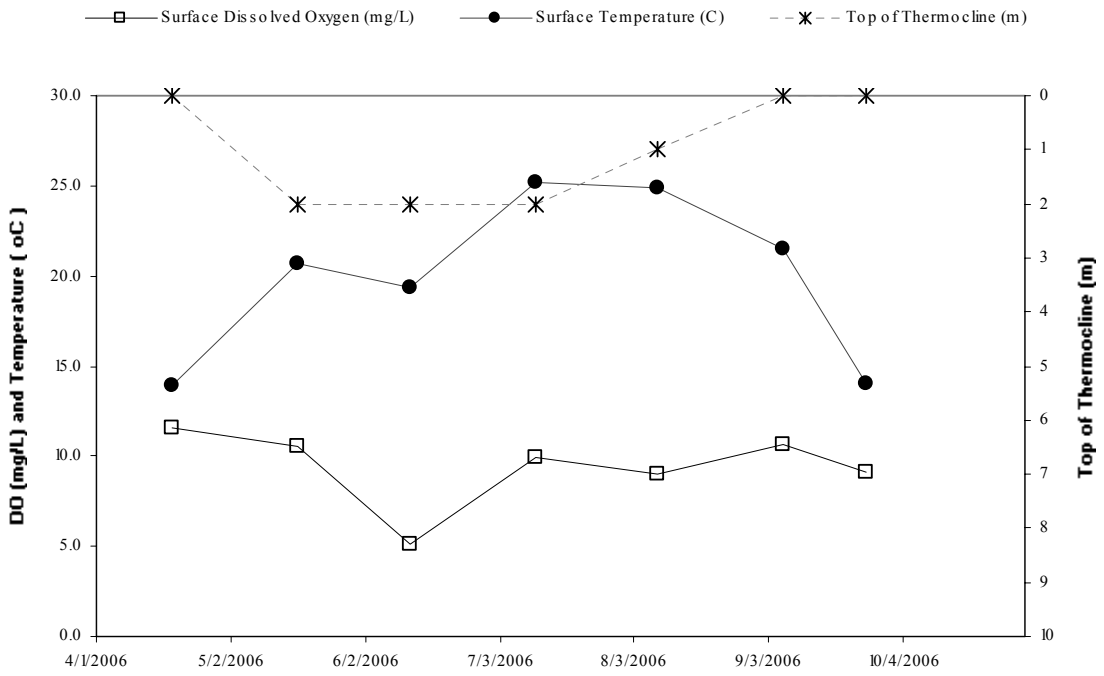






July Avenue Pond
City of Hugo

Dissolved Oxygen, Temperature, and Top of Thermocline by Sampling Date

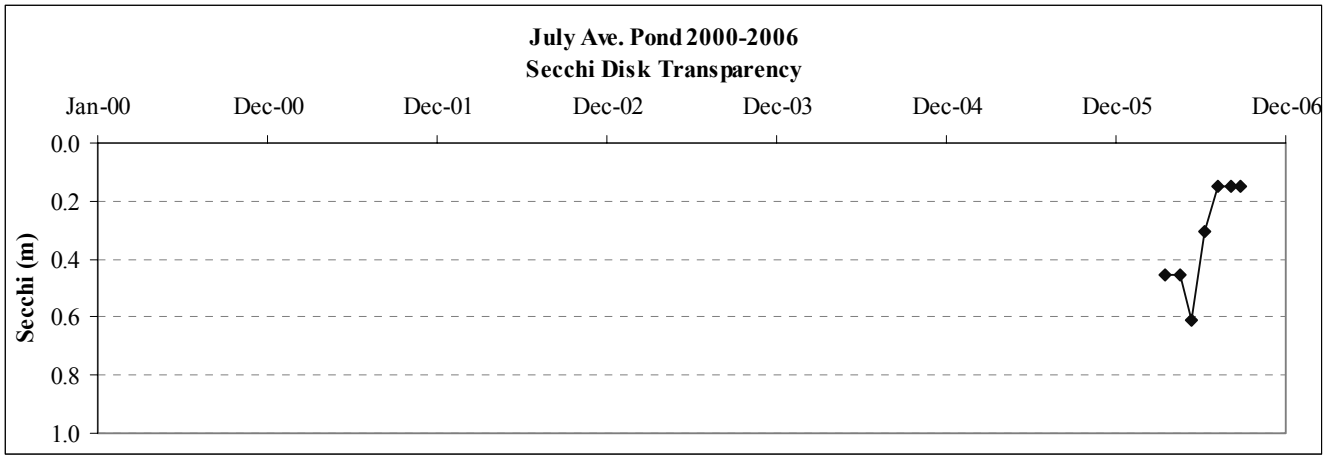


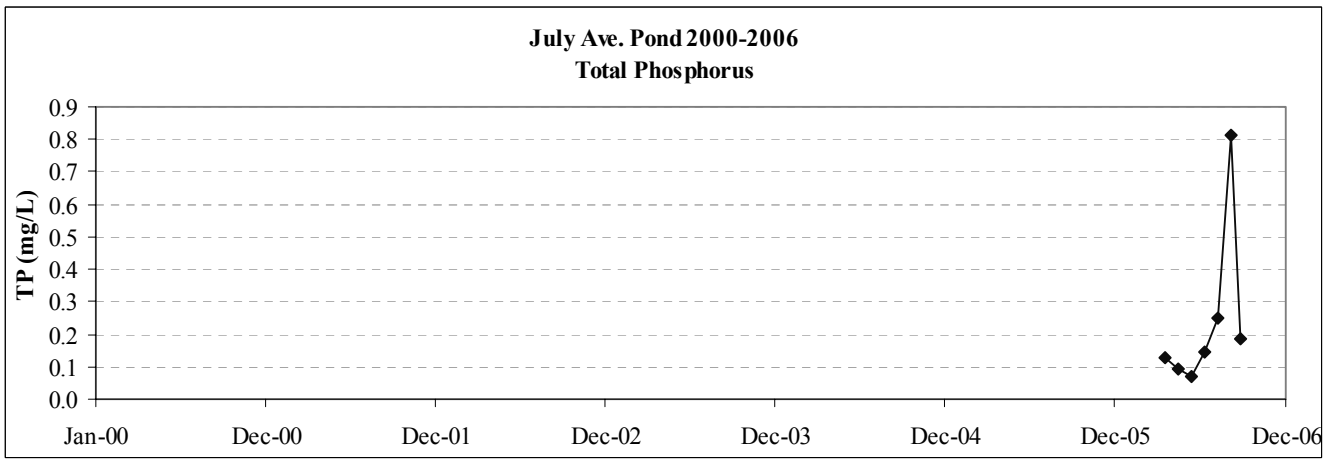
Dissolved Oxygen and Temperature Profile by Sampling Date and Depth

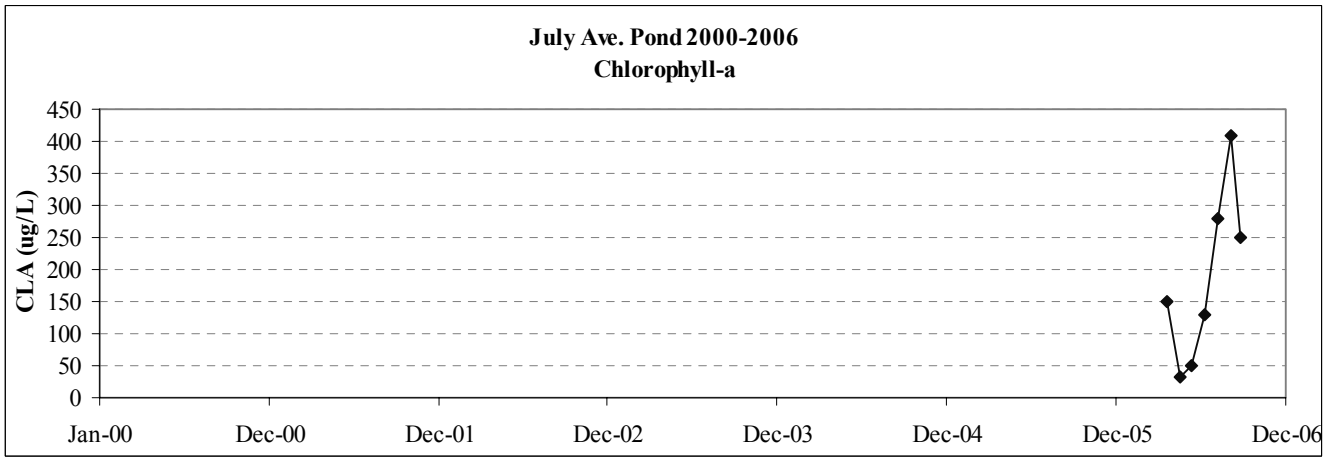
Sampling Date

	4/18/2006		5/17/2006		6/12/2006		7/11/2006		8/8/2006		9/6/2006		9/25/2006	
Depth (m)	D.O.	Temp	D.O.	Temp	D.O.	Temp	D.O.	Temp	D.O.	Temp	D.O.	Temp	D.O.	Temp
surface	11.53	13.9	10.53	20.7	5.15	19.4	9.98	25.2	9.06	24.9	10.60	21.5	9.08	14.0
1	11.38	13.8	10.79	18.7	5.44	18.9	7.82	25.0	6.59	24.5	2.54	20.7	9.09	13.7
2	10.80	13.8	1.54	13.2	0.51	18.3	0.10	21.7	0.09	22.0			0.15	13.6
3					0.07	18.2								
4														
5														
Top of Thermocline (m)			2		2		2		1					

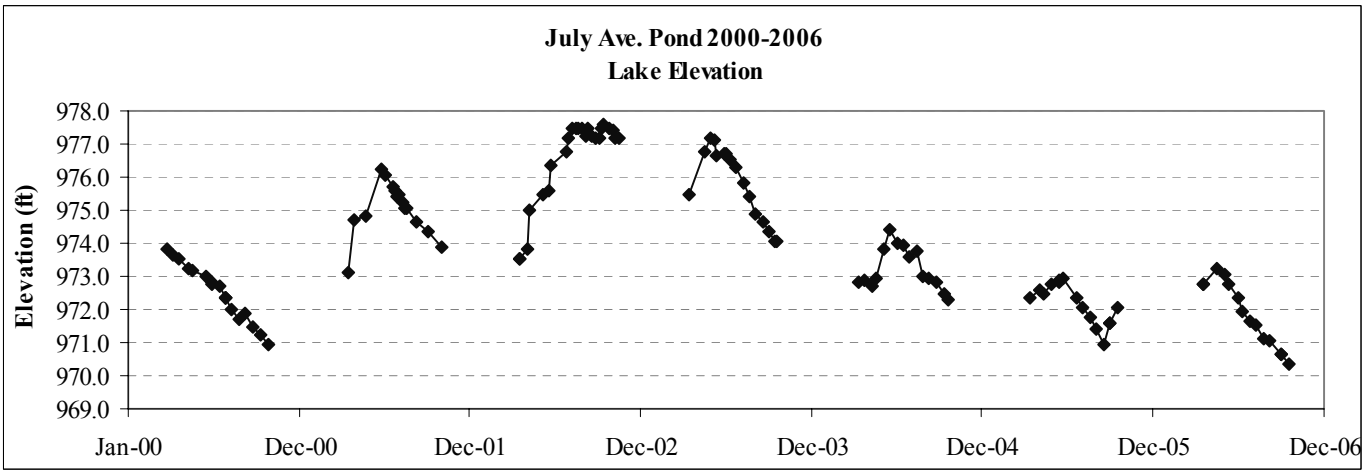
July Avenue Pond
City of Hugo

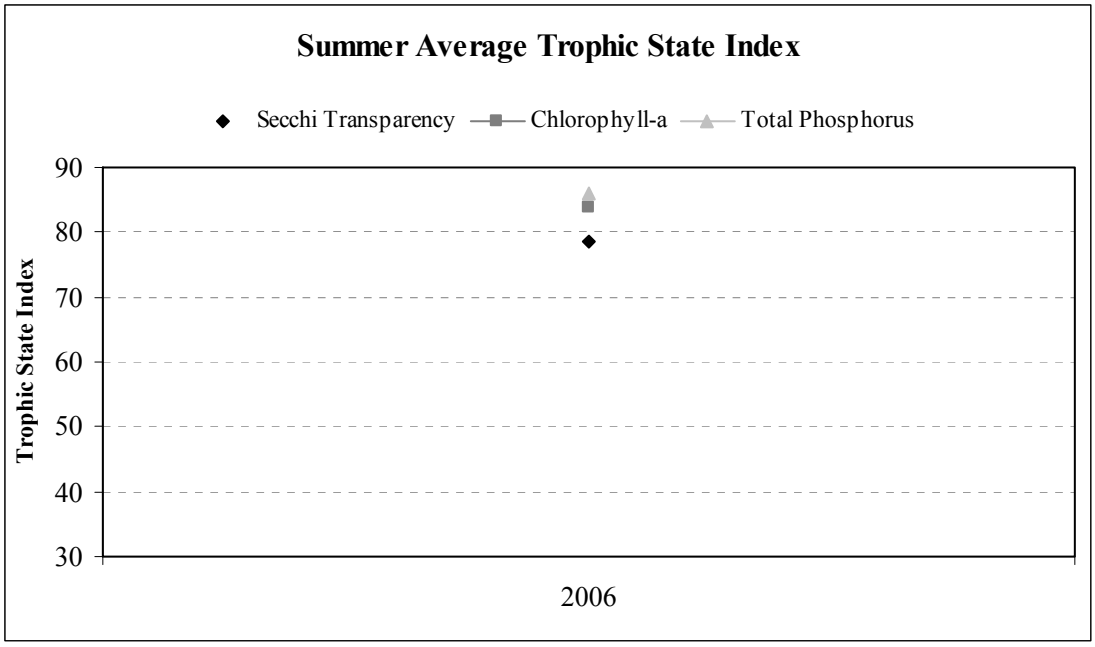






July Avenue Pond
City of Hugo





Kismet Basin
City of Grant

Vital Statistics

DNR ID #: 82-0334
LOCATION: $S^{1/2}$ Section 11, T30N-R21W
MUNICIPALITY: City of Grant
LAKE SIZE: 23 Acres
MAXIMUM DEPTH: 12 Feet
ORDINARY HIGH WATER MARK: 943.50 Feet
100-YEAR HIGH WATER LEVEL: 944.90 Feet

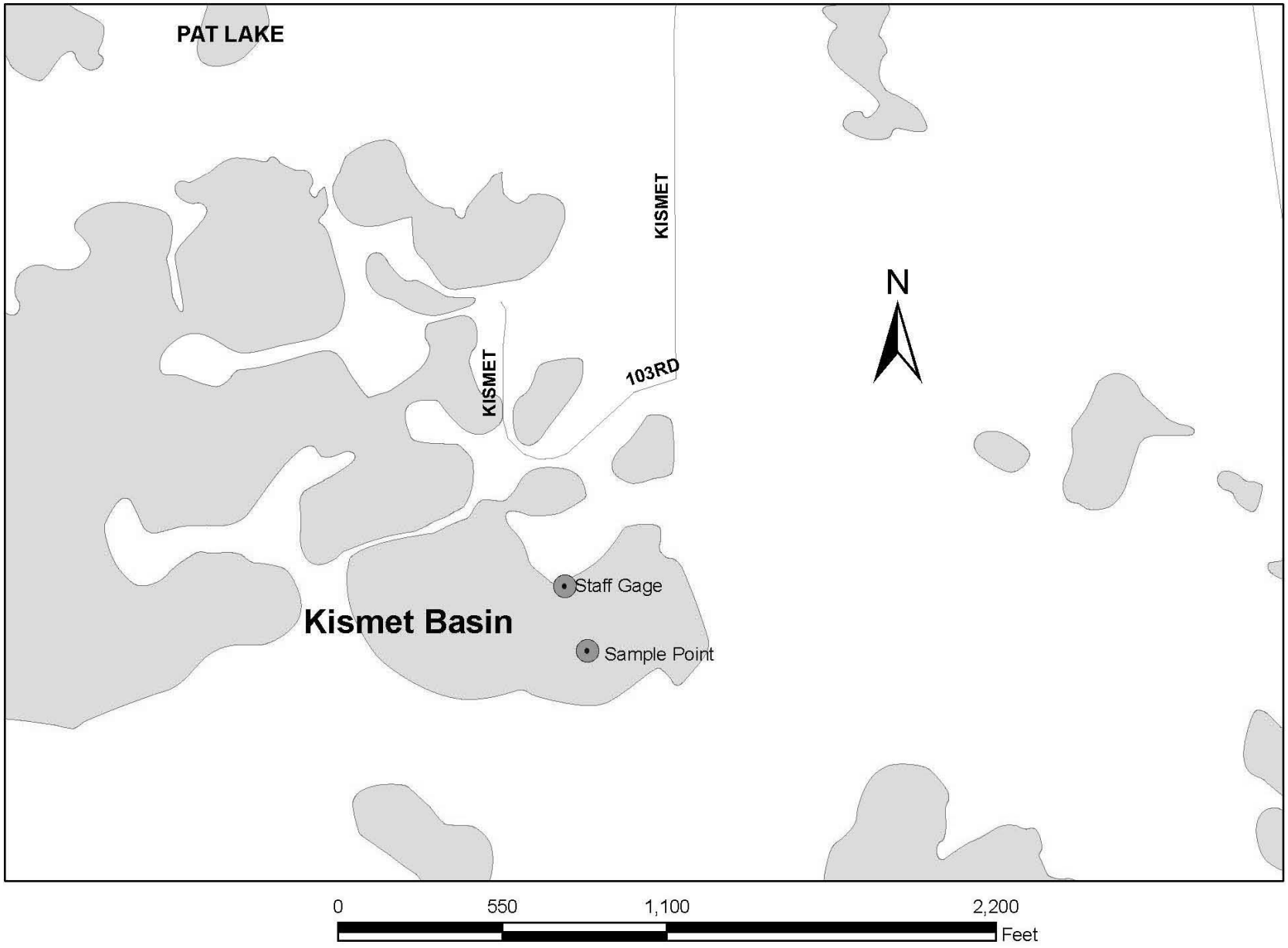
Date	Total Phosphorus (mg/L)	Chlorophyll-a (ug/L)	Total Chloride Ions (mg/L)	Secchi Disk Depths (m)	Surface Dissolved Oxygen Levels (mg/L)	Surface Temperature Levels (Celsius)
4/18/2006	0.031	9	5	2.59	9.88	14.4
5/3/2006	0.029	6	5	2.13	8.45	16.3
5/17/2006	0.028	9	6	2.13	10.21	17.6
5/31/2006	0.040	11	5	1.68	6.16	26.1
6/12/2006	0.046	17	5	1.98	4.87	21.0
6/27/2006	0.058	6	5	2.29	8.29	24.7
7/11/2006	0.070	43	5	1.52	8.95	26.2
7/24/2006	0.209	11	5	1.83	8.41	27.5
8/8/2006	0.069	29	5	1.52	7.20	27.2
8/21/2006	0.071	88	NA	1.52	7.51	24.8
9/6/2006	0.079	24	5	1.52	7.27	23.4
9/13/2006	0.044	11	6	1.52	5.94	19.2
9/25/2006	0.033	6	5	1.68	10.48	14.4
10/10/2006	0.153	9	6	1.52	8.49	12.7
2006 Average	0.069	20	5	1.82	8.01	21.1
2006 Summer Average	0.072	25	5	1.71	7.51	23.5

	High	High Date	Low	Low Date	Average
2006 Elevation (ft)	942.11	5/17/2006	940.71	10/27/2006	941.41

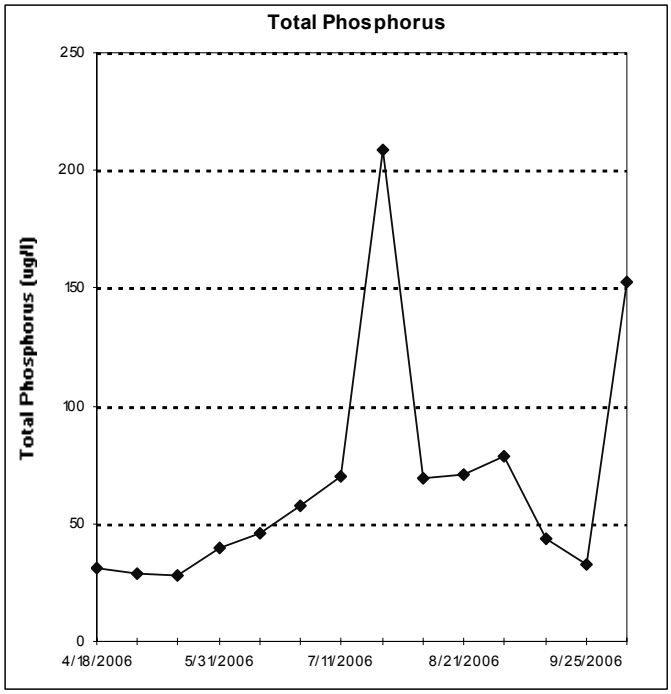
Lake Water Quality Summary

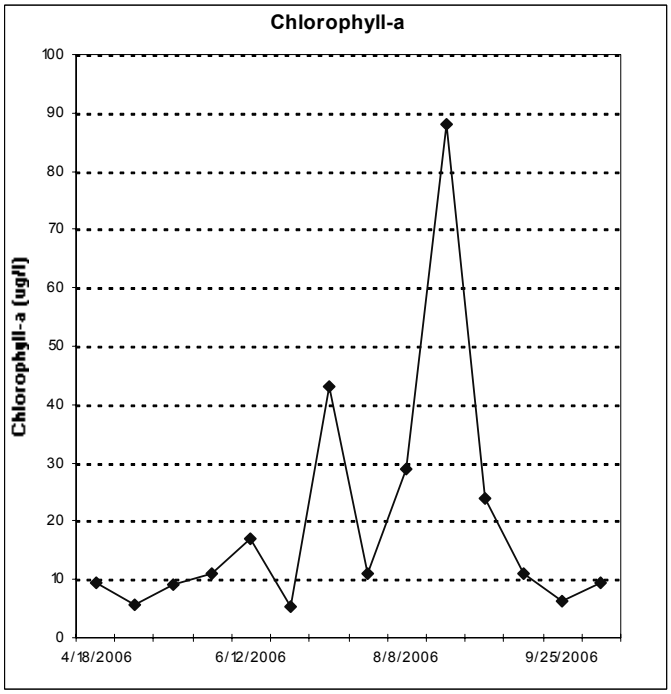
	Trophic Status	Summertime Lake Grades						
	2006	2006	2005	2004	2003	2002	2001	2000
Total Phosphorus (mg/l)	Hypereutrophic	D	C+	B+	B	C	C	D
Chlorophyll-*a* (ug/l)	Eutrophic	C	C+	A-	B	B-	C	F
Secchi disk (ft)	Eutrophic	C	C+	B	C+	C+	C	D
Overall	Eutrophic	C-	C+	B+	B-	C+	C	D-

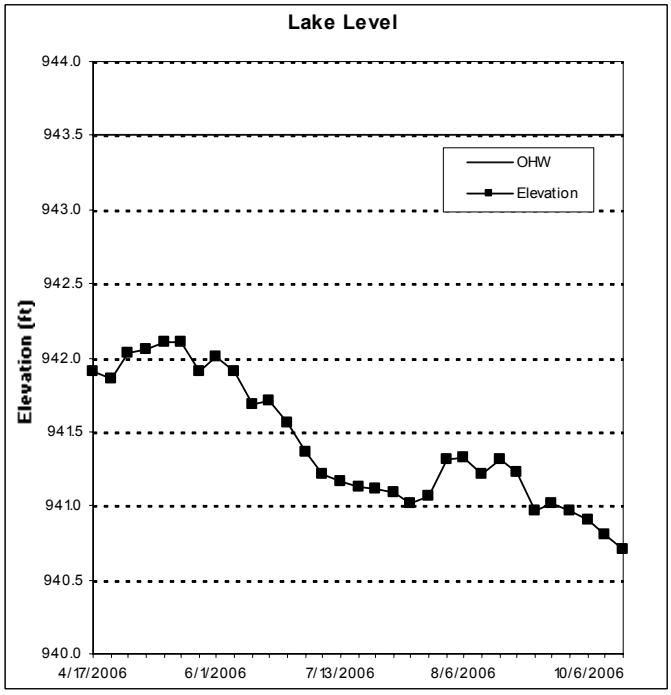
Kismet Basin

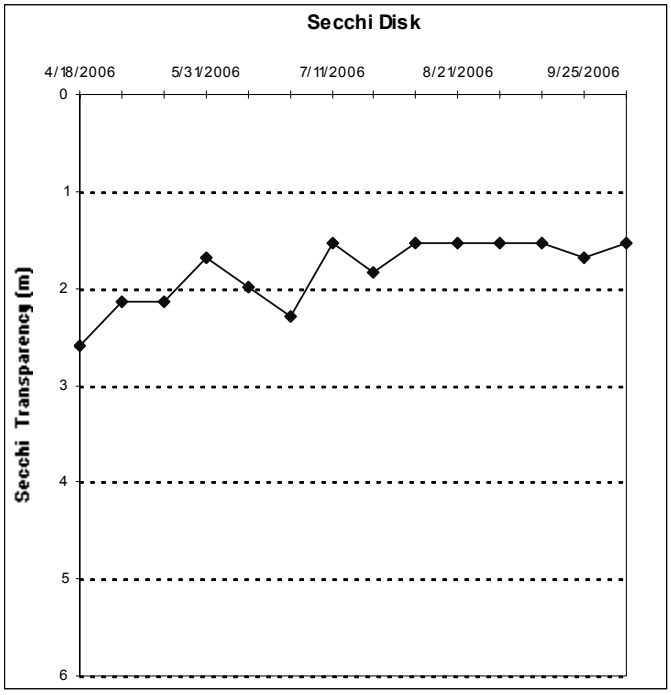


Kismet Basin
City of Grant

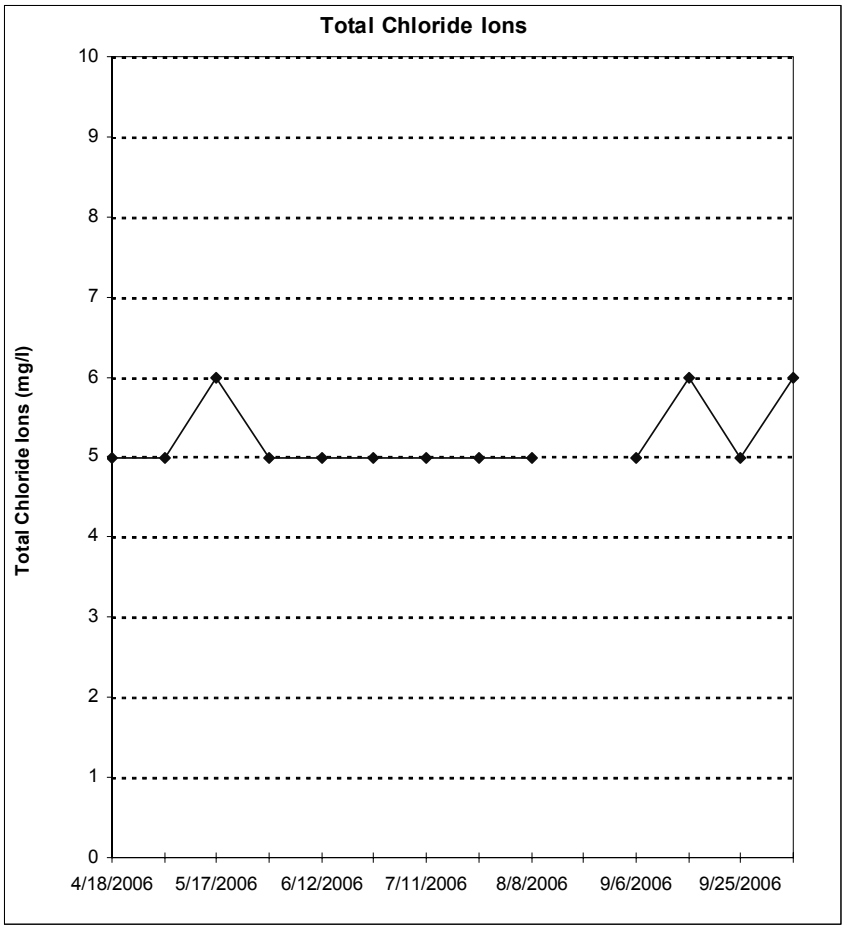






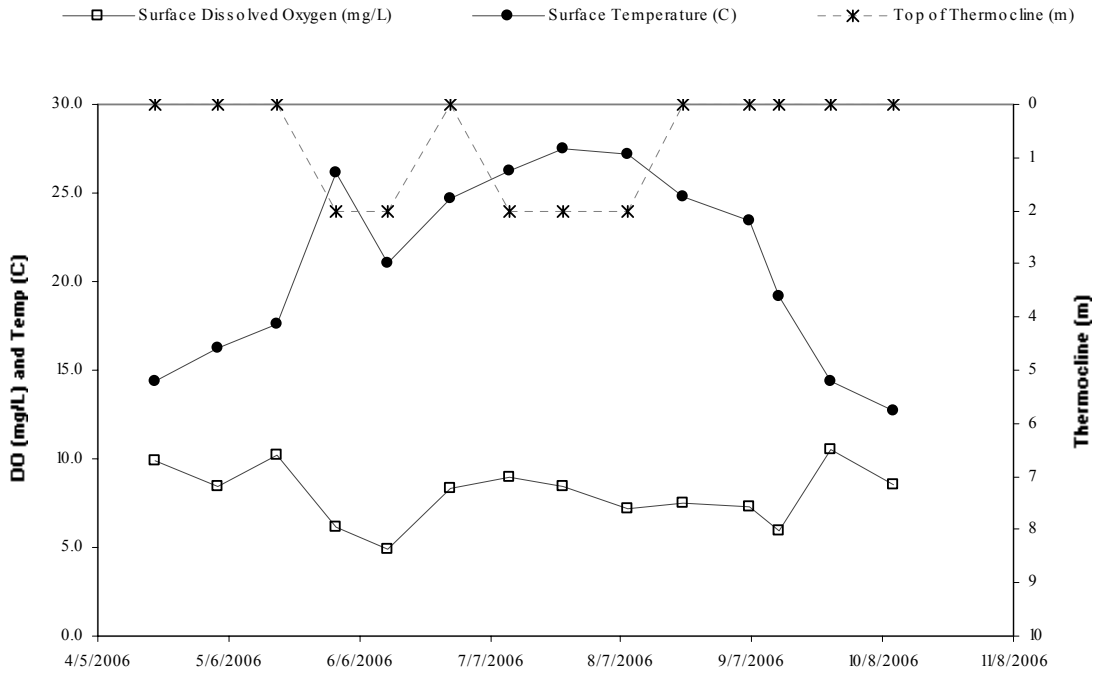


Kismet Basin
City of Grant



Kismet Basin
City of Grant

Dissolved Oxygen, Temperature, and Top of Thermocline by Sampling Date

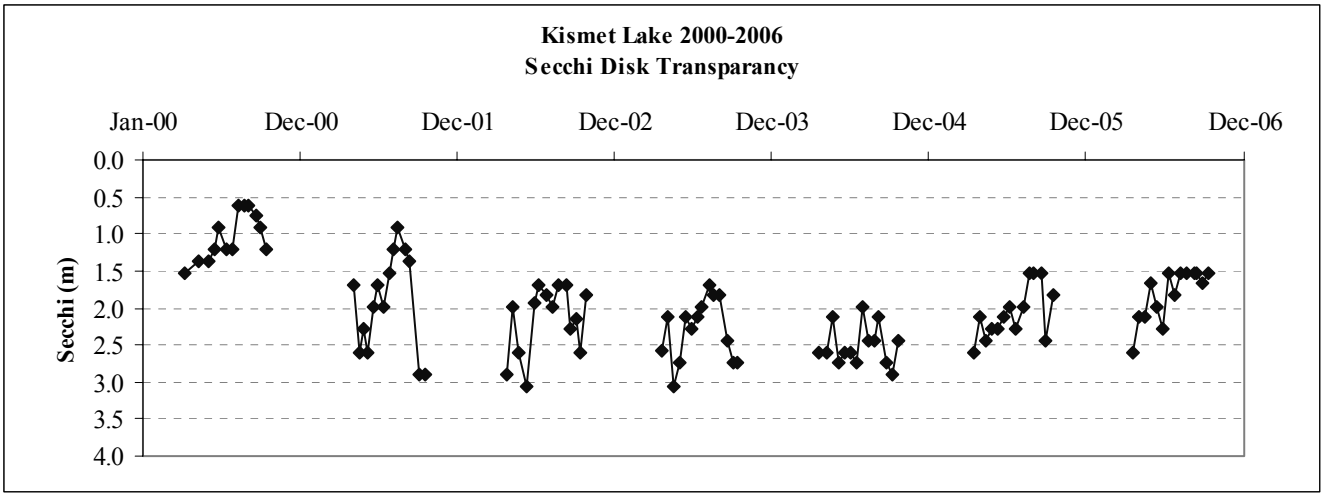


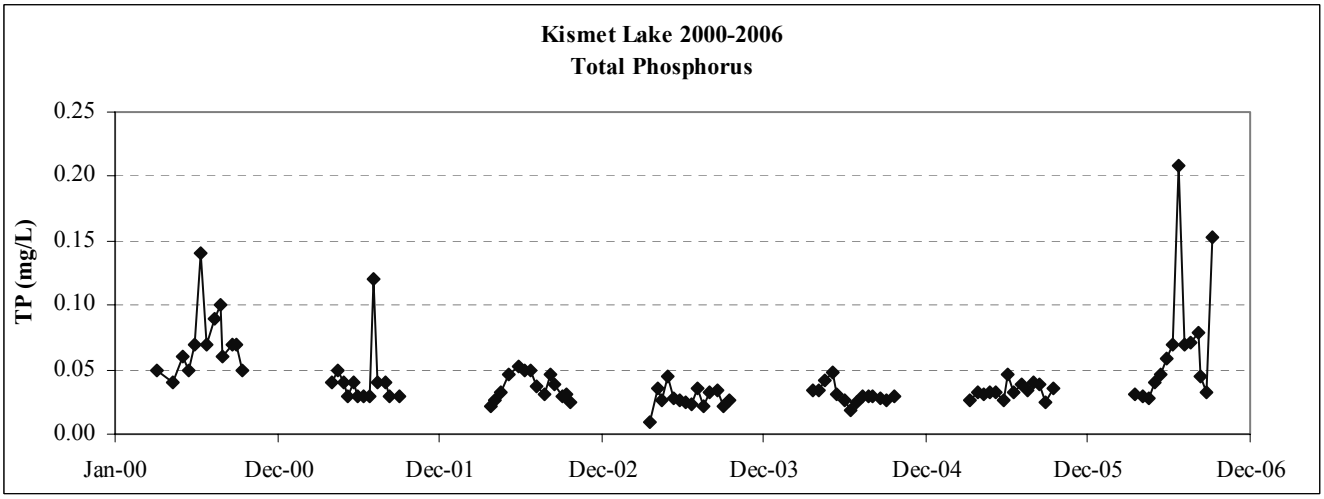
Dissolved Oxygen and Temperature Profile by Sampling Date and Depth

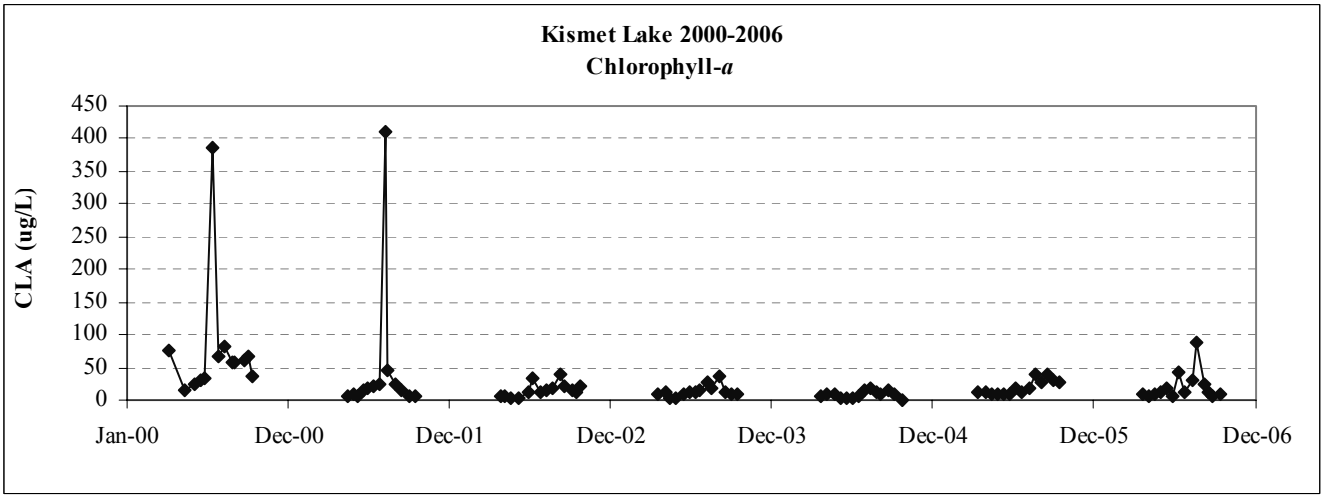
Sampling Date

Depth (m)	4/18/2006		5/3/2006		5/17/2006		5/31/2006		6/12/2006		6/27/2006		7/11/2006		7/24/2006		8/8/2006		8/21/2006		9/6/2006		9/13/2006		9/25/2006		10/10/2006	
	D.O.	Temp	D.O.	Temp	D.O.	Temp	D.O.	Temp	D.O.	Temp	D.O.	Temp	D.O.	Temp	D.O.	Temp	D.O.	Temp	D.O.	Temp	D.O.	Temp	D.O.	Temp	D.O.	Temp	D.O.	Temp
surface	9.88	14.4	8.45	16.3	10.21	17.6	6.16	26.1	4.87	21.0	8.29	24.7	8.95	26.2	8.41	27.5	7.20	27.2	7.51	24.8	7.27	23.4	5.94	19.2	10.48	14.4	8.49	12.7
1	10.03	14.3	8.63	16.3	10.11	17.6	5.95	25.5	5.72	20.5	8.14	24.7	9.02	25.9	9.37	27.0	7.08	26.0	8.06	24.3	8.78	22.2	7.38	18.0	10.39	14.4	8.63	12.8
2	10.43	13.9	8.40	14.7	10.63	17.2	6.40	19.2	1.19	20.1	1.20	23.2	0.23	23.7	0.12	24.2	0.18	24.4	0.13	22.7	0.17	20.6	4.92	17.3	6.92	13.9	8.02	12.7
3	8.80	9.4	4.60	13.4	6.01	13.1	0.08	16.5	0.38	19.6	0.09	20.8	0.08	21.7	0.08	22.3	0.06	22.9	0.06	21.8			0.07	17.2	0.12	13.9	0.05	12.8
4									0.07	19.2			0.05	21.2														
5																												
Top of Thermocline (m)							2		2				2		2		2											

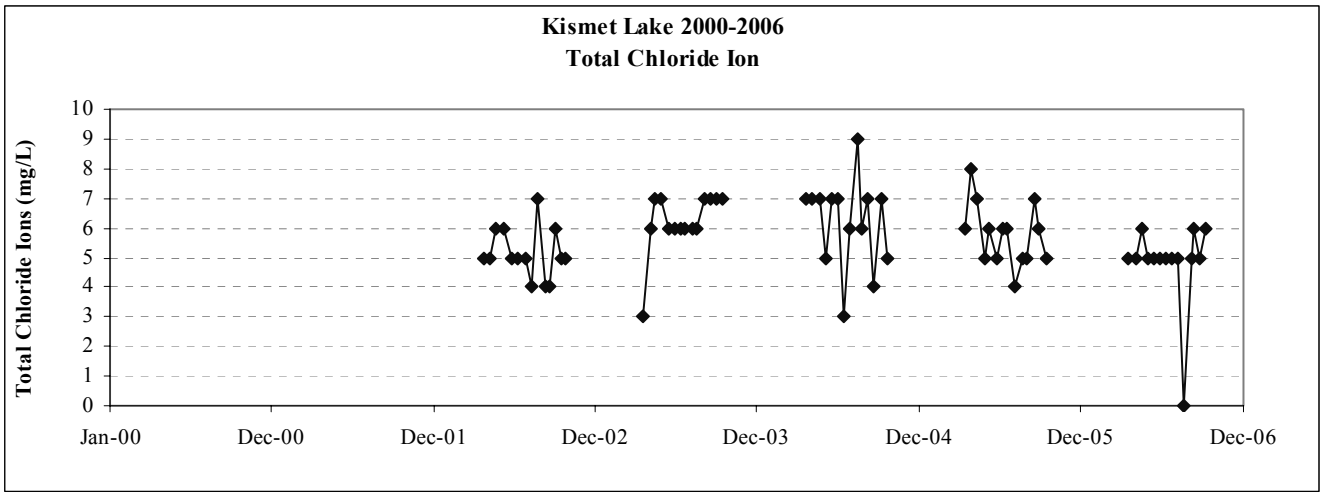
Kismet Basin
City of Grant

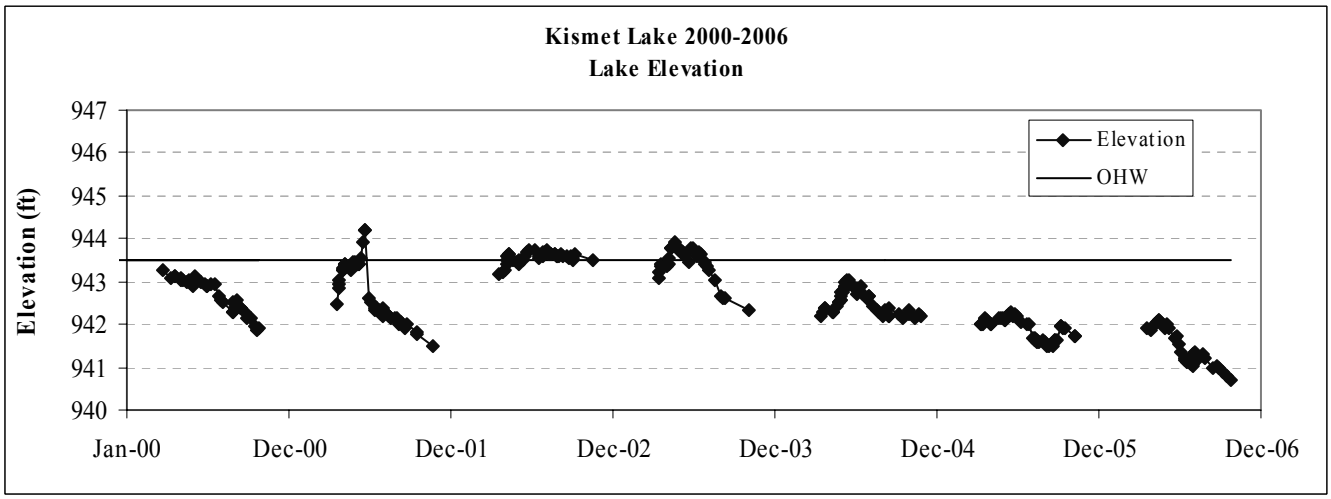




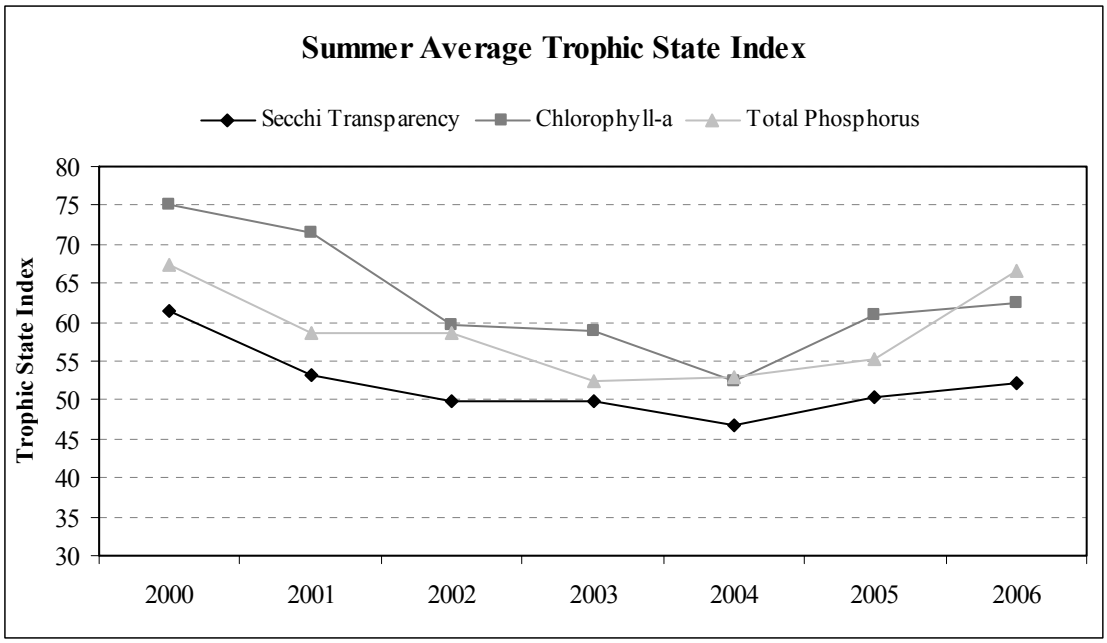


Kismet Basin
City of Grant





Kismet Basin
City of Grant



Long Lake
City of Stillwater

Vital Statistics

DNR ID #: 82-0021
LOCATION: Section 31, T30N-R20W
MUNICIPALITY: City of Stillwater
LAKE SIZE: 95 Acres
MAXIMUM DEPTH: 22 Feet
ORDINARY HIGH WATER MARK: 891.50 Feet
100-YEAR HIGH WATER LEVEL: 893.20 Feet

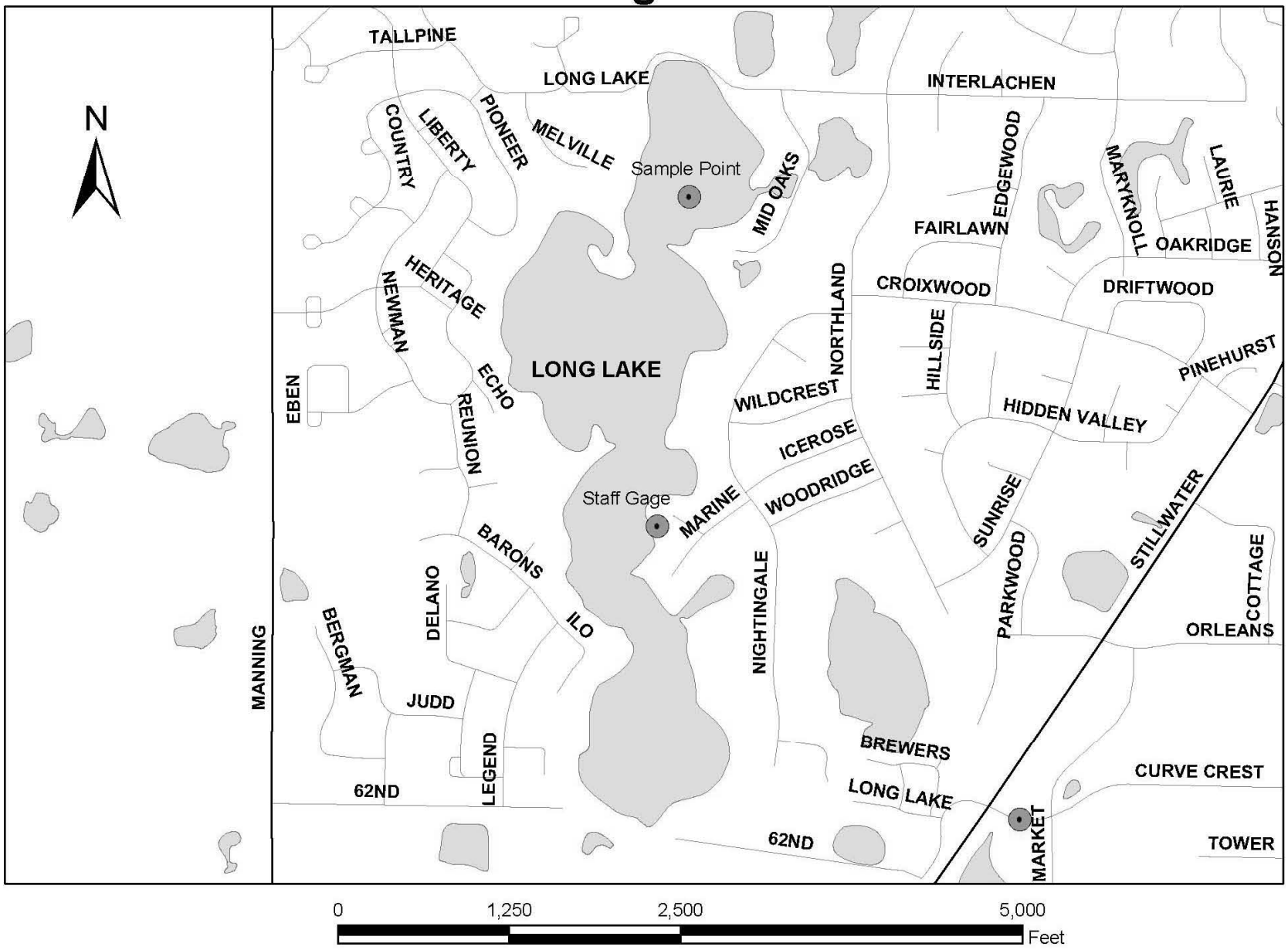
Date	Total Phosphorus (mg/L)	Chlorophyll-a (ug/L)	Secchi Disk Depths (m)	Surface Dissolved Oxygen Levels (mg/L)	Surface Temperature Levels (Celsius)
4/17/2006	0.060	17	1.37	6.64	15.5
5/2/2006	0.043	21	1.52	9.66	16.5
5/15/2006	0.046	14	1.37	8.86	14.7
5/31/2006	0.048	15	1.22	6.81	27.5
6/15/2006	0.083	48	0.61	12.20	24.0
6/28/2006	0.123	15	1.37	6.17	24.2
7/12/2006	0.148	16	1.22	9.74	27.1
7/26/2006	0.096	73	0.61	10.90	28.8
8/8/2006	0.082	41	0.76	10.52	27.8
8/22/2006	0.086	28	0.76	10.71	25.9
9/7/2006	0.111	17	1.22	10.38	23.6
9/14/2006	0.064	18	1.22	8.52	19.7
9/28/2006	0.092	13	1.37	7.84	15.4
10/9/2006	0.071	29	1.07	9.51	14.4
2006 Average	0.082	26	1.12	9.18	21.8
2006 Summer Average	0.098	30	1.02	9.66	24.1

	High	High Date	Low	Low Date	Average
2006 Elevation (ft)	889.96	9/28/2006	889.12	7/10/2006	889.66

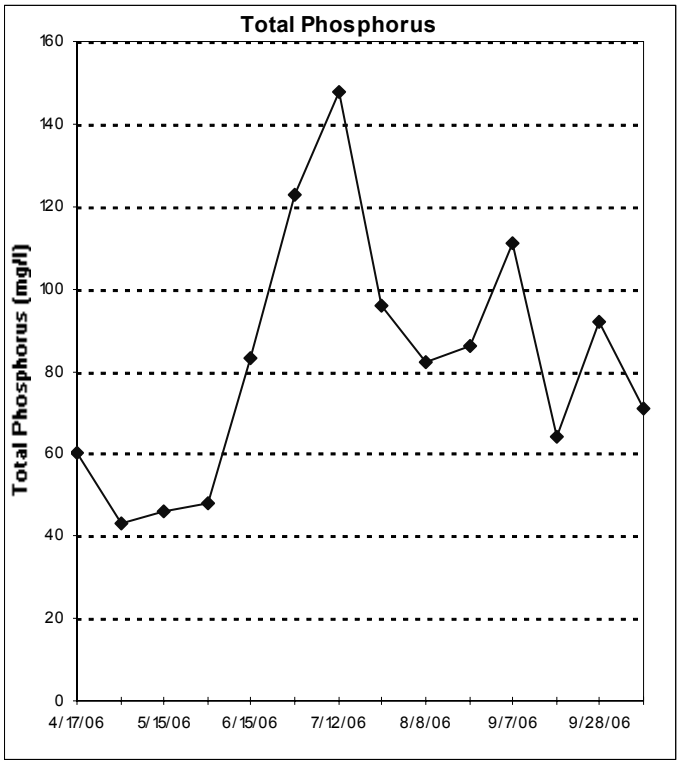
Lake Water Quality Summary

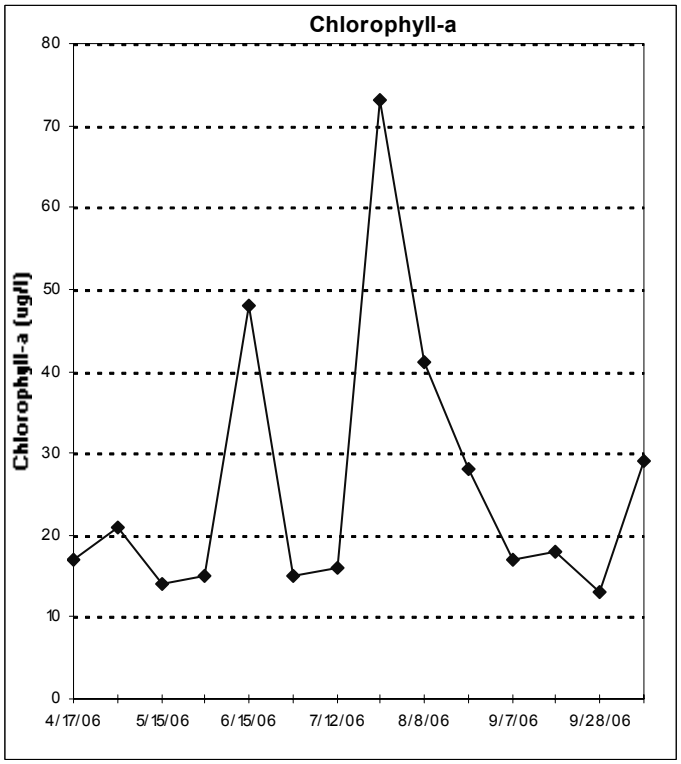
	Trophic Status	Summertime Lake Grades						
	2006	2006	2005	2004	2003	2002	2001	2000
Total Phosphorus (mg/l)	Hypereutrophic	D	D	D	D	D	D-	F
Chlorophyll-*a* (ug/l)	Eutrophic	C	D	C	D-	F+	F	F
Secchi disk (ft)	Eutrophic	D	F	C-	F	F	F	F
Overall	Eutrophic	D+	D-	C-	D-	F	F	F

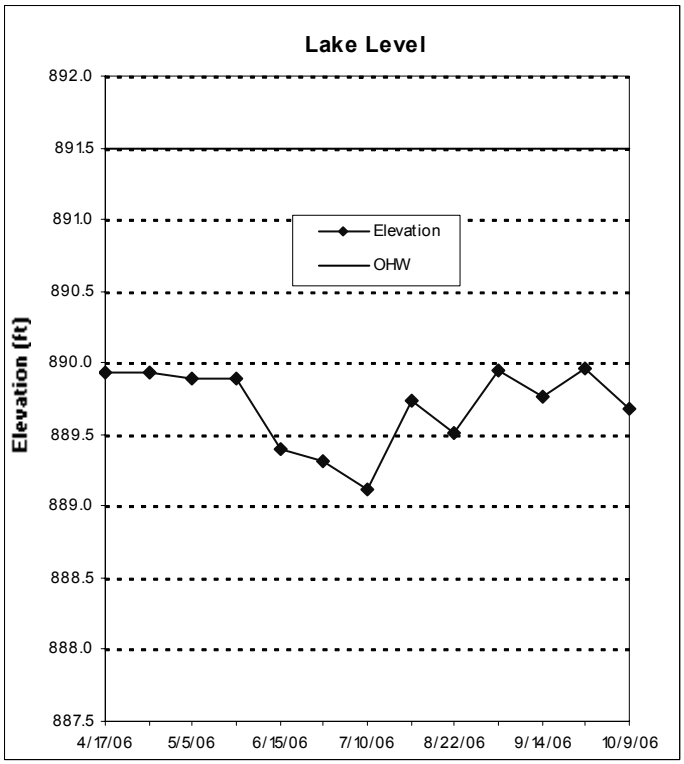
Long Lake

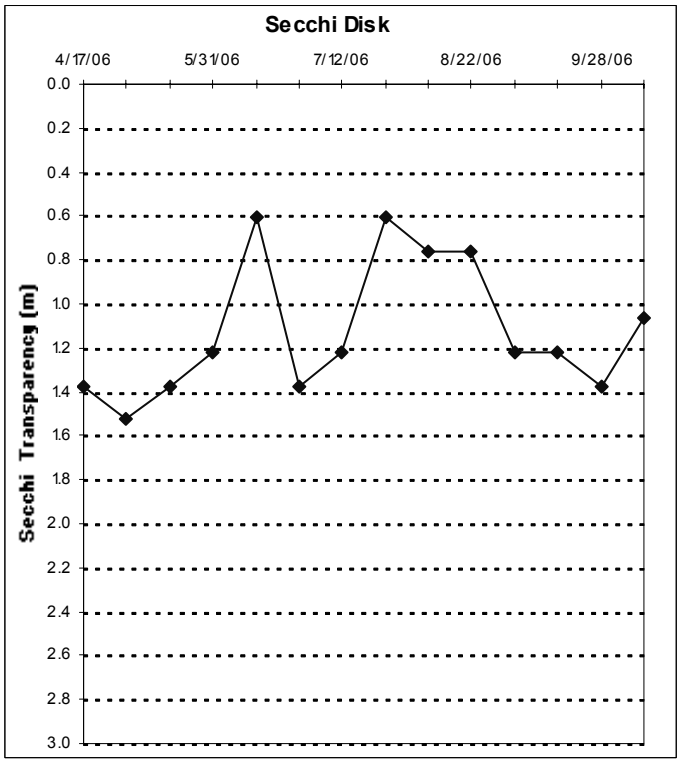

N
TALLPINE
LONG LAKE
INTERLACHEN
COUNTRY
LIBERTY
PIONEER
MELVILLE
Sample Point
MID OAKS
EDGEWOOD
MARYKNOLL
LAURIE
HANSON
FAIRLAWN
OAKRIDGE
HERITAGE
NEWMAN
CROIXWOOD
DRIFTWOOD
NORTHLAND
HILLSIDE
PINEHURST
LONG LAKE
ECHO
EBEN
REUNION
WILDCREST
HIDDEN VALLEY
ICEROSE
WOODRIDGE
Staff Gage
MARINE
SUNRISE
STILLWATER
BARONS
NIGHTINGALE
PARKWOOD
COTTAGE
ORLEANS
DELANO
ILO
BERGMAN
MANNING
JUDD
BREWERS
CURVE CREST
LEGEND
62ND
LONG LAKE
MARKET
TOWER
62ND
0
1,250
2,500
5,000
Feet

Long Lake
City of Stillwater



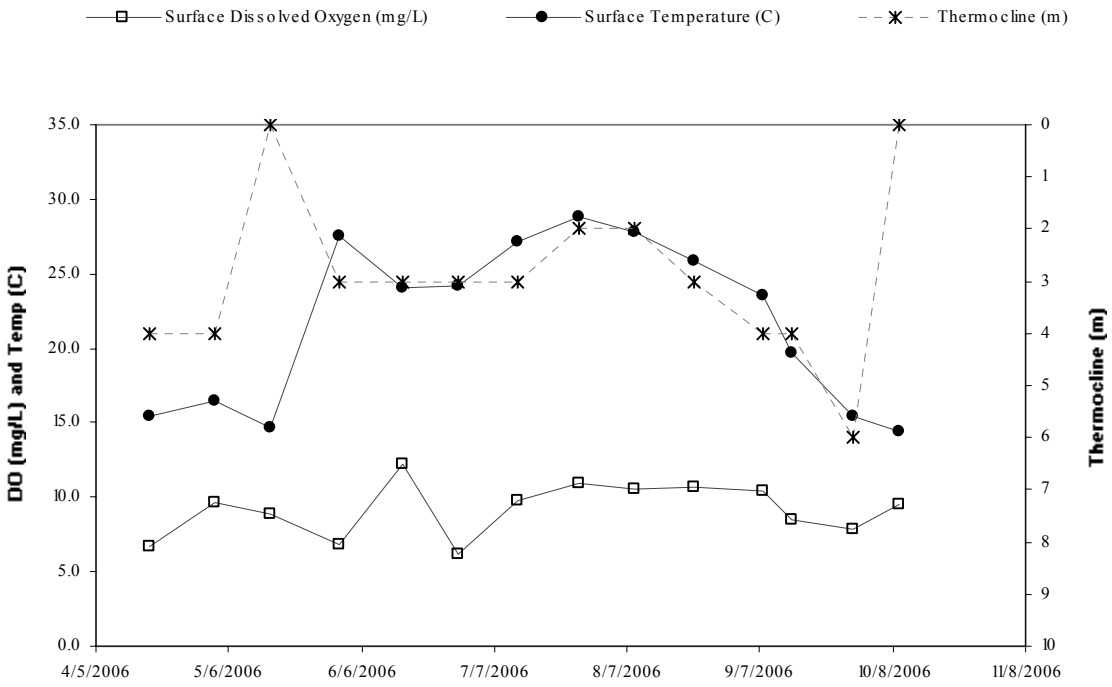






Long Lake
City of Stillwater

Dissolved Oxygen, Temperature, and Top of Thermocline by Sampling Date

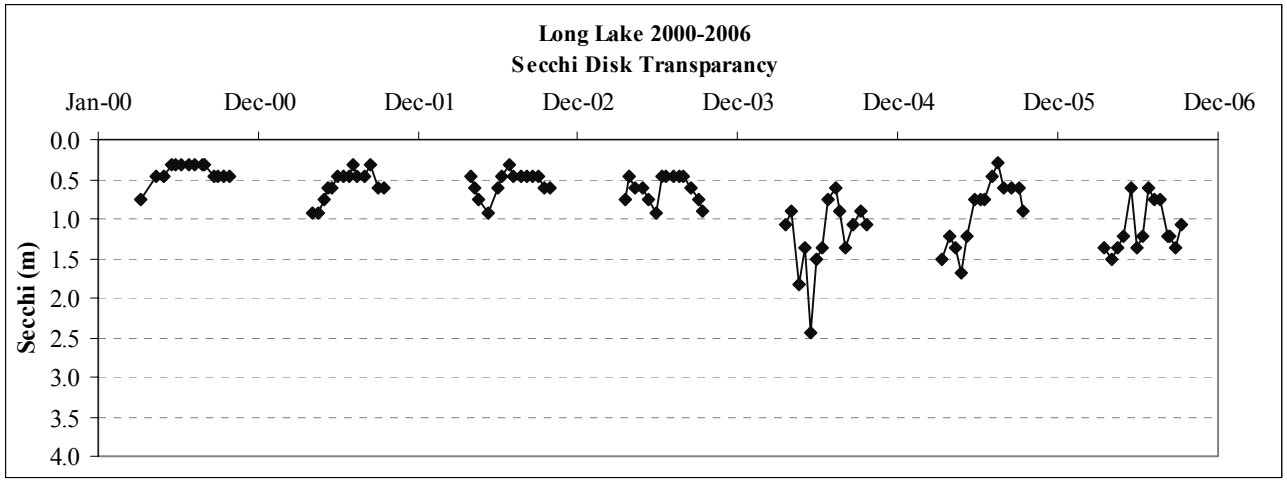


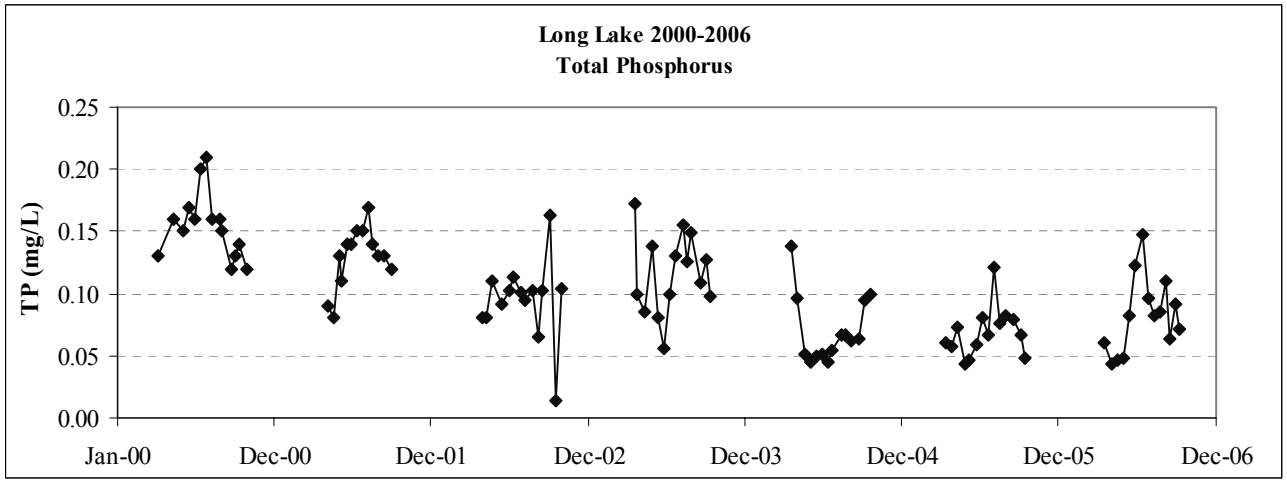
Dissolved Oxygen and Temperature Profile by Sampling Date and Depth

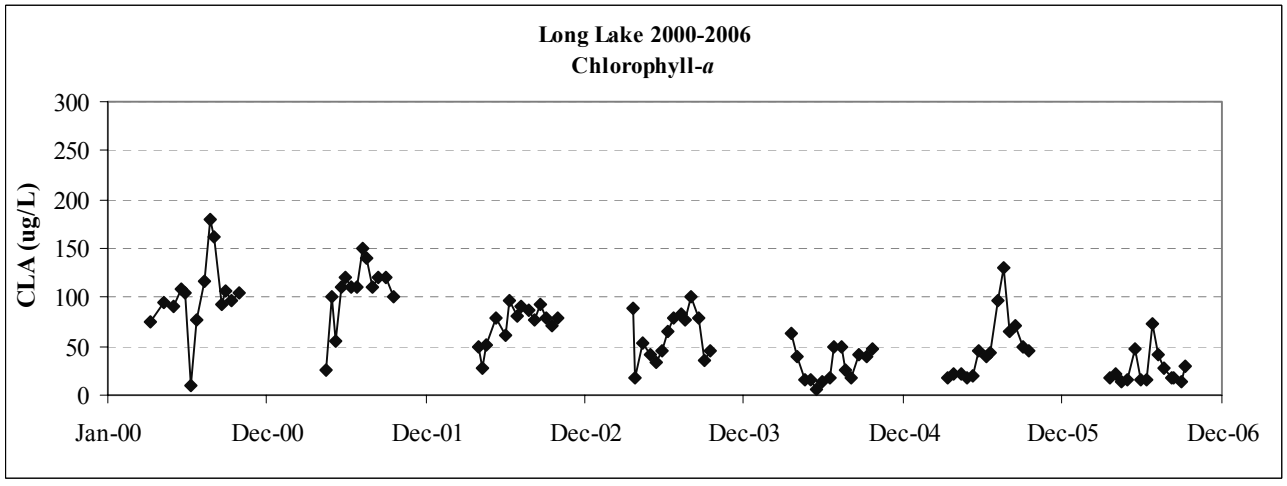
Sampling Date

Depth (m)	4/17/2006		5/2/2006		5/15/2006		5/31/2006		6/15/2006		6/28/2006		7/12/2006		7/26/2006		8/8/2006		8/22/2006		9/7/2006		9/14/2006		9/28/2006		10/9/2006	
	D.O.	Temp	D.O.	Temp	D.O.	Temp	D.O.	Temp	D.O.	Temp	D.O.	Temp	D.O.	Temp	D.O.	Temp	D.O.	Temp	D.O.	Temp	D.O.	Temp	D.O.	Temp	D.O.	Temp	D.O.	Temp
surface	6.64	15.5	9.66	16.5	8.86	14.7	6.81	27.5	12.20	24.0	6.17	24.2	9.74	27.1	10.90	28.8	10.52	27.8	10.71	25.9	10.38	23.6	8.52	19.7	7.84	15.4	9.51	14.4
1	6.51	15.3	9.80	16.3	8.77	14.6	7.16	26.1	12.23	23.7	6.10	23.9	9.54	26.6	10.29	28.6	10.68	27.0	10.89	25.2	10.40	23.4	8.52	19.6	7.73	15.4	9.51	14.4
2	6.30	14.3	10.27	14.5	8.63	14.4	5.85	24.4	6.24	20.8	5.85	23.6	7.01	25.8	4.41	25.9	8.68	25.8	10.03	24.5	10.09	23.0	6.57	18.6	7.30	15.2	9.50	14.3
3	5.83	10.9	9.70	14.0	8.47	13.5	3.05	16.6	4.24	20.0	1.40	22.9	4.56	24.9	0.12	24.8	6.43	25.6	3.64	23.8	7.38	22.1	5.36	18.2	6.88	14.9	9.45	14.3
4	4.43	8.3	1.01	11.9	6.99	12.7	0.29	13.4	0.07	14.6	0.07	15.4	0.15	17.9	0.09	16.5	0.13	20.0	0.15	21.2	0.14	20.7	3.92	17.8	5.87	14.7	9.40	14.2
5	1.33	6.4	0.43	7.6	6.68	12.7	0.11	9.7	0.07	10.4	0.07	10.7	0.09	11.0	0.09	12.5	0.12	13.5	0.10	14.4	0.11	15.5	0.15	17.0	5.71	14.7	9.10	14.2
6	1.14	5.5	0.39	6.2	0.37	8.6	0.03	7.8	0.05	8.1			0.09	9.6	0.07	10.6	0.10	10.7	0.09	11.1	0.11	11.9	0.07	12.3	0.05	14.3	8.96	14.1
7	1.09	5.2					0.02	7.3	0.04	7.6					0.08	10.6			0.07	10.5	0.08	11.2	0.06	11.6	0.04	13.9		
8																			0.1	10.7								
9																												
10																												
Top of Thermocline (m)	4		4				3		3		3		3		2		2		3		4		4		6			

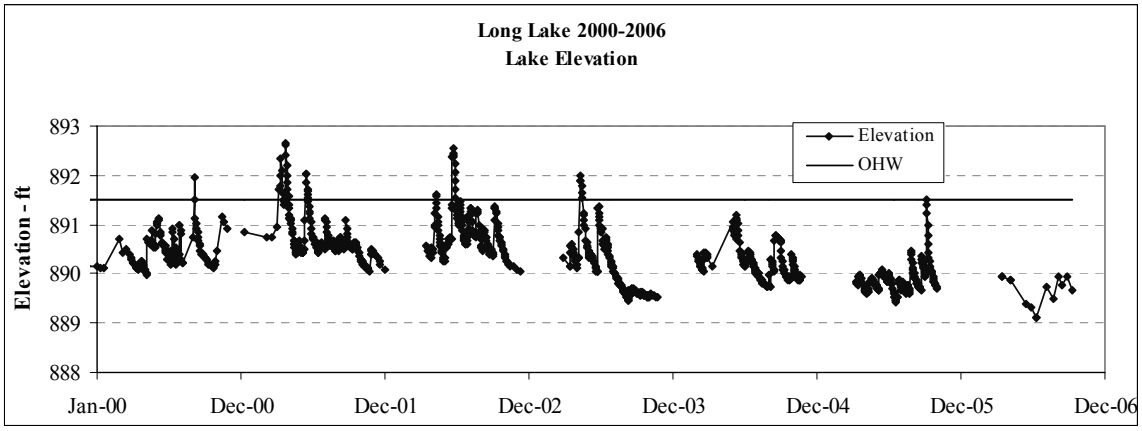
Long Lake
City of Stillwater

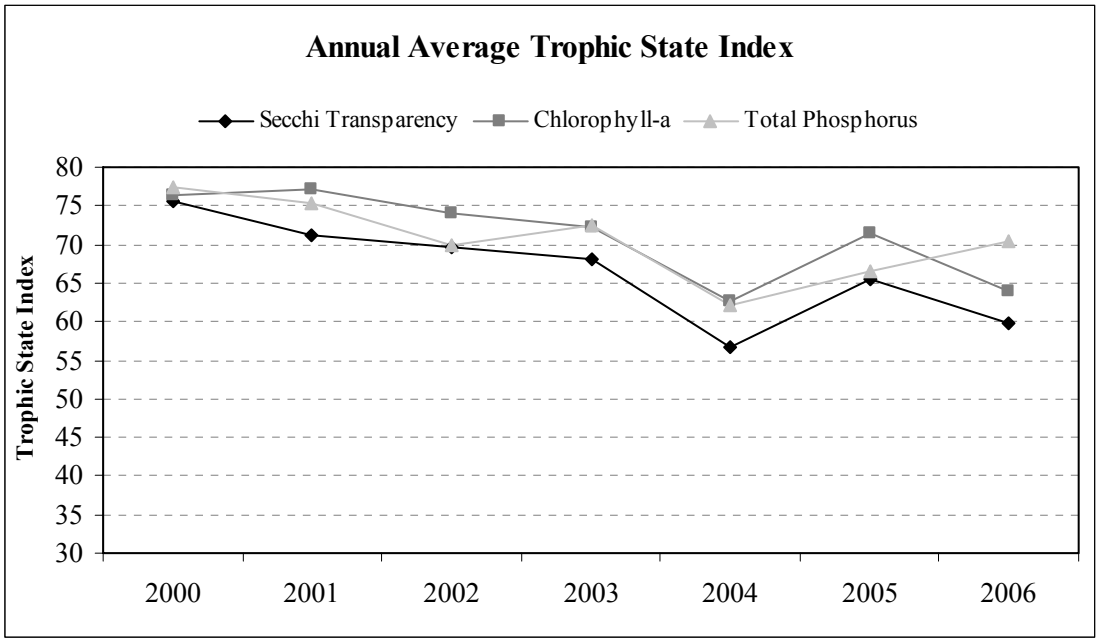






Long Lake
City of Stillwater





Lynch Lake
May Township

Vital Statistics

DNR ID #: 82-0042
LOCATION: Section 29, T31N-R19W
MUNICIPALITY: Township of May
LAKE SIZE: 941.4 acres
MAXIMUM DEPTH: 6 Feet
ORDINARY HIGH WATER MARK: 1005.30 Feet
100-YEAR HIGH WATER LEVEL: 1008.10 Feet

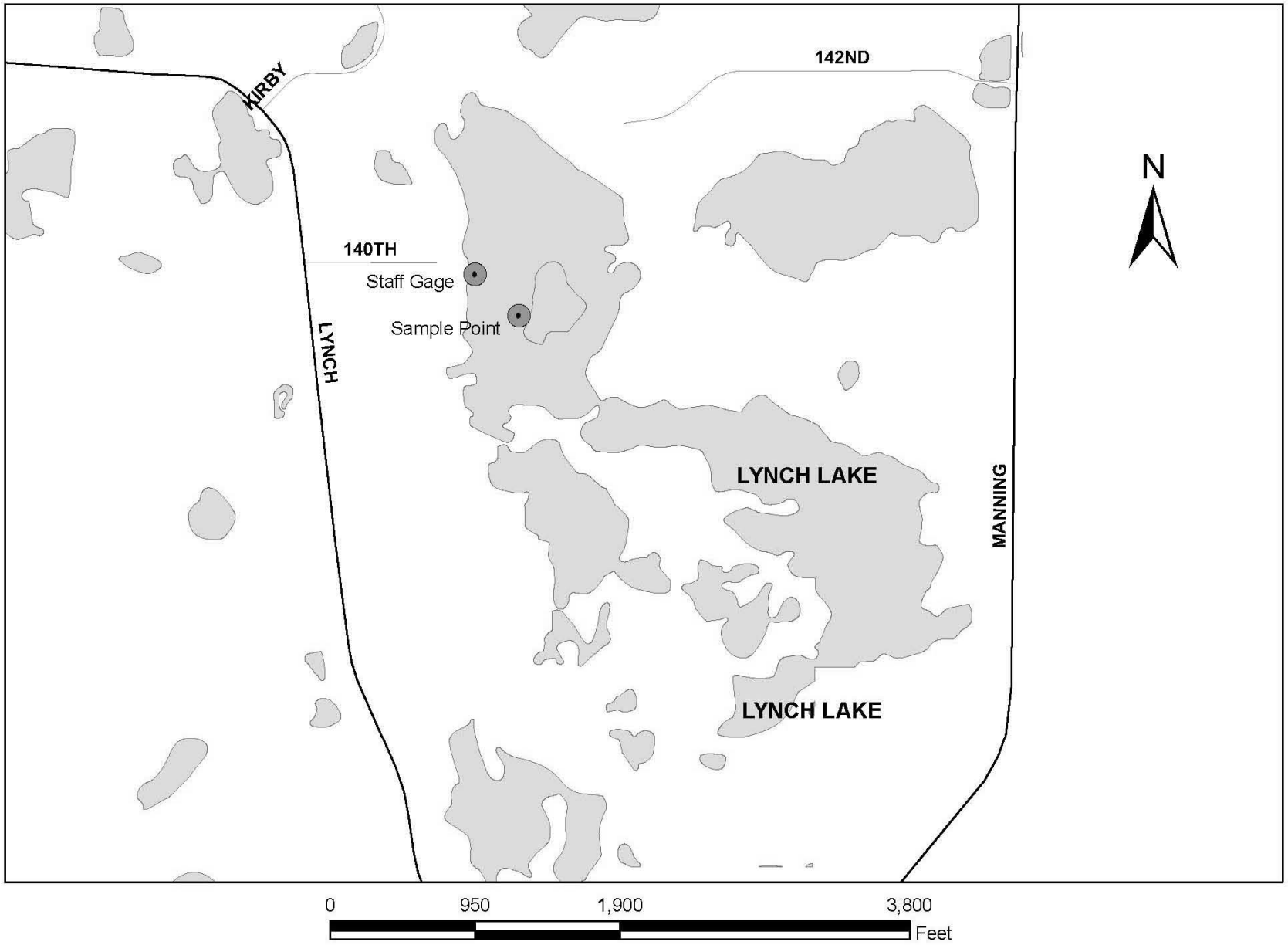
Date	Total Phosphorus (mg/L)	Chlorophyll-a (ug/L)	Secchi Disk Depths (m)	Surface Dissolved Oxygen Levels (mg/L)	Surface Temperature Levels (Celsius)
4/24/2006	0.154	100	0.61	7.74	15.8
5/15/2006	0.822	95	0.46	10.25	13.0
6/12/2006	0.162	120	0.30	7.11	18.3
7/11/2006	0.134	280	0.30	8.95	24.6
8/8/2006	0.251	35	0.15	6.43	24.7
9/6/2006	0.296	340	0.15	7.99	21.4
9/25/2006	0.247	230	0.30	10.73	13.3
2006 Average	0.295	171	0.33	8.46	18.7
2006 Summer Average	0.218	201	0.24	8.24	20.5

	High	High Date	Low	Low Date	Average
2006 Elevation (ft)	1005.50	4/18/2006	1004.27	10/18/2006	1004.83

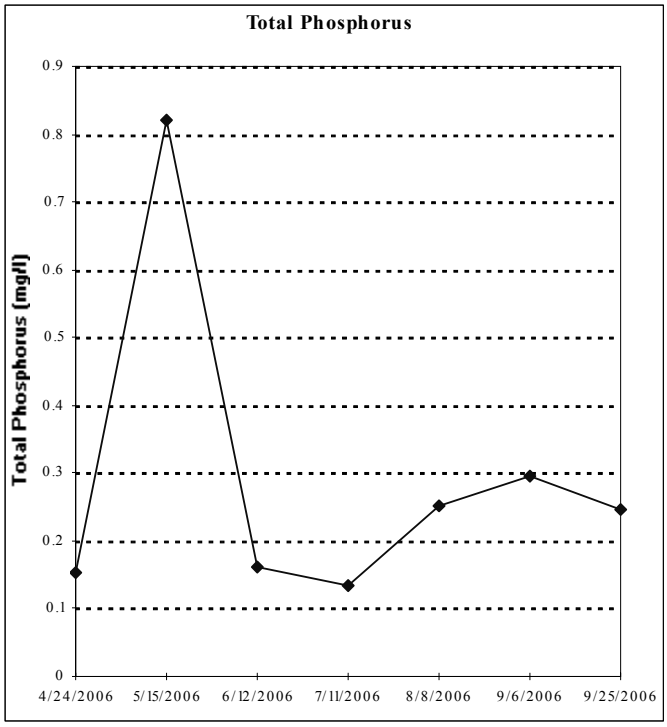
Lake Water Quality Summary

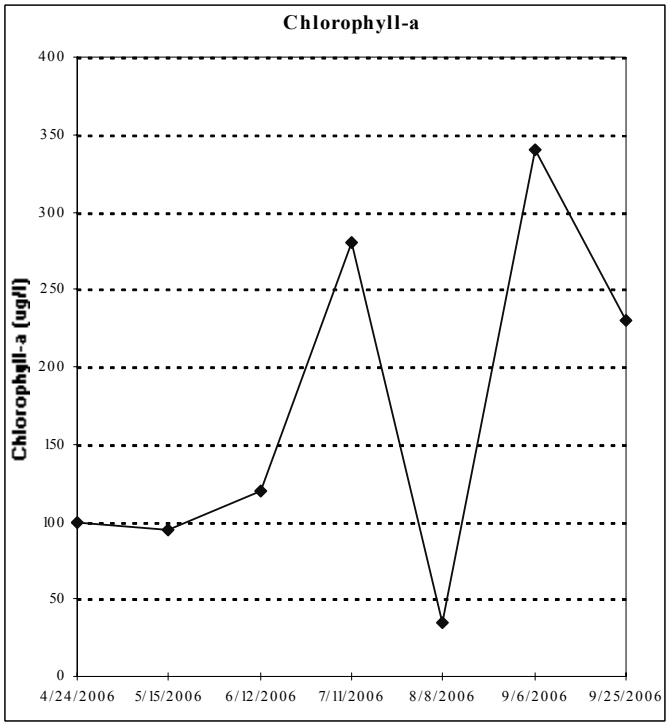
	Trophic Status	Summertime Lake Grades						
	2006	2006	2005	2004	2003	2002	2001	2000
Total Phosphorus (mg/l)	Hypereutrophic	F	NA	NA	NA	NA	NA	NA
Chlorophyll-*a* (ug/l)	Hypereutrophic	F	NA	NA	NA	NA	NA	NA
Secchi disk (ft)	Hypereutrophic	F	NA	NA	NA	NA	NA	NA
Overall	Hypereutrophic	F	NA	NA	NA	NA	NA	NA

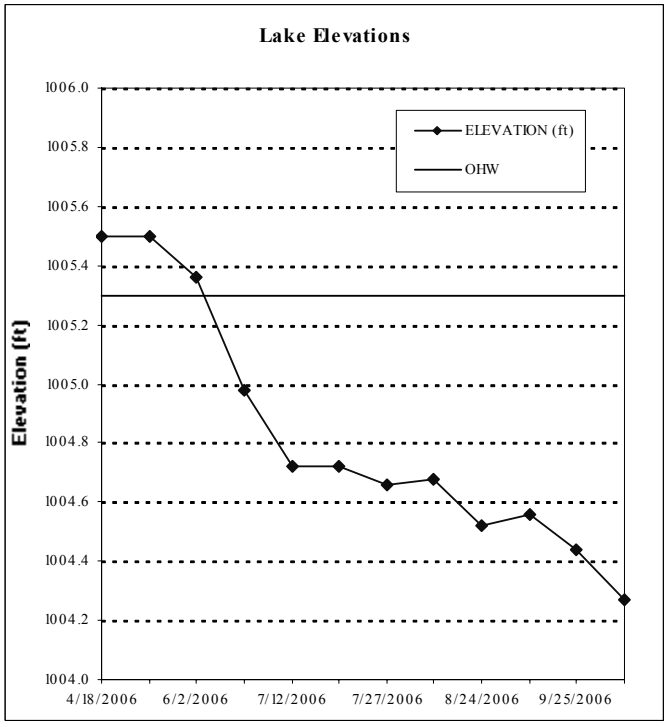
Lynch Lake

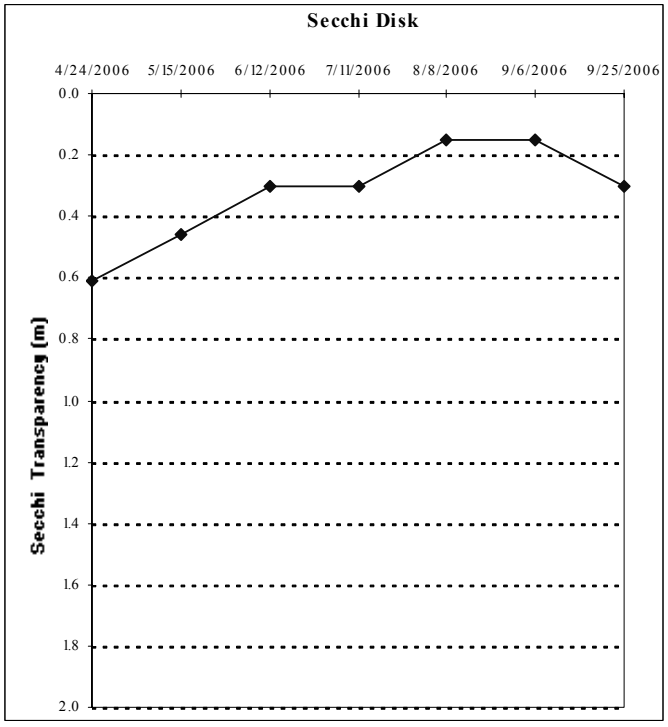

142ND
KIRBY
140TH
Staff Gage
Sample Point
LYNCH
LYNCH LAKE
MANNING
LYNCH LAKE
N
0
950
1,900
3,800
Feet

Lynch Lake
May Township



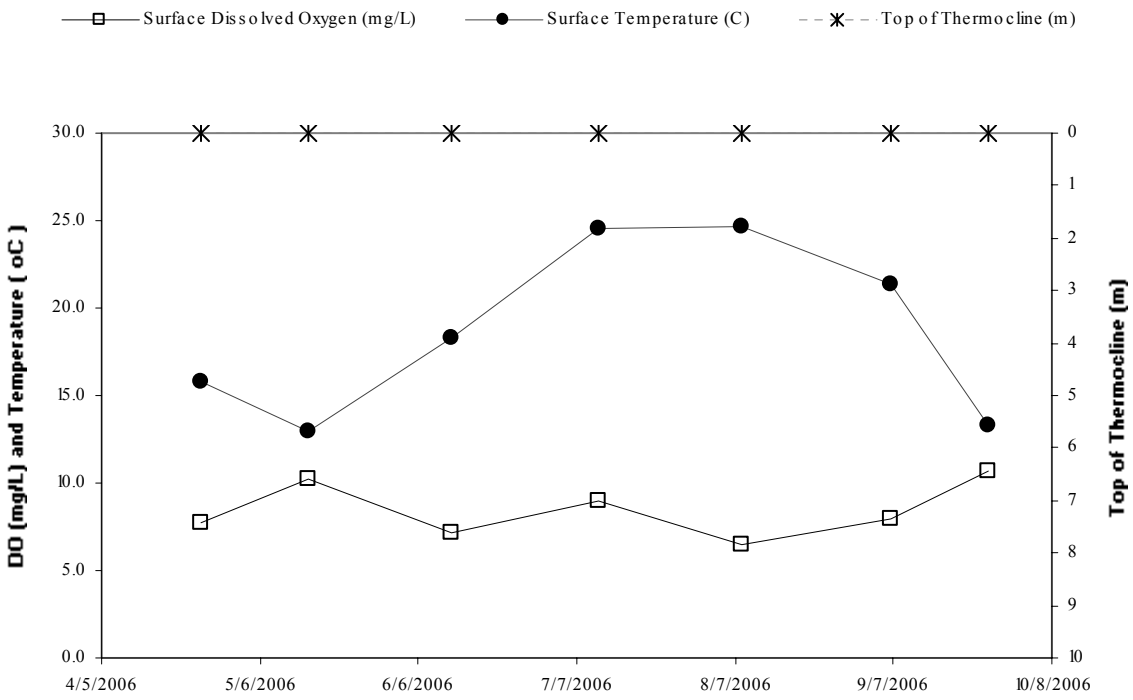






Lynch Lake
May Township

Dissolved Oxygen, Temperature, and Top of Thermocline by Sampling Date

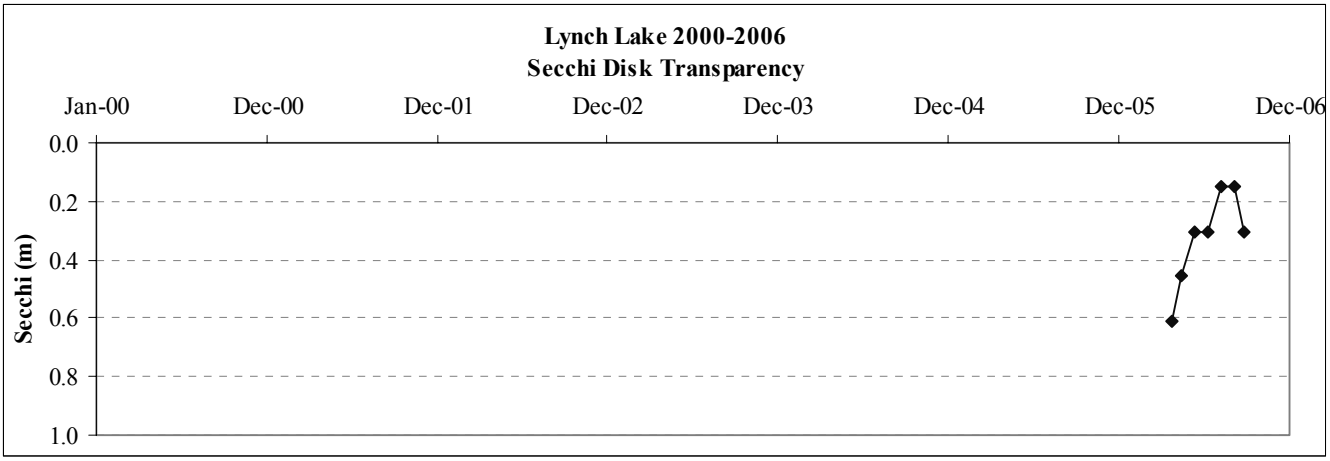


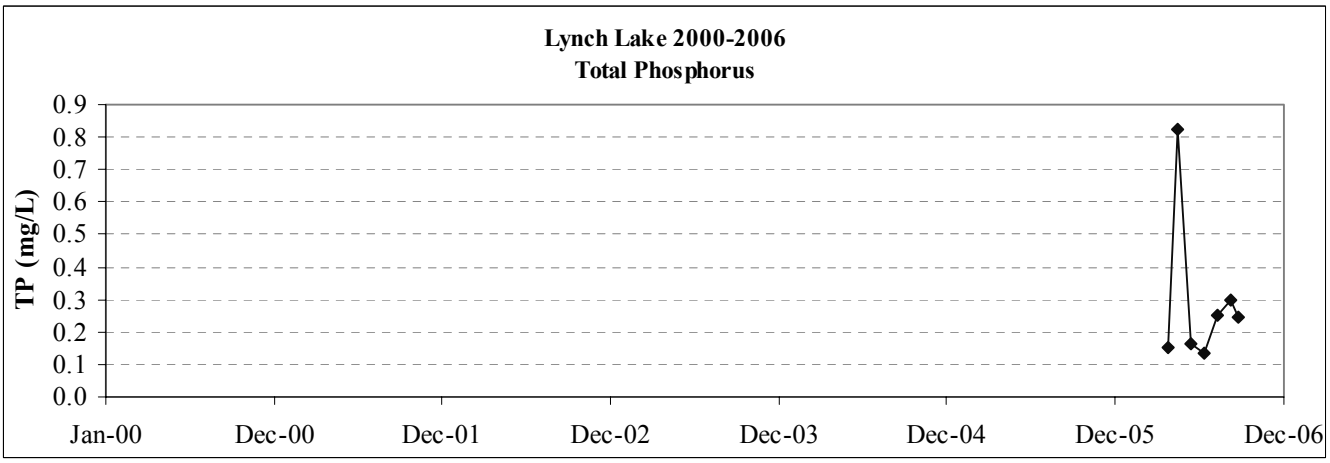
Dissolved Oxygen and Temperature Profile by Sampling Date and Depth

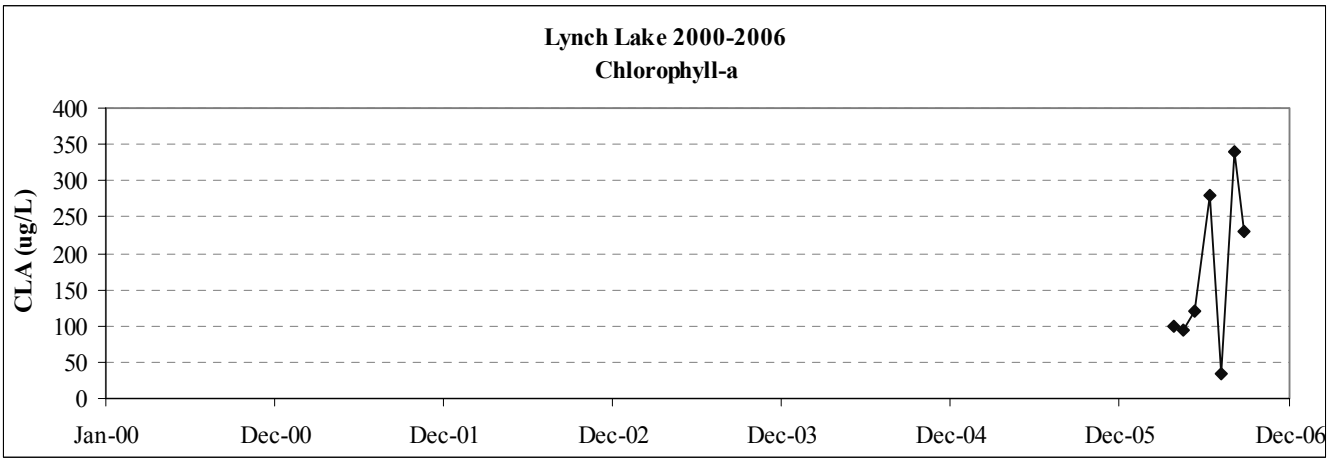
Sampling Date

	4/24/2006		5/15/2006		6/12/2006		7/11/2006		8/8/2006		9/6/2006		9/25/2006	
Depth (m)	D.O.	Temp	D.O.	Temp	D.O.	Temp	D.O.	Temp	D.O.	Temp	D.O.	Temp	D.O.	Temp
surface	7.74	15.8	10.25	13.0	7.11	18.3	8.95	24.6	6.43	24.7	7.99	21.4	10.73	13.3
1	7.42	15.8	10.11	12.9	5.88	18.1	7.63	24.5	5.44	24.5	8.12	21.4	10.23	13.2
2	0.57	15.7	9.64	12.5	0.11	18.0	0.08	23.3					0.10	13.0
3														
4														
5														
No Thermocline Present														

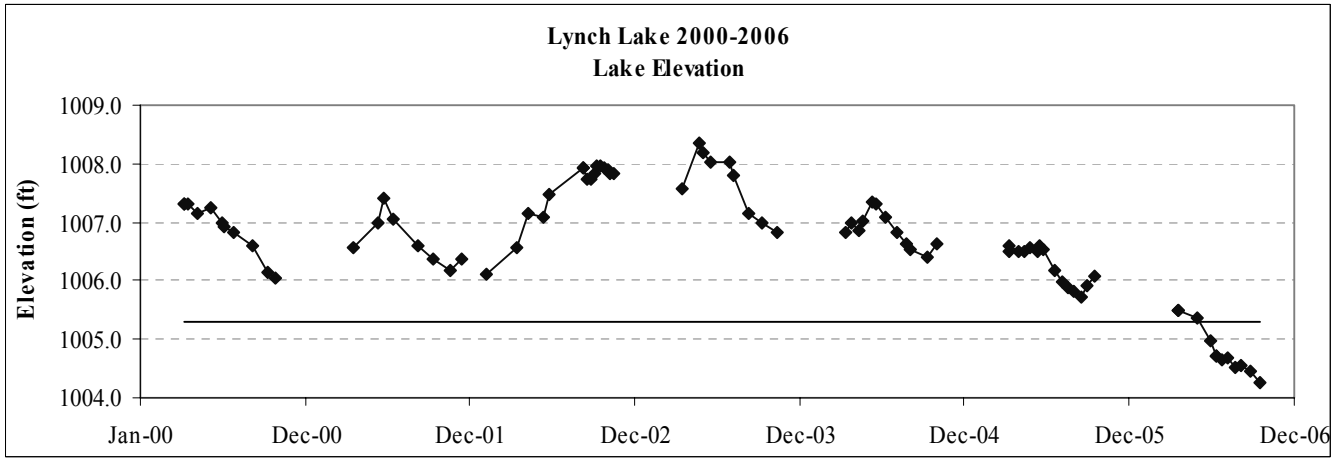
Lynch Lake
May Township

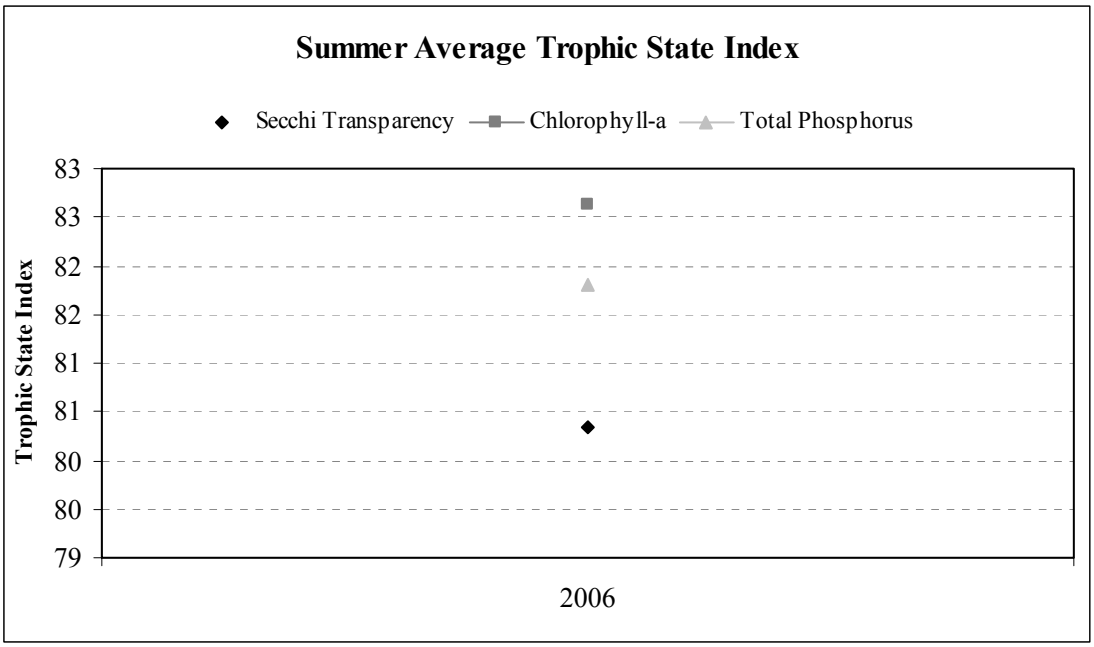






Lynch Lake
May Township





Lake Masterman
City of Grant

Vital Statistics

DNR ID #: 82-0126
LOCATION: Section 23, T30N-R21W
MUNICIPALITY: Township of Grant
LAKE SIZE: 422.6 acres
MAXIMUM DEPTH: 11 Feet
ORDINARY HIGH WATER MARK: 955.70 Feet
100-YEAR HIGH WATER LEVEL: 955.90 Feet

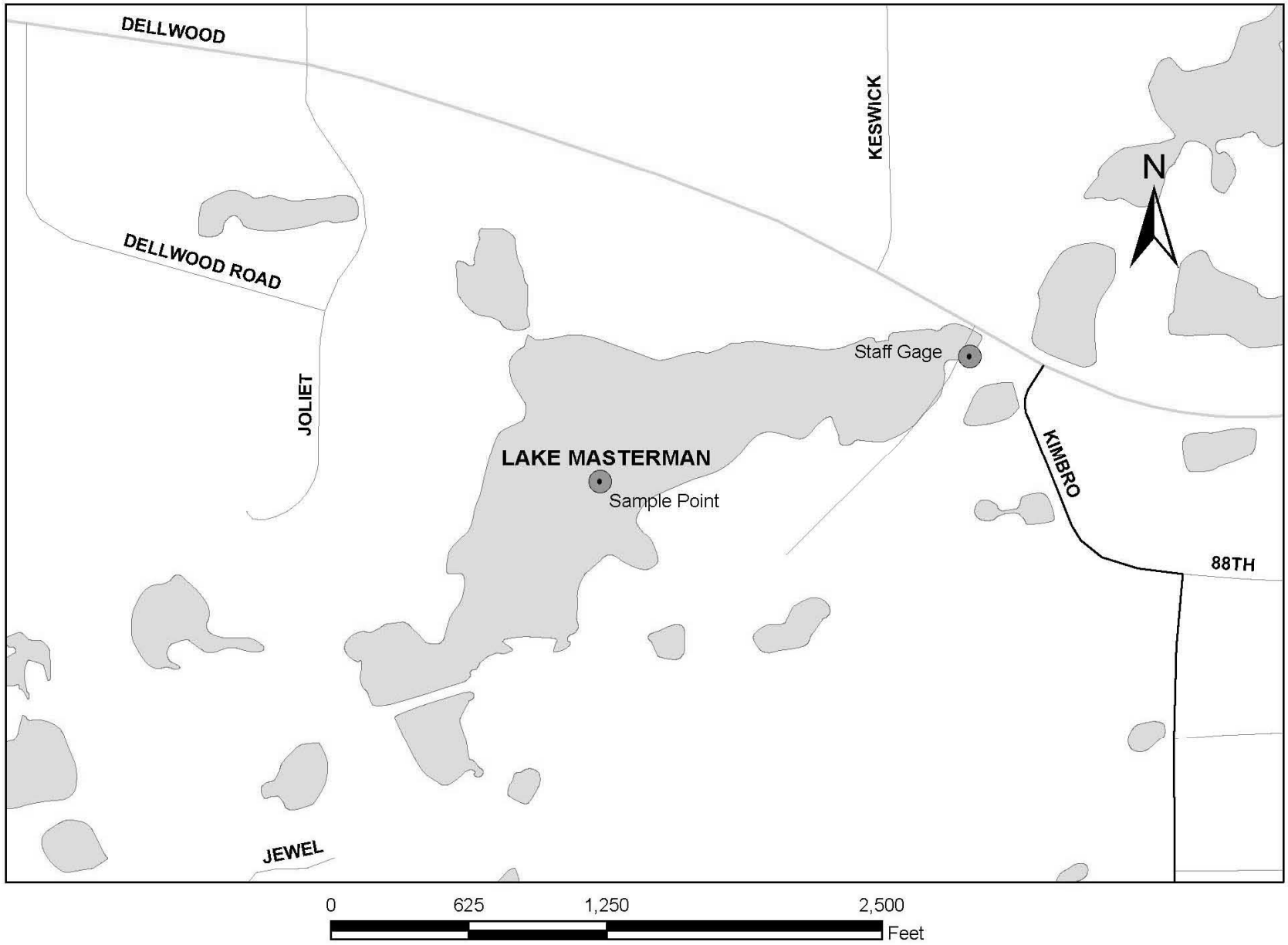
Date	Total Phosphorus (mg/L)	Chlorophyll-a (ug/L)	Secchi Disk Depths (m)	Surface Dissolved Oxygen Levels (mg/L)	Surface Temperature Levels (Celsius)
4/17/2006	0.030	5	2.44	6.26	15.2
5/5/2006	0.029	9	2.13	8.07	14.2
5/23/2006	0.036	4	2.29	10.52	19.3
5/31/2006	0.034	6	2.29	6.19	26.5
6/13/2006	0.052	16	1.37	9.62	23.5
6/26/2006	0.067	36	0.76	10.35	27.1
7/11/2006	0.114	27	1.07	10.08	25.4
7/24/2006	0.093	40	1.83	9.04	28.3
8/9/2006	0.073	15	1.68	7.46	26.3
8/23/2006	0.040	19	1.98	8.31	26.2
9/6/2006	0.040	14	2.13	9.31	24.2
9/12/2006	0.059	11	1.83	5.96	17.7
9/28/2006	0.068	21	1.98	9.19	14.7
10/10/2006	0.081	5	1.98	7.76	13.3
2006 Average	0.058	16	1.84	8.44	21.6
2006 Summer Average	0.067	22	1.63	8.81	23.7

	High	High Date	Low	Low Date	Average
2006 Elevation (ft)	954.63	5/5/2006	953.69	10/25/2006	954.19

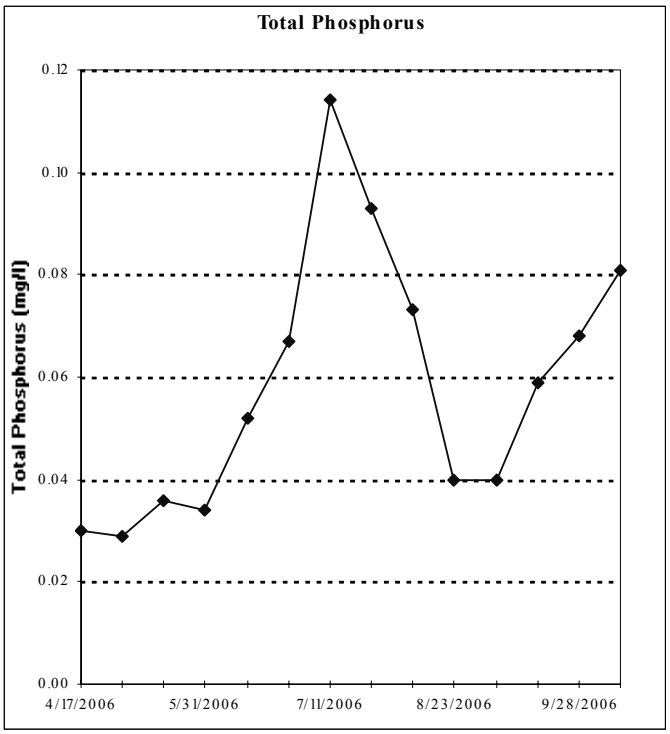
Lake Water Quality Summary

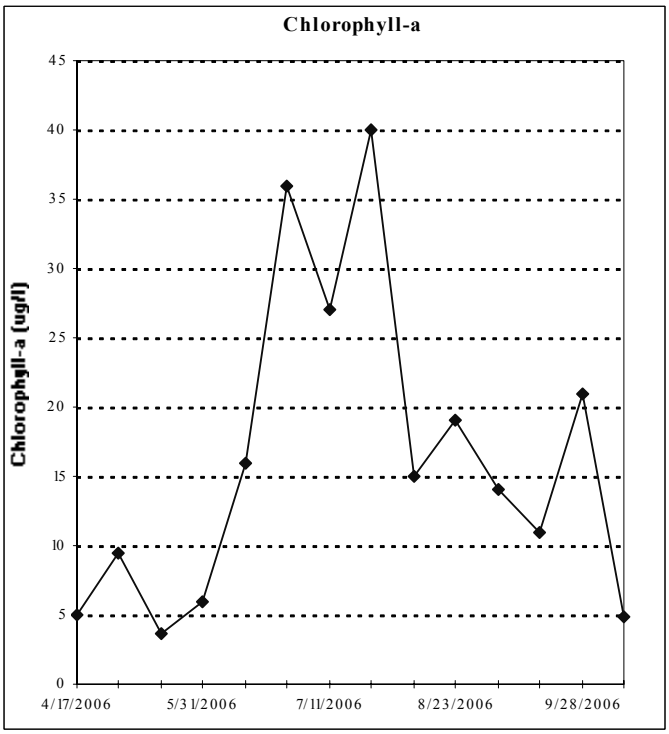
	Trophic Status	Summertime Lake Grades						
	2006	2006	2005	2004	2003	2002	2001	2000
Total Phosphorus (mg/l)	Hypereutrophic	D	NA	NA	NA	NA	NA	NA
Chlorophyll-*a* (ug/l)	Eutrophic	C	NA	NA	NA	NA	NA	NA
Secchi disk (ft)	Eutrophic	C	NA	NA	NA	NA	NA	NA
Overall	Eutrophic	C-	NA	NA	NA	NA	NA	NA

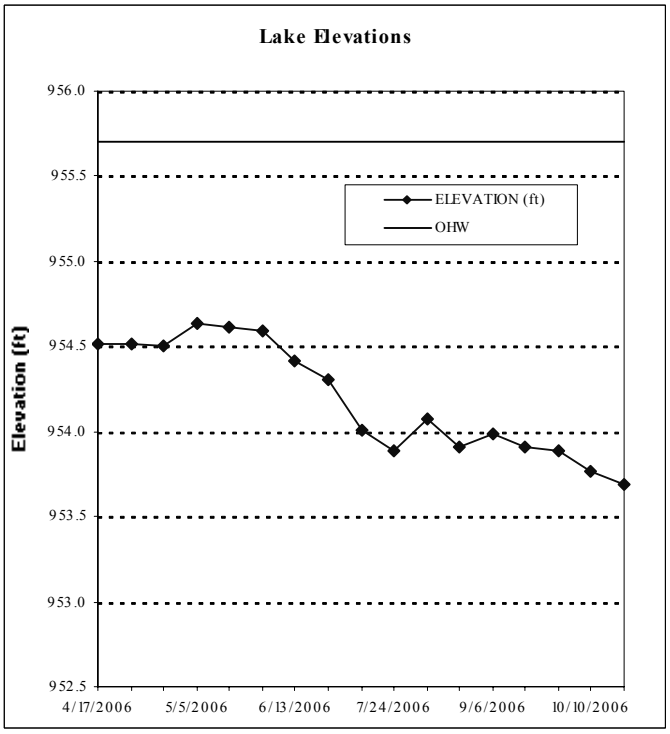
Lake Masterman

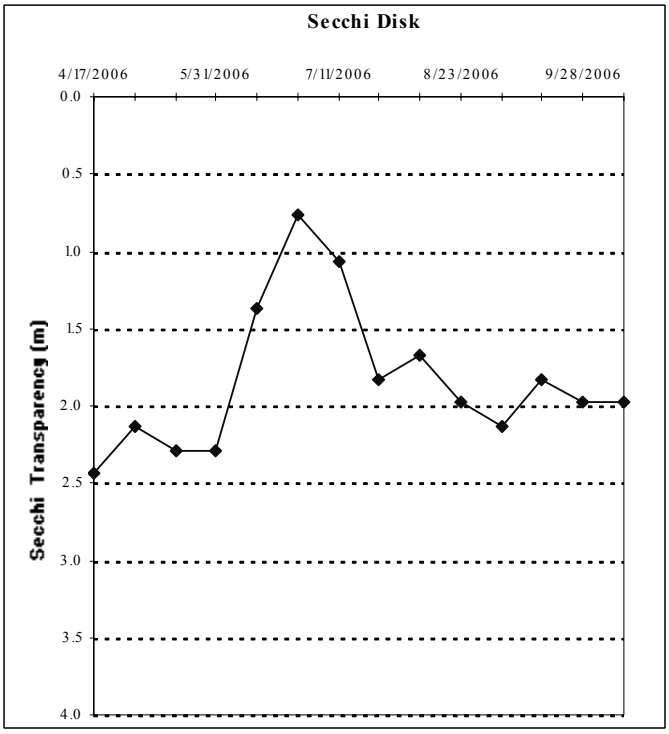


Lake Masterman
City of Grant



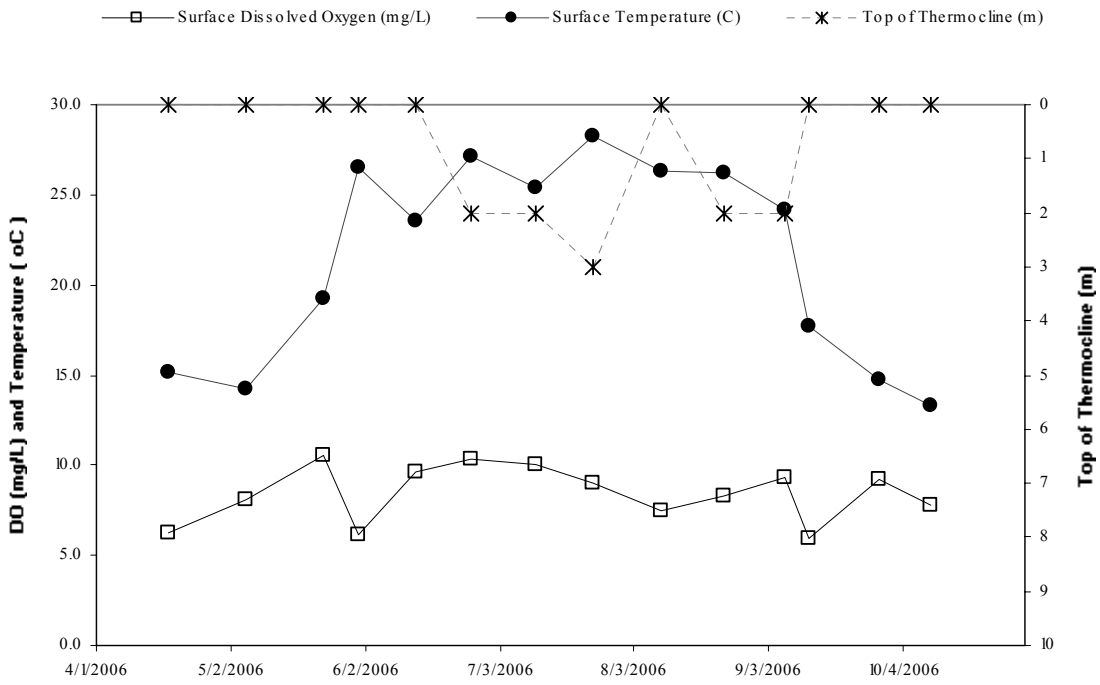






Lake Masterman
City of Grant

Dissolved Oxygen, Temperature, and Top of Thermocline by Sampling Date

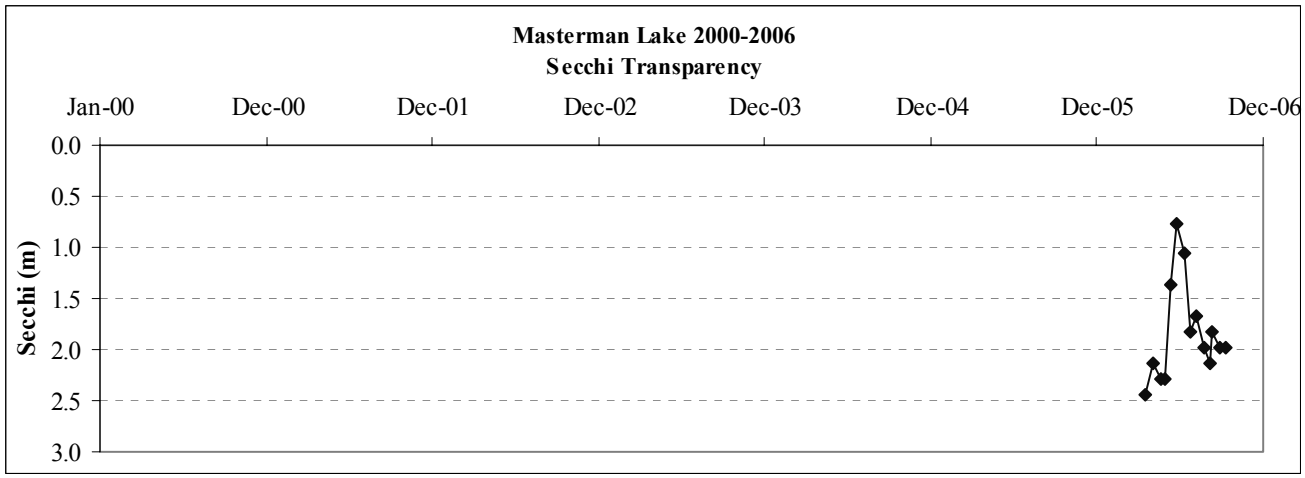


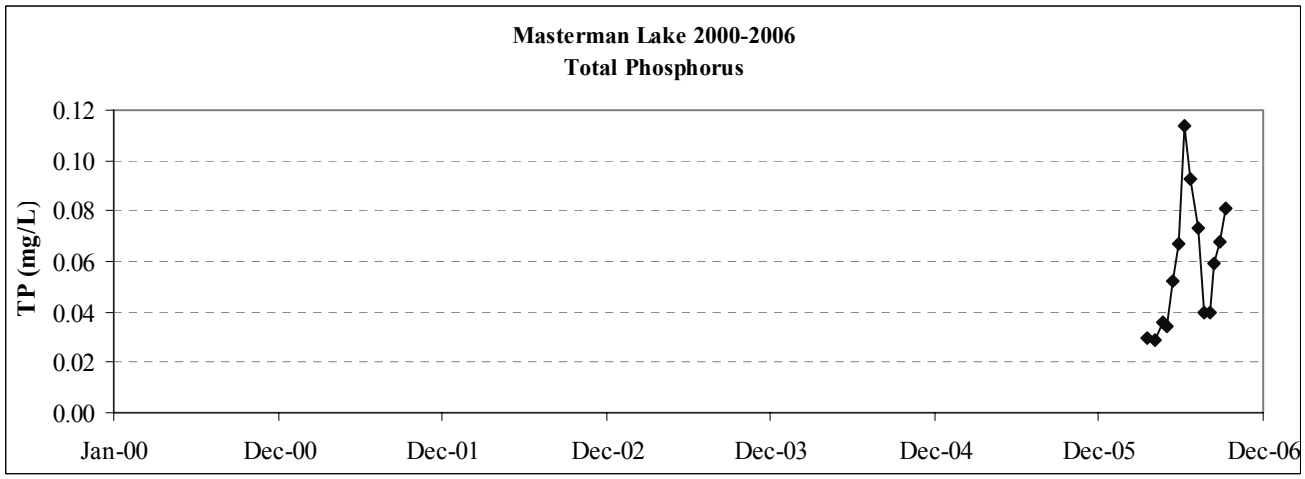
Dissolved Oxygen and Temperature Profile by Sampling Date and Depth

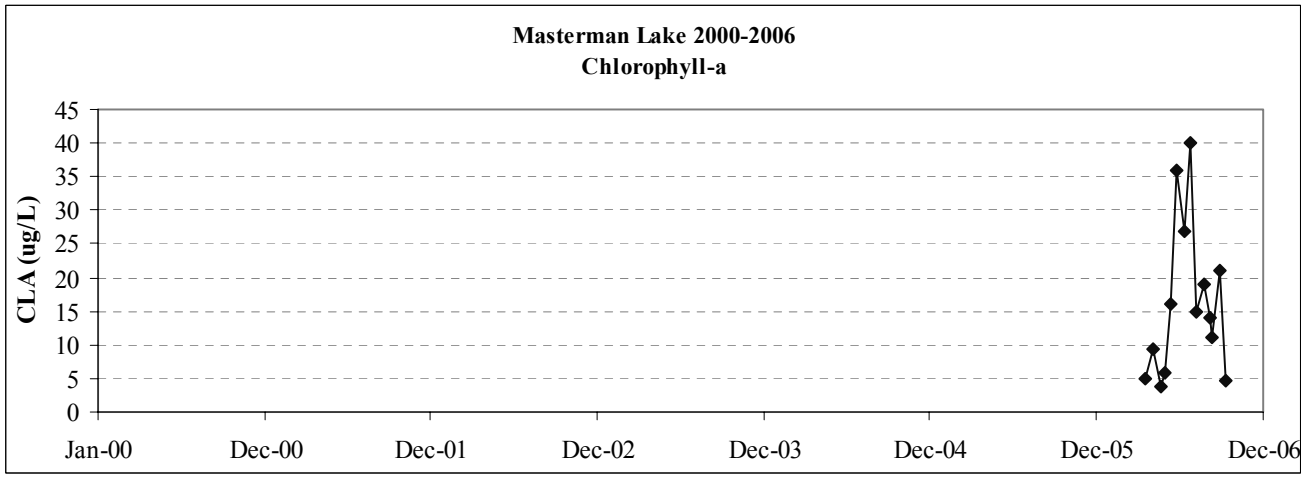
Sampling Date

	4/17/2006		5/5/2006		5/23/2006		5/31/2006		6/13/2006		6/26/2006		7/11/2006		7/24/2006		8/9/2006		8/23/2006		9/6/2006		9/12/2006		9/28/2006		10/10/2006	
Depth (m)	D.O.	Temp	D.O.	Temp	D.O.	Temp	D.O.	Temp	D.O.	Temp	D.O.	Temp	D.O.	Temp	D.O.	Temp	D.O.	Temp	D.O.	Temp	D.O.	Temp	D.O.	Temp	D.O.	Temp	D.O.	Temp
surface	6.26	15.2	8.07	14.2	10.52	19.3	6.19	26.5	9.62	23.5	10.35	27.1	10.08	25.4	9.04	28.3	7.46	26.3	8.31	26.2	9.31	24.2	5.96	17.7	9.19	14.7	7.76	13.3
1	5.99	15.2	7.71	14.2	11.01	18.7	6.30	26.0	9.33	23.1	11.56	24.7	10.35	25.4	9.08	28.3	7.15	26.3	8.35	25.2	10.89	22.9	5.94	17.7	9.18	14.7	7.81	13.4
2	6.30	14.3	7.75	14.2	10.53	17.9	9.13	23.0	8.26	20.8	6.09	22.5	3.95	23.7	9.73	25.8	1.42	26.0	0.31	23.9	1.36	21.6	5.16	17.6	5.66	14.7	7.72	13.3
3	6.80	11.7	7.67	14.2	6.61	16.2	0.63	17.7	0.14	19.2	0.06	19.5	0.13	19.4	0.09	22.8	0.04	22.2	0.08	22.7	0.09	21.2	4.94	17.6	4.19	14.7	5.68	13.4
4															0.08	21.8			0.05	21.6			0.93	17.7			5.73	13.4
5																												
Top of Thermocline (m)											2		2		3				2		2							

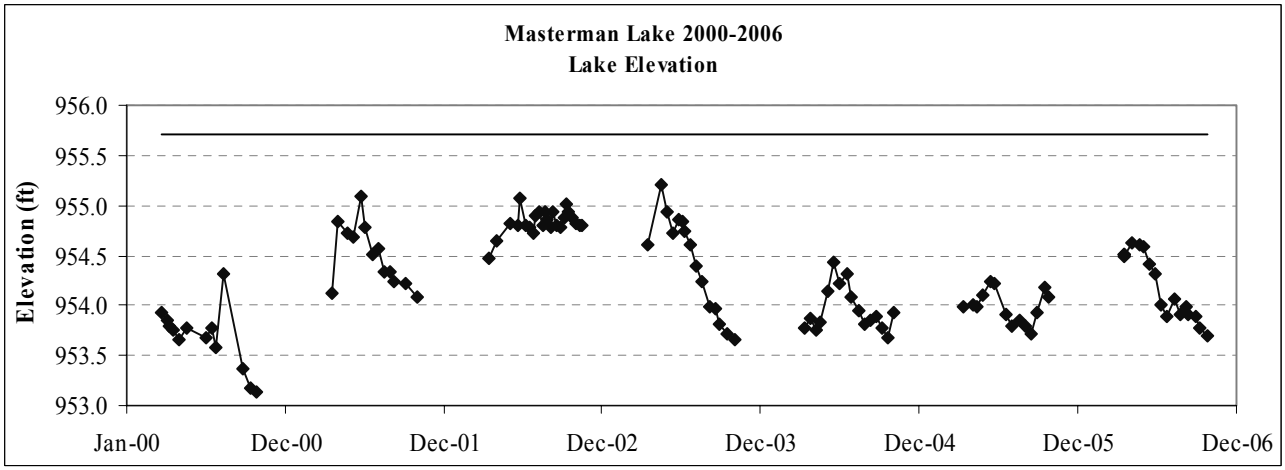
Lake Masterman
City of Grant

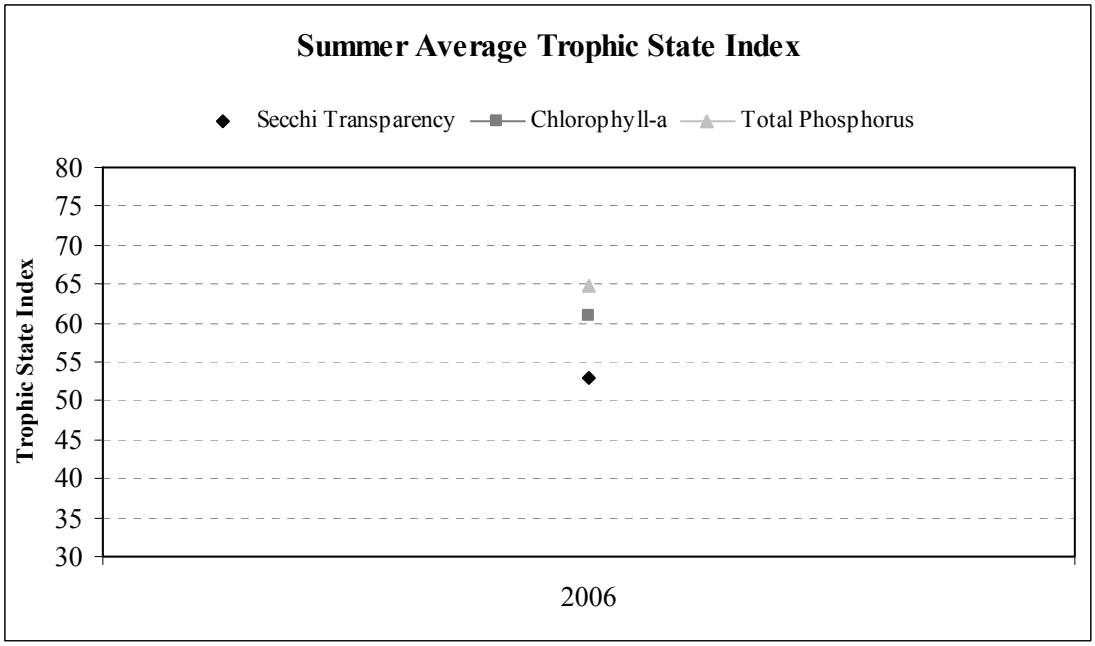






Lake Masterman
City of Grant





Pat Lake
City of Grant

Vital Statistics

DNR ID #: 82-0125
LOCATION: Section 11, T30N-R21W
MUNICIPALITY: Township of Grant
LAKE SIZE: 233.0 acres
MAXIMUM DEPTH: 16 Feet
ORDINARY HIGH WATER MARK: 941.80 Feet
100-YEAR HIGH WATER LEVEL: 949.10 Feet

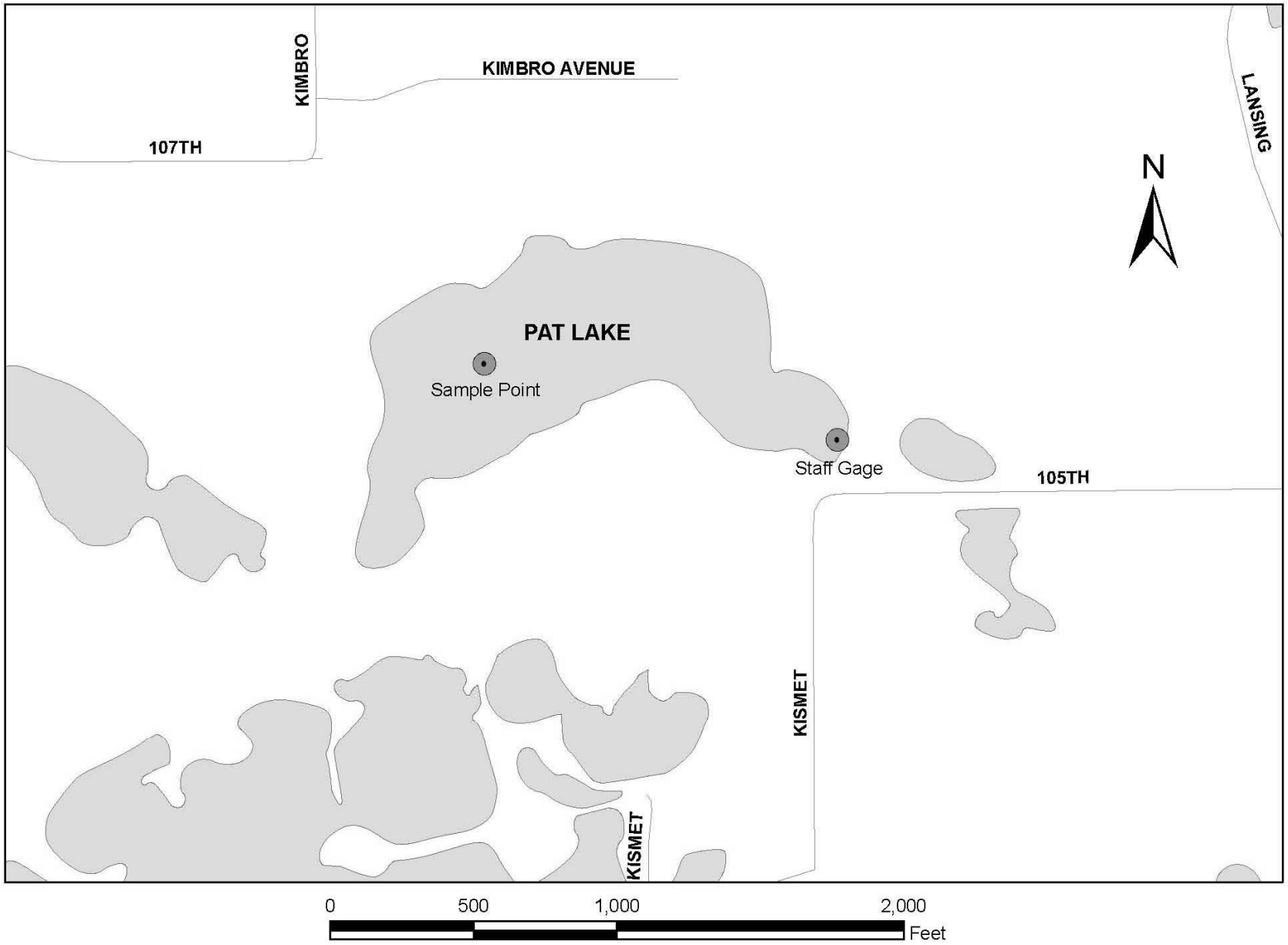
Date	Total Phosphorus (mg/L)	Chlorophyll-a (ug/L)	Secchi Disk Depths (m)	Surface Dissolved Oxygen Levels (mg/L)	Surface Temperature Levels (Celsius)
4/24/2006	0.034	10	1.98	9.70	14.4
5/15/2006	0.028	4	3.35	8.77	18.3
6/12/2006	0.153	37	0.76	4.77	21.5
7/11/2006	0.046	36	0.91	8.76	26.9
8/8/2006	0.074	19	1.22	9.56	27.4
9/6/2006	0.254	8	2.13	8.06	23.2
9/25/2006	0.057	36	1.83	10.27	14.7
2006 Average	0.092	21	1.74	8.56	20.9
2006 Summer Average	0.117	27	1.37	8.28	22.7

	High	High Date	Low	Low Date	Average
2006 Elevation (ft)	941.47	5/3/2006 5/17/2006	940.92	10/18/2006	940.92

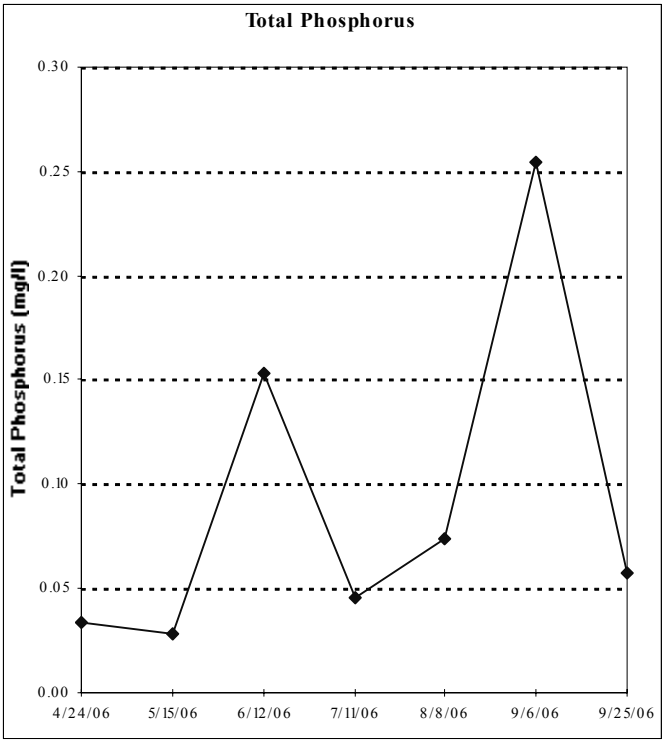
Lake Water Quality Summary

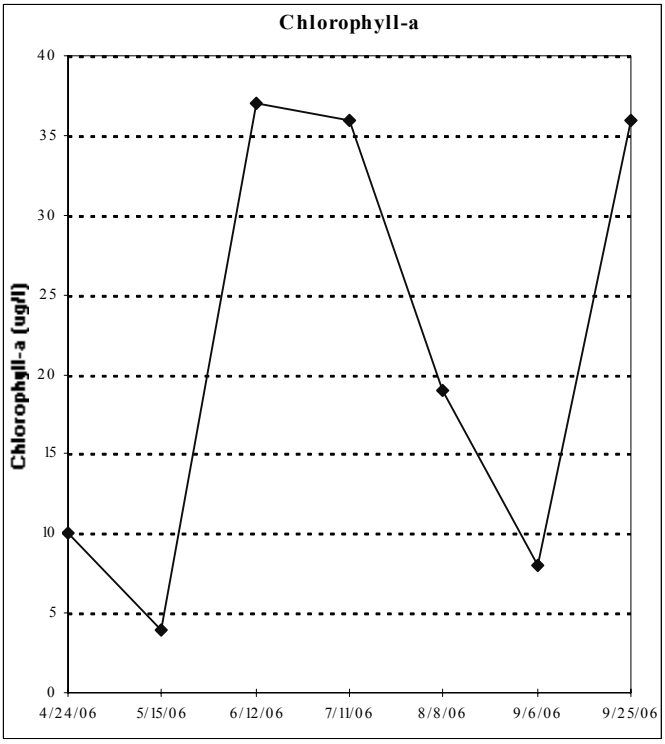
	Trophic Status	Summertime Lake Grades						
	2006	2006	2005	2004	2003	2002	2001	2000
Total Phosphorus (mg/l)	Hypereutrophic	D	NA	NA	NA	NA	NA	NA
Chlorophyll-*a* (ug/l)	Eutrophic	C	NA	NA	NA	NA	NA	NA
Secchi disk (ft)	Eutrophic	C	NA	NA	NA	NA	NA	NA
Overall	Eutrophic	C-	NA	NA	NA	NA	NA	NA

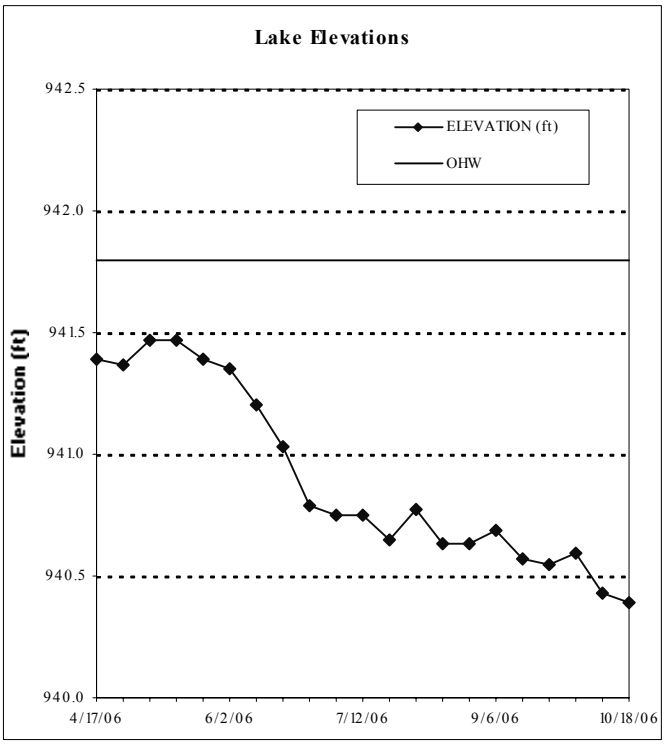
Pat Lake

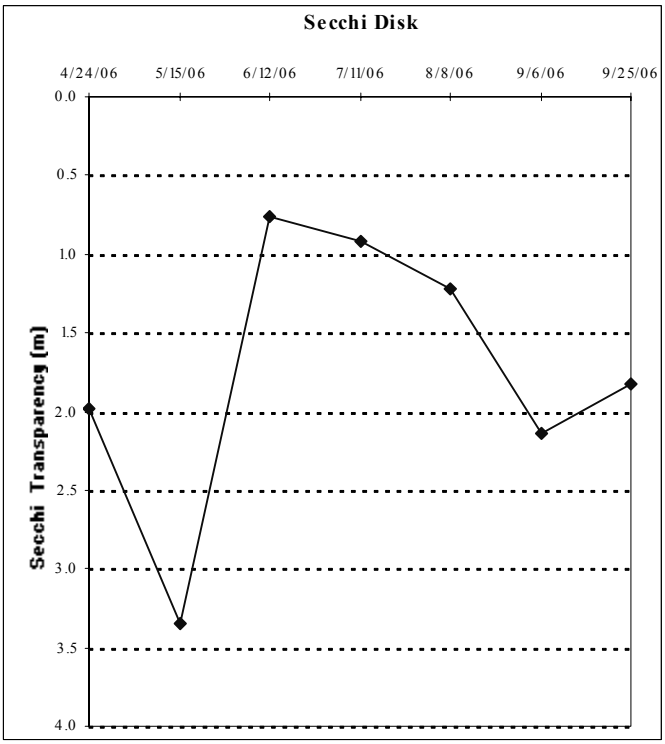

KIMBRO
KIMBRO AVENUE
107TH
LANSING
N
PAT LAKE
Sample Point
Staff Gage
105TH
KISMET
KISMET
0
500
1,000
2,000
Feet

Pat Lake
City of Grant



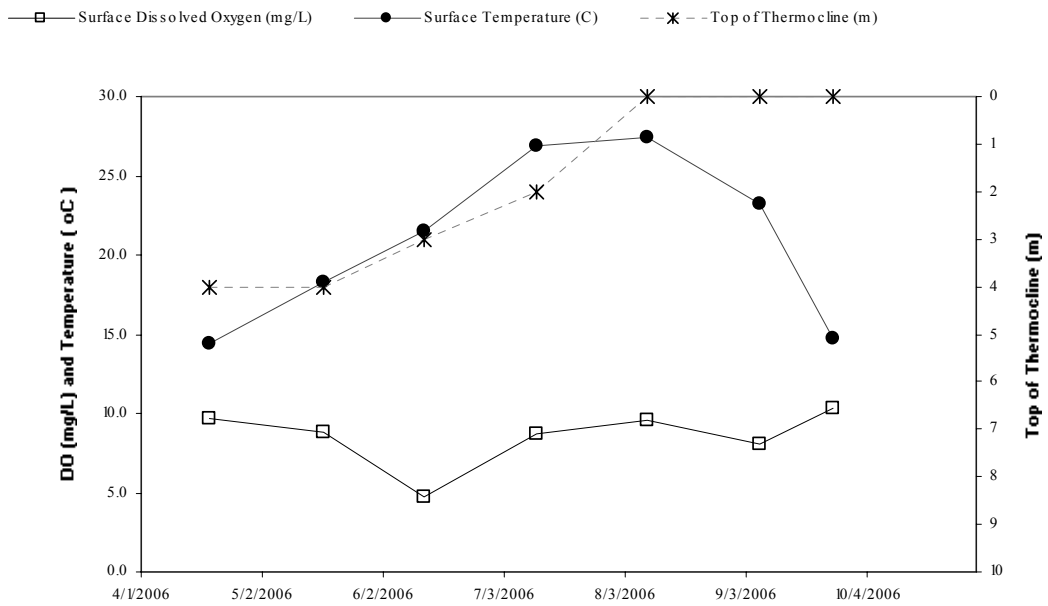






Pat Lake
City of Grant

Dissolved Oxygen, Temperature, and Top of Thermocline by Sampling Date

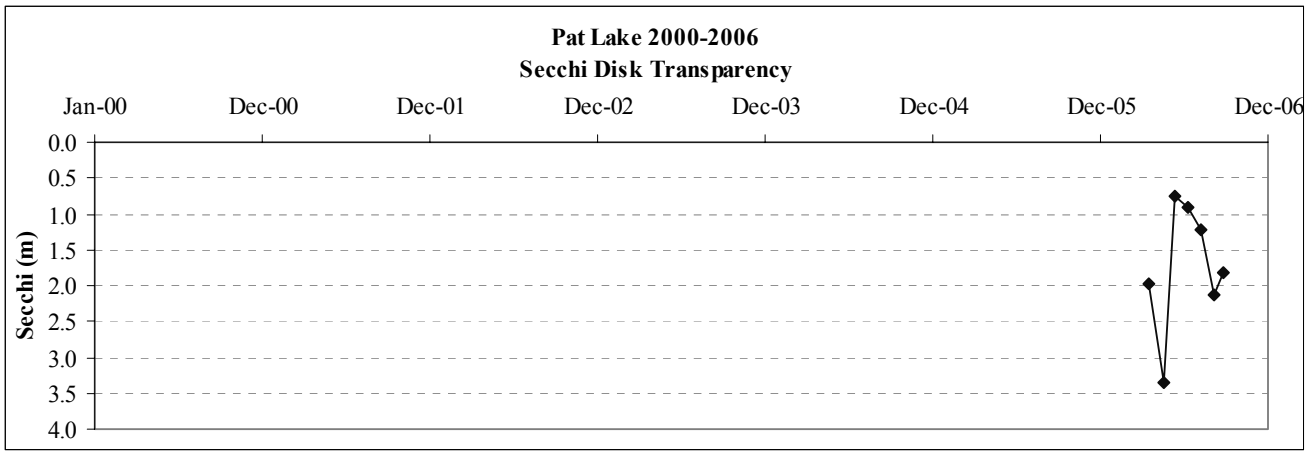


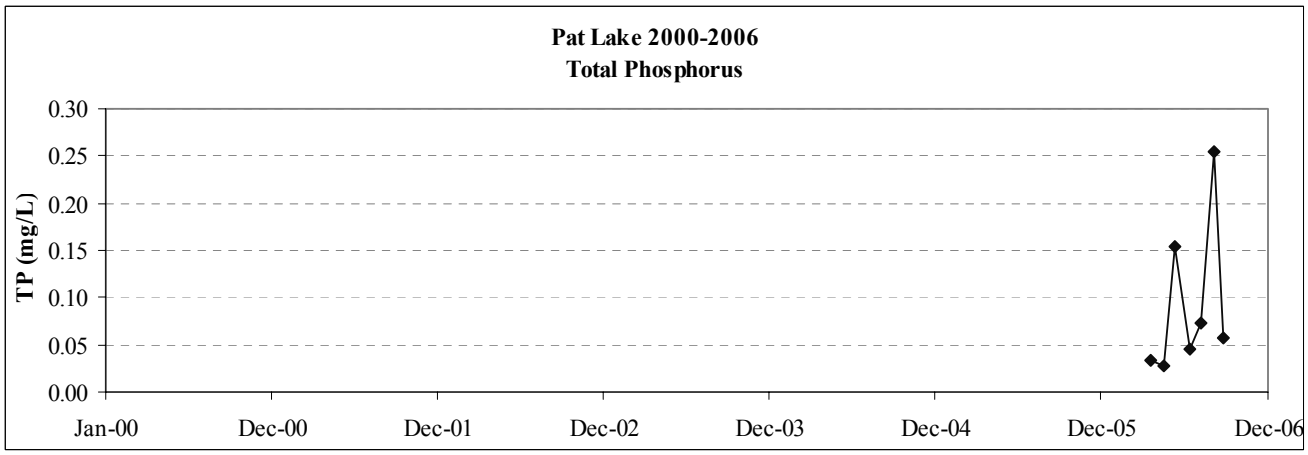
Dissolved Oxygen and Temperature Profile by Sampling Date and Depth

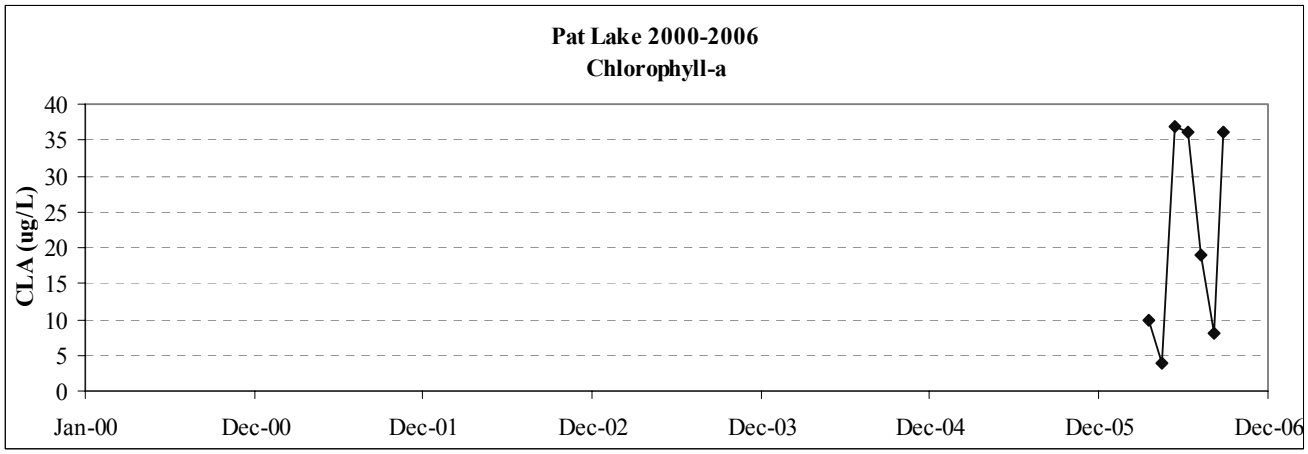
Sampling Date

	4/18/2006		5/17/2006		6/12/2006		7/11/2006		8/8/2006		9/6/2006		9/25/2006	
Depth (m)	D.O.	Temp	D.O.	Temp	D.O.	Temp	D.O.	Temp	D.O.	Temp	D.O.	Temp	D.O.	Temp
surface	9.70	14.4	8.77	18.3	4.77	21.5	8.76	26.9	9.56	27.4	8.06	23.2	10.27	14.7
1	9.43	14.3	8.43	17.7	4.36	20.2	8.09	25.9	9.76	27.0	8.41	22.5	10.27	14.5
2	9.47	14.3	8.74	16.3	3.56	20.0	0.61	25.0	8.29	26.2	6.29	22.0	10.24	14.3
3	9.46	14.2	8.73	15.1	0.15	19.8	0.11	23.5	5.66	26.0			8.69	14.3
4	2.43	7.4	7.11	13.6			0.06	23.5						
5	1.55	6.8	0.52	12.2										
Top of Thermocline (m)	4		4		3		2							

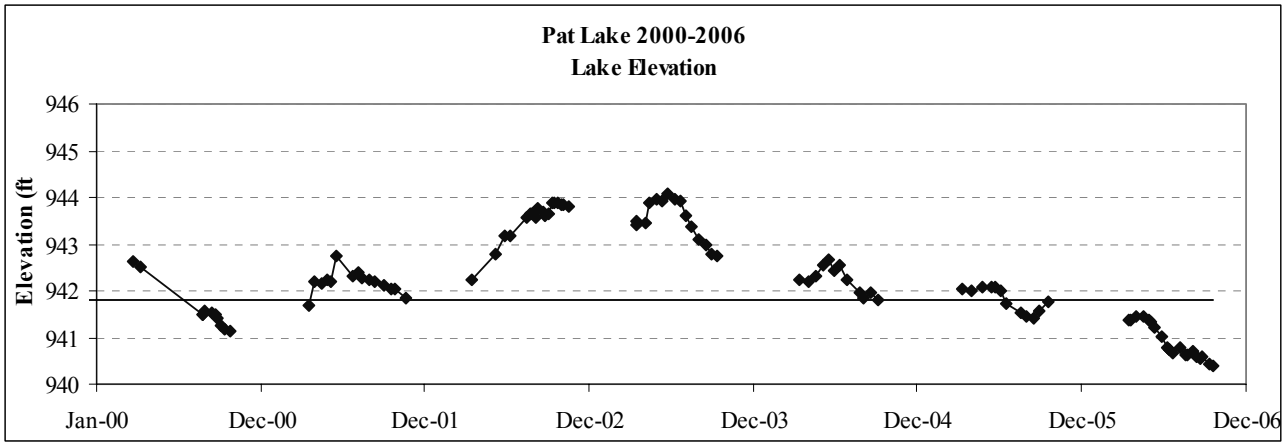
Pat Lake
City of Grant

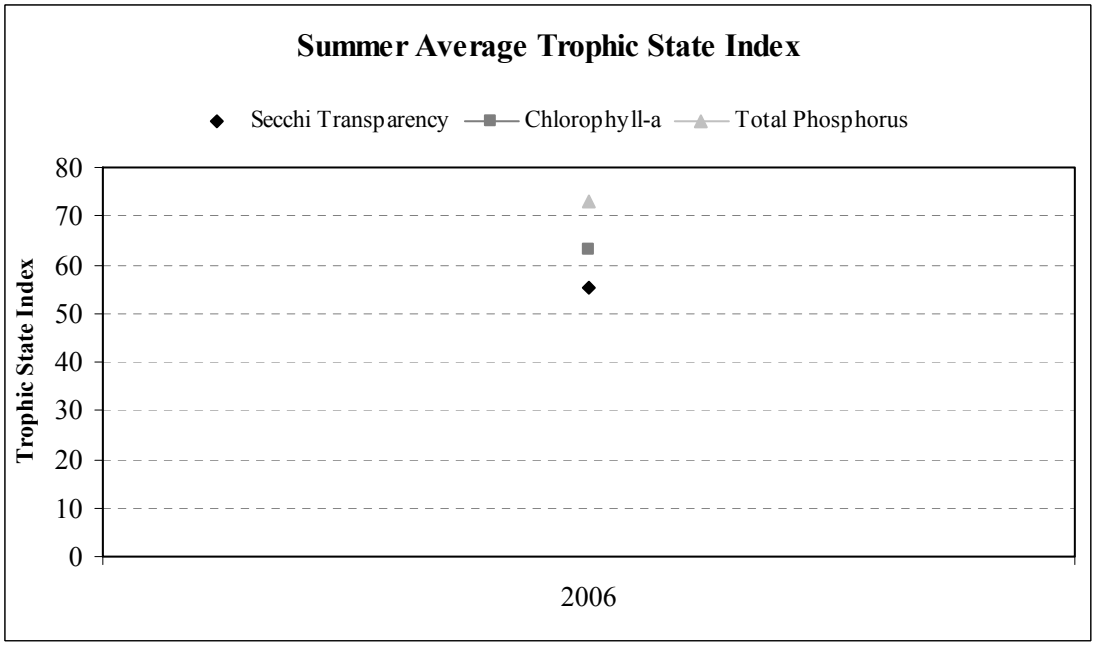






Pat Lake
City of Grant





South School Section Lake

City of Hugo

Vital Statistics

DNR ID #: 82-0151
LOCATION: S ½ Section 25, T31N-R21W
MUNICIPALITY: City of Withrow
LAKE SIZE: 124 Acres
MAXIMUM DEPTH: 26 Feet
ORDINARY HIGH WATER MARK: 965.30 Feet
100-YEAR HIGH WATER LEVEL: 972.20 Feet

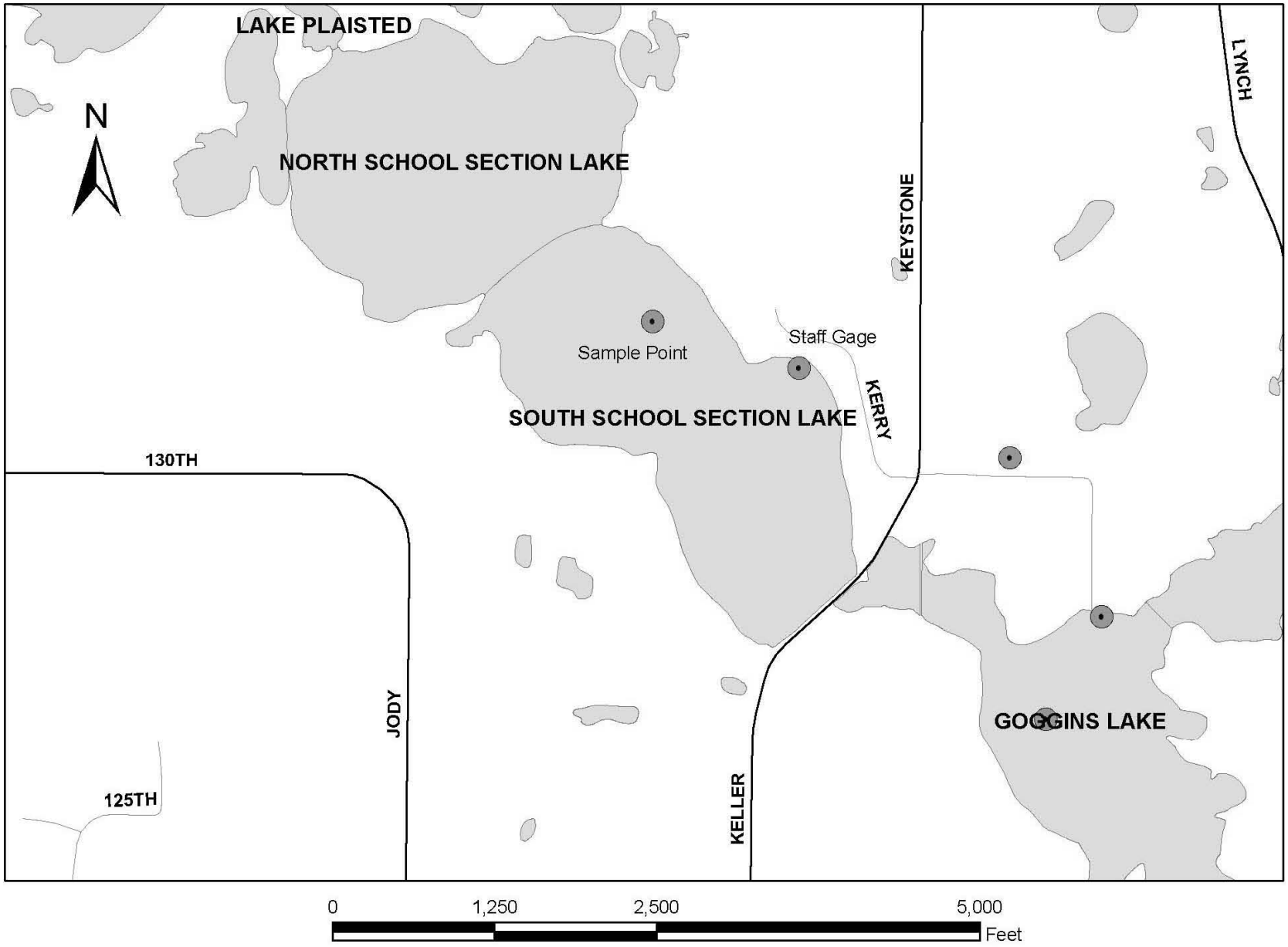
Date	Total Phosphorus (mg/L)	Chlorophyll-a (ug/L)	Secchi Disk Depths (m)	Surface Dissolved Oxygen Levels (mg/L)	Surface Temperature Levels (Celsius)
4/18/2006	0.025	7	2.13	11.06	11.3
5/3/2006	0.029	9	2.90	8.61	13.8
5/15/2006	0.032	10	2.44	9.09	13.5
5/30/2006	0.030	5	3.35	6.04	23.8
6/12/2006	0.031	10	3.35	5.90	20.9
6/26/2006	0.057	19	1.52	8.41	23.5
7/11/2006	0.056	24	1.07	9.96	27.4
7/24/2006	0.072	70	0.46	11.88	27.0
8/8/2006	0.080	60	0.76	6.57	25.6
8/21/2006	0.067	61	0.76	9.61	24.4
9/6/2006	0.069	54	0.76	8.66	22.2
9/13/2006	0.051	33	1.07	6.30	20.0
9/25/2006	0.037	30	1.98	9.14	15.2
10/9/2006	0.070	29	1.52	9.26	14.4
2006 Average	0.050	30	1.72	8.61	20.2
2006 Summer Average	0.058	40	1.30	8.49	22.9

	High	High Date	Low	Low Date	Average
2006 Elevation (ft)	968.08	5/3/2006	966.54	10/27/2006	967.39

Lake Water Quality Summary

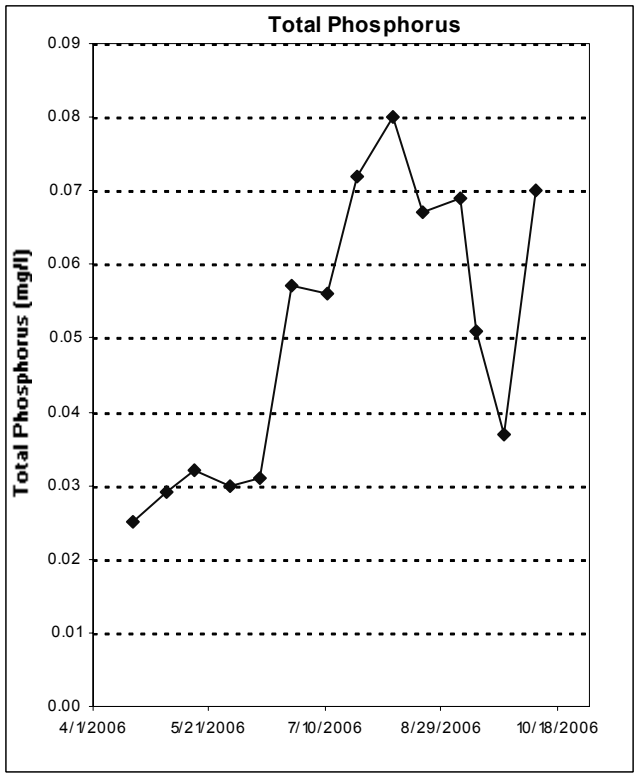
	Trophic Status	Summertime Lake Grades						
	2006	2006	2005	2004	2003	2002	2001	2000
Total Phosphorus (mg/l)	Eutrophic	C	C	NA	NA	NA	NA	NA
Chlorophyll-*a* (ug/l)	Hypereutrophic	C	C+	NA	NA	NA	NA	NA
Secchi disk (ft)	Eutrophic	C	C	NA	NA	NA	NA	NA
Overall	Eutrophic	C	C	NA	NA	NA	NA	NA

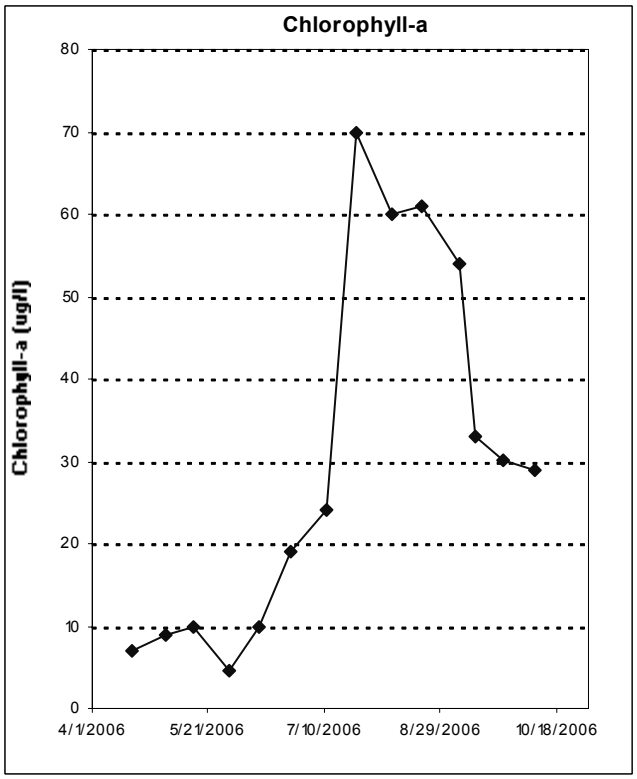
South School Section Lake

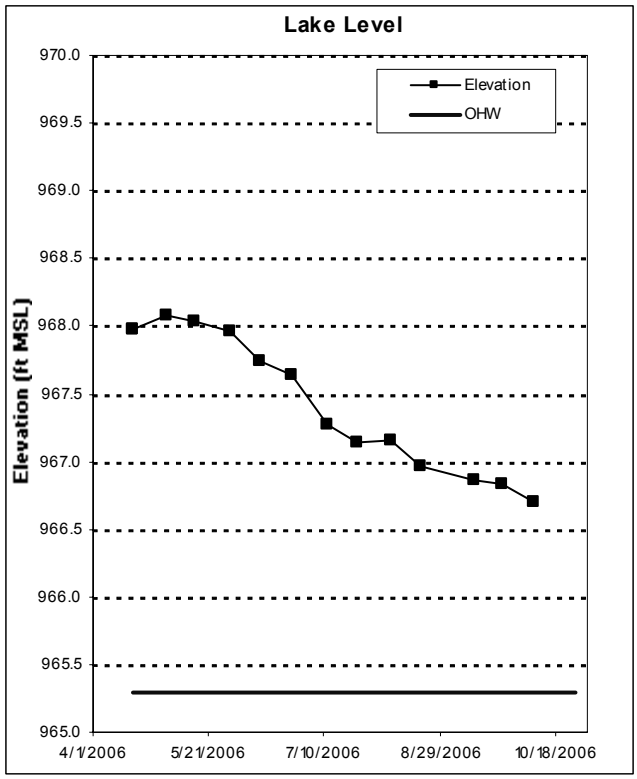


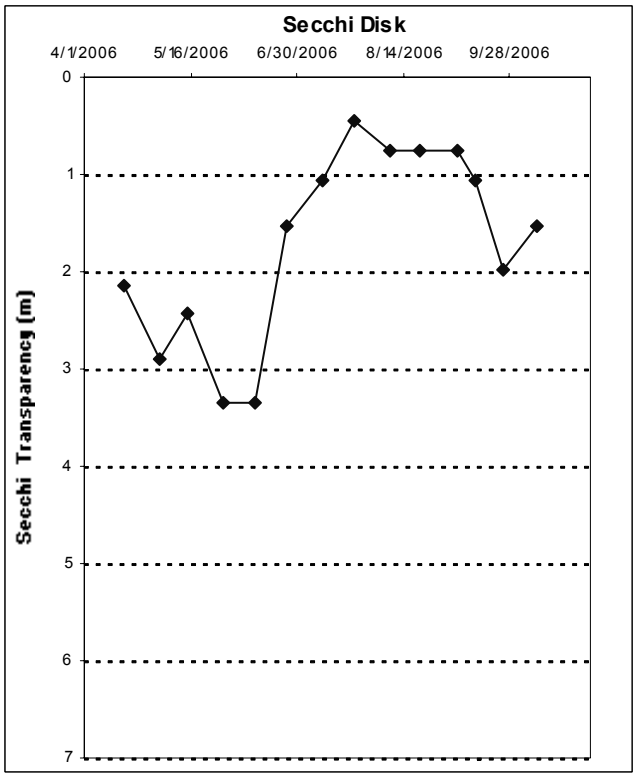
South School Section Lake

City of Hugo



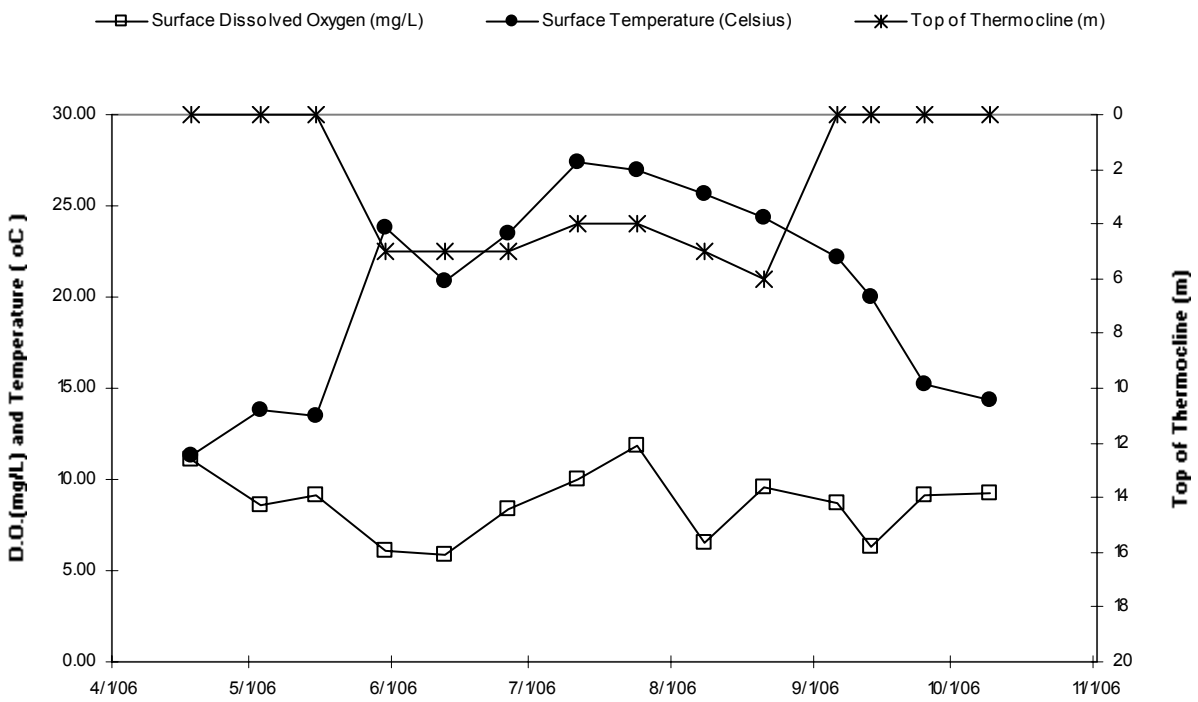






South School Section Lake
City of Hugo

Dissolved Oxygen, Temperature, and Top of Thermocline by Sampling Date

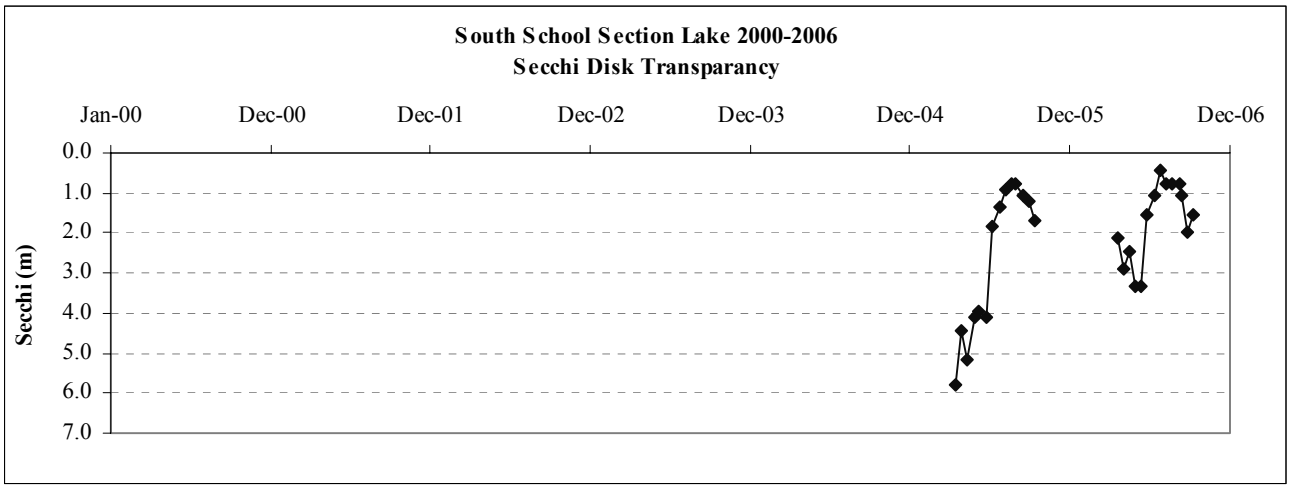


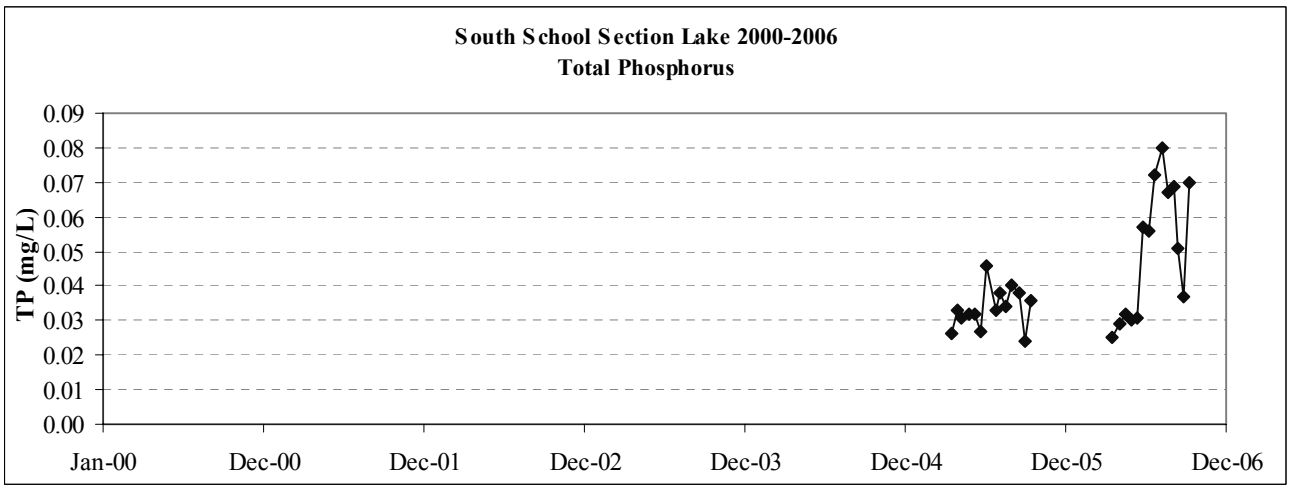
Dissolved Oxygen and Temperature Profile by Sampling Date and Depth

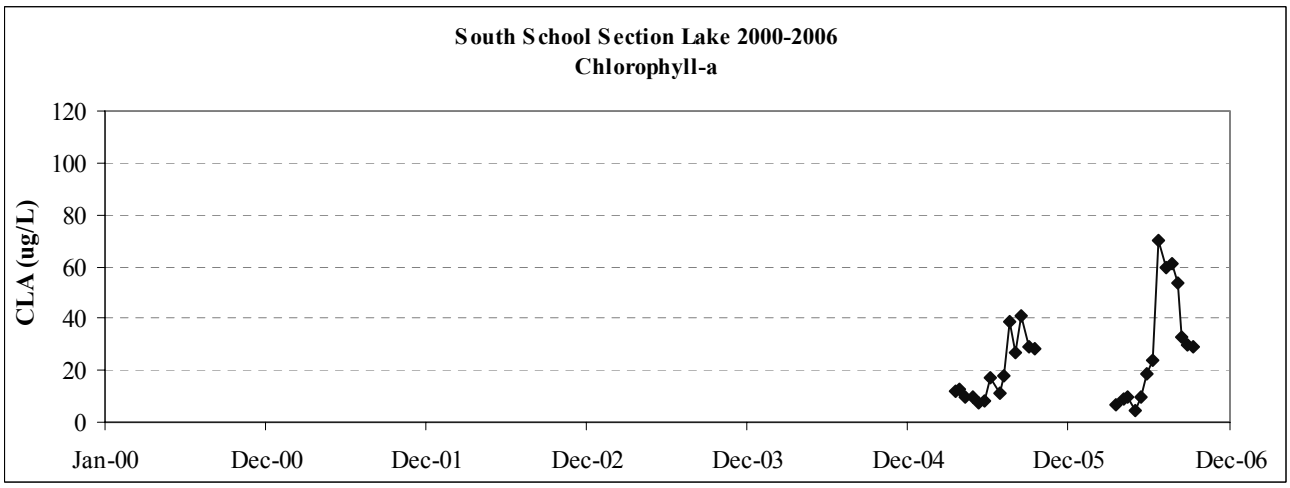
Sampling Date

	4/18/2006		5/3/2006		5/15/2006		5/30/2006		6/12/2006		6/26/2006		7/11/2006		7/24/2006		8/8/2006		8/21/2006		9/6/2006		9/13/2006		9/25/2006		10/9/2006	
Depth (m)	D.O.	Temp	D.O.	Temp	D.O.	Temp	D.O.	Temp	D.O.	Temp	D.O.	Temp	D.O.	Temp	D.O.	Temp	D.O.	Temp	D.O.	Temp	D.O.	Temp	D.O.	Temp	D.O.	Temp	D.O.	Temp
surface	11.06	11.3	8.61	13.8	9.09	13.5	6.04	23.8	5.90	20.9	8.41	23.5	9.96	27.4	11.88	27.0	6.57	25.6	9.61	24.4	8.66	22.2	6.30	20.0	9.14	15.2	9.26	14.4
1	10.66	11.5	8.32	13.8	8.78	13.4	5.82	23.8	5.60	20.8	8.48	23.5	10.45	26.4	11.22	26.9	6.15	25.7	9.61	24.4	8.51	22.2	6.19	19.4	9.00	15.2	0.00	0.0
2	10.62	11.5	8.17	13.7	8.82	13.2	5.84	23.7	5.00	20.7	8.31	23.4	9.32	25.4	8.49	25.9	6.39	25.7	9.35	24.3	7.46	22.1	5.21	18.9	15.20	15.2	9.42	14.3
3	10.78	11.5	8.37	13.7	8.73	13.1	6.39	21.2	5.36	20.7	7.59	23.4	6.17	24.9	5.04	25.1	6.35	25.7	8.33	24.1	4.79	21.8	5.31	18.8	9.03	9.2	9.11	14.3
4	10.74	11.4	8.25	13.7	8.65	13.0	6.58	19.3	5.23	20.6	6.86	23.2	0.81	24.1	1.66	24.5	4.24	25.5	4.52	23.4	3.37	21.6	5.52	18.8	8.78	15.2	9.16	14.3
5	10.66	11.5	8.37	13.5	8.68	13.0	4.03	16.3	2.94	19.0	0.12	21.2	0.16	22.2	0.16	21.2	0.11	21.8	3.58	23.2	0.84	21.4	5.37	18.8	8.61	15.1	9.13	14.2
6	10.46	11.4	8.08	13.3	8.49	12.9	1.97	15.2	0.28	15.9	0.06	17.8	0.10	18.5	0.08	18.8			0.90	22.9	0.06	21.2	5.22	18.8	8.21	15.1	9.15	14.2
7	2.22	11.4			0.33	12.9	0.06	14.7	0.07	15.3	0.02	16.8	0.07	17.4	0.06	18.1			0.05	19.7			0.07	18.8	0.11	15.2		
8																							0.05	18.8	0.07	15.2		
9																												
10																												
Thermocline Present (m)							5		5		5		4		4		5		6									

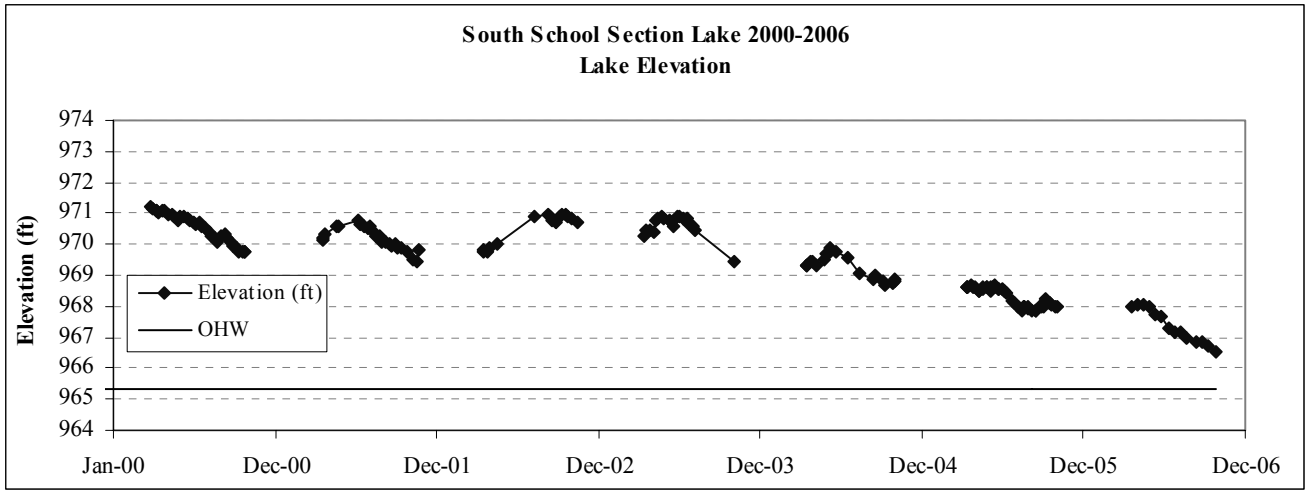
South School Section Lake
City of Hugo

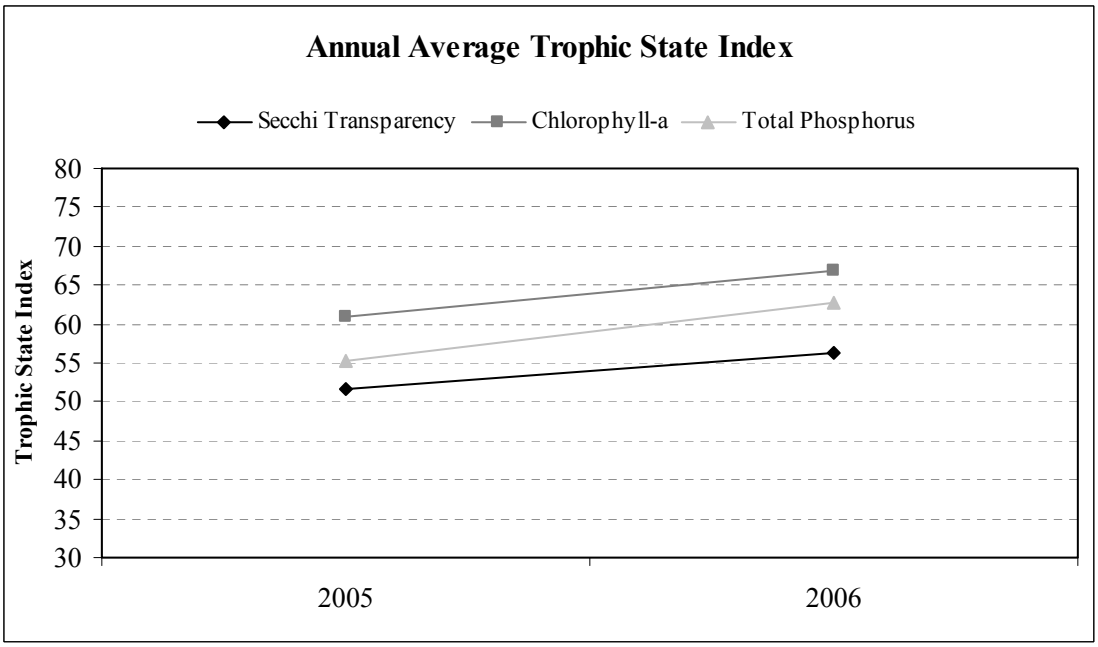






South School Section Lake
City of Hugo





Wood Pile Lake
City of Grant

Vital Statistics

DNR ID #: 82-0132
LOCATION: Section 23, T30N-R21W
MUNICIPALITY: Township of Grant
LAKE SIZE: 166.4 acres
MAXIMUM DEPTH: 27 Feet
ORDINARY HIGH WATER MARK: 968.5 Feet
100-YEAR HIGH WATER LEVEL: 971.00 Feet

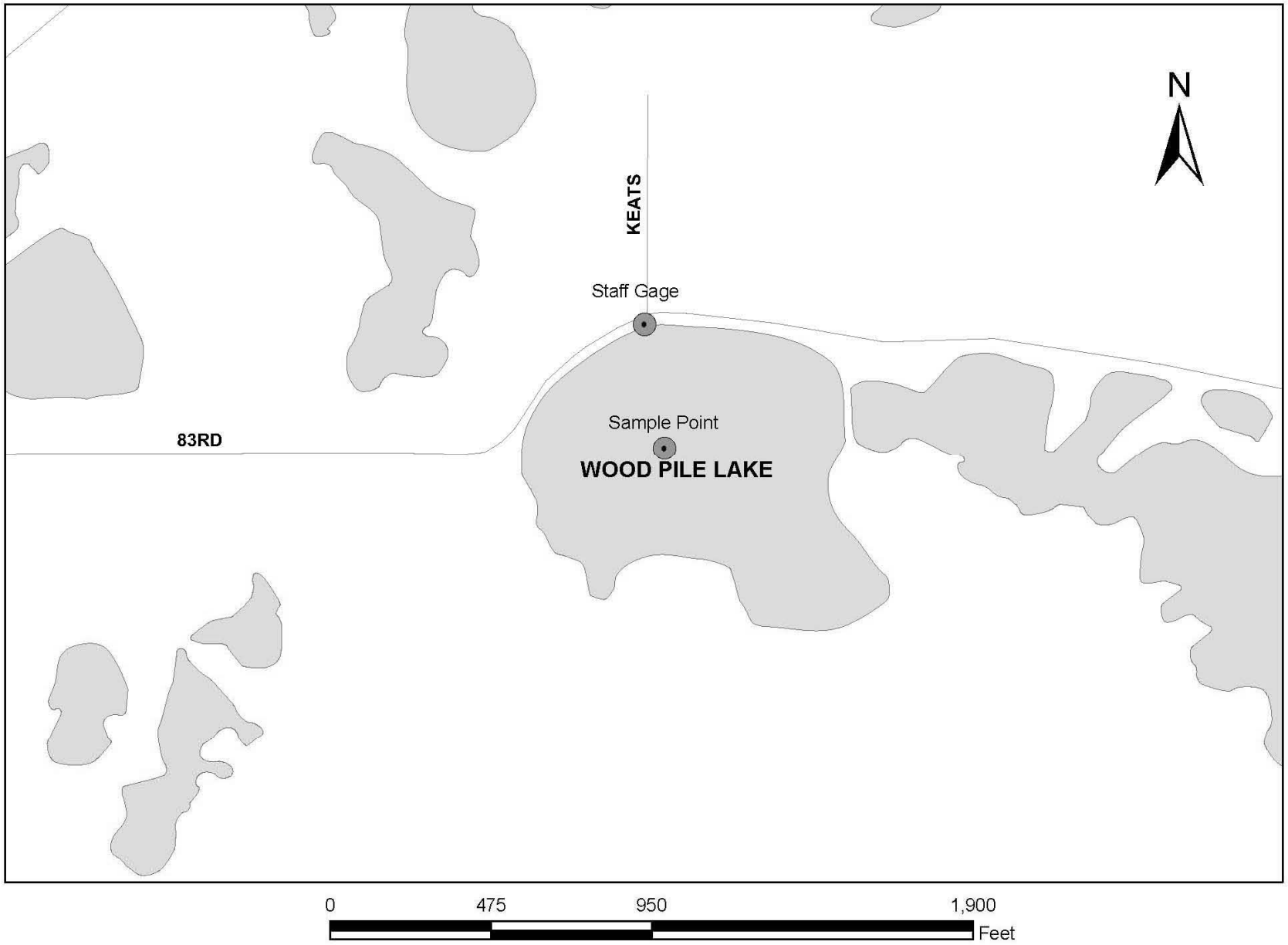
Date	Total Phosphorus (mg/L)	Chlorophyll-a (ug/L)	Secchi Disk Depths (m)	Surface Dissolved Oxygen Levels (mg/L)	Surface Temperature Levels (Celsius)
4/18/2006	0.065	31	0.76	11.16	13.8
5/23/2006	0.052	5	2.13	10.62	18.7
6/13/2006	0.068	13	1.83	9.95	23.2
7/11/2006	0.050	11	1.68	10.19	26.0
8/9/2006	0.122	18	1.22	8.04	26.4
9/6/2006	0.073	28	0.91	13.10	24.5
9/28/2006	0.089	24	0.91	8.80	14.9
2006 Average	0.074	19	1.35	10.27	21.1
2006 Summer Average	0.080	19	1.31	10.02	23.0

	High	High Date	Low	Low Date	Average
2006 Elevation (ft)	966.29	4/17/2006	965.19	10/18/2006	965.82

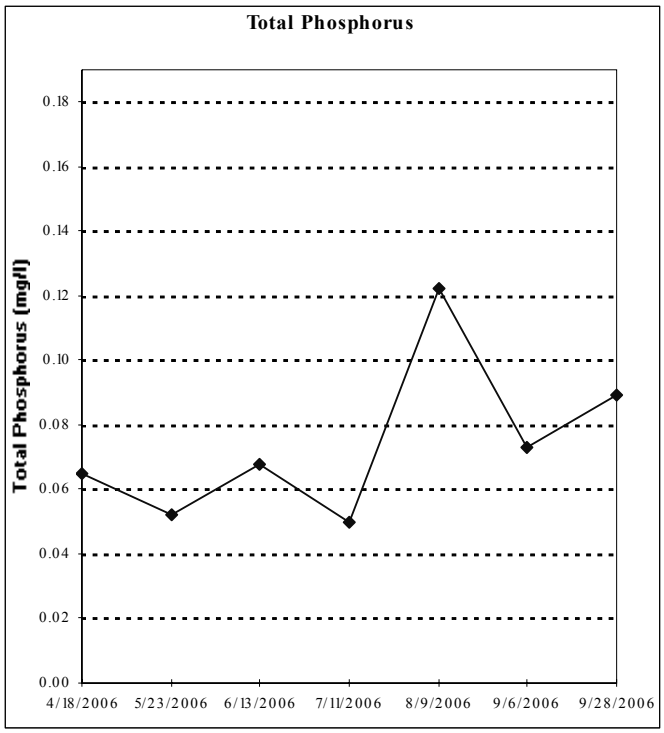
Lake Water Quality Summary

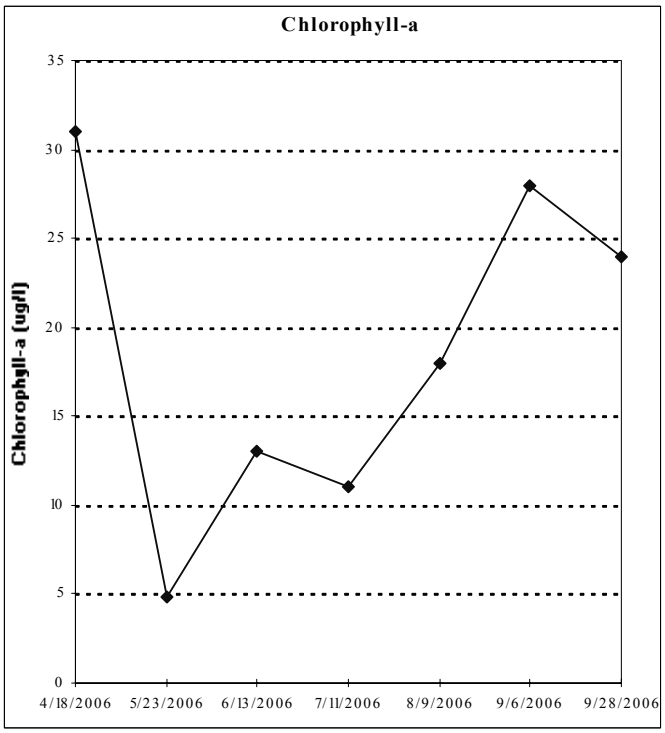
	Trophic Status	Summertime Lake Grades						
	2006	2006	2005	2004	2003	2002	2001	2000
Total Phosphorus (mg/l)	Eutrophic	D	NA	NA	NA	NA	NA	NA
Chlorophyll-*a* (ug/l)	Hypereutrophic	B	NA	NA	NA	NA	NA	NA
Secchi disk (ft)	Eutrophic	C	NA	NA	NA	NA	NA	NA
Overall	Eutrophic	C	NA	NA	NA	NA	NA	NA

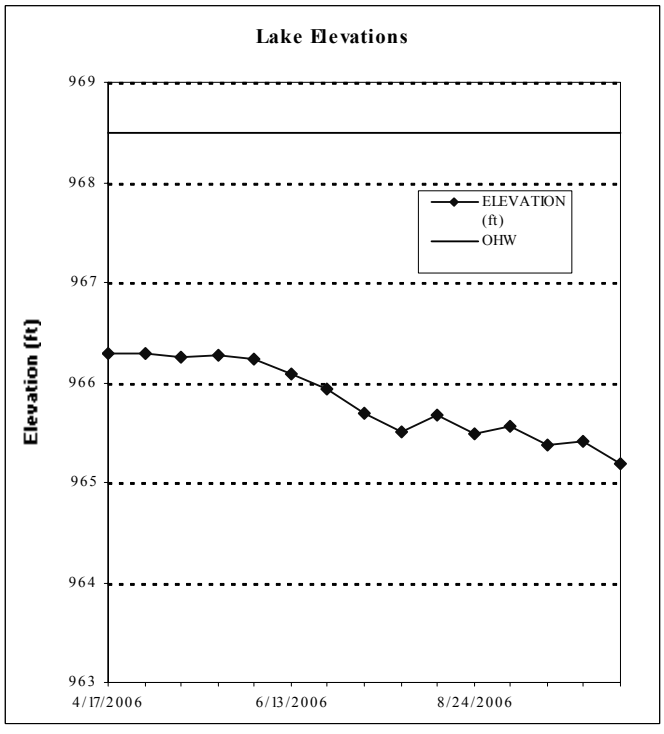
Wood Pile Lake

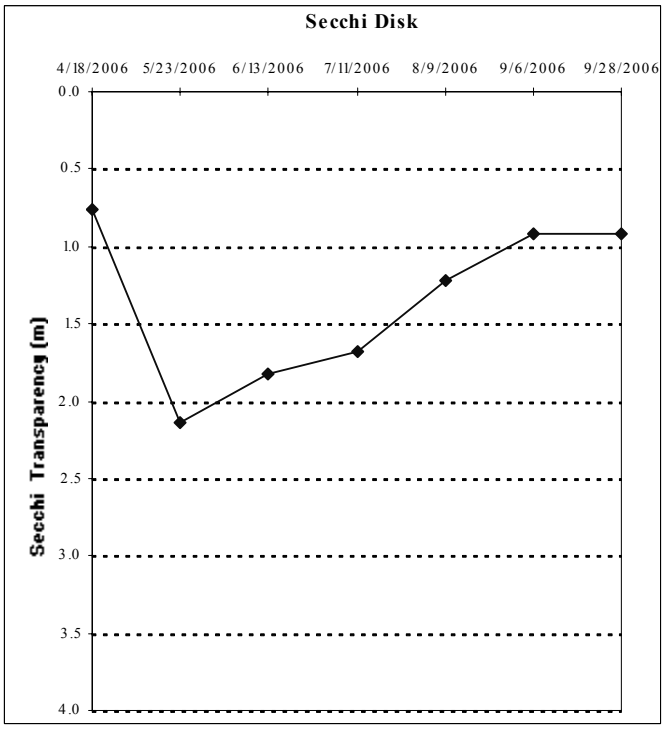


Wood Pile Lake
City of Grant



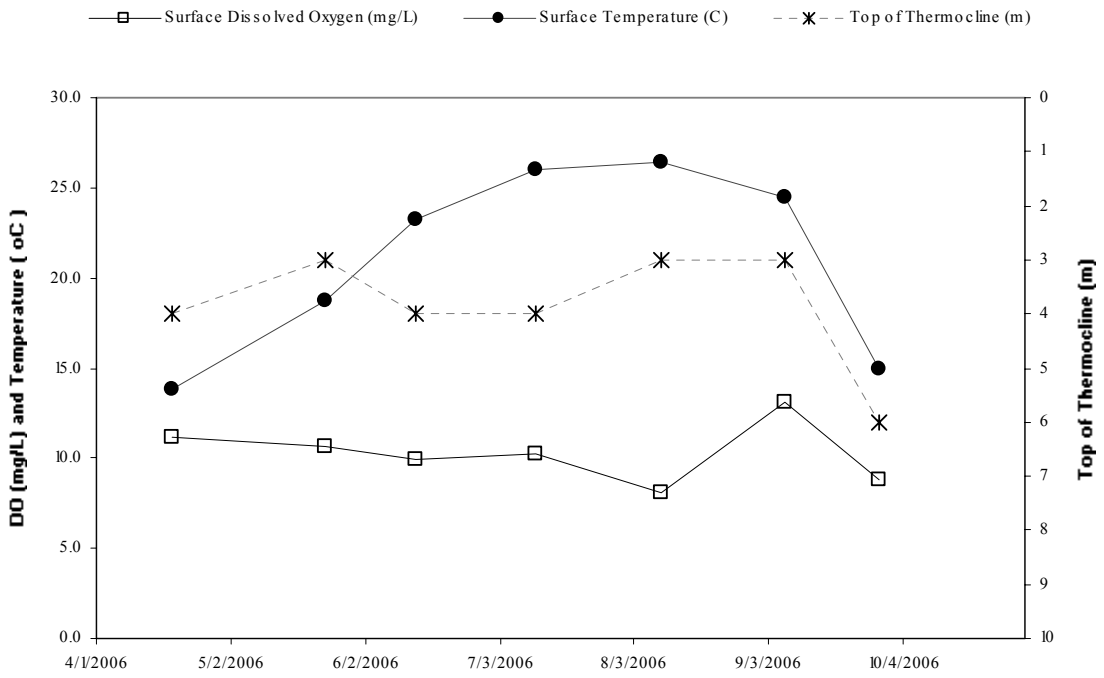






Wood Pile Lake
City of Grant

Dissolved Oxygen, Temperature, and Top of Thermocline by Sampling Date

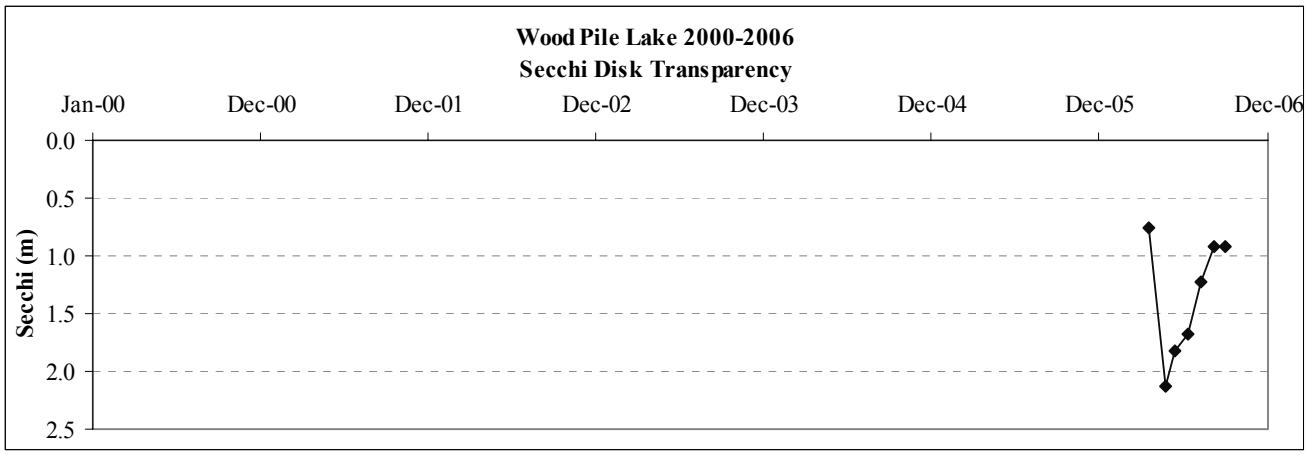


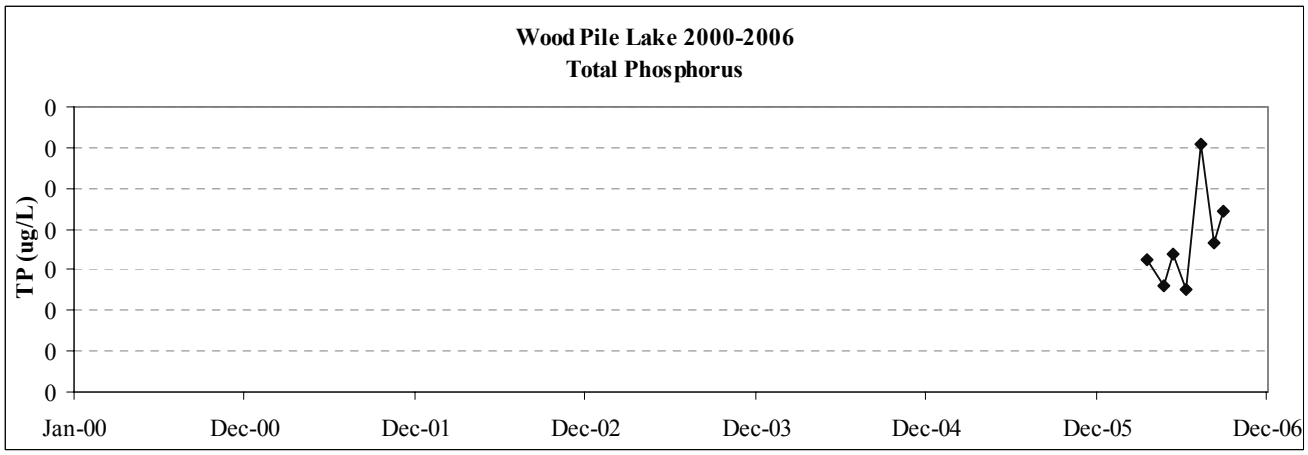
Dissolved Oxygen and Temperature Profile by Sampling Date and Depth

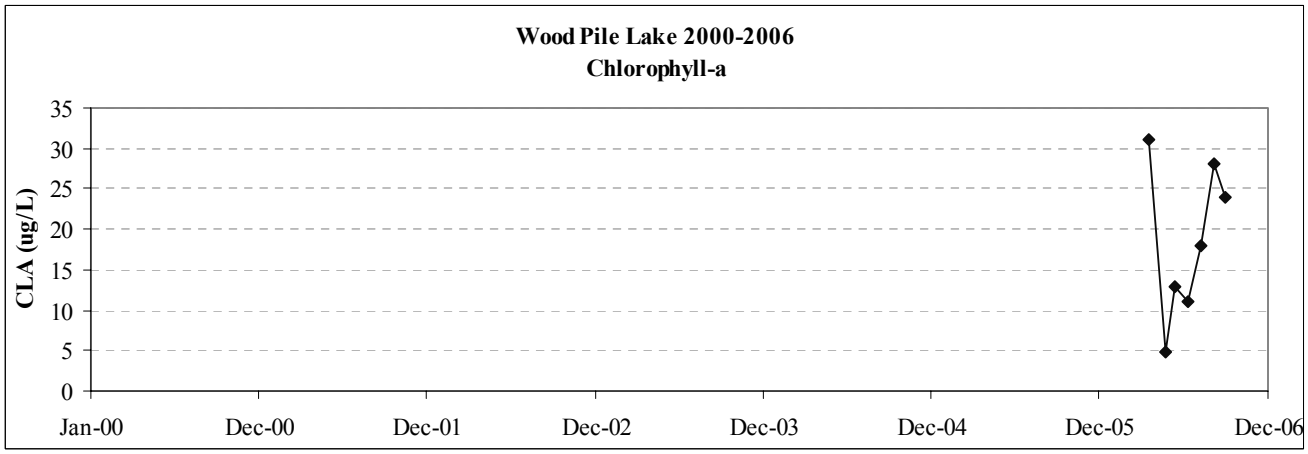
Sampling Date

Depth (m)	4/18/2006		5/23/2006		6/13/2006		7/11/2006		8/9/2006		9/6/2006		9/28/2006	
	D.O.	Temp	D.O.	Temp	D.O.	Temp	D.O.	Temp	D.O.	Temp	D.O.	Temp	D.O.	Temp
surface	11.16	13.8	10.62	18.7	9.95	23.2	10.19	26.0	8.04	26.4	13.10	24.5	8.80	14.9
1	10.96	13.7	10.45	18.6	10.45	21.9	10.17	26.0	8.02	26.4	12.33	23.0	8.86	14.9
2	11.02	13.6	10.50	17.0	10.79	20.9	9.56	26.0	8.11	26.4	10.57	22.1	8.85	14.8
3	11.34	10.7	7.73	15.2	7.99	19.8	8.95	25.1	4.49	25.9	6.24	21.7	8.96	14.8
4	6.64	6.8	1.72	11.0	0.91	13.9	0.38	17.0	0.10	18.8	0.12	19.3	8.92	14.7
5	6.12	5.9	0.68	7.8	0.21	9.3	0.19	10.4	0.10	12.1	0.08	12.5	8.86	14.5
6	5.16	5.4	0.67	6.1	0.09	6.7	0.14	7.9	0.08	8.5	0.07	12.4	0.20	10.0
7	4.37	5.1	0.67	5.6	0.08	6.0	0.13	6.5	0.07	6.9	0.10	9.4	0.15	7.3
8	1.23	4.9	0.68	5.4	0.08	5.8	0.12	6.0	0.08	6.3			0.13	6.8
9	1.11	4.9	0.66	5.4									0.11	6.7
10														
Top of Thermocline (m)	4		3		4		4		3		3		6	

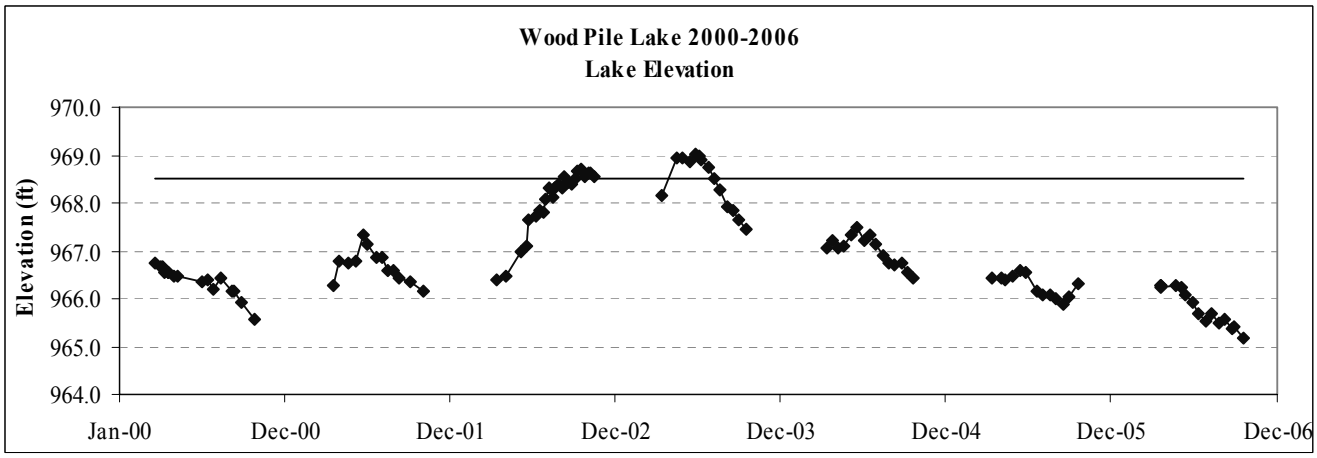
Wood Pile Lake
City of Grant

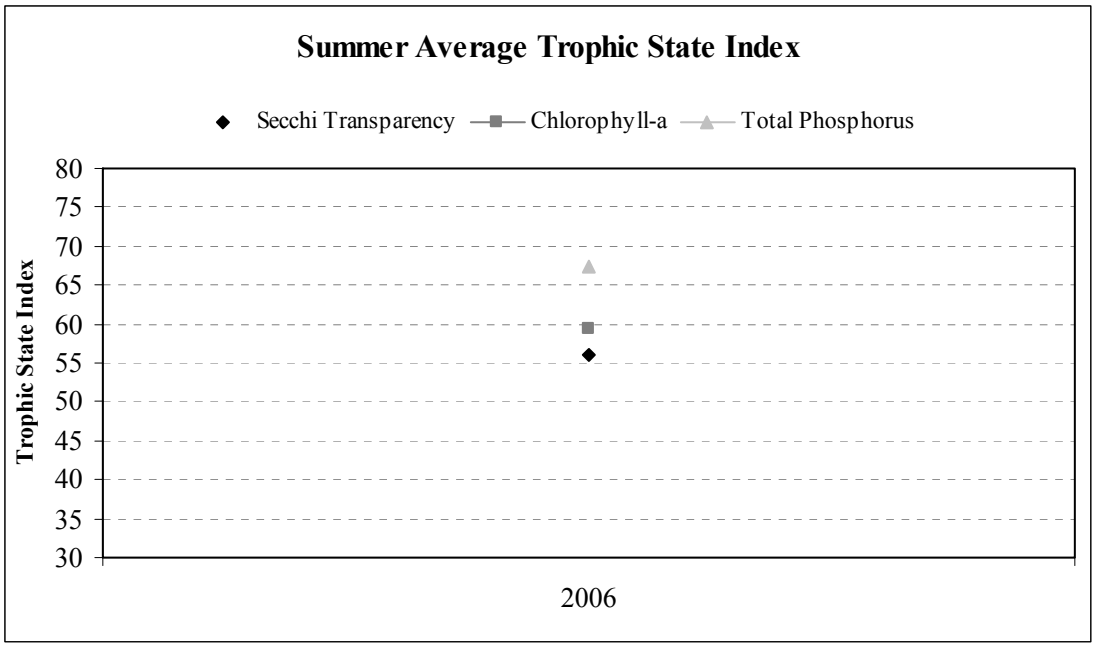






Wood Pile Lake
City of Grant





APPENDIX B – BROWN'S CREEK HISTORICAL FLOW AND WATER QUALITY DATA (1998-2005)

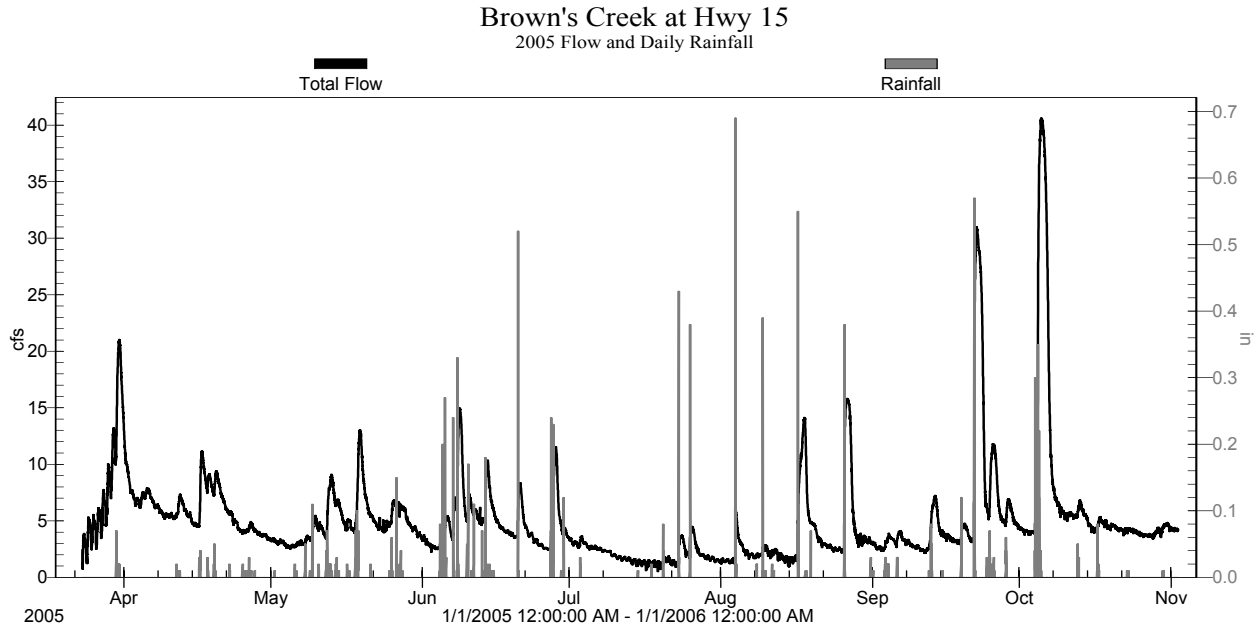


Figure 46: Brown's Creek at Hwy 15 2005 Flow and Daily Rainfall

Table 44: Brown's Creek at Hwy 15 2005 Total Suspended Solids (TSS) and Phosphorus (TP) Loading

	Sample Collection Time						Loading Interval				
Sample Type	Start Date	Start Time	End Date	End Time	TSS (mg/L)	TP (mg/L)	Start	End	Interval Volume (cf)	Interval TP (lb)	Interval TSS (lb)
BASE					*12*	*0.100*	*1/1/2005 0:00*	*2/2/2005 12:00*	*2,246,400*	*13.99*	*1,613*
Snowmelt Grab	2/3/05	10:00	2/3/05	10:00	7	0.070	2/2/2005 12:00	2/4/2005 12:00	691,200	3.02	302
BASE					*12*	*0.100*	*2/4/2005 12:00*	*3/23/2005 13:45*	*4,067,100*	*25.33*	*2,920*
BASE					*12*	*0.100*	*3/23/2005 13:45*	*3/30/2005 7:45*	*3,448,570*	*21.47*	*2,476*
Storm Composite	3/28/05	16:58	3/31/05	7:51	82	0.317	3/30/2005 7:45	4/2/2005 3:45	3,489,546	69.05	17,863
BASE					*12*	*0.100*	*4/2/2005 3:45*	*4/12/2005 0:45*	*5,470,455*	*34.06*	*3,927*
STORM					*120*	*0.350*	*4/12/2005 0:45*	*4/13/2005 7:45*	*744,168*	*16.26*	*5,570*
BASE					*12*	*0.100*	*4/13/2005 7:45*	*4/16/2005 8:45*	*1,353,771*	*8.43*	*972*
STORM					*120*	*0.350*	*4/16/2005 8:45*	*4/20/2005 23:45*	*3,412,380*	*74.58*	*25,539*
Base Grab	4/26/05	10:30	4/26/05	10:30	3	0.077	4/20/2005 23:45	4/26/2005 11:45	2,414,925	11.61	452
STORM					*120*	*0.350*	*4/26/2005 11:45*	*4/27/2005 22:45*	*559,546*	*12.23*	*4,188*
BASE					*12*	*0.100*	*4/27/2005 22:45*	*5/8/2005 1:45*	*2,810,627*	*17.50*	*2,018*
STORM					*120*	*0.350*	*5/8/2005 1:45*	*5/12/2005 8:45*	*1,510,845*	*33.02*	*11,307*
Storm Composite	5/13/05	12:10	5/13/05	20:11	113	0.151	5/12/2005 8:45	5/14/2005 9:45	1,276,524	12.03	9,005
STORM					*120*	*0.350*	*5/14/2005 9:45*	*5/15/2005 21:45*	*788,463*	*17.23*	*5,901*
BASE					*12*	*0.100*	*5/15/2005 21:45*	*5/18/2005 5:45*	*917,002*	*5.71*	*658*
Storm Composite	5/18/05	19:35	5/20/05	3:51	59	0.239	5/18/2005 5:45	5/21/2005 0:45	2,054,359	30.65	7,566
BASE					*12*	*0.100*	*5/21/2005 0:45*	*5/25/2005 13:45*	*1,872,775*	*11.66*	*1,344*
STORM					*120*	*0.350*	*5/25/2005 13:45*	*5/28/2005 15:45*	*1,642,111*	*35.89*	*12,290*
BASE					*12*	*0.100*	*5/28/2005 15:45*	*6/4/2005 13:45*	*2,132,688*	*13.28*	*1,531*
STORM					*120*	*0.350*	*6/4/2005 13:45*	*6/8/2005 1:45*	*1,437,913*	*31.43*	*10,762*
Storm Composite	6/8/05	5:49	6/9/05	7:26	86	0.327	6/8/2005 1:45	6/9/2005 8:45	1,345,525	27.47	7,224
BASE					*12*	*0.100*	*6/9/2005 8:45*	*6/10/2005 6:45*	*477,340*	*2.97*	*343*
STORM					*120*	*0.350*	*6/10/2005 6:45*	*6/11/05 1:45*	*447,832*	*9.79*	*3,352*
BASE					*12*	*0.100*	*6/11/2005 1:45*	*6/13/05 20:45*	*1,396,256*	*8.69*	*1,002*
STORM					*120*	*0.350*	*6/13/2005 20:45*	*6/15/05 6:45*	*1,013,252*	*22.15*	*7,583*
BASE					*12*	*0.100*	*6/15/2005 6:45*	*6/20/05 11:45*	*1,973,166*	*12.29*	*1,417*
STORM					*120*	*0.350*	*6/20/2005 11:45*	*6/21/05 18:45*	*762,777*	*16.67*	*5,709*
BASE					*12*	*0.100*	*6/21/2005 18:45*	*6/27/05 5:45*	*1,536,020*	*9.56*	*1,103*
Storm Composite	6/28/05	3:22	6/28/05	11:17	171	0.488	6/27/2005 5:45	6/28/05 22:45	1,185,671	36.12	12,657
Base Composite	7/13/05	9:21	7/15/05	6:33	20	0.119	6/28/2005 22:45	7/23/05 8:45	4,576,579	34.00	5,714
STORM					*120*	*0.350*	*7/23/2005 8:45*	*7/24/05 17:45*	*385,149*	*8.42*	*2,883*
BASE					*12*	*0.100*	*7/24/2005 17:45*	*7/25/05 16:45*	*181,092*	*1.13*	*130*
STORM					*120*	*0.350*	*7/25/2005 16:45*	*7/26/05 23:45*	*435,203*	*9.51*	*3,257*
BASE					*12*	*0.100*	*7/26/2005 23:45*	*8/3/05 22:45*	*1,160,605*	*7.23*	*833*
STORM					*120*	*0.350*	*8/3/2005 22:45*	*8/5/05 2:45*	*410,186*	*8.97*	*3,070*
BASE					*12*	*0.100*	*8/5/2005 2:45*	*8/9/05 13:45*	*827,827*	*5.15*	*594*
STORM					*120*	*0.350*	*8/9/2005 13:45*	*8/10/05 16:45*	*261,705*	*5.72*	*1,959*
BASE					*12*	*0.100*	*8/10/2005 16:45*	*8/16/05 16:45*	*1,003,828*	*6.25*	*721*
Storm Composite	8/17/05	5:43	8/17/05	9:49	168	0.461	8/16/2005 16:45	8/18/05 21:45	1,905,960	54.85	19,989
BASE					*12*	*0.100*	*8/18/2005 21:45*	*8/26/05 5:45*	*2,061,262*	*12.84*	*1,480*
Storm Composite	8/26/05	19:16	8/27/05	3:35	120	0.289	8/26/2005 5:45	8/28/05 20:45	2,345,628	42.32	17,571
BASE					*12*	*0.100*	*8/28/2005 20:45*	*9/3/05 15:45*	*1,508,913*	*9.40*	*1,083*
STORM					*120*	*0.350*	*9/3/2005 15:45*	*9/7/05 5:45*	*1,069,788*	*23.38*	*8,007*
BASE					*12*	*0.100*	*9/7/2005 5:45*	*9/12/05 13:45*	*1,260,735*	*7.85*	*905*
STORM					*120*	*0.350*	*9/12/2005 13:45*	*9/15/05 0:45*	*1,128,447*	*24.66*	*8,446*
Base Composite	9/19/05	9:21	9/21/05	7:17	18	0.111	9/15/2005 0:45	9/21/05 18:45	2,133,136	14.78	2,397
Storm Composite	9/21/05	20:25	9/22/05	13:02	192	0.559	9/21/2005 18:45	9/24/05 4:45	4,773,912	166.59	57,219
BASE					*12*	*0.100*	*9/24/2005 4:45*	*9/24/05 19:45*	*323,103*	*2.01*	*232*
STORM					*120*	*0.350*	*9/24/2005 19:45*	*9/27/05 6:45*	*1,880,990*	*41.11*	*14,078*
BASE					*12*	*0.100*	*9/27/2005 6:45*	*9/28/05 7:45*	*448,744*	*2.79*	*322*
STORM					*120*	*0.350*	*9/28/2005 7:45*	*9/30/05 2:45*	*925,372*	*20.23*	*6,926*
BASE					*12*	*0.100*	*9/30/2005 2:45*	*10/4/05 5:45*	*1,508,744*	*9.39*	*1,083*
Storm Composite	10/4/05	19:32	10/5/05	14:24	88	0.320	10/4/2005 5:45	10/8/05 9:45	8,318,170	166.17	45,696
BASE					*12*	*0.100*	*10/8/2005 9:45*	*10/12/2005 20:45*	*2,244,966*	*13.98*	*1,612*
STORM					*120*	*0.350*	*10/12/2005 20:45*	*10/14/2005 8:45*	*789,738*	*17.26*	*5,911*
BASE					*12*	*0.100*	*10/14/2005 8:45*	*10/17/2005 0:45*	*1,074,930*	*6.69*	*772*
STORM					*120*	*0.350*	*10/17/2005 0:45*	*10/18/2005 9:45*	*588,681*	*12.87*	*4,406*
Base Grab	10/19/05	10:30	10/19/05	10:30	5	0.092	10/18/2005 9:45	11/2/2005 13:45	5482697	31.49	1,711
BASE					*12*	*0.100*	*11/2/2005 13:45*	*1/1/2006 0:00*	*15411600*	*95.97*	*11,064*
Storm Average					120	0.350					
Base Average					12	0.100					
Snowmelt Average					7	0.070					
All Average					81	0.259					
Total									**120,906,897**	1,507	398,661
Brown's Creek Major Subwatershed Total Acres									7,193		
Total TP/TSS(lb/ac/yr)										0.21	55.42
Total TP/TSS (kg/ha/yr)										0.23	62.12

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

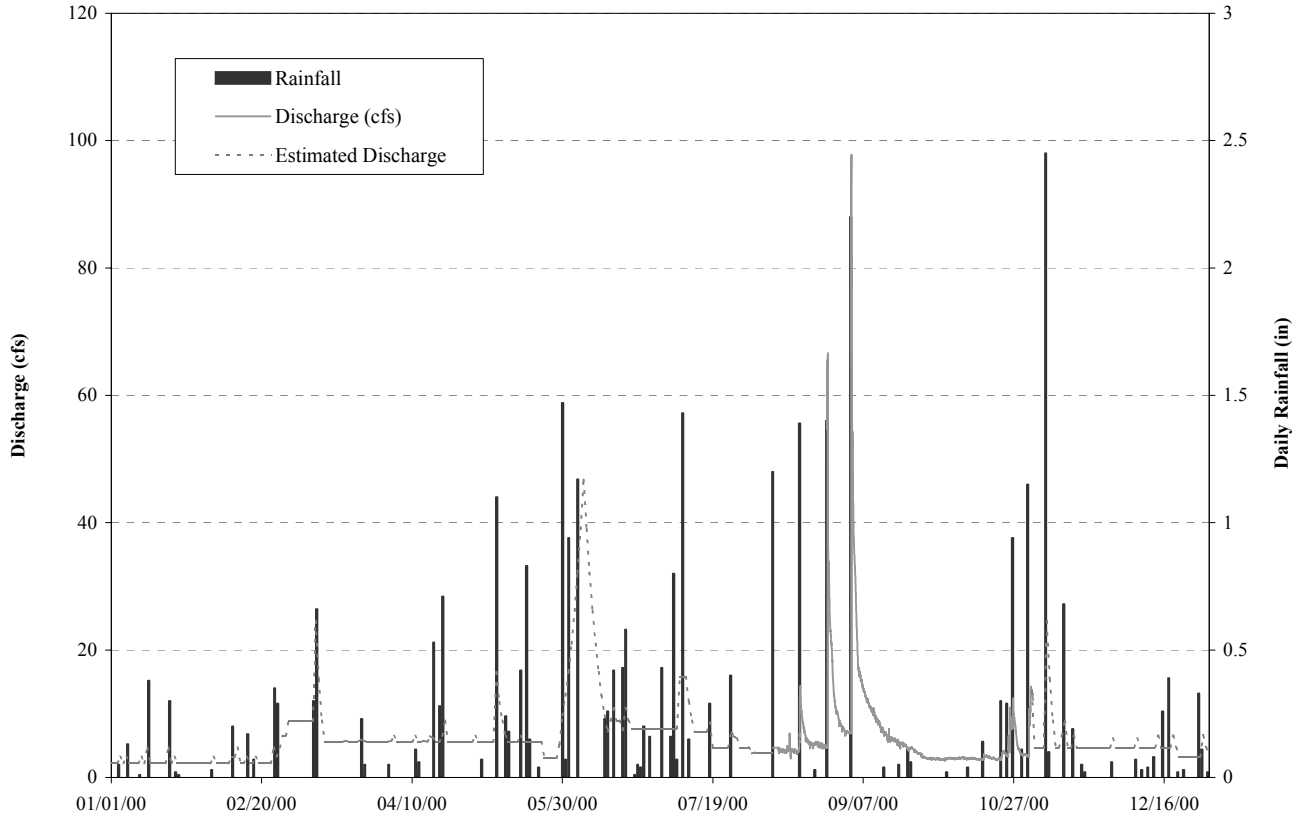


Figure 47: 2000 Brown's Creek at McKusick Road Discharge and Rainfall

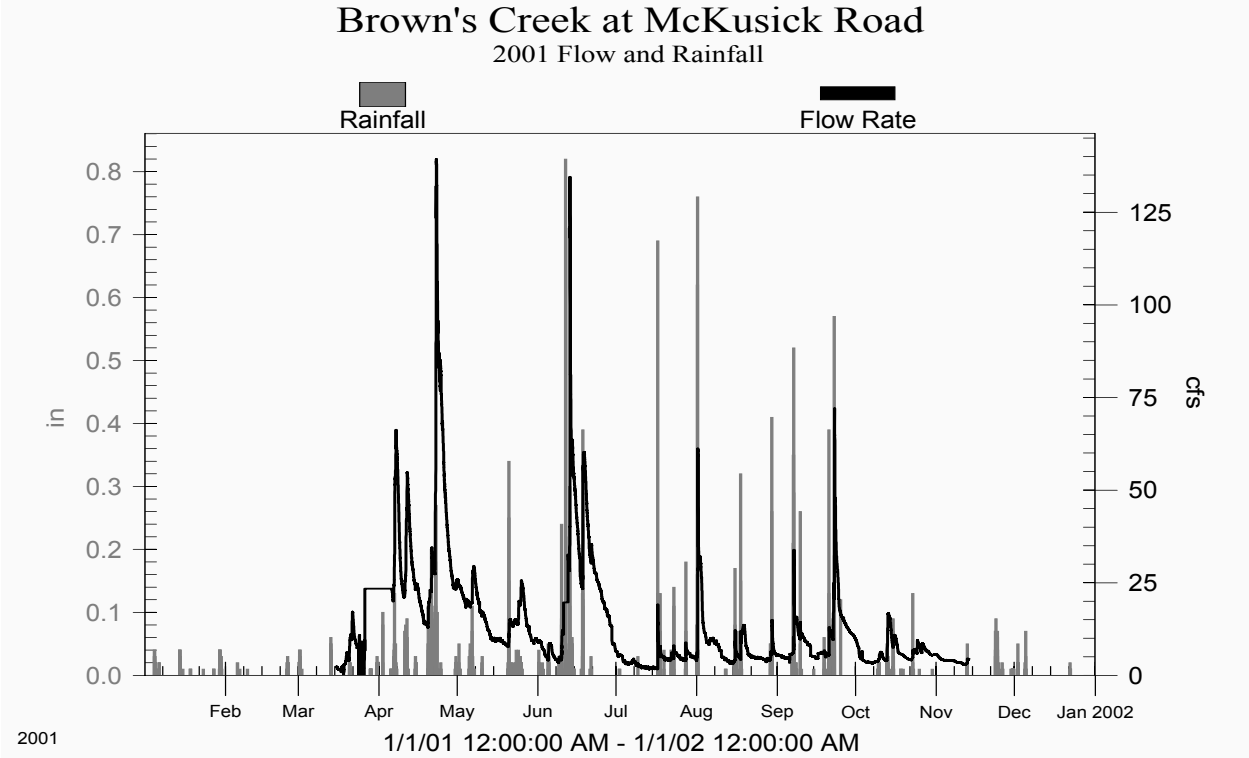


Figure 48: 2001 Brown's Creek at McKusick Road Discharge and Rainfall

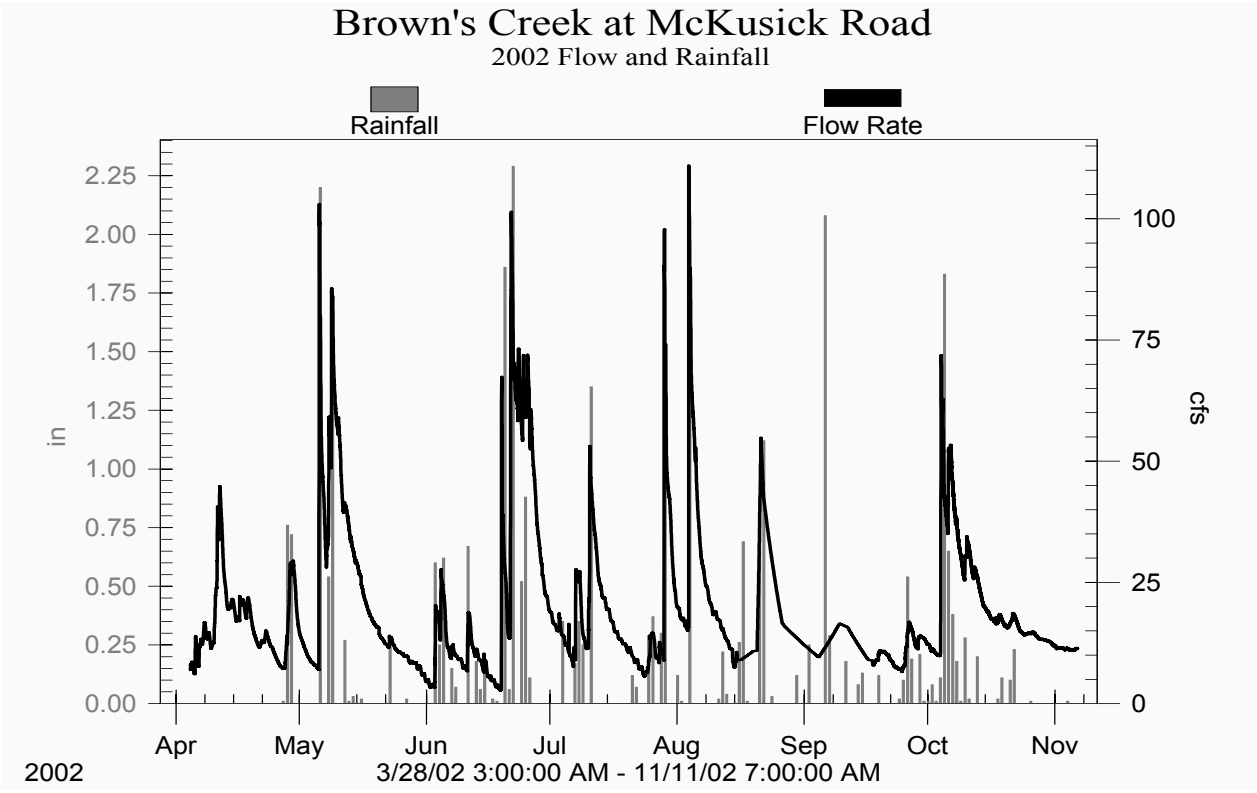


Figure 49: 2002 Brown's Creek at McKusick Road Discharge and Rainfall

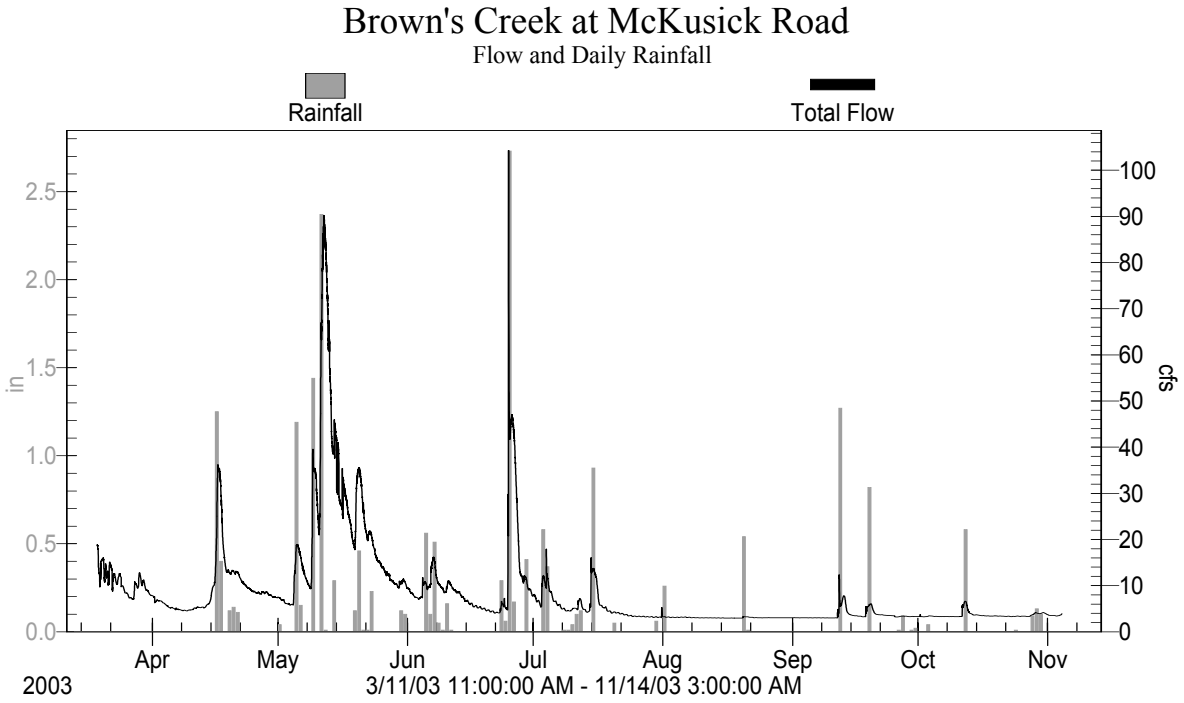


Figure 50: 2003 Brown's Creek at McKusick Road Discharge and Rainfall

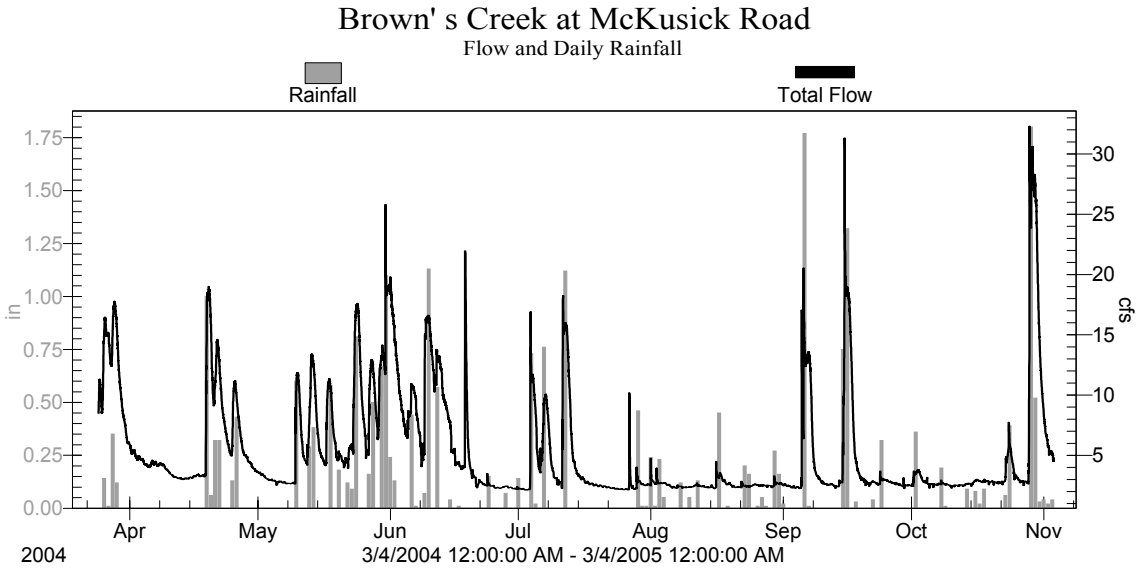


Figure 51: 2004 Brown's Creek at McKusick Road Discharge and Rainfall

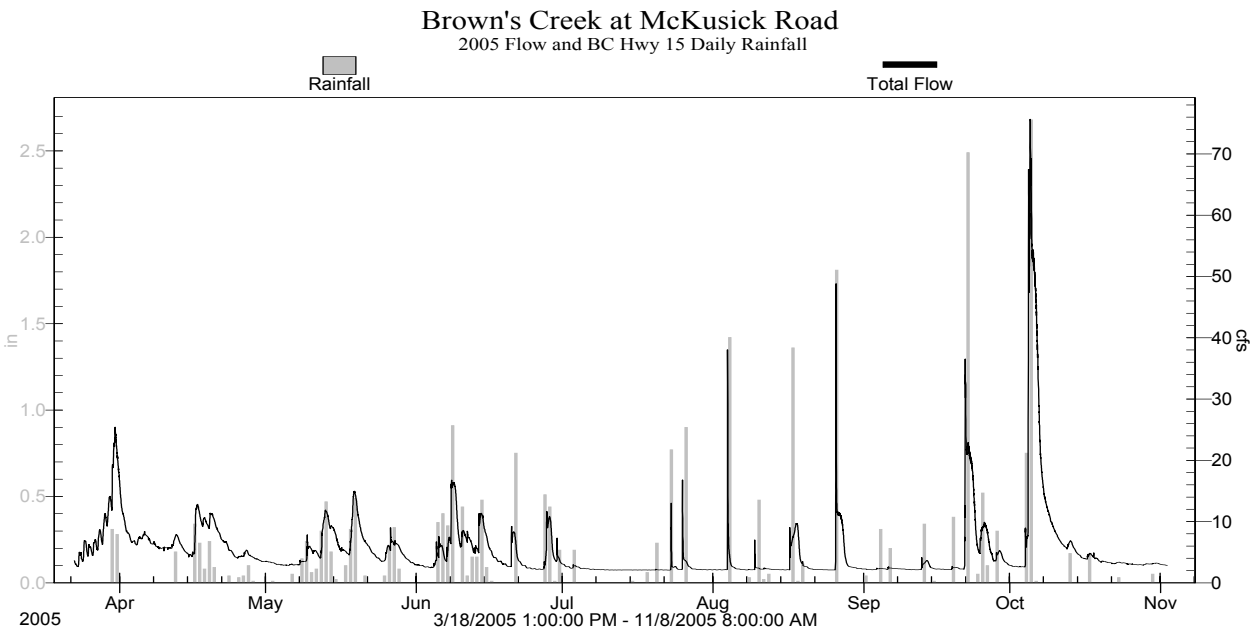


Figure 52: 2005 Brown's Creek at McKusick Road Discharge and Brown's Creek at Hwy 15 Daily Rainfall

Table 45: Brown's Creek at McKusick Road 2000 Total Phosphorus Loading (TP)

Type	Sampling Interval		TP (mg/L)	TSS (mg/L)	Loading Interval		Total Discharge (cf)	TP (lb)
	Start	End			Start	End		
					Interval		Interval (cf)	Interval TP(lb)
Storm Grab 1	*6/6/00 10:50*		*0.350*	*180*				
Storm Grab 2	*6/14/00 11:50*		*0.150*	*19*				
Storm Grab 3	*6/16/00 11:20*		*0.150*	*24*				
Storm Grab 4	*6/19/00 12:20*		*0.130*	*15*				
Storm Grab 5	*6/20/00 14:40*		*0.220*	*62*				
Base Grab 1	*6/22/00 8:00*		*0.150*	*16*				
Baseflow Composite 1	*7/24/00 12:30*	*7/24/00 13:50*	*0.091*	*4*			*16,000*	*0.1*
Stormflow Composite 1	*7/26/00 12:26*	*7/27/00 8:35*	*0.140*	*20*	*7/26/00*	*7/27/00*	*4,000*	*0.0*
Base Grab 2	8/9/00 12:45		0.099	2	7/27/00	8/9/00	618,143	3.8
Estimated Baseflow			0.147	40	8/9/00	8/16/00	2,600,954	23.9
Storm Grab 6	8/17/00 17:00		0.120	7	8/16/00	8/17/00	921,457	6.9
Base Grab 3	8/25/00 10:00		0.120	4	8/17/00	8/25/00	3,763,721	28.2
Estimated Baseflow			0.147	40	8/25/00	8/28/00	262,326	2.4
Storm Grab 7	8/28/00 12:30		0.180	12	8/28/00	8/28/00	5,290,064	59.5
Estimated Baseflow			0.147	40	8/28/00	9/2/00	3,864,555	35.5
Baseflow Composite 2	9/2/00 23:00	9/3/00 0:33	0.340	240	9/2/00	9/3/00	404,572	8.6
Base Grab 4	9/18/00 10:40		0.091	28	9/3/00	9/18/00	17,953,553	102.1
Base Grab 5	10/10/00 13:20		0.065	4	9/18/00	10/10/00	6,808,333	27.7
Estimated Baseflow			0.147		10/10/00	10/23/00	3,398,115	31.2
Baseflow Composite 3	10/23/00 14:18	10/24/00 10:39	0.085	8	10/23/00	10/24/00	286,360	1.5
Estimated Baseflow			0.147	40	10/24/00	10/25/00	453,648	4.2
Storm Composite 2	10/25/00 20:54	10/26/00 17:27	0.150	28	10/25/00	10/26/00	630,483	5.9
Estimated Baseflow			0.147	40	10/26/00	11/1/00	2,309,672	21.2
Storm Composite 3	11/1/00 2:39	11/1/00 10:00	0.220	52	11/1/00	11/2/00	1,342,093	18.5
		Grab Averages	0.147	31				

Estimated baseflow TP is average of grabs taken in 2000

**Italicized samples are samples taken before continuous flow monitored

8/8/00 - 11/2/00 Total (cf)	50,928,048	
8/8/00 - 11/2/00 Total TP(lb)		381.2
Brown's Creek Watershed Total Acres		12,502
8/8/00 - 11/2/00 Measured Total TP(lb)/Acre		0.03
8/8/00 - 11/2/00 Measured Total TP(Kg)/ha		0.03

Table 46: Brown's Creek at McKusick Road 2001 Total Suspended Solids (TSS) and Phosphorus Loading (TP)

Type	Sampling Interval		TP* (mg/L)	TSS* (mg/L)	Loading Interval		Total Discharge (cf)	TP (lb)	TSS (lb)
	Start	End			Start	End			
BASE			*0.07*	13	1/1/01 0:15	3/15/01 17:30	*10,829,340*	47	8788
SNOWMELT			*0.19*	*35*	3/15/01 17:45	3/18/01 23:45	540,470	6.4	1,181
Snowmelt Grab	3/21/01 12:55	NA	0.22	40	3/19/01 0:00	3/23/01 23:45	3,755,161	52	9377
SNOWMELT			*0.19*	*35*	3/24/01 0:00	3/31/01 23:45	12,162,894	144	26575
Snowmelt Grab	4/2/01 12:00	NA	0.16	24	4/1/01 0:00	4/4/01 23:45	8,082,893	81	12110
Snowmelt Grab	4/5/01 13:45	NA	0.20	41	4/5/01 0:00	4/6/01 23:45	4,034,343	50	10326
STORM			*0.14*	*270*	4/7/01 0:00	4/8/01 23:45	8,945,174	78	150771
BASE			*0.07*	*13*	4/9/01 0:00	4/11/01 9:45	5,280,560	24	4285
Storm Grab	4/12/01 11:40	NA	0.14	270	4/11/01 10:00	4/13/01 13:00	7,929,237	69	133,648
Base Composite	4/18/01 15:55	4/19/01 5:08	0.07	13	4/13/01 13:15	4/21/01 5:00	13,516,744	61	10,969
Storm Grab	4/24/01 17:10	NA	0.13	110	4/21/01 5:15	4/28/01 20:00	37,627,429	305	258,383
Base Composite	5/4/01 11:45	5/6/01 19:07	0.07	12	4/28/01 20:15	5/6/01 20:00	15,366,103	62	11,511
STORM			*0.10*	*18*	5/6/01 20:15	5/10/01 17:00	7,438,331	45	8,358
BASE			*0.07*	*13*	5/10/01 17:15	5/21/01 10:00	9,991,801	45	8,109
Storm Composite	5/22/01 10:14	5/24/01 12:59	0.10	18	5/21/01 10:15	5/28/01 0:00	9,694,727	58	10,894
BASE			*0.07*	*13*	5/28/01 0:15	6/5/01 15:00	6,411,145	29	5,203
Storm Composite	6/5/01 16:51	6/7/01 10:25	0.13	22	6/5/01 15:15	6/7/01 10:30	1,052,974	9	1,446
BASE			*0.07*	*13*	6/7/01 10:45	6/10/01 5:00	1,021,544	5	829
Storm Composite	6/12/01 14:12	6/12/01 22:19	0.21	110	6/10/01 5:15	6/14/01 8:00	11,995,023	157	82,368
Storm Grab	6/19/01 15:10	NA	0.14	18	6/14/01 8:15	6/22/01 12:00	28,840,242	252	32,407
BASE			*0.07*	*13*	6/22/01 12:15	6/29/01 12:15	12,507,114	56	10,150
Base Composite	6/29/01 12:31	7/2/01 9:57	0.30	170	6/29/01 12:30	7/2/01 10:00	1,743,677	33	18,505
Base Composite	7/9/01 15:55	7/11/01 12:20	0.11	9	7/2/01 10:15	7/17/01 3:00	3,665,874	25	2,060
Storm Composite	7/17/01 3:07	7/17/01 11:17	0.32	120	7/17/01 3:15	7/18/01 12:00	777,497	16	5,824
BASE			*0.07*	*13*	7/18/01 12:15	7/23/01 14:45	2,070,894	9	1,681
Storm Composite	7/23/01 14:57	7/26/01 12:10	0.10	10	7/23/01 15:00	7/26/01 12:15	1,310,368	8	818
BASE			*0.07*	*13*	7/26/01 12:30	8/1/01 8:45	2,582,576	12	2,096
Storm Composite	8/1/01 8:57	8/1/01 18:43	1.00	440	8/1/01 9:00	8/2/01 4:30	2,597,757	162	71,354
STORM			*0.15*	*31*	8/2/01 4:45	8/4/01 0:00	3,385,578	32	6,552
BASE			*0.07*	*13*	8/4/01 0:15	8/15/01 20:00	6,853,222	31	5,562
Storm Composite	8/15/01 20:37	8/16/01 19:03	0.15	31	8/15/01 20:15	8/16/01 19:00	520,663	5	1,008
BASE			*0.07*	*13*	8/16/01 19:15	8/17/01 20:15	465,112	2	377
Storm Composite	8/17/01 20:31	8/19/01 12:07	0.15	24	8/17/01 20:30	8/20/01 10:00	2,344,827	22	3,513
Base Composite	8/22/01 14:21	8/24/01 13:44	0.10	8	8/20/01 10:15	8/29/01 22:45	3,950,261	23	1,973
STORM			*0.15*	*24*	8/29/01 23:00	8/30/01 22:00	739,260	7	1,108
BASE			*0.07*	*13*	8/30/01 22:15	9/7/01 9:00	3,394,788	15	2,755
STORM			*0.15*	*24*	9/7/01 9:15	9/10/01 7:30	3,409,057	32	5,108
Base Composite	9/18/01 12:23	9/20/01 11:09	0.06	12	9/10/01 7:45	9/20/01 21:15	6,153,511	22	4,610
STORM			*0.15*	*24*	9/20/01 21:30	9/25/01 15:00	9,120,864	85	13,665
Base Composite	10/4/01 15:02	10/8/01 9:45	0.06	14	9/25/01 15:15	10/13/01 7:00	10,856,552	39	9,488
Storm Composite	10/13/01 11:41	10/14/01 6:05	0.12	42	10/13/01 7:15	10/17/01 18:00	4,184,112	31	10,970
BASE			*0.07*	*13*	10/17/01 18:15	11/13/01 13:15	11,726,949	53	9,517
BASE			*0.07*	*13*	11/13/01 13:30	12/31/01 23:45	*7,050,282*	31	5,722

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

3/15/01-11/13/01 Total Discharge (cf)	288,047,312		
3/15/01-11/13/01 Total (lb)		2,329	981,952
Browns Creek Watershed Total Acres		12,502	12,502
3/15/01-11/13/01 Total lb/Acre		0.19	78.5
3/15/01-11/13/01 Total kg/ha		0.21	88.0

Table 47: Brown's Creek at McKusick Road 2002 Total Suspended Solids (TSS) and Phosphorus Loading (TP)

	Sample Collection Time						Loading Interval				
Sample Type	**Start Date**	**Start Time**	**End Date**	**End Time**	**TP (mg/L)**	**TSS (mg/L)**	**Start**	**End**	**Interval Volume (cf)**	**Interval TP (lb)**	**Interval TSS (lb)**
BASE					*0.11*	*15.3*	*1/1/02 0:00*	*3/10/02 0:00*	*54,276,565*	*373*	*51,942*
Snowmelt Grab	*3/13/02*	*13:30*	*3/13/02*	*13:30*	*0.46*	*80.0*	*3/10/02 0:15*	*3/16/02 21:45*	*8,184,513*	*233*	*40,874*
BASE					*0.11*	*15.3*	*3/16/02 22:00*	*3/27/02 12:45*	*9,574,147*	*66*	*9,162*
Snowmelt Grab	*3/28/02*	*14:30*	*3/28/02*	*14:30*	*0.70*	*307.0*	*3/27/02 13:00*	*3/31/02 3:15*	*10,447,376*	*457*	*200,222*
BASE					*0.10*	*15.3*	*3/31/02 3:30*	*4/4/02 11:30*	*4,966,467*	*31*	*4,753*
Snowmelt Grab	4/8/02	11:40	4/8/02	11:40	0.15	21.0	4/4/02 11:45	4/10/02 10:15	6,038,007	58	7,916
Storm Grab	4/11/02	16:05	4/11/02	16:05	0.41	256.0	4/10/02 10:30	4/13/02 15:30	8,282,700	211	132,367
Storm Grab	4/18/02	17:25	4/18/02	17:25	0.18	32.0	4/13/02 15:45	4/21/02 9:15	12,087,320	137	24,146
Base Composite	4/22/02	13:06	4/23/02	15:30	0.13	17.0	4/21/02 9:30	4/27/02 7:15	5,579,754	46	5,921
STORM					*0.46*	*205.3*	*4/27/02 7:30*	*5/1/02 6:30*	*6,750,247*	*194*	*86,524*
BASE					*0.11*	*15.3*	*5/1/02 6:45*	*5/5/02 17:45*	*3,735,579*	*26*	*3,575*
Storm Composite	5/5/02	18:36	5/6/02	2:36	0.83	580.0	5/5/02 18:00	5/7/02 13:00	8,091,950	419	292,987
STORM					*0.46*	*205.3*	*5/7/02 13:15*	*5/8/02 16:00*	*4,053,185*	*116*	*51,954*
Storm Composite	5/8/02	19:15	5/9/02	3:15	0.55	276.0	5/8/02 16:15	5/15/02 6:30	26,132,060	892	450,245
BASE					*0.11*	*15.3*	*5/15/02 6:45*	*6/2/02 22:45*	*19,600,940*	*135*	*18,758*
Storm Composite	6/3/02	1:55	6/4/02	9:30	0.23	78.0	6/2/02 23:00	6/4/02 10:00	2,068,631	30	10,073
Storm Composite	6/4/02	10:21	6/5/02	9:37	0.27	70.0	6/4/02 10:15	6/7/02 16:30	4,378,301	73	19,132
BASE					*0.11*	*15.3*	*6/7/02 16:45*	*6/10/02 22:00*	*2,401,001*	*16*	*2,298*
STORM					*0.46*	*205.3*	*6/10/02 22:15*	*6/13/02 17:15*	*3,090,812*	*89*	*39,618*
BASE					*0.11*	*15.3*	*6/13/02 17:30*	*6/19/02 3:45*	*2,691,311*	*18*	*2,576*
Storm Composite	6/19/02	5:06	6/19/02	18:12	0.67	247.0	6/19/02 4:00	6/20/02 23:30	4,398,503	184	67,822
Storm Composite	6/21/02	9:04	6/21/02	15:46	0.44	254.0	6/20/02 23:45	6/28/02 1:15	35,962,650	979	570,232
BASE					*0.11*	*15.3*	*6/28/02 1:30*	*7/7/02 5:45*	*13,911,100*	*96*	*13,313*
STORM					*0.46*	*205.3*	*7/7/02 6:00*	*7/10/02 4:00*	*4,792,912*	*138*	*61,435*
Storm Composite	7/10/02	16:07	7/11/02	10:30	0.46	103.0	7/10/02 4:15	7/13/02 23:00	10,019,890	288	64,427
BASE					*0.11*	*15.3*	*7/13/02 23:15*	*7/28/02 18:00*	*15,390,680*	*106*	*14,729*
Storm Composite	7/28/02	18:52	7/29/02	4:59	0.54	189.0	7/28/02 18:15	8/3/02 12:15	15,189,890	514	179,219
Storm Composite	8/3/02	18:36	8/4/02	3:08	0.42	161.0	8/3/02 12:30	8/7/02 22:15	17,819,100	463	179,093
Base Composite	*8/14/02*	*12:16*	*8/15/02*	*4:31*	*0.11*	*14.0*	*8/7/02 22:30*	*8/20/02 10:45*	*15,907,452*	*104*	*13,903*
STORM					*0.46*	*205.3*	*8/20/02 11:00*	*8/26/02 14:30*	*13,806,653*	*396*	*176,973*
BASE					*0.11*	*15.3*	*8/26/02 14:45*	*9/4/02 11:00*	*9,726,751*	*67*	*9,308*
STORM					*0.46*	*205.3*	*9/4/02 11:15*	*9/11/02 18:30*	*17,345,196*	*498*	*222,330*
BASE					*0.11*	*15.3*	*9/11/02 18:45*	*9/24/02 19:30*	*4,548,406*	*31*	*4,353*
STORM					*0.46*	*205.3*	*9/24/02 19:45*	*10/1/02 1:00*	*6,902,490*	*198*	*88,476*
BASE					*0.11*	*15.3*	*10/1/02 1:15*	*10/4/02 1:45*	*2,816,168*	*19*	*2,695*
Storm Composite	10/4/02	5:21	10/4/02	18:34	0.48	218.0	10/4/02 2:00	10/5/02 22:30	7,283,991	220	99,127
STORM					*0.46*	*205.3*	*10/5/02 22:45*	*10/14/02 4:45*	*23,425,910*	*673*	*300,272*
Base Composite	10/23/02	12:22	10/25/02	10:40	0.09	15.0	10/14/02 5:00	11/6/02 11:15	29,431,740	169	27,560
BASE					*0.11*	*15.3*	*11/6/02 11:30*	*12/31/02 23:45*	*21,582,450*	*148*	*20,654*
Storm Average					0.46	205.3					
Base Average					0.11	15.3					
Snowmelt Average					0.44	136.0					
Total Average					0.31	122.0					
Total									**472,692,798**	8,912	3,570,963
Brown's Creek Major Subwatershed Total Acres									12,502		
Total TP/TSS(lb/ac/yr)										0.71	285.63
Total TP/TSS (kg/ha/yr)										0.80	320.14

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

**Discharge values and concentrations within the periods 1/1/02 0:15-4/4/02 11:30 and 8/16/02 21:15-9/18/02 21:45 are estimates based on Hwy. 96 site

Table 48: Brown's Creek at McKusick Road 2003 Total Suspended Solids (TSS) and Phosphorus Loading (TP)

	Sample Collection Time						Loading Interval				
Sample Type	**Start Date**	**Start Time**	**End Date**	**End Time**	**TP (mg/L)**	**TSS (mg/L)**	**Start**	**End**	**Interval Volume (cf)**	**Interval TP (lb)**	**Interval TSS (lb)**
Base grab	1/22/03	9:23	1/22/03	9:23	0.04	11	1/1/03 0:00	2/1/03 9:30	9,494,100	22	6,519
Base grab	2/14/03	11:45	2/14/03	11:45	0.10	12	2/1/03 9:45	3/1/03 11:45	8,492,400	52	6,362
BASE					*0.09*	*14*	*3/1/03 12:00*	*3/15/03 0:00*	*4,082,400*	23	3,568
Snowmelt grab	3/17/03	10:30	3/17/03	10:30	0.35	48	3/15/03 0:15	3/25/03 0:15	12,574,800	276	37,680
BASE					*0.09*	*14*	*3/25/03 0:30*	*3/27/03 12:00*	*1,703,195*	10	1,489
Storm grab	3/31/03	12:30	3/31/03	12:30	0.07	11	3/27/03 12:15	3/31/03 12:30	3,408,306	14	2,340
BASE					*0.09*	*14*	*3/31/03 12:45*	*4/14/03 14:45*	*6,858,735*	39	5,994
Storm composite	4/16/03	7:11	4/17/03	3:17	0.45	192	4/14/03 15:00	4/17/03 10:00	4,553,664	129	54,579
BASE					*0.09*	*14*	*4/17/03 10:15*	*5/4/03 16:45*	*14,572,606*	82	12,736
Storm composite	5/4/03	20:50	5/6/03	18:59	0.17	56	5/4/03 17:00	5/8/03 20:45	4,907,705	53	17,157
Storm composite	5/9/03	2:27	5/10/03	2:19	0.75	147	5/8/03 21:00	5/10/03 21:15	4,870,620	229	44,696
STORM					*0.34*	*100*	5/10/03 21:30	*5/13/03 2:30*	*13,430,070*	285	83,839
Base grab	5/15/03	15:50	5/15/03	15:50	0.11	29	5/13/03 2:45	5/19/03 9:45	17,898,310	124	32,402
STORM					*0.34*	*100*	*5/19/03 10:00*	*5/21/03 4:00*	*4,775,774*	101	29,813
BASE					*0.09*	*14*	*5/21/03 4:15*	*6/4/03 13:45*	*16,295,220*	92	14,241
STORM					*0.34*	*100*	*6/4/03 14:00*	*6/8/03 1:30*	*3,571,114*	76	22,293
BASE					*0.09*	*14*	*6/8/03 1:45*	*6/10/03 4:00*	*1,732,226*	10	1,514
STORM					*0.34*	*100*	*6/10/03 4:15*	*6/11/03 8:15*	*1,033,362*	22	6,451
BASE					*0.09*	*14*	*6/11/03 8:30*	*6/24/03 22:45*	*7,051,451*	40	6,163
Storm composite	6/24/03	23:50	6/26/03	14:39	0.51	290	6/24/03 23:00	6/26/03 17:00	6,654,217	211	120,465
BASE					*0.09*	*14*	*6/26/03 17:15*	*6/29/03 11:00*	*4,039,685*	23	3,531
BASE					*0.09*	*14*	*6/29/03 11:15*	*7/3/03 0:45*	*2,387,854*	13	2,087
Storm composite	7/3/03	2:55	7/5/03	3:13	0.26	36	7/3/03 1:00	7/5/03 4:00	1,967,080	32	4,421
BASE					*0.09*	*14*	*7/5/03 4:15*	*7/14/03 16:15*	*4,463,698*	25	3,901
Storm composite	7/14/03	20:24	7/16/03	13:47	0.26	56	7/14/03 16:30	7/16/03 14:00	1,913,718	32	6,690
Base composite	7/29/03	9:46	7/31/03	1:47	0.09	11	7/16/03 14:15	8/3/03 2:45	5,707,978	32	3,920
Base composite	8/7/03	14:08	8/11/03	12:18	0.09	13	8/3/03 3:00	8/17/03 9:00	3,757,286	20	3,049
Base composite	8/26/03	10:59	8/28/03	8:52	0.08	12	8/17/03 9:15	9/1/03 11:15	3,978,872	20	2,981
Base composite	9/5/03	8:51	9/8/03	12:52	0.08	9	9/1/03 11:30	9/11/03 18:15	2,675,143	14	1,503
Storm composite	9/11/03	19:11	9/12/03	5:06	0.30	78	9/11/03 18:30	9/13/03 10:30	913,223	17	4,447
BASE					*0.09*	*14*	*9/13/03 10:45*	*9/18/03 13:45*	*1,679,385*	9	1,468
Storm grab	9/19/03	9:30	9/19/03	9:30	0.17	19	9/18/03 14:00	9/19/03 21:45	628,100	7	745
Base composite	10/3/03	15:22	10/6/03	9:49	0.09	14	9/19/03 22:00	10/11/03 13:00	6,426,140	36	5,616
Storm composite	10/11/03	14:32	10/12/03	13:11	0.16	26	10/11/03 13:15	10/12/03 12:15	491,678	5	798
Base grab	10/28/03	8:00	10/28/03	8:00	0.09	15	10/12/03 12:30	11/4/03 9:30	7,132,971	40	6,679
BASE					*0.09*	*14*	*11/4/03 9:45*	*12/31/03 23:45*	*14,925,600*	84	13,044
Storm Average					0.34	100					
Base Average					0.09	14					
Snowmelt Average					0.35	48					
All Average					0.19	46					
Total									**211,048,686**	2,297	575,181
Brown's Creek Major Subwatershed Total Acres									12,502		
Total TP/TSS(lb/ac/yr)										0.18	46.01
Total TP/TSS (kg/ha/yr)										0.21	51.57

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

Table 49: Brown's Creek at McKusick Road 2004 Total Suspended Solids (TSS) and Phosphorus Loading (TP)

	Sample Collection Time						Loading Interval				
Sample Type	Start Date	Start Time	End Date	End Time	TP (mg/L)	TSS (mg/L)	Start	End	Interval Volume (cf)	Interval TP (lb)	Interval TSS (lb)
BASE					*0.15*	*16*	*1/1/2004 0:00*	*1/4/2004 22:00*	*676,800*	*6.35*	*687*
SNOWMELT					*0.22*	*42*	*1/4/2004 22:15*	*1/6/2004 0:15*	*936,000*	*12.88*	*2,454*
BASE					*0.15*	*16*	*1/6/2004 0:30*	*1/18/2004 18:30*	*2,203,200*	*20.66*	*2,235*
SNOWMELT					*0.22*	*42*	*1/18/2004 18:45*	*1/20/2004 0:45*	*756,000*	*10.41*	*1,982*
BASE					*0.15*	*16*	*1/20/2004 1:00*	*1/21/2004 21:00*	*316,800*	*2.97*	*321*
SNOWMELT					*0.22*	*42*	*1/21/2004 21:15*	*1/23/2004 2:15*	*730,800*	*10.06*	*1,916*
BASE					*0.15*	*16*	*1/23/2004 2:30*	*2/3/2004 22:00*	*2,041,200*	*19.15*	*2,071*
SNOWMELT					*0.22*	*42*	*2/3/2004 22:15*	*2/4/2004 13:15*	*972,000*	*13.38*	*2,548*
BASE					*0.15*	*16*	*2/4/2004 13:30*	*2/14/2004 21:30*	*1,785,600*	*16.75*	*1,811*
SNOWMELT					*0.22*	*42*	*2/14/2004 21:45*	*2/15/2004 13:15*	*613,800*	*8.45*	*1,609*
BASE					*0.15*	*16*	*2/15/2004 13:30*	*2/28/2004 15:30*	*2,260,800*	*21.21*	*2,293*
Snowmelt grab	3/1/2004	11:20	3/1/2004	11:20	0.22	24	2/28/2004 15:45	3/3/2004 1:45	2,656,800	37.15	3,980
BASE					*0.15*	*16*	*3/3/2004 2:00*	*3/10/2004 13:00*	*1,288,800*	*12.09*	*1,307*
Snowmelt grab	3/11/2004	14:00	3/11/2004	14:00	0.22	60	3/10/2004 13:15	3/12/2004 11:15	1,656,000	22.43	6,203
BASE					*0.15*	*16*	*3/12/2004 11:30*	*3/17/2004 14:45*	*887,400*	*8.32*	*900*
SNOWMELT					*0.22*	*42*	*3/17/2004 15:00*	*3/20/2004 21:00*	*3,088,800*	*42.52*	*8,099*
BASE					*0.15*	*16*	*3/20/2004 21:15*	*3/24/2004 16:00*	*651,600*	*6.11*	*661*
STORM					*0.30*	*110*	*3/24/2004 16:15*	*3/29/2004 9:15*	*5,635,952*	*105.47*	*38,810*
BASE					*0.15*	*16*	*3/29/2004 9:30*	*4/18/2004 9:30*	*7,668,144*	*71.92*	*7,779*
Storm composite	4/18/2004	20:18	4/20/2004	2:36	0.52	198	4/18/2004 9:45	4/20/2004 2:00	1,959,969	63.87	24,226
Storm composite	4/21/2004	7:35	4/21/2004	19:43	0.16	119	4/20/2004 2:15	4/22/2004 13:00	2,497,163	25.57	18,551
BASE					*0.15*	*16*	*4/22/2004 13:15*	*4/24/2004 21:30*	*2,529,277*	*23.72*	*2,566*
STORM					*0.30*	*110*	*4/24/2004 21:45*	*4/26/2004 14:15*	*1,385,690*	*25.93*	*9,542*
Base composite	5/4/2004	16:20	5/7/2004	11:55	0.23	14	4/26/2004 14:30	5/9/2004 17:15	4,023,419	56.76	3,516
Storm composite	5/9/2004	18:24	5/10/2004	15:13	0.39	135	5/9/2004 17:30	5/12/2004 9:00	1,751,599	42.21	14,762
Storm composite	5/13/2004	9:34	5/14/2004	5:47	0.26	76	5/12/2004 9:15	5/14/2004 11:30	1,773,453	29.23	8,414
BASE					*0.15*	*16*	*5/14/2004 11:45*	*5/17/2004 0:15*	*1,229,092*	*11.53*	*1,247*
STORM					*0.30*	*110*	*5/17/2004 0:30*	*5/18/2004 17:15*	*1,411,318*	*26.41*	*9,718*
BASE					*0.15*	*16*	*5/18/2004 17:30*	*5/23/2004 7:15*	*2,007,981*	*18.83*	*2,037*
Storm composite	5/23/2004	16:31	5/24/2004	13:44	0.26	124	5/23/2004 7:30	5/24/2004 19:45	1,987,420	32.38	15,384
BASE					*0.15*	*16*	*5/24/2004 20:00*	*5/26/2004 22:30*	*1,440,256*	*13.51*	*1,461*
STORM					*0.30*	*110*	*5/26/2004 22:45*	*5/28/2004 5:15*	*1,275,682*	*23.87*	*8,784*
BASE					*0.15*	*16*	*5/28/2004 5:30*	*5/29/2004 4:30*	*696,027*	*6.53*	*706*
STORM					*0.30*	*110*	*5/29/2004 4:45*	*5/30/2004 19:15*	*1,697,078*	*31.76*	*11,686*
Storm composite	5/30/2004	20:50	5/30/2004	20:50	0.50		5/30/2004 19:30	6/1/2004 8:15	2,496,021	77.91	0
BASE					*0.15*	*16*	*6/1/2004 8:30*	*6/5/2004 0:00*	*3,462,877*	*32.48*	*3,513*
STORM					*0.30*	*110*	*6/5/2004 0:15*	*6/7/2004 1:30*	*1,679,861*	*31.44*	*11,568*
BASE					*0.15*	*16*	*6/7/2004 1:45*	*6/8/2004 7:00*	*739,356*	*6.93*	*750*
Storm composite	6/9/2004	4:26	6/10/2004	9:18	0.30	76	6/8/2004 7:15	6/10/2004 10:00	2,205,528	41.30	10,464
BASE					*0.15*	*16*	*6/10/2004 10:15*	*6/18/2004 10:30*	*5,759,439*	*54.02*	*5,843*
Base composite	6/24/2004	12:33	6/28/2004	5:24	0.12	14	6/18/2004 10:45	7/3/2004 18:15	3,954,722	28.64	3,456
Storm composite	7/3/2004	19:00	7/6/2004	11:32	0.29	120	7/3/2004 18:30	7/4/2004 15:30	4,036,477	72.57	30,238
BASE					*0.15*	*16*	*7/4/2004 15:45*	*7/6/2004 2:45*	*784,001*	*7.35*	*795*
Storm composite	7/6/2004	16:48	7/8/2004	9:14	0.19	55	7/6/2004 3:00	7/8/2004 10:00	1,497,592	17.67	5,142
BASE					*0.15*	*16*	*7/8/2004 10:15*	*7/11/2004 5:45*	*795,957*	*7.47*	*807*
Storm composite	7/11/2004	7:51	7/12/2004	13:55	0.31	98	7/11/2004 6:00	7/13/2004 1:15	2,203,893	42.79	13,483
Base composite	7/22/2004	13:47	7/25/2004	13:21	0.17	24	7/13/2004 1:30	7/26/2004 22:15	3,403,307	35.27	5,099
STORM					*0.30*	*110*	*7/26/2004 22:30*	*7/27/2004 0:30*	*15,561*	*0.29*	*107*
BASE					*0.15*	*16*	*7/27/2004 0:45*	*9/5/2004 4:30*	*8,852,624*	*83.03*	*8,980*
Storm composite	9/5/2004	7:42	9/6/2004	6:08	0.26	102	9/5/2004 4:45	9/7/2004 6:00	2,127,673	35.07	13,548
BASE					*0.15*	*16*	*9/7/2004 6:15*	*9/14/2004 20:45*	*2,267,054*	*21.26*	*2,300*
Storm composite	9/15/2004	7:03	9/16/2004	10:16	0.27	90	9/14/2004 21:00	9/16/2004 13:30	2,403,099	40.05	13,501
Base composite	10/12/2004	12:05	10/14/2004	10:36	0.09	13	9/16/2004 13:45	10/22/2004 22:45	9,589,567	55.67	7,782
Storm composite	10/23/2004	13:24	10/24/2004	8:56	0.11	23	10/22/2004 23:00	10/24/2004 9:00	637,590	4.46	915
BASE					*0.15*	*16*	*10/24/2004 9:15*	*10/28/2004 10:00*	*1,108,278*	*10.40*	*1,124*
Storm composite	10/28/2004	13:15	10/29/2004	4:48	0.37	218	10/28/2004 10:15	10/30/2004 17:15	4,884,859	112.52	66,478
BASE					*0.15*	*16*	*10/30/2004 17:30*	*11/18/2004 23:30*	*6,580,480*	*61.72*	*6,675*
STORM					*0.30*	*110*	*11/18/2004 23:45*	*11/22/2004 21:45*	*2,030,400*	*38.00*	*13,982*
BASE					*0.15*	*16*	*11/22/2004 22:00*	*12/13/2004 12:30*	*6,230,700*	*58.44*	*6,321*
SNOWMELT					*0.22*	*42*	*12/13/2004 12:45*	*12/14/2004 12:45*	*432,000*	*5.95*	*1,133*
BASE					*0.15*	*16*	*12/14/2004 13:00*	*12/18/2004 19:30*	*1,107,000*	*10.38*	*1,123*
SNOWMELT					*0.22*	*42*	*12/18/2004 19:45*	*12/19/2004 12:45*	*306,000*	*4.21*	*802*
BASE					*0.15*	*16*	*12/19/2004 13:00*	*12/22/2004 13:00*	*777,600*	*7.29*	*789*
SNOMELT					*0.22*	*42*	*12/22/2004 13:15*	*12/24/2004 17:15*	*936,000*	*12.88*	*2,454*
BASE					*0.15*	*16*	*12/24/2004 17:30*	*12/31/2004 23:45*	*1,881,900*	*17.65*	*1,909*
Storm Average					0.30	110					
Base Average					0.15	16					
Snowmelt Average					0.22	42					
All Average					0.21	52					
Total									**149,679,336**	1,916	461,349
Brown's Creek Major Subwatershed Total Acres									12,502		
Total TP/TSS(lb/ac/yr)										0.15	36.90
Total TP/TSS (kg/ha/yr)										0.17	41.36

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

Table 50: Brown's Creek at McKusick Road 2005 Total Suspended Solids (TSS) and Phosphorus Loading (TP)

	Sample Collection Time						Loading Interval				
Sample Type	Start Date	Start Time	End Date	End Time	TP (mg/L)	TSS (mg/L)	Start	End	Interval Volume (cf)	Interval TP (lb)	Interval TSS (lb)
BASE					*0.102*	*8*	*1/1/2005 0:00*	*2/2/2005 12:00*	*7,020,000*	*44.87*	*3,593*
Snowmelt Grab	2/3/05	10:30	2/3/05	10:30	0.058	7	2/2/2005 12:00	2/4/2005 12:00	1,036,800	3.75	453
BASE					*0.102*	*8*	*2/4/2005 12:00*	*3/22/2005 17:15*	*11,979,900*	*76.58*	*6,132*
BASE					*0.102*	*8*	*3/22/2005 17:15*	*3/30/2005 10:15*	*4,546,020*	*29.06*	*2,327*
Storm Composite	3/30/05	10:36	3/30/05	23:55	0.484	195	3/30/2005 10:15	4/1/2005 15:15	3,542,915	107.05	43,128
BASE					*0.102*	*8*	*4/1/2005 15:15*	*4/11/2005 18:15*	*6,048,728*	*38.67*	*3,096*
STORM					*0.441*	*164*	*4/11/2005 18:15*	*4/13/2005 21:15*	*1,265,580*	*34.85*	*12,978*
BASE					*0.102*	*8*	*4/13/2005 21:15*	*4/16/2005 10:15*	*1,074,260*	*6.87*	*550*
STORM					*0.441*	*164*	*4/16/2005 10:15*	*4/21/2005 5:15*	*4,272,200*	*117.64*	*43,811*
Base Grab	4/26/05	12:15	4/26/05	12:15	0.062	3	4/21/2005 5:15	5/9/2005 12:15	6,481,002	25.08	1,214
STORM					*0.441*	*164*	*5/9/2005 12:15*	*5/11/2005 16:15*	*1,008,374*	*27.77*	*10,341*
BASE					*0.102*	*8*	*5/11/2005 16:15*	*5/12/2005 8:15*	*251,559*	*1.61*	*129*
Storm Composite	5/12/05	15:56	5/15/05	13:05	0.129	33	5/12/2005 8:15	5/15/2005 8:15	2,431,202	19.58	5,008
BASE					*0.102*	*8*	*5/15/2005 8:15*	*5/18/2005 8:15*	*1,466,358*	*9.37*	*751*
Storm Composite	5/18/05	21:07	5/20/05	5:00	0.196	62	5/18/2005 8:15	5/21/2005 8:15	2,676,979	32.75	10,361
BASE					*0.102*	*8*	*5/21/2005 8:15*	*5/25/2005 15:15*	*1,777,667*	*11.36*	*910*
STORM					*0.441*	*164*	*5/25/2005 15:15*	*5/29/2005 11:15*	*1,930,525*	*53.16*	*19,797*
BASE					*0.102*	*8*	*5/29/2005 11:15*	*6/4/2005 15:15*	*1,630,285*	*10.42*	*835*
STORM					*0.441*	*164*	*6/4/2005 15:15*	*6/6/2005 12:15*	*784,372*	*21.60*	*8,044*
BASE					*0.102*	*8*	*6/6/2005 12:15*	*6/7/2005 5:15*	*256,444*	*1.64*	*131*
STORM					*0.441*	*164*	*6/7/2005 5:15*	*6/8/2005 3:15*	*480,838*	*13.24*	*4,931*
Storm Composite	6/8/05	4:37	6/9/05	10:13	0.331	128	6/8/2005 3:15	6/9/2005 12:15	1,738,671	35.93	13,893
BASE					*0.102*	*8*	*6/9/2005 12:15*	*6/10/2005 10:15*	*552,824*	*3.53*	*283*
STORM					*0.441*	*164*	*6/10/2005 10:15*	*6/11/2005 13:15*	*756,602*	*20.83*	*7,759*
STORM					*0.441*	*164*	*6/11/2005 13:15*	*6/12/2005 12:15*	*588,734*	*16.21*	*6,037*
BASE					*0.102*	*8*	*6/12/2005 12:15*	*6/13/2005 21:15*	*636,876*	*4.07*	*326*
Storm Grab	6/14/05	14:45	6/14/05	14:45	0.296	63	6/13/2005 21:15	6/15/2005 21:15	1,583,564	29.26	6,228
BASE					*0.102*	*8*	*6/15/2005 21:15*	*6/20/2005 13:15*	*1,495,832*	*9.56*	*766*
STORM					*0.441*	*164*	*6/20/2005 13:15*	*6/22/2005 0:15*	*827,157*	*22.78*	*8,482*
BASE					*0.102*	*8*	*6/22/2005 0:15*	*6/27/2005 8:15*	*1,167,847*	*7.47*	*598*
Storm Composite	6/27/05	20:39	6/28/05	17:51	0.422	130	6/27/2005 8:15	6/29/2005 6:15	1,240,836	32.69	10,070
BASE					*0.102*	*8*	*6/29/2005 6:15*	*6/29/2005 22:15*	*217,931*	*1.39*	*112*
STORM					*0.441*	*164*	*6/29/2005 22:15*	*6/30/2005 15:15*	*256,570*	*7.06*	*2,631*
Base Grab	7/15/05	11:30	7/15/05	11:30	0.147	11	6/30/2005 15:15	7/23/2005 10:15	4,424,952	40.61	3,039
STORM					*0.441*	*164*	*7/23/2005 10:15*	*7/24/2005 11:15*	*271,294*	*7.47*	*2,782*
BASE					*0.102*	*8*	*7/24/2005 11:15*	*7/25/2005 18:15*	*249,801*	*1.60*	*128*
STORM					*0.441*	*164*	*7/25/2005 18:15*	*7/27/2005 5:15*	*511,630*	*14.09*	*5,247*
BASE					*0.102*	*8*	*7/27/2005 5:15*	*8/4/2005 0:15*	*1,469,289*	*9.39*	*752*
Storm Composite	8/4/05	1:10	8/4/05	4:36	0.740	400	8/4/2005 0:15	8/4/2005 23:15	514,437	23.76	12,846
BASE					*0.102*	*8*	*8/4/2005 23:15*	*8/9/2005 14:15*	*891,934*	*5.70*	*457*
STORM					*0.441*	*164*	*8/9/2005 14:15*	*8/9/2005 19:15*	*56,510*	*1.56*	*580*
BASE					*0.102*	*8*	*8/9/2005 19:15*	*8/16/2005 19:15*	*1,342,790*	*8.58*	*687*
Storm Composite	8/16/05	19:52	8/18/05	20:00	0.269	80	8/16/2005 19:15	8/19/2005 13:15	1,581,545	26.56	7,898
Base Composite	8/25/05	9:45	8/25/05	9:45	0.117	12	8/19/2005 13:15	8/26/2005 6:15	1,302,856	9.52	976
Storm Composite	8/26/05	6:58	8/26/05	9:24	0.892	335	8/26/2005 6:15	8/28/2005 10:15	1,957,443	109.00	40,936
BASE					*0.102*	*8*	*8/28/2005 10:15*	*9/12/2005 23:15*	*3,098,352*	*19.81*	*1,586*
STORM					*0.441*	*164*	*9/12/2005 23:15*	*9/14/2005 17:15*	*485,080*	*13.36*	*4,974*
Base Composite	9/19/05	10:03	9/21/05	11:11	0.109	12	9/14/2005 17:15	9/21/2005 19:15	1,409,018	9.59	1,056
Storm Composite	9/21/05	19:55	9/22/05	9:20	0.654	229	9/21/2005 19:15	9/23/2005 18:15	3,466,370	141.52	49,554
BASE					*0.102*	*8*	*9/23/2005 18:15*	*9/24/2005 22:15*	*751,439*	*4.80*	*385*
STORM					*0.441*	*164*	*9/24/2005 22:15*	*9/26/2005 20:15*	*1,398,019*	*38.50*	*14,337*
BASE					*0.102*	*8*	*9/26/2005 20:15*	*9/28/2005 7:15*	*548,905*	*3.51*	*281*
STORM					*0.441*	*164*	*9/28/2005 7:15*	*9/29/2005 16:15*	*565,990*	*15.58*	*5,804*
BASE					*0.102*	*8*	*9/29/2005 16:15*	*10/4/2005 6:15*	*1,132,923*	*7.24*	*580*
Storm Composite	10/4/05	20:37	10/5/05	6:08	0.439	152	10/4/2005 6:15	10/8/2005 23:15	12,813,500	351.15	121,584
BASE					*0.102*	*8*	*10/8/2005 23:15*	*10/12/2005 23:15*	*2,722,815*	*17.41*	*1,394*
STORM					*0.441*	*164*	*10/12/2005 23:15*	*10/14/2005 6:15*	*713,519*	*19.65*	*7,317*
BASE					*0.102*	*8*	*10/14/2005 6:15*	*10/17/2005 0:15*	*1,064,326*	*6.80*	*545*
STORM					*0.441*	*164*	*10/17/2005 0:15*	*10/18/2005 8:15*	*517,061*	*14.24*	*5,302*
Base Grab	10/19/05	10:15	10/19/05	10:15	0.077	3	10/18/2005 8:15	11/2/2005 15:15	4,235,747	20.36	793
BASE					*0.102*	*8*	*11/2/2005 15:15*	*1/1/2006 0:00*	*12,827,250*	*82.00*	*6,566*
Storm Average					0.441	164					
Base Average					0.102	8					
Snowmelt Average					0.058	7					
All Average					0.319	109					
Total									**135,350,245**	1,901	534,090
Brown's Creek Major Subwatershed Total Acres									11,877		
Total TP/TSS(lb/ac/yr)										0.16	44.97
Total TP/TSS (kg/ha/yr)										0.18	50.40

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

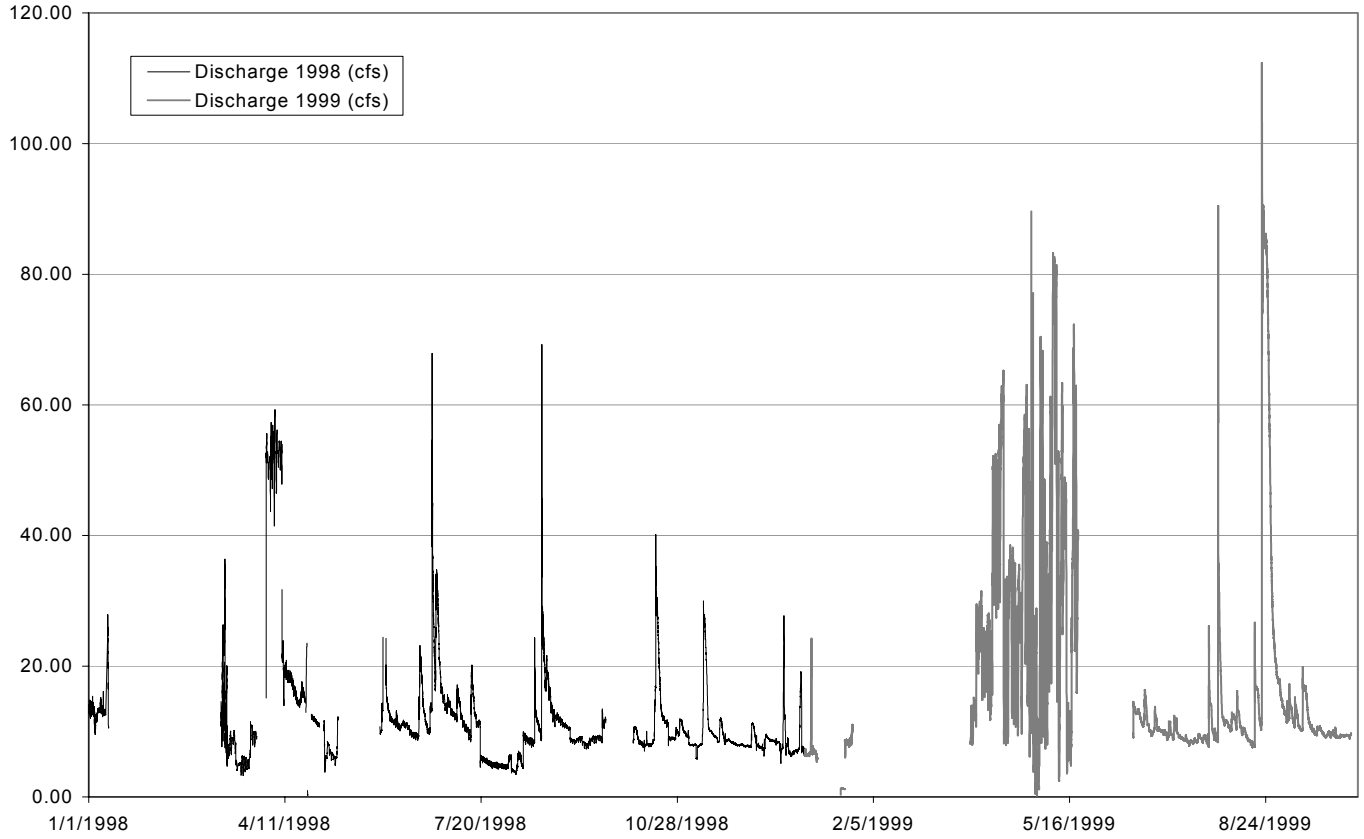


Figure 53: Brown's Creek at Mouth (Highway 96) 1998-1999 Discharge

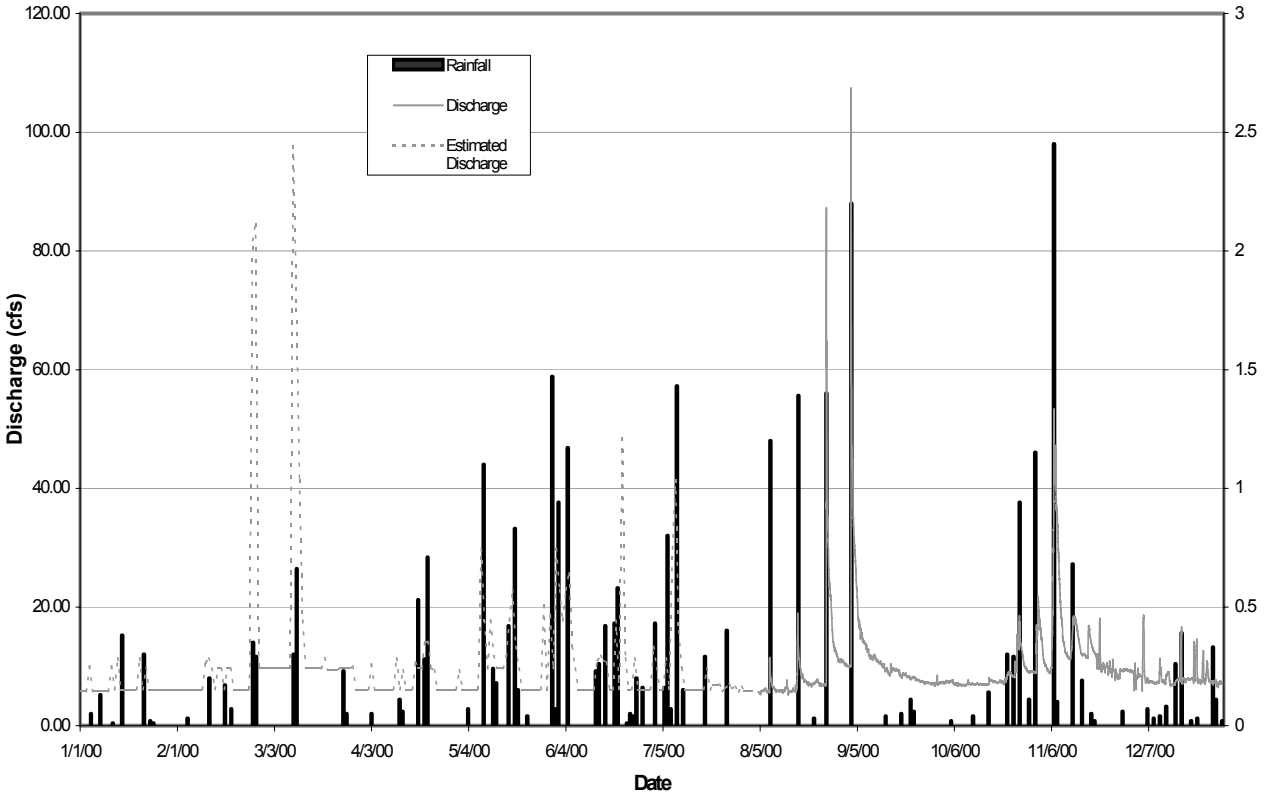


Figure 54: Brown's Creek at Mouth (Highway 96) 2000 Continuous Flow and Rainfall

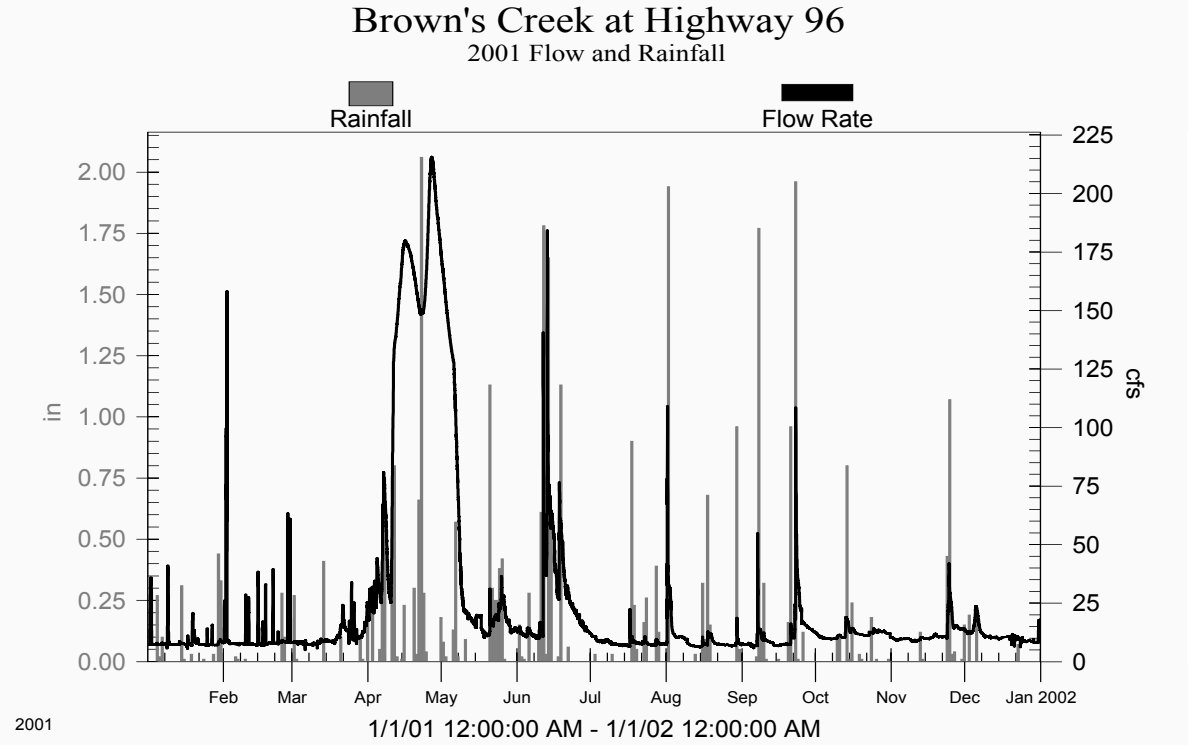


Figure 55: Brown's Creek at Mouth (Highway 96) 2001 Continuous Flow and Rainfall

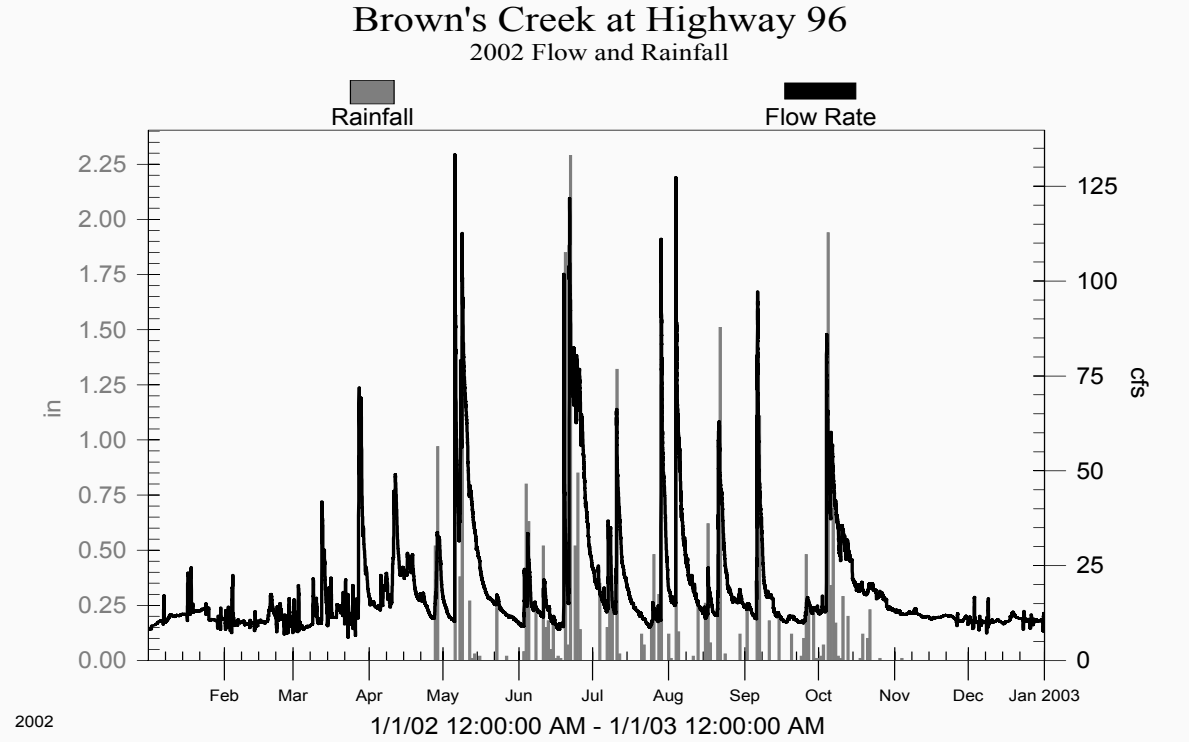


Figure 56: Brown's Creek at Mouth (Highway 96) 2002 Continuous Flow and Rainfall

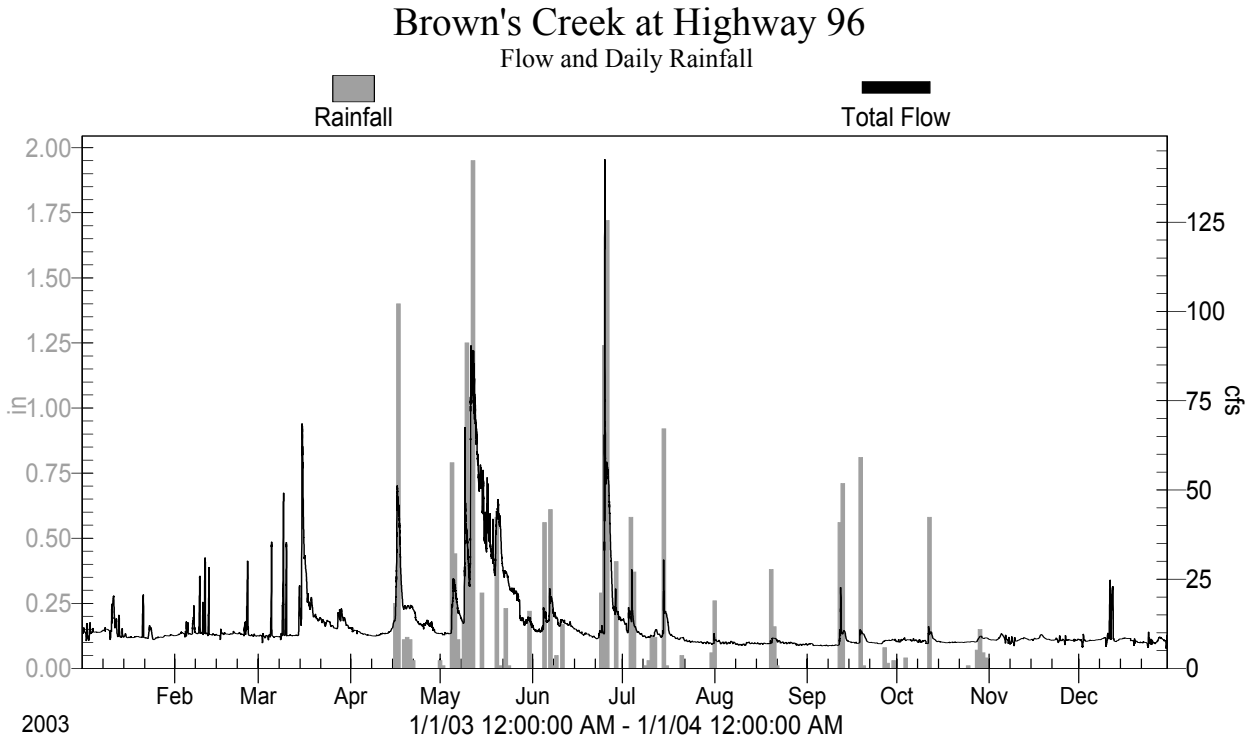


Figure 57: Brown's Creek at Mouth (Highway 96) 2003 Continuous Flow and Rainfall

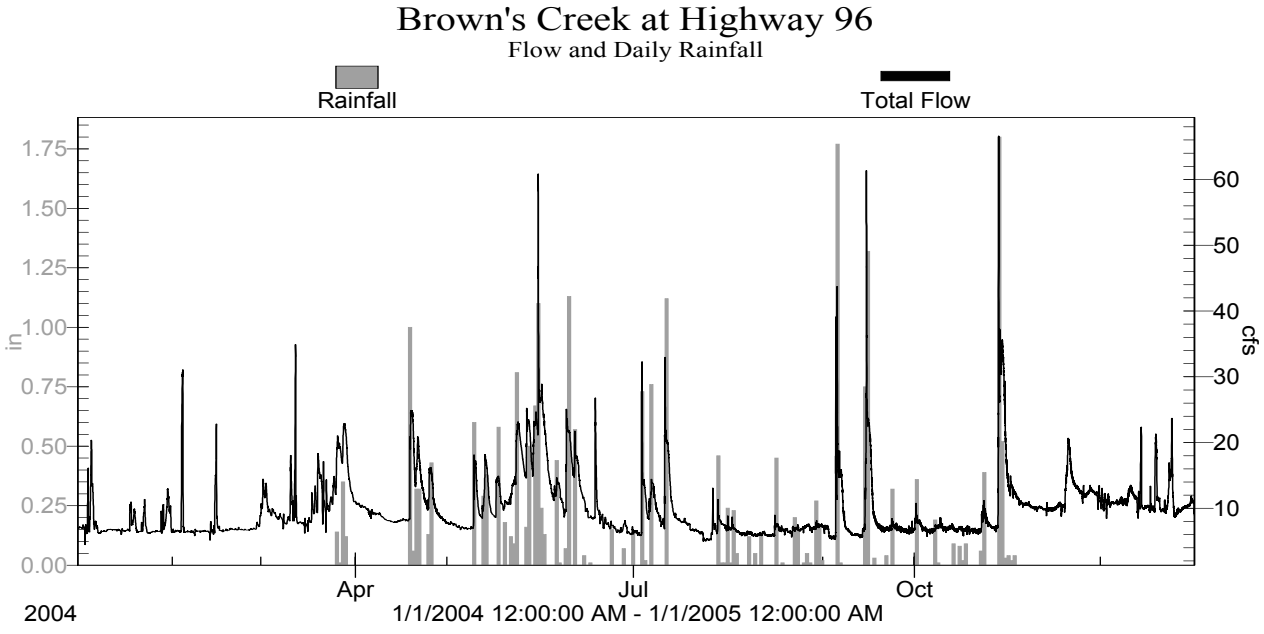


Figure 58: Brown's Creek at Mouth (Highway 96) 2004 Continuous Flow and Rainfall

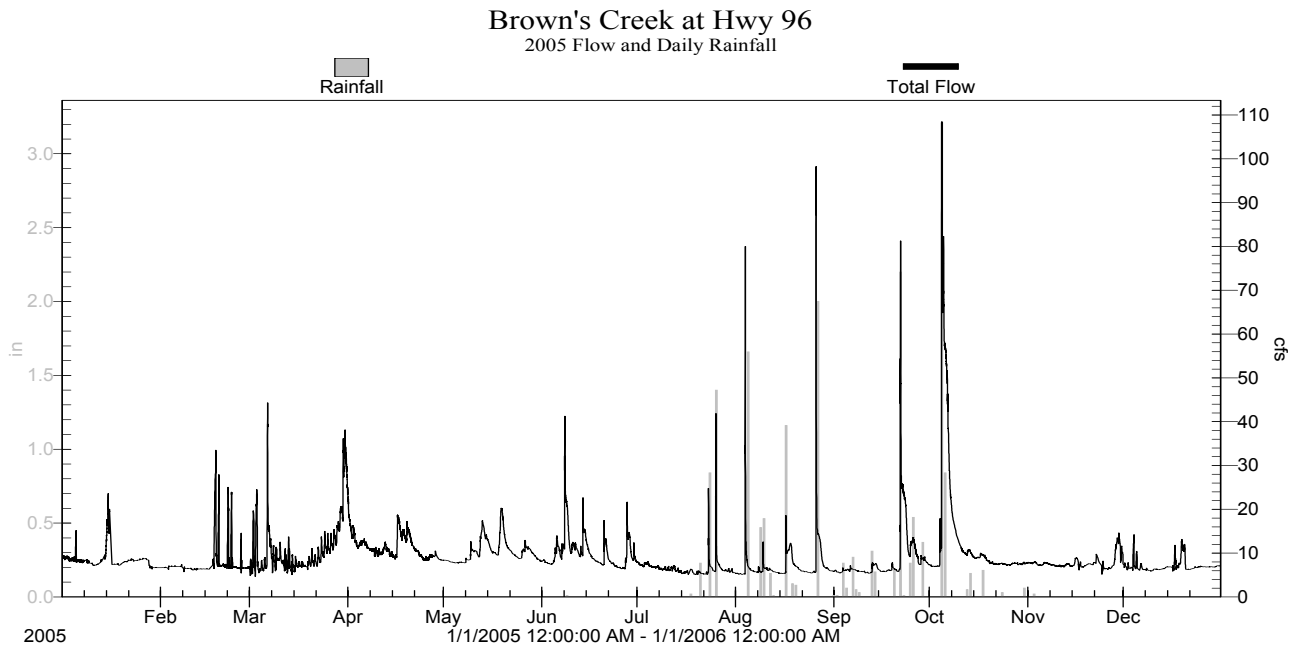


Figure 59: Brown's Creek at Mouth (Highway 96) 2005 Continuous Flow and Daily Rainfall

Table 51: Brown's Creek at Highway 96 2000 Total Phosphorus Loading (TP)

					Interval			
Sample events	Date	Time	Flow (cfs)	T.P. (mg/L)	Start Date & time	End Date & time	Interval (cf)	Interval TP(lb)
Base Grab	*2/25/00*	*10:45*		4.40				
Base Grab	*3/28/00*	*15:00*		0.10				
Base Grab	*4/17/00*	*14:15*		0.08				
Storm Grab	*4/20/00*	*10:40*		0.12				
Storm Grab	*5/8/00*	*13:00*		0.17				
Storm Grab	*5/12/00*	*14:25*		0.19				
Storm Grab	*5/16/00*	*13:15*		0.11				
Storm Grab	*5/18/00*	*13:30*		0.18				
Storm Grab	*5/30/00*	*10:50*		0.40				
Storm Grab	*6/5/00*							
Storm Grab	*6/14/00*	*10:30*		0.15				
Storm Grab	*6/16/00*	*11:05*		0.16				
Storm Grab	*7/10/00*	*12:50*		0.22				
Base Grab	*7/24/00*	*9:50*		0.08				
Estimated Baseflow	8/4/00	9:30	9.2	0.15	8/4/00 9:30	8/7/00 23:15	1,798,739	16.9
Storm Grab	8/8/00	11:45	8.4	0.05	8/7/00 23:30	8/8/00 7:30	258,458	0.8
Estimated Baseflow				0.15	8/8/00 7:45	8/16/00 17:15	4,409,427	41.3
Storm Grab	8/17/00	10:54	11.0	0.07	8/16/00 17:30	8/17/00 16:30	1,005,890	4.4
Base Grab	8/25/00	9:40	6.2	0.15	8/17/00 16:45	8/26/00 1:30	5,323,978	49.9
Storm Grab	8/28/00	11:00	12.9	0.16	8/26/00 1:45	8/27/00 21:45	4,886,983	48.9
Estimated Baseflow				0.15	8/27/00 22:00	9/2/00 22:00	5,902,845	55.3
Storm Grab	9/5/00	16:00	24.5	0.14	9/2/00 22:15	9/7/00 7:30	9,745,500	85.3
Base Grab	10/20/00	11:40	11.6	0.15	9/7/00 7:45	10/20/00 7:45	30,422,890	285.2
Base Grab	10/24/00	10:00		0.15	10/20/00 8:00	10/24/00 8:00	2,759,560	25.9
Estimated Baseflow				0.15	10/24/00 8:15	10/25/00 4:45	599,591	5.6
Composite	10/25/00	23:33-21:11		0.41	10/25/00 5:00	10/28/00 2:30	3,148,976	80.7
Estimated Baseflow				0.15	10/28/00 2:45	11/1/00 2:30	3,195,217	30.0
Composite	11/1/00	5:50-18:09		0.78	11/1/00 2:45	11/2/00 14:45	2,233,327	108.9
Estimated Baseflow				0.15	11/2/00 15:00	11/5/00 15:15	2,789,628	26.2
Composite	11/6/00	4:32-10:33		0.11	11/5/00 15:30	11/6/00 22:30	2,470,829	17.0
Composite	11/7/00	16:54-8:53		0.18	11/6/00 22:45	11/8/00 21:45	5,561,275	62.6
Estimated Baseflow				0.15	11/8/00 21:45	12/31/00 23:45	44,269,150	415.1
		Grab Average		0.15				
		8/4/00 - 12/31/00 Total (cf)					130,782,263	
		8/4/00 - 12/31/00 Total TP(lb)						1,360
		Brown's Creek Watershed Total Acres						13,491
		8/4/00 - 12/31/00 Measured Total TP(lb)/Acre						0.10
		8/4/00 - 12/31/00 Measured Total TP(Kg)/ha						0.11

Baseflow TP is average of grabs taken in 2000

**Italicized samples are *samples taken before continuous flow monitored*

Table 52: Brown's Creek at Mouth (Highway 96) 2001 Total Suspended Solids (TSS) and Phosphorus Loading (TP)

Type	Sampling Interval		TP (mg/L)	TSS (mg/L)	Loading Interval		Total Discharge (cf)	TP (lb)	TSS (lb)
	Start	End			Start	End			
Base Est			*0.13*	*14*	1/1/01 0:15	3/20/01 12:00	63,553,540	527	56,110
Snowmelt	3/20/01 15:00	3/20/01 15:00	0.23	64	3/20/01 12:15	3/27/01 1:00	8,025,838	115	32,065
Snowmelt	3/29/01 12:50	3/29/01 12:50	0.08	11	3/27/01 1:15	3/30/01 12:30	3,260,507	16	2,239
Snowmelt	3/30/01 22:39	4/2/01 22:26	0.49	360	3/30/01 12:45	4/2/01 22:30	6,225,943	190	139,918
Snowmelt	4/2/01 22:25	4/5/01 13:53	0.44	321	4/2/01 22:45	4/6/01 12:30	9,475,984	260	189,887
Snowmelt,Storm	4/6/01 12:30	4/7/01 19:20	0.91	281	4/6/01 12:45	4/7/01 19:45	6,228,077	354	109,251
Snowmelt	4/7/01 19:50	4/9/01 3:23	0.31	68	4/7/01 20:00	4/10/01 10:00	10,076,570	195	42,775
Storm	4/10/01 18:51	4/12/01 6:41	0.46	327	4/10/01 10:15	4/12/01 21:45	22,645,130	650	462,263
Snowmelt	4/13/01 11:00	4/13/01 11:00	0.12	14	4/12/01 22:00	4/14/01 1:00	14,661,540	110	12,814
Snowmelt	4/14/01 16:00	4/14/01 16:00	0.15	89	4/14/01 1:15	4/14/01 22:00	12,198,470	114	67,774
Snowmelt	4/16/01 13:30	4/16/01 13:30	0.53	70	4/14/01 22:15	4/17/01 21:30	45,417,030	1,503	198,465
Snowmelt	4/18/01 12:00	4/18/01 12:00	0.12	32	4/17/01 21:45	4/23/01 1:30	72,131,500	540	144,093
Storm	4/25/01 15:30	4/25/01 15:30	0.39	224	4/23/01 1:45	4/30/01 18:30	123,411,930	3,005	1,725,725
Snowmelt Est			*0.34*	*159*	4/30/01 18:45	5/7/01 9:15	81,433,510	1,748	810,244
Storm Est			*0.58*	*410*	5/7/01 9:30	5/11/01 6:15	13,821,520	498	353,650
Base Est			*0.13*	*14*	5/11/01 6:30	5/20/01 17:30	13,352,610	111	11,789
Storm	5/22/01 10:40	5/22/01 10:40	0.13	30	5/20/01 17:45	5/29/01 16:00	15,111,170	123	28,300
Base	6/6/01 10:21	6/6/01 10:21	0.11	18	5/29/01 16:15	6/11/01 15:30	13,992,140	96	15,723
Storm	6/11/01 18:30	6/12/01 21:39	1.60	1320	6/11/01 15:45	6/13/01 0:45	6,183,204	618	509,512
Storm	6/13/01 10:39	6/14/01 11:32	0.81	648	6/13/01 1:00	6/18/01 4:30	24,757,120	1,252	1,001,479
Storm Est			*0.58*	*410*	6/18/01 4:45	6/23/01 5:00	16,719,840	602	427,809
Base	6/29/01 9:40	6/29/01 9:40	0.30	19	6/23/01 5:15	7/6/01 8:00	16,229,260	304	19,249
Base	7/13/01 18:30	7/16/01 7:11	0.13	11	7/6/01 8:15	7/16/01 14:45	6,829,937	55	4,690
Storm	7/17/01 4:33	7/18/01 6:59	0.21	68	7/16/01 15:00	7/18/01 7:45	1,333,332	17	5,660
Base Est			*0.13*	*14*	7/18/01 8:00	8/1/01 6:45	9,431,251	78	8,327
Storm	8/1/01 9:58	8/2/01 7:02	0.72	406	8/1/01 7:00	8/3/01 11:45	5,964,576	268	151,172
Base	8/13/01 9:11	8/14/01 8:26	0.07	11	8/3/01 12:00	8/17/01 17:00	10,487,870	46	7,202
Storm	8/18/01 0:42	8/18/01 0:42	0.28	*410*	8/17/01 17:15	8/21/01 4:30	2,923,177	51	74,818
Base	8/28/01 9:27	8/29/01 8:53	0.14	26	8/21/01 4:45	8/29/01 22:15	5,410,717	47	8,782
Storm Est			*0.58*	*410*	8/29/01 22:30	8/31/01 2:00	948,167	34	24,261
Base Est			*0.13*	*14*	8/31/01 2:15	9/7/01 5:00	4,394,771	36	3,880
Storm Est			*0.58*	*410*	9/7/01 5:15	9/10/01 19:30	3,771,030	136	96,489
Base	9/18/01 9:20	9/19/01 8:30	0.10	11	9/10/01 19:45	9/20/01 17:30	6,485,526	40	4,454
Storm	9/22/01 23:08	9/23/01 15:13	0.59	256	9/20/01 17:45	9/26/01 0:45	11,121,860	410	177,739
Base	11/9/01 13:35	11/9/01 13:35	0.08	3	9/26/01 1:00	11/23/01 14:15	57,117,050	285	10,697
Storm Est			*0.58*	*410*	11/23/01 14:30	11/26/01 14:00	5,650,514	203	144,579
Base	12/17/01 13:40	12/17/01 13:40	*0.13*	7	11/26/01 14:15	12/31/01 23:45	34,831,420	283	15,221
						TOTAL	765,613,631	14,922	7,099,104

Avg. Base	0.13	14
Avg. Storm	0.58	410
Avg. Snowmelt	0.36	164
Avg. All	0.37	205

*Italicized values are estimates based on storm and baseflow averages

1/1/01 - 12/31/01 Total (cf)	765,613,631	
1/1/01 - 12/31/01 Total TP(lb)		14,922
Brown's Creek Watershed Total Acres		13,491
1/1/01 - 12/31/01 Measured Total TP(lb)/Acre		1.11
1/1/01 - 12/31/01 Measured Total TP(Kg)/ha		1.24

Table 53: Brown's Creek at Mouth (Highway 96) 2002 Total Suspended Solids TSS) and Phosphorus Loading (TP)

	Sample Collection Time						Loading Interval				
Sample Type	Start Date	Start Time	End Date	End Time	TP (mg/L)	TSS (mg/L)	Start	End	Interval Volume (cf)	Interval TP (lb)	Interval TSS (lb)
Base Grab	1/17/02	11:10	1/17/02	11:10	0.08	13.0	1/1/02 0:00	2/18/02 12:15	46,982,170	235	38,128
SNOWMELT					*0.38*	*240.3*	*2/18/02 12:30*	*2/22/02 4:00*	*4,214,985*	*100*	*63,229*
Base Grab	2/25/02	14:40	2/25/02	14:40	0.10	8.0	2/22/02 4:15	3/2/02 20:45	8,109,107	49	4,050
SNOWMELT					*0.38*	*240.3*	*3/2/02 21:00*	*3/3/02 12:15*	*865,688*	*5*	*665*
BASE					*0.10*	*12.3*	*3/3/02 12:30*	*3/12/02 12:45*	*7,990,672*	*190*	*119,868*
Snowmelt Grab	3/13/02	10:00	3/13/02	10:00	0.39	54.0	3/12/02 13:00	3/16/02 21:45	7,104,031	171	23,948
BASE					*0.10*	*12.3*	*3/16/02 22:00*	*3/27/02 12:45*	*11,435,360*	*71*	*8,781*
Snowmelt Grab	3/28/02	13:30	3/28/02	13:30	0.65	640.0	3/27/02 13:00	3/31/02 3:15	11,846,530	479	473,301
BASE					*0.10*	*12.3*	*3/31/02 3:30*	*4/5/02 15:00*	*7,202,608*	45	5,530
Snowmelt Grab	4/8/02	11:30	4/8/02	11:30	0.12	27.0	4/5/02 15:15	4/10/02 12:00	7,512,494	56	12,662
Storm Grab	4/11/02	15:40	4/11/02	15:40	0.36	226.0	4/10/02 12:15	4/16/02 12:15	14,861,780	332	209,675
Storm Grab	4/18/02	17:00	4/18/02	17:00	0.14	34.0	4/16/02 12:30	4/19/02 12:15	6,530,785	56	13,862
BASE					*0.10*	*12.3*	*4/19/02 12:30*	*4/21/02 5:15*	*2,479,502*	*15*	*1,904*
Storm Grab	4/22/02	12:00	4/22/02	12:00	0.09	11.0	4/21/02 5:30	4/23/02 13:45	3,422,669	20	2,350
BASE					*0.10*	*12.3*	*4/23/02 14:00*	*4/26/02 21:00*	*3,681,427*	*23*	*2,827*
STORM					*0.43*	*326.5*	*4/26/02 21:15*	*5/1/02 19:45*	*8,865,152*	*238*	*180,691*
BASE					*0.10*	*12.3*	*5/1/02 20:00*	*5/5/02 18:00*	*4,003,712*	*25*	*3,074*
Storm Composite	5/8/02	4:04	5/9/02	15:50	0.46	648.0	5/5/02 18:15	5/17/02 18:30	48,861,710	1,397	1,976,561
BASE					*0.10*	*12.3*	*5/17/02 18:45*	*6/2/02 23:30*	*18,501,900*	*116*	*14,207*
Storm Composite	6/3/02	4:53	6/3/02	21:31	0.14	187.0	6/2/02 23:45	6/4/02 7:45	2,113,554	18	24,673
Storm Composite	6/4/02	11:13	6/5/02	15:46	0.38	246.0	6/4/02 8:00	6/5/02 23:45	3,303,421	78	50,730
BASE					*0.10*	*12.3*	*6/5/02 0:00*	*6/10/02 22:45*	*7,448,887*	*47*	*5,720*
STORM					*0.43*	*326.5*	*6/10/02 23:00*	*6/13/02 10:00*	*3,421,893*	*92*	*69,745*
BASE					*0.10*	*12.3*	*6/13/02 10:15*	*6/19/02 3:30*	*4,823,023*	*30*	*3,703*
Storm Composite	6/19/02	5:22	6/19/02	12:40	0.92	634.0	6/19/02 3:45	6/21/02 3:45	5,628,070	325	222,749
Storm Composite	6/21/02	10:08	6/21/02	13:29	0.54	331.0	6/21/02 4:00	7/1/02 22:15	50,481,270	1,702	1,043,097
BASE					*0.10*	*12.3*	*7/1/02 22:30*	*7/6/02 11:15*	*6,843,122*	*43*	*5,254*
STORM					*0.43*	*326.5*	*7/6/02 11:30*	*7/8/02 18:15*	*4,828,183*	*130*	*98,409*
BASE					*0.10*	*12.3*	*7/8/02 18:30*	*7/10/02 2:30*	*1,630,376*	*10*	*1,252*
Storm Composite	7/10/02	17:17	7/10/02	20:49	*0.43*	*326.5*	7/10/02 2:45	7/16/02 12:15	15,106,120	405	307,895
BASE					*0.10*	*12.3*	*7/16/02 12:30*	*7/28/02 18:15*	*59,704,935*	*373*	*45,844*
Storm Composite	7/28/02	19:58	7/29/02	11:37	0.63	387.0	7/28/02 18:15	7/31/02 19:15	12,046,700	471	291,035
BASE					*0.10*	*12.3*	*7/31/02 19:30*	*8/3/02 10:00*	*4,179,034*	*26*	*3,209*
Storm Composite	8/3/02	19:24	8/4/02	8:55	*0.43*	323.0	8/3/02 19:00	8/9/02 1:15	20,555,635	552	414,477
Base Composite	8/14/02	8:03	8/14/02	10:49	0.12	13.0	8/9/02 1:30	8/16/02 18:15	3,051,950	22	2,477
STORM					*0.43*	*326.5*	*8/16/02 18:30*	*8/18/02 6:30*	*2,286,302*	*61*	*46,600*
BASE					*0.10*	*12.3*	*8/18/02 6:45*	*8/20/02 19:00*	*2,771,217*	*17*	*2,128*
STORM					*0.43*	*326.5*	*8/20/02 19:15*	*8/26/02 0:15*	*14,516,170*	*390*	*295,871*
BASE					*0.10*	*12.3*	*8/26/02 0:30*	*9/5/02 16:45*	*13,577,650*	*85*	*10,425*
Storm Composite	9/6/02	2:32	9/6/02	11:56	0.72	590.0	9/5/02 17:00	9/9/02 4:30	12,201,054	545	449,382
BASE					*0.10*	*12.3*	*9/9/02 4:45*	*10/4/02 0:30*	*32,839,563*	*205*	*25,216*
Storm Composite	10/4/02	6:17	10/4/02	10:00	0.76	628.0	10/4/02 0:45	10/16/02 22:30	38,496,480	1,834	1,509,201
Base Composite	10/25/02	15:36	10/28/02	15:49	0.10	15.0	10/16/02 22:45	11/4/02 7:00	25,851,924	157	24,208
BASE					*0.10*	*12.3*	*11/4/02 7:15*	*12/31/02 23:45*	*54,688,680*	*341*	*41,992*
Storm Average					0.43	326.5					
Base Average					0.10	12.3					
Snowmelt Average					0.38	240.3					
Total Average					0.28	174.2					
Total									**626,867,495**	11,579	8,150,602
Brown's Creek Major Subwatershed Total Acres									13,491		
Total TP/TSS (lb/ac/yr)										0.86	604.15
Total TP/TSS (kg/ha/yr)										0.96	677.15

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

Table 54: Brown's Creek at Mouth (Highway 96) 2003 Total Suspended Solids TSS) and Phosphorus Loading (TP)

	Sample Collection Time						Loading Interval				
Sample Type	Start Date	Start Time	End Date	End Time	TP (mg/L)	TSS (mg/L)	Start	End	Interval Volume (cf)	Interval TP (lb)	Interval TSS (lb)
Base grab	1/22/03	9:15	1/22/03	9:15	0.08	11	1/1/03 0:00	2/1/03 0:00	26,451,670	127	18,164
Base grab	2/14/03	11:35	2/14/03	11:35	0.03	11	2/1/03 0:15	3/14/03 9:30	36,397,570	70	24,994
Snowmelt grab	3/17/03	10:10	3/17/03	10:10	0.31	61	3/14/03 9:45	3/18/03 9:30	9,183,821	179	34,972
Storm grab	3/31/03	15:35	3/31/03	15:35	0.09	28	3/18/03 9:45	4/14/03 17:15	27,415,110	154	47,920
Storm composite**	4/16/03	7:11	4/17/03	3:17	0.45	192	4/14/03 17:30	4/17/03 20:00	7,158,824	202	85,804
BASE					*0.09*	*16*	*4/17/03 20:15*	*5/4/03 17:30*	*18,958,225*	*105*	*18,581*
Storm composite	5/5/03	4:56	5/6/03	12:39	0.17	207	5/4/03 17:45	5/6/03 16:00	3,367,651	36	43,518
BASE					*0.09*	*16*	*5/6/03 16:15*	*5/8/03 23:30*	*2,901,347*	*16*	*2,844*
Storm grab	5/12/03	15:45	5/12/03	15:45	0.24	112	5/8/03 23:45	5/13/03 21:00	23,280,930	355	162,774
Storm grab	5/15/03	15:30	5/15/03	15:30	0.11	37	5/13/03 21:15	5/19/03 10:00	18,924,040	132	43,710
STORM					*0.23*	*99*	*5/19/03 10:15*	*5/21/03 20:30*	*8,178,877*	*120*	*50,343*
BASE					*0.09*	*16*	*5/21/03 20:45*	*6/4/03 14:00*	*19,912,380*	*111*	*19,516*
STORM					*0.23*	*99*	*6/4/03 14:15*	*6/9/03 3:30*	*6,113,705*	*90*	*37,631*
BASE					*0.09*	*16*	*6/9/03 3:45*	*6/24/03 23:30*	*14,630,945*	*81*	*14,340*
Storm composite**	6/24/03	23:50	6/26/03	14:39	0.51	290	6/24/03 23:45	6/27/03 3:15	10,094,720	321	182,751
BASE					*0.09*	*16*	*6/27/03 3:30*	*7/3/03 1:45*	*7,863,330*	*44*	*7,707*
Storm composite**	7/3/03	2:55	7/5/03	3:13	0.26	36	7/3/03 2:00	7/5/03 15:30	2,092,414	34	4,702
BASE					*0.09*	*16*	*7/5/03 15:45*	*7/14/03 18:30*	*8,443,557*	*47*	*8,275*
Storm composite**	7/14/03	20:24	7/16/03	13:47	0.26	56	7/14/03 18:45	7/16/03 14:00	1,828,733	30	6,393
Base grab	7/22/03	10:50	7/22/03	10:50	0.11	8	7/16/03 14:15	7/22/03 21:30	5,195,676	37	2,595
Base composite	7/29/03	8:40	7/30/03	22:40	0.15	28	7/22/03 21:45	7/31/03 14:00	5,470,621	51	9,562
Base grab	8/11/03	15:40	8/11/03	15:40	0.05	4	7/31/03 14:15	8/26/03 9:00	16,018,010	45	4,000
Base composite	8/26/03	9:17	8/27/03	13:08	0.12	36	8/26/03 9:15	9/5/03 8:30	5,803,936	43	13,043
Base composite	9/5/03	8:35	9/8/03	7:16	0.08	10	9/5/03 8:45	9/11/03 2:30	3,183,707	16	1,987
Base grab	9/11/03	8:40	9/11/03	8:40	0.09	17	9/11/03 2:45	9/11/03 18:30	369,983	2	393
Storm grab	9/12/03	13:10	9/12/03	13:10	0.13	17	9/11/03 18:45	9/12/03 13:30	766,986	6	814
BASE					*0.09*	*16*	*9/12/03 13:45*	*9/18/03 14:00*	*4,146,356*	*23*	*4,064*
Storm grab	9/19/03	8:25	9/19/03	8:25	0.11	11	9/18/03 14:15	9/19/03 21:15	1,106,712	8	760
Base composite	10/6/03	16:35	10/7/03	8:15	0.10	22	9/19/03 21:30	10/11/03 13:30	14,324,320	93	19,673
STORM					*0.23*	*99*	*10/11/03 13:45*	*10/11/03 19:15*	*197,204*	*3*	*1,214*
Base grab	10/28/03	9:00	10/28/03	9:00	0.08	10	10/11/03 19:30	12/11/03 4:45	41,712,450	208	26,039
SNOWMELT					*0.31*	*61*	*12/11/03 5:00*	*12/12/03 13:30*	*2,047,398*	*40*	*7,796*
BASE					*0.09*	*16*	*12/12/03 13:45*	*12/31/03 23:45*	*12,913,210*	*72*	*12,656*
Storm Average					0.23	99					
Base Average					0.09	16					
Snowmelt Average					0.31	61					
All Average					0.16	51					
Total									**366,454,418**	2,902	919,534
Brown's Creek Major Subwatershed Total Acres									13,491		
Total TP/TSS (lb/ac/yr)										0.22	68.16
Total TP/TSS (kg/ha/yr)										0.24	76.39

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

**Values and sampling intervals in gray areas are from the upstream McKusick Rd. stream site and were used because of equipment malfunction

Table 55: Brown's Creek at Mouth (Highway 96) 2004 Total Suspended Solids TSS) and Phosphorus Loading (TP)

	Sample Collection Time						Loading Interval				
Sample Type	Start Date	Start Time	End Date	End Time	TP (mg/L)	TSS (mg/L)	Start	End	Interval Volume (cf)	Interval TP (lb)	Interval TSS (lb)
BASE					*0.10*	*13*	*1/1/2004 0:00*	*1/4/2004 22:00*	*2,477,253*	*14.89*	*2,010*
SNOWMELT					*0.20*	*46*	*1/4/2004 22:15*	*1/6/2004 0:15*	*1,293,705*	*15.83*	*3,715*
BASE					*0.10*	*13*	*1/6/2004 0:30*	*1/18/2004 1:45*	*7,051,449*	*42.39*	*5,723*
SNOWMELT					*0.20*	*46*	*1/18/2004 2:00*	*1/19/2004 23:30*	*1,452,848*	*17.78*	*4,172*
Base Grab	1/21/04	9:00	1/21/04	9:00	0.06	17	1/19/2004 23:45	1/21/2004 20:00	1,052,644	3.88	1,117
SNOWMELT					*0.20*	*46*	*1/21/2004 20:15*	*1/23/2004 2:15*	*897,969*	*10.99*	*2,579*
BASE					*0.10*	*13*	*1/23/2004 2:30*	*1/28/2004 18:45*	*3,221,419*	*19.37*	*2,614*
SNOWMELT					*0.20*	*46*	*1/28/2004 19:00*	*1/31/2004 19:00*	*2,442,131*	*29.88*	*7,013*
BASE					*0.10*	*13*	*1/31/2004 19:15*	*2/3/2004 22:00*	*1,744,852*	*10.49*	*1,416*
SNOWMELT					*0.20*	*46*	*2/3/2004 22:15*	*2/4/2004 14:00*	*1,339,581*	*16.39*	*3,847*
BASE					*0.10*	*13*	*2/4/2004 14:15*	*2/14/2004 21:45*	*5,797,978*	*34.86*	*4,705*
SNOWMELT					*0.20*	*46*	*2/14/2004 22:00*	*2/15/2004 13:00*	*830,596*	*10.16*	*2,385*
BASE					*0.10*	*13*	*2/15/2004 13:15*	*2/28/2004 12:45*	*7,615,111*	*45.78*	*6,180*
Snowmelt Grab	3/1/04	11:05	3/1/04	11:05	0.27	53	2/28/2004 13:00	3/3/2004 8:45	3,373,189	56.01	11,160
BASE					*0.10*	*13*	*3/3/2004 9:00*	*3/10/2004 13:00*	*5,380,309*	*32.34*	*4,366*
Snowmelt Grab	3/11/04	14:05	3/11/04	14:05	0.13	39	3/10/2004 13:15	3/12/2004 10:30	2,281,915	17.95	5,556
BASE					*0.10*	*13*	*3/12/2004 10:45*	*3/16/2004 10:15*	*2,699,211*	*16.23*	*2,191*
SNOWMELT					*0.20*	*46*	*3/16/2004 10:30*	*3/20/2004 11:30*	*3,836,472*	*46.94*	*11,017*
BASE					*0.10*	*13*	*3/20/2004 11:45*	*3/23/2004 13:00*	*2,899,808*	*17.43*	*2,353*
STORM					*0.42*	*143*	*3/23/2004 13:15*	*3/27/2004 18:15*	*5,608,697*	*148.43*	*50,098*
STORM					*0.42*	*143*	*3/27/2004 18:30*	*3/29/2004 2:30*	*2,477,727*	*65.57*	*22,131*
BASE					*0.10*	*13*	*3/29/2004 2:45*	*4/18/2004 19:45*	*17,132,660*	*103.00*	*13,904*
Storm Composite	4/19/04	11:26	4/20/04	7:18	0.40	167	4/18/2004 20:00	4/20/2004 16:30	3,297,983	82.97	34,382
Storm Composite	4/21/04	3:44	4/22/04	3:13	0.15	67	4/20/2004 16:45	4/22/2004 4:45	2,279,295	21.91	9,533
BASE					*0.10*	*13*	*4/22/2004 5:00*	*4/24/2004 19:00*	*2,732,294*	*16.43*	*2,217*
STORM					*0.42*	*143*	*4/24/2004 19:15*	*4/26/2004 3:15*	*1,654,085*	*43.77*	*14,775*
Base Composite	5/4/04	18:14	5/7/04	12:06	0.09	23	4/26/2004 3:30	5/9/2004 14:30	9,286,619	51.02	13,334
Storm Composite	5/9/04	19:55	5/10/04	13:15	0.43	188	5/9/2004 14:45	5/10/2004 17:15	1,391,133	37.34	16,326
BASE					*0.10*	*13*	*5/10/2004 17:30*	*5/12/2004 13:30*	*1,546,133*	*9.29*	*1,255*
Storm Composite	5/13/04	9:31	5/14/04	7:23	0.29	107	5/12/2004 13:45	5/14/2004 7:30	2,109,912	38.72	14,093
BASE					*0.10*	*13*	*5/14/2004 7:45*	*5/17/2004 0:00*	*2,321,344*	*13.96*	*1,884*
STORM					*0.42*	*143*	*5/17/2004 0:15*	*5/18/2004 2:15*	*1,327,170*	*35.12*	*11,854*
BASE					*0.10*	*13*	*5/18/2004 2:30*	*5/23/2004 9:30*	*5,355,282*	*32.19*	*4,346*
Storm Composite	5/23/04	9:52	5/24/04	13:13	0.14	50	5/23/2004 9:45	5/24/2004 14:00	2,097,121	18.59	6,546
Storm Grab	5/24/04	16:00	5/24/04	16:00	0.49	216	5/24/2004 14:15	5/25/2004 20:45	2,161,021	66.24	29,139
BASE					*0.10*	*13*	*5/25/2004 21:00*	*5/26/2004 23:30*	*1,496,288*	*9.00*	*1,214*
STORM					*0.42*	*143*	*5/26/2004 23:45*	*5/27/2004 17:30*	*1,459,462*	*38.62*	*13,036*
BASE					*0.10*	*13*	*5/27/2004 17:45*	*5/29/2004 4:45*	*2,409,304*	*14.48*	*1,955*
Storm Composite	5/30/04	21:21	5/30/04	22:54	1.15	*142*	5/29/2004 5:00	6/2/2004 7:30	8,832,517	634.09	78,296
Base and Fecal Grab	6/8/04	10:30	6/8/04	10:30	0.16	21	6/2/2004 7:45	6/9/2004 0:15	7,500,061	74.91	9,832
STORM					*0.42*	*143*	*6/9/2004 0:30*	*6/13/2004 11:45*	*7,140,579*	*188.96*	*63,781*
BASE					*0.10*	*13*	*6/13/2004 12:00*	*6/18/2004 12:00*	*4,617,365*	*27.76*	*3,747*
STORM					*0.42*	*143*	*6/18/2004 12:15*	*6/18/2004 20:00*	*599,615*	*15.87*	*5,356*
Base Composite	6/24/04	14:42	6/28/04	8:06	0.11	17	6/18/2004 20:15	7/3/2004 18:30	9,353,324	64.81	9,926
Storm Composite	7/3/04	20:29	7/5/04	4:11	0.32	130	7/3/2004 18:45	7/7/2004 17:30	4,192,204	84.01	34,021
BASE					*0.10*	*13*	*7/7/2004 17:45*	*7/11/2004 6:00*	*2,780,432*	*16.71*	*2,256*
Storm Composite	7/11/04	8:05	7/11/04	12:00	0.43	140	7/11/2004 6:15	7/12/2004 11:45	2,250,245	60.68	19,666
Base and Fecal Grab	7/15/04	10:30	7/15/04	10:30	0.15	15	7/12/2004 12:00	7/22/2004 9:15	7,323,676	67.21	6,858
Base Composite	7/22/04	9:41	7/26/04	7:55	0.10	8	7/22/2004 9:30	8/12/2004 7:30	11,761,440	74.89	5,874
Base and Fecal Grab	8/12/04	8:00	8/12/04	8:00	0.07	1	8/12/2004 7:45	9/5/2004 6:45	13,862,810	57.12	865
Storm Composite	9/5/04	8:32	9/7/04	8:21	0.41	154	9/5/2004 7:00	9/6/2004 11:00	1,829,889	46.26	17,592
BASE					*0.10*	*13*	*9/6/2004 11:15*	*9/14/2004 21:15*	*5,568,877*	*33.48*	*4,519*
Storm Composite	9/15/04	3:44	9/16/04	12:20	0.34	158	9/14/2004 21:30	9/16/2004 14:30	3,441,218	73.90	33,942
Base and Fecal Grab	9/27/04	10:30	9/27/04	10:30	0.08	5	9/16/2004 14:45	10/6/2004 4:15	12,694,320	64.98	3,962
Base Composite	10/12/04	12:50	10/14/04	7:10	0.10	13	10/6/2004 4:30	10/28/2004 10:15	13,603,172	84.07	11,040
Storm Composite	10/28/04	13:49	10/29/04	10:28	0.52	198	10/28/2004 10:30	10/30/2004 19:45	6,335,747	206.06	78,312
BASE					*0.10*	*13*	*10/30/2004 20:00*	*11/19/2004 7:00*	*18,472,310*	*111.05*	*14,991*
STORM					*0.42*	*143*	*11/19/2004 7:15*	*11/21/2004 14:45*	*3,277,310*	*86.73*	*29,273*
BASE					*0.10*	*13*	*11/21/2004 15:00*	*12/13/2004 8:30*	*22,220,780*	*133.58*	*18,033*
SNOWMELT					*0.20*	*46*	*12/13/2004 8:45*	*12/14/2004 11:45*	*1,344,025*	*16.44*	*3,860*
BASE					*0.10*	*13*	*12/14/2004 12:00*	*12/18/2004 19:30*	*3,786,603*	*22.76*	*3,073*
SNOWMELT					*0.20*	*46*	*12/18/2004 19:45*	*12/19/2004 10:45*	*1,009,385*	*12.35*	*2,899*
BASE					*0.10*	*13*	*12/19/2004 11:00*	*12/22/2004 12:45*	*2,807,209*	*16.88*	*2,278*
SNOWMELT					*0.20*	*46*	*12/22/2004 13:00*	*12/24/2004 14:30*	*2,547,012*	*31.16*	*7,314*
Base Grab	12/27/04	15:00	12/27/04	15:00	0.05	10	12/24/2004 14:45	12/31/2004 23:45	6,502,682	19.89	4,059
Storm Average					0.42	143					
Base Average					0.10	13					
Snowmelt Average					0.20	46					
All Average					0.22	59					
Total									**311,486,775**	3,633	821,769
Brown's Creek Major Subwatershed Total Acres									13,491		
Total TP/TSS (lb/ac/yr)										0.27	60.91
Total TP/TSS (kg/ha/yr)										0.30	68.27

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

Table 56: Brown's Creek at Mouth (Highway 96) 2005 Total Suspended Solids TSS) and Phosphorus Loading (TP)

	Sample Collection Time						Loading Interval				
Sample Type	Start Date	Start Time	End Date	End Time	TP (mg/L)	TSS (mg/L)	Start	End	Interval Volume (cf)	Interval TP (lb)	Interval TSS (lb)
Base					*0.107*	*7*	*1/1/2005 0:00*	*1/5/2005 5:00*	*3,178,730*	*21.15*	*1,389*
Snowmelt					*0.062*	*10*	*1/5/2005 5:00*	*1/5/2005 13:00*	*371,901*	*1.44*	*232*
Base					*0.107*	*7*	*1/5/2005 13:00*	*1/14/2005 11:00*	*6,162,663*	*41.01*	*2,693*
Snowmelt					*0.062*	*10*	*1/14/2005 11:00*	*1/15/2005 23:45*	*2,006,661*	*7.77*	*1,253*
No Data							**1/15/2005 23:45**	**1/16/2005 16:00**		**0.00**	**0**
Base					*0.107*	*7*	*1/16/2005 16:00*	*1/24/2005 18:00*	*5,524,508*	*36.76*	*2,414*
Base Grab	*1/28/05*	*9:30*	*1/28/05*	*9:30*	*0.052*	*8*	*1/24/2005 18:00*	*1/28/2005 11:00*	*2,747,267*	*8.92*	*1,372*
Base					*0.107*	*7*	*1/28/2005 11:00*	*2/2/2005 12:00*	*2,928,474*	*19.49*	*1,280*
Snowmelt Grab	*2/3/05*	*9:00*	*2/3/05*	*9:00*	*0.062*	*10*	*2/2/2005 12:00*	*2/4/2005 12:00*	*1,173,502*	*4.54*	*733*
Base					*0.107*	*7*	*2/4/2005 12:00*	*2/16/2005 12:45*	*6,810,994*	*45.32*	*2,976*
No Data							**2/16/2005 12:45**	**2/17/2005 11:00**		**0.00**	**0**
Snowmelt					*0.062*	*10*	*2/17/2005 11:00*	*2/18/2005 16:00*	*1,747,468*	*6.76*	*1,091*
Base					*0.107*	*7*	*2/18/2005 16:00*	*2/19/2005 1:00*	*243,976*	*1.62*	*107*
Snowmelt					*0.062*	*10*	*2/19/2005 1:00*	*2/19/2005 11:00*	*638,562*	*2.47*	*399*
Base					*0.107*	*7*	*2/19/2005 11:00*	*2/22/2005 0:00*	*1,559,329*	*10.38*	*681*
Snowmelt					*0.062*	*10*	*2/22/2005 0:00*	*2/22/2005 20:00*	*934,068*	*3.62*	*583*
Base					*0.107*	*7*	*2/22/2005 20:00*	*2/23/2005 2:00*	*141,602*	*0.94*	*62*
Snowmelt					*0.062*	*10*	*2/23/2005 2:00*	*2/23/2005 19:00*	*771,580*	*2.99*	*482*
Base Grab	2/25/05	9:15	2/25/05	9:15	0.055	6	2/23/2005 19:00	2/26/2005 5:00	1,395,276	4.79	523
Snowmelt					*0.062*	*10*	*2/26/2005 5:00*	*2/26/2005 17:00*	*363,839*	*1.41*	*227*
Base					*0.107*	*7*	*2/26/2005 17:00*	*3/1/2005 5:00*	*1,436,807*	*9.56*	*628*
Snowmelt					*0.062*	*10*	*3/1/2005 5:00*	*3/3/2005 19:00*	*2,522,696*	*9.76*	*1,575*
Base					*0.107*	*7*	*3/3/2005 19:00*	*3/6/2005 11:00*	*1,538,222*	*10.24*	*672*
Snowmelt					*0.062*	*10*	*3/6/2005 11:00*	*3/9/2005 22:00*	*3,525,868*	*13.65*	*2,201*
Base Grab	3/25/05	9:00	3/25/05	9:00	0.164	10	3/9/2005 22:00	3/30/2005 10:00	17,247,030	176.57	10,767
Storm Grab	3/31/05	13:30	3/31/05	13:30	0.298	129	3/30/2005 10:00	4/2/2005 7:00	6,106,364	113.60	49,174
Base					*0.107*	*7*	*4/2/2005 7:00*	*4/16/2005 7:00*	*13,427,840*	*89.36*	*5,868*
Storm Grab	4/18/05	13:30	4/18/05	13:30	0.117	36	4/16/2005 7:00	4/21/2005 10:00	6,394,777	46.71	14,371
Base Grab	4/26/05	12:00	4/26/05	12:00	0.064	10	4/21/2005 10:00	5/1/2005 10:00	8,050,882	32.17	5,026
Base Grab	5/5/05	8:45	5/5/05	8:45	0.058	5	5/1/2005 10:00	5/9/2005 10:00	5,567,699	20.16	1,738
Storm					*0.389*	*260*	*5/9/2005 10:00*	*5/9/2005 21:00*	*399,518*	*9.69*	*6,489*
Base					*0.107*	*7*	*5/9/2005 21:00*	*5/12/2005 9:00*	*2,196,951*	*14.62*	*960*
Storm Composite	5/13/05	9:10	5/13/05	16:33	0.049	180	5/12/2005 9:00	5/15/2005 12:00	3,768,618	11.53	42,347
Base					*0.107*	*7*	*5/15/2005 12:00*	*5/18/2005 8:00*	*2,516,624*	*16.75*	*1,100*
Storm Composite	5/19/05	0:16	5/19/05	23:22	0.347	188	5/18/2005 8:00	5/20/2005 22:00	3,455,644	74.86	40,556
Base					*0.107*	*7*	*5/20/2005 22:00*	*5/25/2005 18:00*	*4,114,972*	*27.38*	*1,798*
Storm					*0.389*	*260*	*5/25/2005 18:00*	*5/28/2005 2:00*	*2,217,094*	*53.79*	*36,008*
Base					*0.107*	*7*	*5/28/2005 2:00*	*6/4/2005 14:00*	*5,605,672*	*37.30*	*2,450*
Storm					*0.389*	*260*	*6/4/2005 14:00*	*6/16/2005 10:00*	*12,591,360*	*305.50*	*204,499*
Base					*0.107*	*7*	*6/16/2005 10:00*	*6/20/2005 13:00*	*2,913,516*	*19.39*	*1,273*
Storm					*0.389*	*260*	*6/20/2005 13:00*	*6/21/2005 23:00*	*1,408,170*	*34.17*	*22,870*
Base					*0.107*	*7*	*6/21/2005 23:00*	*6/27/2005 8:00*	*3,326,384*	*22.14*	*1,454*
Storm					*0.389*	*260*	*6/27/2005 8:00*	*6/30/2005 2:00*	*2,659,726*	*64.53*	*43,197*
Base Grab	7/13/05	11:30	7/13/05	11:30	0.108	6	6/30/2005 2:00	7/23/2005 11:00	12,881,830	86.85	4,825
Storm					*0.389*	*260*	*7/23/2005 11:00*	*7/24/2005 0:00*	*467,707*	*11.35*	*7,596*
Base					*0.107*	*7*	*7/24/2005 0:00*	*7/25/2005 18:00*	*959,431*	*6.38*	*419*
Storm Composite	7/25/05	19:00	7/25/05	21:04	0.257	944	7/25/2005 18:00	7/27/2005 2:00	1,134,082	18.19	66,832
Base					*0.107*	*7*	*7/27/2005 2:00*	*8/4/2005 1:00*	*3,934,838*	*26.18*	*1,719*
Storm Composite	8/4/05	1:42	8/4/05	4:56	1.210	916	8/4/2005 1:00	8/5/2005 6:00	1,362,219	102.90	77,895
Base					*0.107*	*7*	*8/5/2005 6:00*	*8/9/2005 14:00*	*2,208,411*	*14.70*	*965*
Storm					*0.389*	*260*	*8/9/2005 14:00*	*8/10/2005 0:00*	*279,110*	*6.77*	*4,533*
Base					*0.107*	*7*	*8/10/2005 0:00*	*8/16/2005 19:00*	*3,424,200*	*22.79*	*1,496*
Storm					*0.389*	*260*	*8/16/2005 19:00*	*8/19/2005 2:00*	*2,133,030*	*51.75*	*34,643*
Base Grab	8/25/05	9:30	8/25/05	9:30	0.076	5	8/19/2005 2:00	8/26/2005 6:00	3,779,465	17.93	1,180
Storm Composite	8/26/05	7:51	8/26/05	13:50	0.970	588	8/26/2005 6:00	8/28/2005 7:00	3,003,167	181.85	110,236
Base					*0.107*	*7*	*8/28/2005 7:00*	*9/12/2005 23:00*	*8,170,775*	*54.37*	*3,570*
Storm					*0.389*	*260*	*9/12/2005 23:00*	*9/14/2005 18:00*	*1,130,221*	*27.42*	*18,356*
Base					*0.107*	*7*	*9/14/2005 18:00*	*9/19/2005 5:00*	*2,306,101*	*15.35*	*1,008*
Storm					*0.389*	*260*	*9/19/2005 5:00*	*9/19/2005 16:00*	*278,309*	*6.75*	*4,520*
Base Composite	9/19/05	16:08	9/20/05	8:54	0.090	12	9/19/2005 16:00	9/21/2005 19:00	1,132,138	6.36	848
Storm					*0.389*	*260*	*9/21/2005 19:00*	*9/23/2005 11:00*	*3,891,700*	*94.42*	*63,206*
Base					*0.107*	*7*	*9/23/2005 11:00*	*9/24/2005 23:00*	*1,743,895*	*11.60*	*762*
Storm					*0.389*	*260*	*9/24/2005 23:00*	*9/26/2005 17:00*	*1,851,870*	*44.93*	*30,077*
Base					*0.107*	*7*	*9/26/2005 17:00*	*9/28/2005 6:00*	*1,149,425*	*7.65*	*502*
Storm					*0.389*	*260*	*9/28/2005 6:00*	*9/28/2005 18:00*	*370,236*	*8.98*	*6,013*
Base					*0.107*	*7*	*9/28/2005 18:00*	*10/4/2005 7:00*	*3,600,247*	*23.96*	*1,573*
Storm Composite	10/4/05	21:25	10/5/05	10:26	0.551	440	10/4/2005 7:00	10/9/2005 17:00	16,396,630	563.99	450,374
Base Grab	10/19/05	10:00	10/19/05	10:00	0.077	5	10/9/2005 17:00	11/15/2005 18:00	26,064,280	125.29	8,135
Storm					*0.457*	*276*	*11/15/2005 18:00*	*11/17/05 18:00*	*1,375,678*	*39.21*	*23,720*
Base					*0.107*	*7*	*11/17/2005 18:00*	*11/28/05 3:00*	*6,481,928*	*43.13*	*2,832*
Storm					*0.457*	*276*	*11/28/2005 3:00*	*12/1/05 2:00*	*2,811,443*	*80.14*	*48,475*
Base					*0.107*	*7*	*12/1/2005 2:00*	*12/4/05 1:00*	*1,734,153*	*11.54*	*758*
Snowmelt					*0.062*	*10*	*12/4/2005 1:00*	*12/4/05 12:00*	*419,162*	*1.62*	*262*
Base					*0.107*	*7*	*12/4/2005 12:00*	*12/5/05 1:00*	*312,612*	*2.08*	*137*
Snowmelt					*0.062*	*10*	*12/5/2005 1:00*	*12/5/05 12:00*	*360,271*	*1.39*	*225*
Base					*0.107*	*7*	*12/5/2005 12:00*	*12/17/05 1:00*	*6,404,546*	*42.62*	*2,799*
Snowmelt					*0.062*	*10*	*12/17/2005 1:00*	*12/20/05 18:00*	*2,872,937*	*11.12*	*1,793*
Base Grab	12/21/05	10:45	12/21/05	10:45	0.322	3	12/20/2005 18:00	1/1/06 0:00	6,570,516	132.08	1,231
Storm Average					0.389	260					
Base Average					0.107	7					
Snowmelt Average					0.062	10					
All Average					0.259	184					
Total									**284,689,396**	3,338	1,499,031
Brown's Creek Major Subwatershed Total Acres									12,864		
Total TP/TSS (lb/ac/yr)										0.26	116.53
Total TP/TSS (kg/ha/yr)										0.29	130.61

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

*Bold indicates data lost due to equipment failure

Table 57. Tributary to Long Lake at 62nd St. 2005 Primary Chemistry Results

Sample Type	Start	End	Total Suspended Solids (mg/L)	Volatile Suspended Solids (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Total Phosphorus (mg/L)	Dissolved P (mg/L)
Storm Grab	3/31/05 12:45	3/31/05 12:45	13	~8	2.50	0.516	0.204
Base Grab	4/26/05 12:30	4/26/05 12:30	~4	~2	0.85	0.077	
Storm Composite	5/12/05 16:14	5/13/05 11:41	129	32	1.10	0.324	
Storm Composite	5/18/05 16:59	5/18/05 22:59	588	140	1.50	0.584	
Storm Composite	6/8/05 6:00	6/8/05 14:55	60	~17	1.50	0.553	
Storm Grab	6/8/05 12:00	6/8/05 12:00	13	~5	1.30	0.286	
Storm Composite	6/13/05 22:54	6/14/05 6:45	49	~12	1.30	0.476	
Storm Composite	6/20/05 14:42	6/20/05 21:00	1860	~135	2.10	0.661	
Storm Composite	6/29/05 23:42	6/30/05 7:17	89	~24	2.20	0.431	
Storm Composite	7/1/05 6:46	7/2/05 0:29	42	~7	0.96	0.192	
Storm Composite	7/25/05 18:53	7/26/05 0:17	32	~8	1.60	0.432	
Storm Grab	8/17/05 11:00	8/17/05 11:00	6	~2	1.60	0.435	
Storm Composite	8/26/05 7:28	8/26/05 14:25	36	~11	1.60	0.450	
Base Composite	9/19/05 9:22	9/21/05 9:59	7	~3	1.70	0.795	
Base Grab	9/21/05 11:00	9/21/05 11:00	~5	~2	1.20	0.095	
Storm Composite	9/21/05 20:39	9/24/05 23:30	32	~10	1.20	0.518	
Storm Composite	9/25/05 0:25	9/25/05 9:34	10	~4	1.10	0.220	
Storm Composite	10/4/05 20:29	10/5/05 7:21	60	~20	2.30	0.590	
Base Grab	10/19/05 11:00	10/19/05 11:00	~4	~3	0.57	0.124	
Average			**160**	**23**	**1.48**	**0.408**	

"Approximate" symbol was left out to calculate averages.

Table 58. Tributary to Long Lake at 62nd St. 2005 Secondary Chemistry Results

Sample Type	Start	End	Copper (mg/L)	Nickel (mg/L)	Lead (mg/L)	Zinc (mg/L)	Cadmium (mg/L)	Chromium (mg/L)	Chloride (mg/L)	Nitrite N (mg/L)	Nitrate N (mg/L)
Storm Grab	3/31/05 12:45	3/31/05 12:45	0.0038	0.0023	0.0006	0.02500	<.00004	0.0013	114	<0.03	0.2
Base Grab	4/26/05 12:30	4/26/05 12:30	0.0015	0.0028	<.00007	0.00380	<.00004	0.0007	154	<0.03	0.07
Storm Composite	5/12/05 16:14	5/13/05 11:41								<0.03	0.14
Storm Composite	5/18/05 16:59	5/18/05 22:59	0.0062	0.0044	0.0025	0.02900	0.00010	0.0031	110	<0.03	0.06
Storm Composite	6/8/05 6:00	6/8/05 14:55	0.0095	0.0036	0.0030	0.02600	0.00080	0.0028	31	<0.03	0.12
Storm Grab	6/8/05 12:00	6/8/05 12:00	0.0084	0.0026	0.0021	0.02100	<.00004	0.0022	23	<0.03	0.18
Storm Composite	6/13/05 22:54	6/14/05 6:45								<0.03	0.12
Storm Composite	6/20/05 14:42	6/20/05 21:00								0.04	0.3
Storm Composite	6/29/05 23:42	6/30/05 7:17								<0.03	0.13
Storm Composite	7/1/05 6:46	7/2/05 0:29	0.0019	0.0017	0.0004	0.00700	0.00008	0.0009	90	<0.03	0.07
Storm Composite	7/25/05 18:53	7/26/05 0:17	0.0072	0.0027	0.0015	0.02000	0.00050	0.0023	19	0.05	0.39
Storm Grab	8/17/05 11:00	8/17/05 11:00	0.0088	0.0030	0.0010	0.02300	<.00004	0.0013	32	<0.03	0.43
Storm Composite	8/26/05 7:28	8/26/05 14:25								0.05	0.38
Base Composite	9/19/05 9:22	9/21/05 9:59								0.03	0.14
Base Grab	9/21/05 11:00	9/21/05 11:00								0.05	0.13
Storm Composite	9/21/05 20:39	9/24/05 23:30								<0.03	0.26
Storm Composite	9/25/05 0:25	9/25/05 9:34								<0.03	0.18
Storm Composite	10/4/05 20:29	10/5/05 7:21	0.0077	0.0046	0.0047	0.02700	0.00010	0.0041	14	<0.03	0.26
Base Grab	10/19/05 11:00	10/19/05 11:00								<0.03	0.11
Average			**0.0061**	**0.0031**	**0.0018**	**0.02020**	**<0.00019**	**0.0021**	**65**	**<0.03**	**0.19**

"Approximate" and "Less Than" symbols were left out to calculate averages.

Table 59. Tributary to Long Lake at Marketplace Pond 2005 Primary Chemistry Results

Sample Type	Start	End	Total Suspended Solids (mg/L)	Volatile Suspended Solids (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Total Phosphorus (mg/L)
Storm Composite	5/12/2005 9:59	5/13/2005 4:27	21	~8	0.94	0.108
Storm Composite	6/7/2005 7:11	6/7/2005 9:09	40	~50	1.70	0.345
Storm Composite	6/8/2005 3:47	6/8/2005 19:34	296	~4	0.67	0.090
Storm Composite	6/13/2005 21:25	6/14/2005 3:19	368	~9	1.10	0.108
Storm Composite	6/20/2005 13:18	6/20/2005 18:37	456	62		
Storm Composite	6/27/2005 19:19	6/27/2005 20:56	68	112	1.10	0.117
Storm Composite	6/29/2005 22:04	6/30/2005 1:13	104	~13	1.60	0.149
Storm Composite	7/23/2005 10:11	7/23/2005 11:32	830	~30	1.30	0.177
Storm Composite	7/25/2005 18:03	7/26/2005 3:52	133	~290	1.10	0.137
Storm Composite	8/4/2005 0:20	8/4/2005 1:55	57	~21	1.30	0.170
Storm Composite	8/9/2005 14:25	8/9/2005 19:59	44	12	0.85	0.127
Storm Composite	8/16/2005 19:01	8/17/2005 0:58	22	~10	0.88	0.105
Storm Composite	8/26/2005 5:50	8/26/2005 17:03	~54	~7	0.72	0.134
Base Composite	9/19/2005 8:14	9/20/2005 4:20	272	~22	0.67	0.080
Storm Composite	9/21/2005 18:58	9/22/2005 3:48	67	76	5.30	1.260
Storm Composite	10/4/2005 6:41	10/4/2005 23:37		~12	0.58	0.139
Average			**179**	**46**	**1.32**	**0.216**

"Approximate" symbol was left out to calculate averages.

Table 60. Tributary to Long Lake at Marketplace Pond 2005 Secondary Chemistry Results

Sample Type	Start	End	Copper (mg/L)	Nickel (mg/L)	Lead (mg/L)	Zinc (mg/L)	Cadmium (mg/L)	Chromium (mg/L)	Chloride (mg/L)	Nitrite N (mg/L)	Nitrate N (mg/L)
Storm Composite	5/12/2005 9:59	5/13/2005 4:27	0.0099	0.0020	0.0016	0.02300	0.00010	0.0038	184	<0.03	0.19
Storm Composite	6/7/2005 7:11	6/7/2005 9:09	0.0360	0.0070	0.0099	0.08000	0.00040	0.0100	66	0.04	0.32
Storm Composite	6/8/2005 3:47	6/8/2005 19:34	0.0067	0.0016	0.0011	0.01300	<.000040	0.0018	102	<0.03	0.18
Storm Composite	6/13/2005 21:25	6/14/2005 3:19								0.04	0.20
Storm Composite	6/20/2005 13:18	6/20/2005 18:37	0.0129	0.0031	0.0035	0.04000	0.00030	0.0064	56	0.03	0.28
Storm Composite	6/27/2005 19:19	6/27/2005 20:56								0.04	0.39
Storm Composite	6/29/2005 22:04	6/30/2005 1:13	0.0115	0.0026	0.0024	0.02200	0.00060	0.0046	54	0.13	0.33
Storm Composite	7/23/2005 10:11	7/23/2005 11:32								<0.03	0.37
Storm Composite	7/25/2005 18:03	7/26/2005 3:52	0.0071	0.0024	0.0014	0.01440	0.00050	0.0039	49	<0.03	0.18
Storm Composite	8/4/2005 0:20	8/4/2005 1:55								<0.03	0.33
Storm Composite	8/9/2005 14:25	8/9/2005 19:59	0.0086	0.0024	0.0020	0.02300	0.00008	0.0048	38	0.10	0.30
Storm Composite	8/16/2005 19:01	8/17/2005 0:58	0.0078	0.0020	0.0017	0.01880	0.00010	0.0021	29	<0.03	0.22
Storm Composite	8/26/2005 5:50	8/26/2005 17:03								<0.03	0.20
Base Composite	9/19/2005 8:14	9/20/2005 4:20								<0.03	0.22
Storm Composite	9/21/2005 18:58	9/22/2005 3:48								<0.03	0.10
Storm Composite	10/4/2005 6:41	10/4/2005 23:37	0.0066	0.0021	0.0022	0.01650	0.00010	0.0030	3	<0.03	0.15
Average			**0.0119**	**0.0028**	**0.0029**	**0.02786**	**0.00027**	**0.0045**	**65**	**0.06**	**0.25**

"Approximate" and "less than" symbols were left out to calculate averages

APPENDIX C – MACROINVERTEBRATE DATA

Brown's Creek Site W3 Macroinvertebrates Found

Date	5/98	10/98	4/99	10/99	5/00	10/00	5/01	10/01	5/02	10/02	5/03	10/03	5/04	10/04	5/05	10/05	4/06	10/07
Baetidae	19	22	83	28	58	25	12	51	33	74	35	7	22	30	86	16	7	48
Heptageniidae			2							2				1	2	6	2	
Chloroperlidae								6										
Perlodidae	17	3	24	9	43	4	10	0	32	0	23	2	10	8	0	4	25	1
Pteronarcyidae	2																	
Brachycentridae		14			1	3		13		10				2		6		2
Glossosomatidae	26	13	7				1	4					1	8	5	3		
Hydropsychidae	20	14	26	18	16	12	3	10	13	7	10	15	17	14	18	4	6	1
Lepidostomatidae																	4	2
Limnephilidae	1				2						11		30					
Odontoceridae							31											
Philpotamidae	1	70	10	60	2	150	6	13	3	12	8	91	2	60		7	3	14
Phryganeidae															1			
Uenoidae	50		1															
Athericidae				1	1			1		1								
Empididae	1		1															
Simuliidae	1	4	9		3			1		51		7	1		85	1	12	2
Tipulidae	4	4		3	4		1	2	2	1		14	4	12	16	11	4	2
Chironomidae, Other	1	2	15		60	3	5		27	6	20		5	2	53	1	163	1
Elmidae	41	55	38	53	6	13	6	15	4	16	5	5	1	13	2	21	3	6
Hydrophilidae															2			
Gammaridae	1			1				5		8	8	1		4	39	7		
Asellidae	5			1		1		5	1						1			
Oligochaeta	4	2	2	1		1		1	1	1	2	1	3	3	2	5		
Gastropoda	1	1													3			
Other_1								1		4								
TOTAL	**195**	**205**	**218**	**175**	**196**	**212**	**75**	**127**	**116**	**189**	**122**	**143**	**96**	**157**	**315**	**92**	**229**	**79**
EPT	**8**	**7**	**7**	**4**	**6**	**5**	**6**	**6**	**4**	**5**	**5**	**4**	**6**	**7**	**5**	**7**	**6**	**6**
Biotic Index	**3.2**	**3.7**	**3.9**	**3.5**	**4.1**	**3.3**	**2.1**	**3.3**	**3.9**	**4.4**	**4**	**3.4**	**3.9**	**3.3**	**4.8**	**3.7**	**5.3**	**3.7**
# Families	**17**	**10**	**11**	**9**	**11**	**9**	**9**	**11**	**9**	**12**	**9**	**9**	**11**	**12**	**14**	**13**	**10**	**10**
Dom. Fam. Tolerance	**4**	**3**	**4**	**3**	**6**	**3**	**0**	**4**	**4**	**4**	**4**	**3**	**4**	**3**	**4**	**4**	**6**	**4**
Dominant Family %	**25.6%**	**34.1%**	**38.1%**	**34.3%**	**30.6%**	**70.8%**	**41.3%**	**40.2%**	**28.4%**	**39.2%**	**28.7%**	**63.6%**	**31.3%**	**38.2%**	**27.3%**	**22.8%**	**71.2%**	**60.8%**

Brown's Creek Site W4 Macroinvertebrates Found

Date	5/98	10/98	4/99	10/99	5/00	10/00	10/01	5/02	10/02	5/03	10/03	5/04	10/04	5/05	10/05	4/06	10/06
Baetidae	42	16	99	6	60	30	50	58	127	27	57	23	32	46	6	14	64
Heptageniidae										3		1		1	3		1
Chloroperlidae							4										
Perlodidae	12	4	12	40	82	12	0	10	0	17	0	6	6	7	3	27	10
Brachycentridae		13		13		85	57		8		98		19		40		31
Glossosomatidae	29	69	9			13	4				10	6	1	3	8		15
Hydropsychidae	35	11		1	15	6	21	1	3	19	30	14	7	6	2	5	4
Hydroptilidae			5														
Limnephilidae	2		1	2	17			1		1		17	1			6	
Philpotamidae	10	1				5	26		3	2					10		
Phryganeidae														2			
Uenoidae	26																
Athericidae							1						1				2
Simuliidae	1	5	1	1					28		6		3	6	2	1	16
Empididae											2			6			
Tipulidae	2	5	1		9	1	5			2	2	1	5	5	16	3	
Chironomidae, Other	2	2	65	3	32		1	11		30	1	6	37	52		84	
Elmidae	11	58	36	36	19	12	4	7	18	3	18	12	2	3	10	10	24
Calopterygidae				1													
Gammaridae						5	22		10		21	2	5	3	3	3	13
Talitridae				2													
Asellidae				6		1	5	1	2		1		1	3	5	1	2
Oligochaeta		2	3		5	3	1	1	5	1		1	6	6	3		1
Gastropoda		2															
Pelecypoda																1	
Other_1							1										
TOTAL	**172**	**188**	**232**	**111**	**239**	**173**	**202**	**90**	**204**	**105**	**246**	**89**	**126**	**149**	**111**	**155**	**183**
EPT	**7**	**6**	**5**	**5**	**4**	**6**	**6**	**4**	**4**	**6**	**4**	**6**	**6**	**6**	**7**	**4**	**6**
Biotic Index	**3**	**2.4**	**4.4**	**3.3**	**2.8**	**2.1**	**3**	**4.1**	**4.3**	**4.2**	**2.7**	**3.8**	**4.8**	**4.9**	**2.7**	**4.7**	**3.3**
# Families	**11**	**12**	**10**	**11**	**8**	**11**	**12**	**8**	**9**	**10**	**11**	**11**	**13**	**14**	**13**	**11**	**12**
Dom. Fam. Tolerance	**4**	**0**	**4**	**2**	**2**	**1**	**1**	**4**	**4**	**6**	**1**	**4**	**6**	**6**	**1**	**6**	**4**
Dominant Family %	**24.4%**	**36.7%**	**42.7%**	**36.0%**	**34.3%**	**49.1%**	**28.2%**	**64.4%**	**62.3%**	**28.6%**	**39.8%**	**25.8%**	**29.6%**	**34.9%**	**36.0%**	**54.2%**	**35.0%**

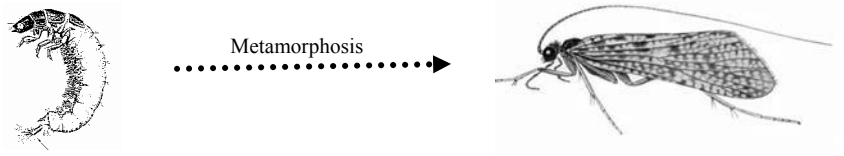
Brown's Creek Site W8 Macroinvertebrates Found

Date	5/8/03	10/4/03	5/6/04	10/7/04	5/5/05	10/13/05	5/4/06	10/6/06
Baetidae		7	2		5	10	2	8
Heptageniidae							1	2
Heptageniidae	1	2						
Perlodidae			2					
Branchycentridae				23	1			2
Glossosomatidae							1	6
Hydropsychidae	5	5	4	1	3			
Uenoidae					1		2	
Limnephilidae		7	22	0	4			
Aeshnidae			2					
Dixidae						1		
Simuliidae					13		9	
Tabaindae	1							
Chironomidae, Other	15		2		34		38	
Elmidae	1	4	2	1	1	1		4
Gammaridae	80	82	75	45	58	70	38	73
Asellidae				1				
Oligochaeta				1	1			
Gastropoda	3		7		4	2	1	2
Pelecypoda						17	5	1
Pelycopoda			1		3			
TOTAL	**106**	**107**	**119**	**72**	**129**	**101**	**97**	**98**

APPENDIX D – MACROINVERTEBRATE MONITORING TERMS

Macroinvertebrate Monitoring Terms

Complete Metamorphosis - occurs in the orders Diptera, Megaloptera, Coleoptera, Trichoptera and Lepidoptera. The life cycle includes the following stages: egg, larva, pupa and adult. This program monitors the larval stage of development.



Trichoptera (caddisfly) larva

Trichoptera (caddisfly) Adult

Dominant Family -The family which comprises the largest single portion of the invertebrate sample.

Dominant Family % Overall - The dominant family's percentage of the total invertebrate sample.

EPT - The number of mayfly (**E**phemeroptera), stonefly (**P**lecoptera), and caddisfly (**T**richoptera) families in the sample. These families represent the pollution intolerant insects. A higher EPT score reflects better water quality than a lower one.

Family Biotic Index (FBI) - Summarizes the various pollution tolerance values of all families in a sample. FBI ranges from 0 to 10, with lower values reflecting higher water quality. Each macroinvertebrate family has a unique pollution tolerance value associated with it. Pollution intolerant families such as stoneflies can only survive in excellent water quality. Pollution tolerant organisms such as leeches and aquatic earthworms can live in poor quality water.

Evaluation of water quality using Hilsenhoff's Family Level Biotic Index

Family Biotic Index	Water Quality	Degree of Organic Pollution
0.00-3.75	Excellent	Organic pollution unlikely
3.76-4.25	Very good	Possible slight organic pollution
4.26-500	Good	Some organic pollution probable
5.01-5.75	Fair	Fairly substantial pollution likely
5.76-6.50	Fairly poor	Substantial pollution likely
6.51-7.25	Poor	Very substantial pollution likely
7.26-10.0	Very poor	Severe organic pollution likely

Habitat Score- Reflects the suitability of a site to host invertebrates regardless of water quality. Ideal stream habitat includes things such as a rocky bottom with low sedimentation and good water flow. Twelve habitat characteristics are examined out in the field and rated on a scoring worksheet. A higher habitat score reflects better quality habitat than a lower one. A "0" reported for habitat indicates that the habitat was not scored for that sampling season.

Hester-Dendy Multi-plate Sampler- these samplers consist of round hardboard tiles stacked on a long eyebolt. The eyebolt is then attached to a cement block with a wing nut and placed in the river 4-5 weeks before sampling.

Incomplete Metamorphosis - occurs in the Ephemeroptera, Plecoptera, Odonata and Hemiptera. The life cycle includes the following stages: egg, early instar larva, late instar larva and adult. This program monitors the larval stage of development.

Number of Families - The number of different benthic macroinvertebrate families found at the site. In general, more diversity is better. Therefore a larger number of families reflect a healthier community than a smaller number. The number of families from the sites sampled in this report ranges from four to seventeen.

Number of Organisms Identified- In the "About the Results" section for each site, occasionally there is a comment about the number of organisms identified. For the protocol that we use, it has been determined that a minimum of 100 organisms per replicate is required to confidently make an assessment. When less than 100 per replicate organisms are collected, the information is still useful, but we cannot be as confident about characterizing the site's health.

Organic Pollution – This type of pollution comes from municipal and on site sewage, animal manure, and food processing facilities. Adding these materials to the stream increases aquatic plant growth, decreases dissolved oxygen, and increases macroinvertebrates that filter organic matter from the water column or gather dead and decaying plant growth.

Water Quality - refers to anything that might affect the invertebrates living in the river for part of their life cycle (such as nutrients, oxygen, sediment, organic pollution, toxins, stream flow, and quality of habitat).