2002 Water Quality Monitoring Report

Wenck File #0002-49

Prepared for:

CLEARWATER RIVER WATERSHED DISTRICT
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January 2003

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1.0 Introduction

The Clearwater River Watershed District has conducted a stream, precipitation and lake monitoring program since 1980. The monitoring program has focused on collecting baseline data to provide long-term analysis of water quality within the District. The base line monitoring consists of monitoring the Clearwater River, Warner Creek, and lakes on a rotating schedule. In recent years the program has expanded to include additional monitoring for fecal coliform bacteria and phosphorus on more Clearwater River sites and tributaries.

In 2002 the Clearwater River was monitored at two locations (CR-28.2 and CR-10.5). Warner Creek was monitored near its inflow to Clearwater Lake at WR-0.2. Forty-seven sites in the watershed were monitored for fecal coliform bacteria; the lakes monitored were Clearwater (East and West basins), Augusta, Betsy, Caroline, Henshaw, Little Mud, Marie, Scott, Union and Weigand. Citizen volunteers collect precipitation data from three stations and Secchi depths for numerous lakes.

Figure 1 shows the baseline monitoring locations and Appendix A gives the monitoring plan.

2.0 Precipitation

Precipitation was above or near historical highs in 2002. Flooding due to both short, intense storms, and long periods of inundation was experienced in the watershed. Figures 2, 3, and 4, show the volunteer precipitation records for the CRWD. The Annandale station recorded 44.72 inches for the year, the Watkins station recorded 37.50 inches, and the Kimball station recorded 40.27 inches.

The volunteer stations annual totals were compared to annual highs for three nearby precipitation stations-- Cokato, Litchfield, and St. Cloud-- in the Midwestern Regional Climate Center (MRCC) database. The MRCC is a program of the National Climatic Data Center (National Oceanic and Atmospheric Administration, U.S. Department of Commerce). The annual highs are given on each figure, and show Litchfield at 39.46 inches in 1965, Cokato at 40.78 inches in 1991, and St. Cloud at 41.01 inches in 1897. The longest periods of record were for the Litchfield (1887 to 2001) and St. Cloud (1893 to 2001) stations, and Cokato has a record from 1971 to 2000.

The Annandale volunteer station annual total exceeded the annual highs for all three MRCC stations, the Kimball station exceeded the Litchfield annual high, and the Watkins station was below the annual highs. Rainfall during the summer months was especially high, but November and December were actually quite dry.

3.0 Streams

3.1 RUNOFF

The average stream flow at the outlet of Clearwater Lake (station CR-10.5) was about 87 cubic feet per second in 2002. This flow rate was equivalent to 7.6 inches of runoff from the 155-square mile watershed. The lake outflow remained high well into the fall as a result of very high rainfall through the summer months.

3.2 TOTAL PHOSPHORUS

Baseline Monitoring:

Baseline phosphorus levels in the Clearwater River remain low, especially as compared with conditions monitored in the early 1980s. The most upstream station, station CR-28.2 had flow-weighted mean total phosphorus concentration of 0.291 mg/l (milligrams per liter, or parts per million). Historically this has ranged from 0.74 to 1.40 mg/l in the early 1980s. Sites WR-0.2 and CR-10.5 had very low flow-weighted mean concentrations of 0.114 mg/l and 0.038 mg/l, respectively. The phosphorus loadings were 9,460 pounds at CR-28.2, and 2,060 and 6,500 pounds, respectively, at WR-0.2 and CR-10.5.

Soluble reactive phosphorus (dissolved form of phosphorus utilized by algae) was also monitored and represents 62%, 12.5%, and 11.3 % of the total phosphorus value at the three stations CR-28.2, WR-0.2 and CR-10.5 respectively. The higher value at CR-28.2 may be indicative of agricultural sources. The low percentage (12.5%) at WR-0.2 is an indicator that the wetlands upstream of this sampling point are assimilating phosphorus successfully.

Special Monitoring:

Results of special phosphorus monitoring are shown on Figures 5, 6 and 7.

Upper Watershed:

Phosphorus values were elevated at 9 of the 10 sites monitored, with WAT-8 being the only site with both values below 0.25 mg/l. Phosphorus concentrations are an issue for the Upper Watershed.

Middle Watershed:

Phosphorus values decreased as the sample location moved downstream along the Clearwater River. From CR-30.0 to CR-28.2 to CR-27.6 to CR-25.0 to CR-23.8 phosphorus values decreased except for one sample (CR-27.9 was slightly (0.03 mg/l) greater than CR-28.2 in August). Above State Highway 15, tributaries off of the Clearwater River, except for KW-4 had elevated phosphorus levels. This includes seven of the eight Kingston wetland tributaries. The Willow Creek stations had low levels of phosphorus except for WIC-3.2 (July sample at 0.95 mg/l) and WT-1.4 (July sample of 0.90 mg/l and August sample of 0.59 mg/l).

Warner Creek:

The west branch of Warner Creek that drains Annandale had elevated concentrations except for WC-1 (water from south of Highway 55). The water quality degrades from State Highway 55 to the site near the Wastewater Treatment Plant (WC-3), and the degradation is not only from runoff from the WWTP, although the pipe outlet from the Wastewater Treatment Plant had elevated values (WC-3A). Water quality improves downstream of the CRWD Annandale Wetland Treatment Project (WC-4).

3.3 FECAL COLIFORM

The state standard of 200 colony-forming units per 100 milliliters is used as a benchmark for coliform contamination in the District.

Upper Watershed:

Results on Figure 5 show that for the six fecal coliform monitoring events, each site except for CL-3 had at least one value greater than 200 colony forming units per 100 milliliters (cfu/100 ml). Seasonal effects are also noticeable, in that no values greater than 200 cfu/100 ml were found during the April and May events. Therefore bacteria contamination is an issue throughout the Upper Watershed after June.

Middle Watershed:

Thirty sites were monitored in the Middle Watershed. Twelve of the sites had no values greater than 200 cfu/100 ml. Eleven of these twelve sites were around lakes Betsy, Scott, and Union. Therefore, fecal coliform contamination is less of an issue near or in these lakes. Upstream of State Highway 15, nine of the ten sites had values above 200 ml. Therefore, fecal contamination is an issue above Highway 15.

Warner Creek:

Concentrations above the 200 cfu/100 ml benchmark were detected at six of the eight stations. Five of the six stations had two exceedances, and concentrations above 1,000 cfu occurred at WC-3, WC-3A and WC-6. Stations WC-3 and WC-3A are near the City of Annandale Wastewater Treatment Plant, and WC-6 is at the outlet of Cedar Lake. Fecal coliform contamination remains an issue for the Warner Creek watershed.

4.0 Annandale Area Water Quality

A CRWD cooperative Annandale Area Stormwater Study was conducted in 2002 with the City of Annandale and Pleasant Lake Improvement Association. The project consisted of modeling, determining sensitive areas for flooding and water quality, determining green space planning areas for the city, and one grab sampling event.

Water quality results are shown on Figure 8. Results for samples taken within the Pleasant Lake watershed, in Subwatersheds 2 and 3, were relatively low except for Subwatershed 2A which had a value of 0.430 mg/l.

Results for the Clearwater Lake Subwatershed (Subwatershed 6) were relatively high. Water quality degrades as it travels from WC-1 through an urbanized area to WC-3 (except for the April 11 event). The cooperative study concluded that several opportunities exist (Subwatershed 6C, 6D and 4) for water quality improvement projects in the Annandale area.

5.0 Water Quality of Lakes Sampled in Year 2002

Ten lakes were sampled in 2002. Figure 9 displays summer average total phosphorus concentration, chlorophyll-*a* concentration, and Secchi depth (water clarity, or transparency) for these lakes. Appendix B presents the Citizen's Lake Monitoring Program Secchi Data. Appendix C presents the 2002 Water Quality Laboratory Reports and Data. Each lake is discussed below.

5.1 LAKE AUGUSTA

Lake Augusta's water quality was good in 2002. The clarity of Augusta (Figure 10) was 6.2 ft in 2002. This lake was monitored by the Wright SWCD and early season readings were 19.5 feet in May and 16 feet in June (not included in above average). Phosphorus was the highest (84.3 µg/l) since 1990, however, chlorophyll-*a* remained at moderate levels, averaging 13.5 µg/l.

5.2 LAKE BETSY

Lake Betsy's water quality was poor. In most years, the Secchi depth is between 2 and 4 feet (Figure 11), and in 2002 it was within this range at 3.0 feet. Phosphorus was the second lowest in the lake's sampling record (180 µg/l); however, chlorophyll-*a* was the third highest value (91.9 µg/l).

5.3 LAKE CAROLINE

Water quality in Lake Caroline was fair. Phosphorus increased in 2002 to 95 µg/l, the highest value since 1987 (Figure 12). Chlorophyll-*a* (45 µg/l) and Secchi depth (5.1 feet) have remained steady since 1994, with chlorophyll-*a* being between 36 and 55 µg/l for eight of eleven years. Secchi has been between three and five feet for seven of eleven years. In 2002, chlorophyll-*a* was within the typical range and Secchi was slightly greater at 5.1 feet.

5.4 CLEARWATER LAKE

Clearwater Lake is sampled in both the West and East basins every year as part of the long-term monitoring plan. Data for 2002 showed good water quality for both basins.

Clearwater West:
Secchi remained good at 6.3 feet and phosphorus remains similar to values since 1993 at 42 µg/l (Figure 13). Chlorophyll-*a* increased significantly as compared to the last few years (18.0 µg/l).

Clearwater East:
The east bay (Figure 14) had similar characteristics as the west bay – an increase in chlorophyll-*a* (to 14 µg/l), and phosphorus (36 mg/l) and Secchi (5.9 feet) values similar to recent years.

5.5 HENSHAW LAKE

Historical data for Henshaw Lake dates back to 1995 (Figure 15). Water quality in 2002 was poor, with low clarity of 2.3 feet, high phosphorus of 210 µg/l, and high chlorophyll-*a* at 103 µg/l.

5.6 LAKE MARIE

Water quality of Lake Marie was fair (Figure 16), with chlorophyll-*a* (37 µg/l) and Secchi (4.0 feet) typical of recent years. However, phosphorus was at a historical low concentration of 70 µg/l.

5.7 LITTLE MUD LAKE

Little Mud Lake (Figure 17) has been sampled in only three years (1995, 1999 and 2002). Secchi was lower than previous years (4.6 feet), total phosphorus (49 µg/l) was slightly lower than previous years, and chlorophyll-*a* (21 µg/l) was near the average of previous years. Overall, Little Mud Lake's water quality was fair.

5.8 SCOTT LAKE

Clarity was low in Scott Lake (2.4 feet on Figure 18), and total phosphorus remained high (210 µg/l), though it continues to decline. Chlorophyll-*a* was also high at 103 µg/l. Overall, water quality was poor.

5.9 UNION LAKE

Water quality in Union Lake was poor in 2002 (Figure 19). Secchi decreased to 3.3 feet and phosphorus (88 µg/l) and chlorophyll-*a* (39 µg/l) increased dramatically relative to levels in 1995 - 1999.

5.10 WEIGAND LAKE

Weigand Lake's water quality was very good in 2002, with a very high clarity at 10.0 feet and low phosphorus (37 µg/l) and chlorophyll-*a* (5.3 µg/l) concentrations.

6.0 Conclusions

1. Precipitation for the year was high, 44.72 inches, which is 155% of normal at the Annandale Station.

2. The high precipitation resulted in extremely wet conditions with 7.6 inches of runoff.

3. The Clearwater River phosphorus load was about 9,460 pounds at CR-28.2, similar to 2001 but significantly higher than previous years due to the high precipitation.

4. Fecal coliform bacteria were found at levels of concern in Clearwater River and Warner Creek. These findings confirm the 2000 and 2001 fecal coliform monitoring results.

5. The water quality of Weigand Lake was very good, while Lake Augusta and Clearwater Lake continued to be good. Caroline's, Marie's, and Little Mud Lake's water quality was fair; but Betsy's, Henshaw's, Scott's, and Union's water quality was poor.

6. The Annandale Area Stormwater Study performed jointly with the City of Annandale and Pleasant Lake Improvement Association confirmed some areas of concern and identified opportunities for water quality improvement projects.

7.0 Recommendations

1. Continue the District's water quality and hydrologic monitoring program.

2. Consider using genetic identification methods to investigate the sources of fecal coliform bacteria in the District, and evaluate bacteria control methods.

3. Continue pursuing methods to improve the water quality of the District lakes.

4. Pursue a Total Maximum Daily Load (TMDL) grant from the Minnesota Pollution Control Agency (MPCA) to develop a plan to address the impaired waters of the District.

5. Consider a groundwater monitoring or data collection program since fecal coliform is prevalent throughout the District and may indicate a public health concern.

6. Consider Stormwater Studies around the areas of Watkins and Kimball to identify opportunities for water quality improvement projects.

7. Consider enhanced phosphorus reduction methods upstream of Lake Betsy and Scott Lake to reduce phosphorus loads to the Chain of Lakes.

Tables

TABLE 1

YEARLY PRECIPITATION AND RUNOFF TOTALS

Clearwater River Watershed District

	Precipitation (inches of water)									
YEAR	Watkins	Kingston		Maine Prairie		Corinna		Area-Weighted Average		Runoff (inches)
1981	--	--		--		--		19.76	(1)	3.6
1982	--	--		--		--		24.58	(1)	6.8
1983	46.54	--		42.32		35.02		41.78		17.4
1984	32.23	30.13		32.37		36.07		32.95		13.3
1985	40.72	39.49		45.28		--		42.22		12.0
1986	40.02	35.63		39.68		33.40		37.26		16.0
1987	18.97	15.40		19.41		16.16		17.52		1.4
1988	16.57	18.98		15.96		15.01		16.48		0.7
1989	22.13	22.68		21.80		16.96		20.68		3.0
1990	40.35	39.18		41.36		32.18		37.94		11.7
1991	41.30	45.11		43.41		36.28		41.01		20.7
1992	23.06	18.41		20.47		24.35		22.01		12.9
1993	40.17	35.27	(2)	37.54	(2)	33.33		36.71		15.5
1994	34.77	--		30.13		30.26		31.98		9.0
1995	33.80	--		33.65		28.66		32.21		8.8
1996	31.31	--		24.32	(2)	26.13	(2)	27.59		4.8
1997	24.18	--		21.90		27.37		24.43		6.3
1998	30.03	--		29.39		27.43	(2)	29.05		5.5
1999	22.08	--		22.31	(2)	27.71		23.84		3.9
2000	23.83	--		20.56		19.91		21.22		1.0
2001	31.00	--		33.56		29.57		31.28		2.8
2002	37.50			40.27		44.72		40.57		7.6
						Mean		29.17		8.4
						Std. Dev.		8.2		5.8

NOTES:

Whole watershed runoff is based on time-weighted average flow at Clearwater Lake outlet (station CR 10.5), and total drainage area of 155 square miles.

(1) Data for single gauge in east-central part of watershed (Camp Heritage on Lake Caroline).

(2) Average values of other stations in District were used to fill in missing data.

TABLE 2
HISTORICAL SUMMARY OF STREAM FLOWS, PHOSPHORUS CONCENTRATIONS, AND LOADINGS

Clearwater River Watershed District

Station	Year	Average Stream Flow (cu m/sec)	Average Stream Flow (cfs)	Average Total Phosphorus Concentration (mg/l)	Total Phosphorus Load (kg)	Total Phosphorus Load (lb)
Main Stem:						
CR 28.2	1981 (1)	--	--	1.40	--	--
	1982 (1)	0.93	32.8	0.74	19,700	43,500
	1983	2.62	92.6	0.92	76,000	168,000
	1984	1.49	52.6	0.76	35,700	78,800
	1985	2.32	81.9	0.90	65,500	144,000
	1986	3.20	113	0.78	55,200	122,000
	1987	0.11	3.90	0.13	460	1,020
	1988	0.09	3.12	0.66	1,850	4,080
	1989	0.02	0.72	0.19	120	260
	1990	0.51	18.0	0.44	7,040	15,500
	1991	1.11	39.1	0.29	10,200	22,500
	1992	0.26	9.30	0.20	1,660	3,650
	1993	1.28	45.2	0.29	11,600	25,600
	1994	1.17	41.2	0.28	10,100	22,300
	1995	1.15	40.4	0.29	10,400	22,900
	1996	0.33	11.7	0.27	2,860	6,300
	1997	0.27	9.36	0.26	2,170	4,790
	1998	0.41	14.4	0.25	3,190	7,020
	1999	0.08	2.78	0.16	400	870
	2000	0.02	0.72	0.38	240	530
	2001 (4),(5)	0.27	9.46	0.51	4,309	9,500
	2002	0.47	16.50	0.29	4,290	9,460
CR 10.5	1981 (1)	1.15	40.6	0.05	2,060	4,550
	1982 (1)	2.20	77.8	0.07	4,990	11,000
	1983	5.64	199	0.10	18,500	40,800
	1984	4.28	151	0.05	6,620	14,600
	1985	3.88	137	0.14	16,700	36,800
	1986	5.52	195	0.15	23,700	52,300
	1987	0.46	16.2	0.04	600	1,320
	1988	0.23	7.95	0.04	260	580
	1989	0.97	34.2	0.08	2,340	5,150
	1990	3.77	133	0.03	3,060	6,750
	1991	6.68	236	0.05	10,500	23,200
	1992	4.16	147	0.06	8,090	17,800
	1993	5.01	177	0.04	6,330	14,000
	1994	2.92	103	0.03	2,850	6,290
	1995	2.83	100	0.03	3,040	6,710
	1996	1.53	54.2	0.04	1,970	4,350
	1997	2.06	72.8	0.04	2,690	5,940
	1998	1.78	63.0	0.04	2,330	5,120
	1999	1.25	44.1	0.04	1,520	3,350
	2000	0.31	10.8	0.03	280	610
	2001 (4),(5)	0.90	31.7	0.03	850	1,873
	2002	2.46	87.0	0.04	2,950	6,500

TABLE 2
HISTORICAL SUMMARY OF STREAM FLOWS, PHOSPHORUS CONCENTRATIONS, AND LOADINGS

Clearwater River Watershed District

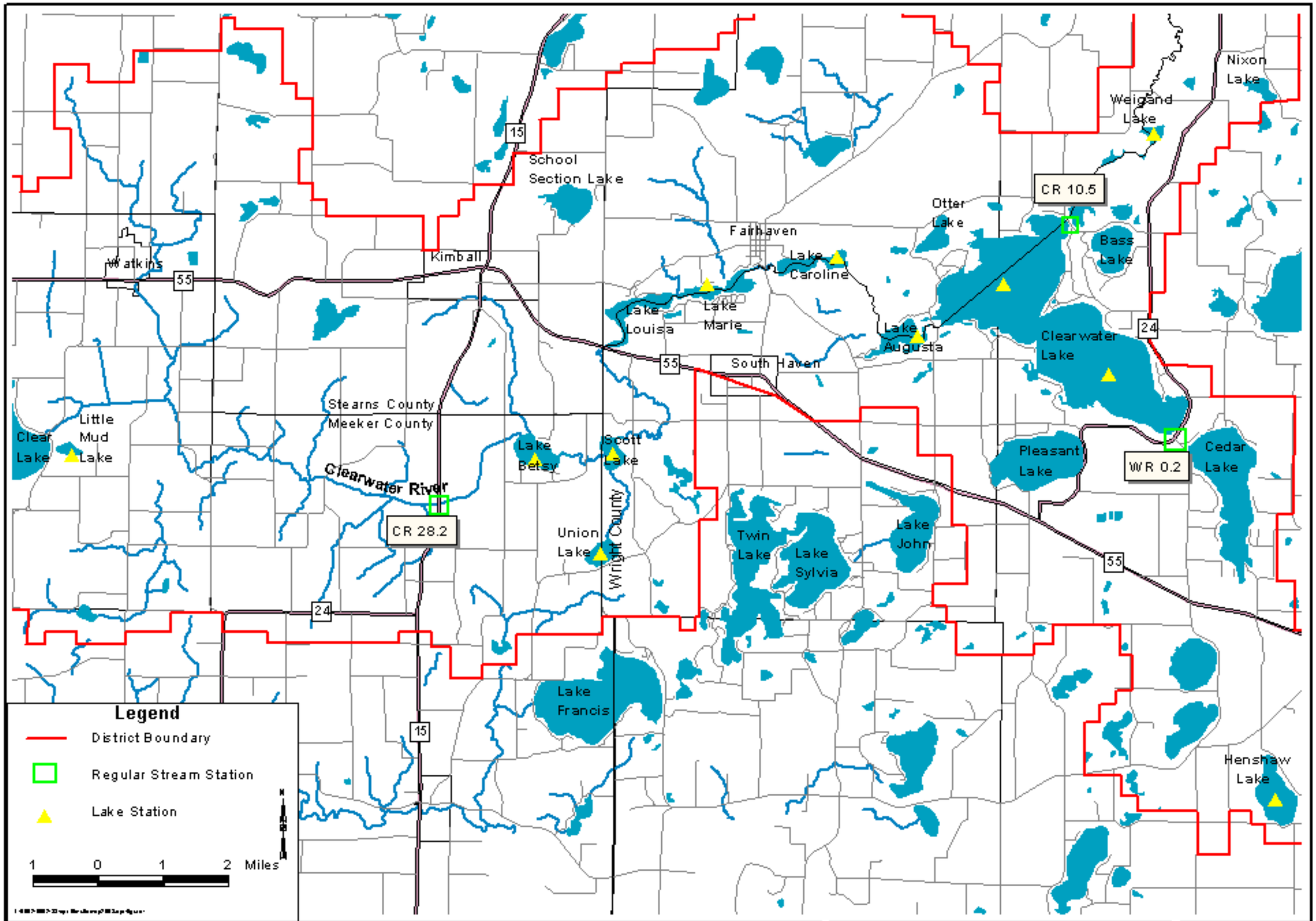
Station	Year	Average Stream Flow (cu m/sec)	Average Stream Flow (cfs)	Average Total Phosphorus Concentration (mg/l)	Total Phosphorus Load (kg)	Total Phosphorus Load (lb)
Tributaries:						
WR 0.2 (2)	1981 (1)	0.07	2.60	0.17	390	860
	1982 (1)	0.23	8.20	0.16	780	1,720
	1983	0.47	16.50	0.09	1,270	2,800
	1984	0.60	21.20	0.05	950	2,100
	1985	0.48	17.10	0.14	2,130	4,700
	1986	0.86	30.40	0.20	4,630	10,200
	1987	0.04	1.50	0.07	100	230
	1988	0.01	0.40	0.17	60	130
	1989	0.03	1.19	0.14	80	180
	1990	0.06	2.28	0.37	750	1,660
	1991	0.26	9.22	0.11	860	1,900
	1992	0.11	4.02	0.05	170	370
	1993	0.24	8.59	0.10	760	1,670
	1994	0.18	6.34	0.06	320	700
	1995	0.12	4.27	0.05	210	460
	1996	0.05	1.78	0.11	180	380
	1997	0.09	3.15	0.08	220	480
	1998	0.09	3.11	0.11	290	650
	1999	0.06	2.03	0.07	130	280
	2000 (3)	0.01	0.44	0.06	25	56
	2001 (4),(5)	0.08	2.88	0.10	257	567
	2002	0.26	9.17	0.11	930	2,060

NOTES:

Flow values are time-weighted averages unless otherwise noted.
Total phosphorus values are flow- and time-weighted averages unless otherwise noted.

(1) Values in 1981 and 1982 are arithmetic means
(2) Station WR 0.2 was designated Station WC 0.2 in 1981-1983
(3) Phosphorus values in 2000 are flow-weighted and adjusted per log-log regression on flow so as to correspond to annual mean flows.
(4) 2001 Flow and total phosphorus values are arithmetic averages.
(5) 2001 total phosphorus loads estimated from arithmetic averages of flow and total phosphorus values.

Figures



CLEARWATER RIVER WATERSHED DISTRICT

2002 Regular Stream and Lake Monitoring Locations

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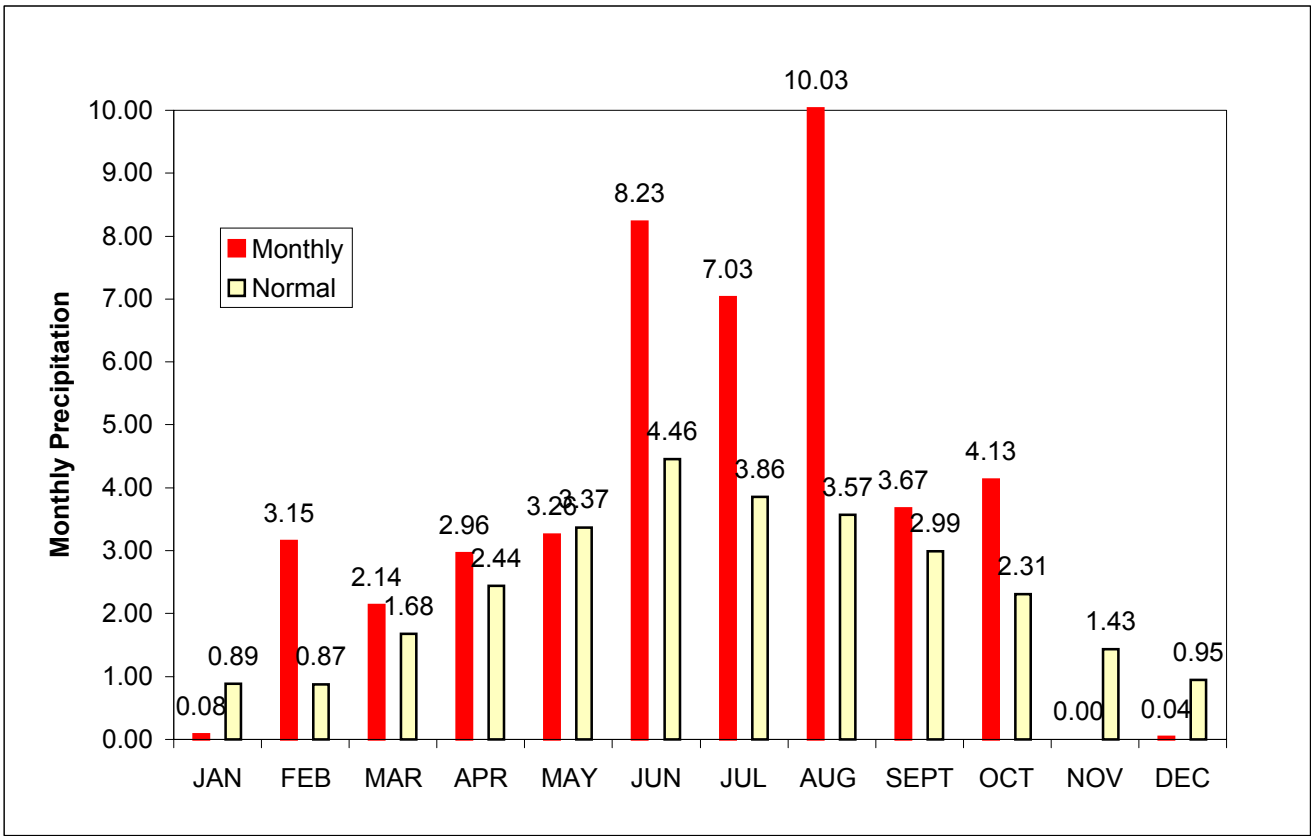
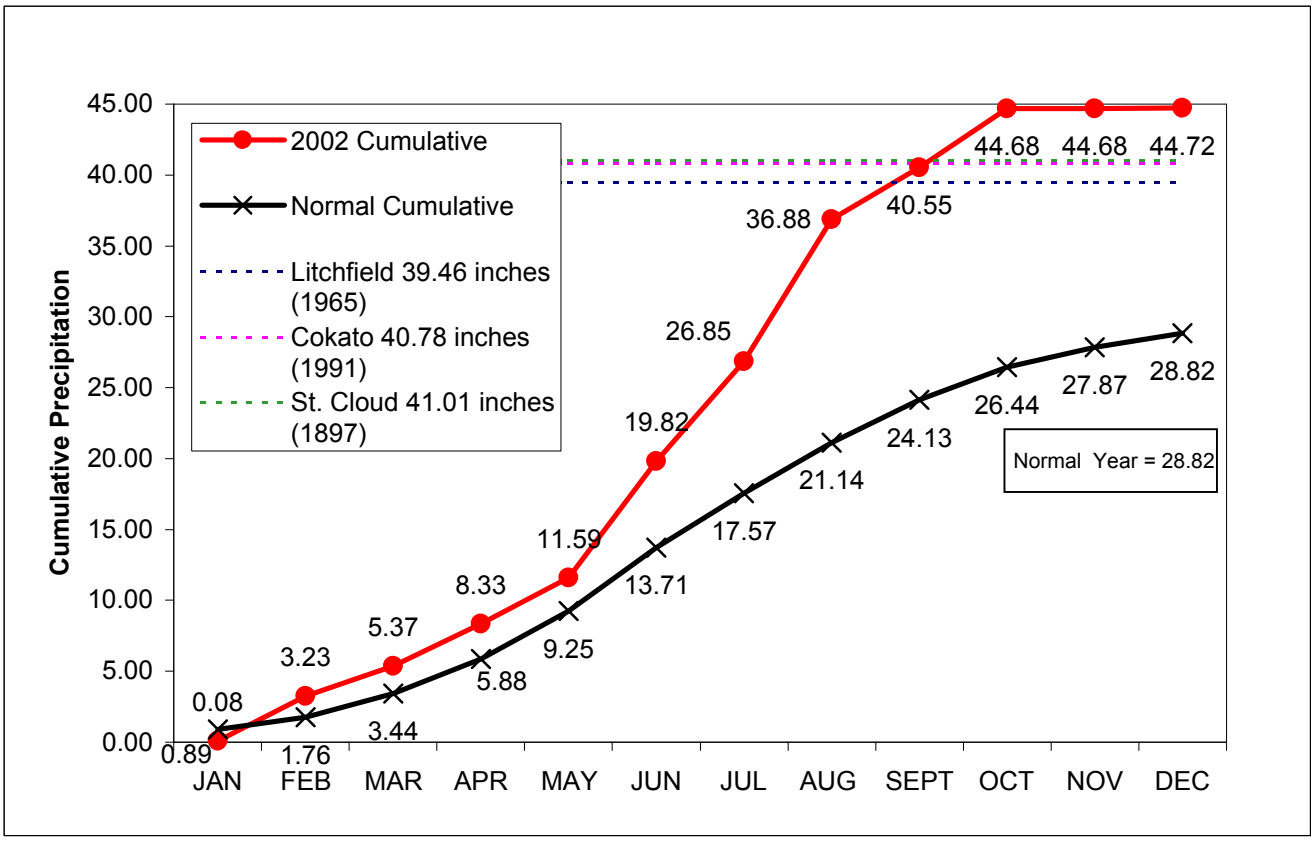
Maple Plain, MN 55359-0429

JAN 2003

Figure 1





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2002 Precipitation Data of Annandale Station and Annual Highs		Figure 2

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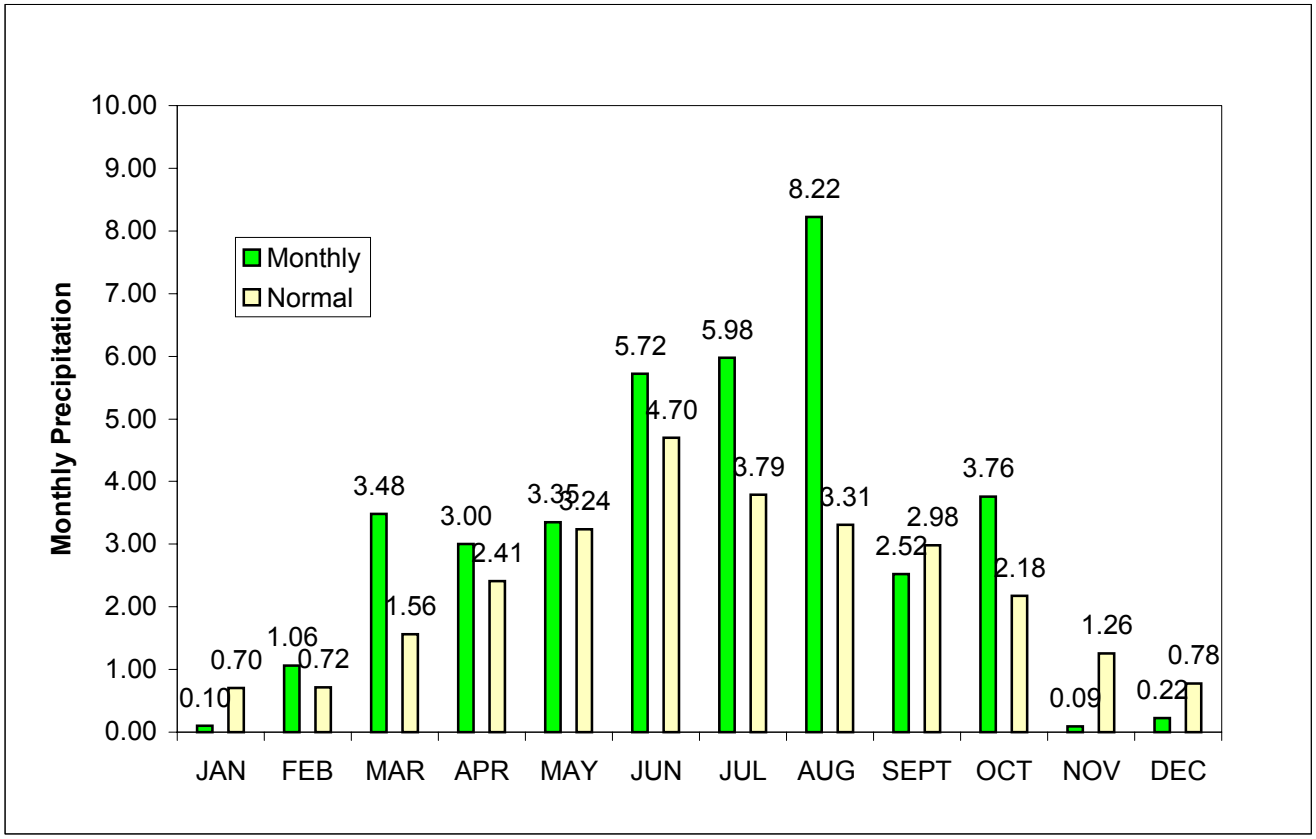

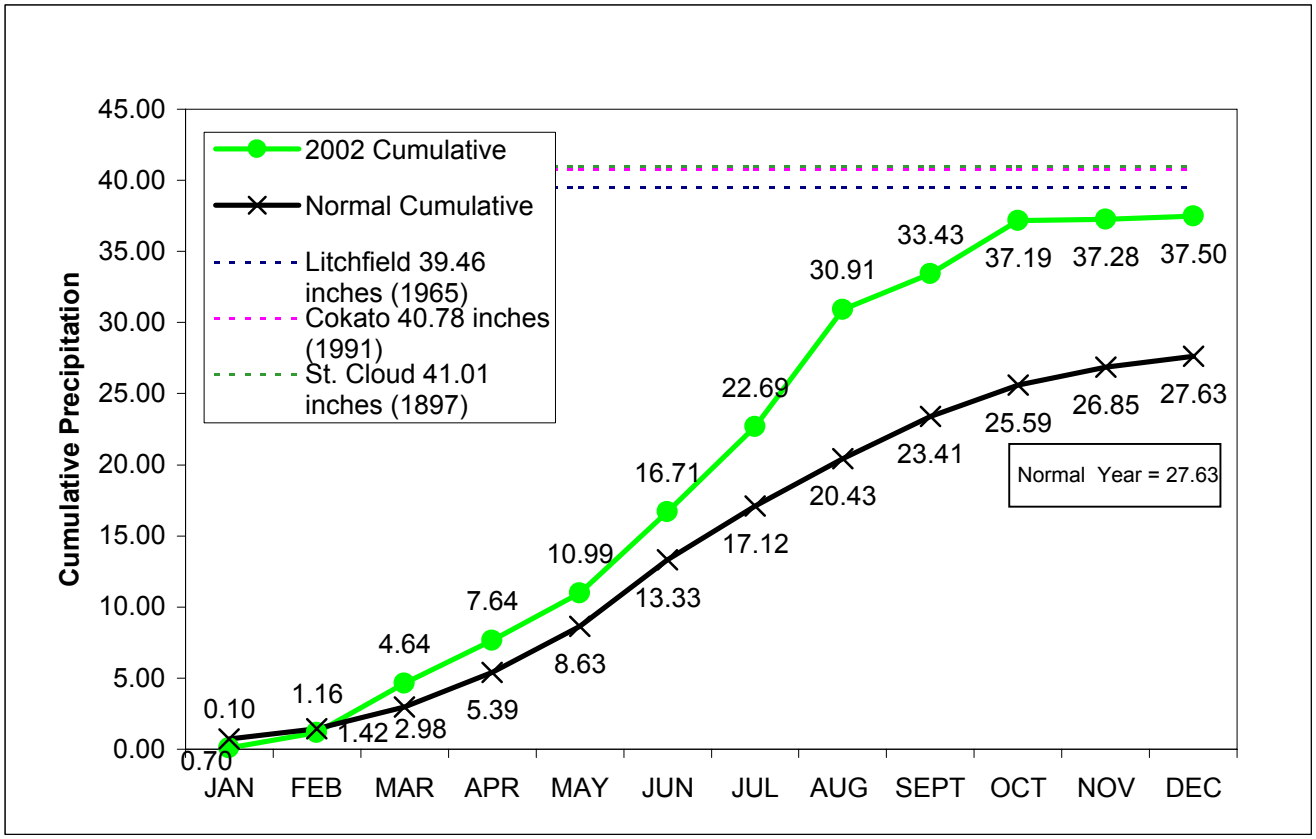

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2002 Precipitation Data of Watkins Station and Annual Highs

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Figure 3

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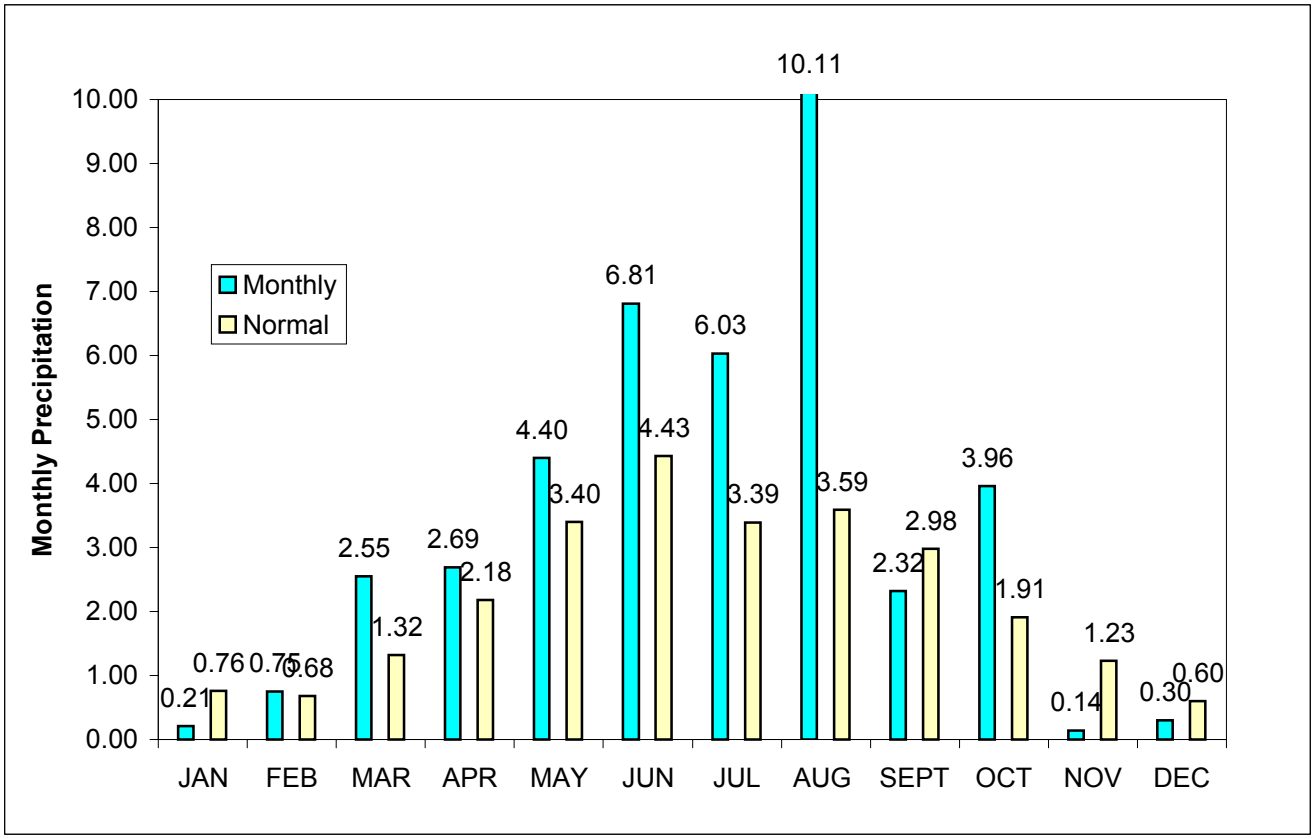

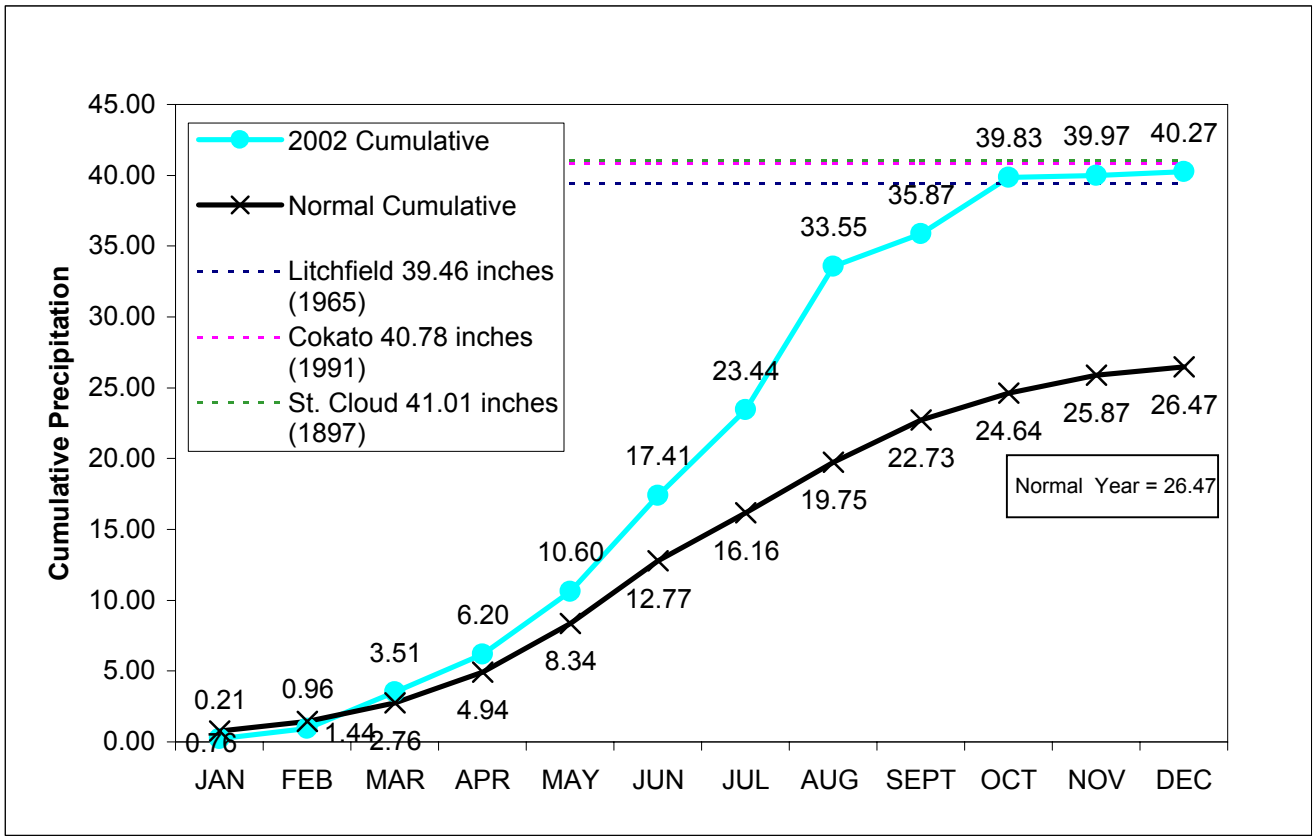

CLEARWATER RIVER WATERSHED DISTRICT	Wenck Associates, Inc. Environmental Engineers — Wenck — 1800 Pioneer Creek Center Maple Plain, MN 55359	JAN. 2003
2002 Precipitation Data of Kimball Station and Annual Highs		Figure 4

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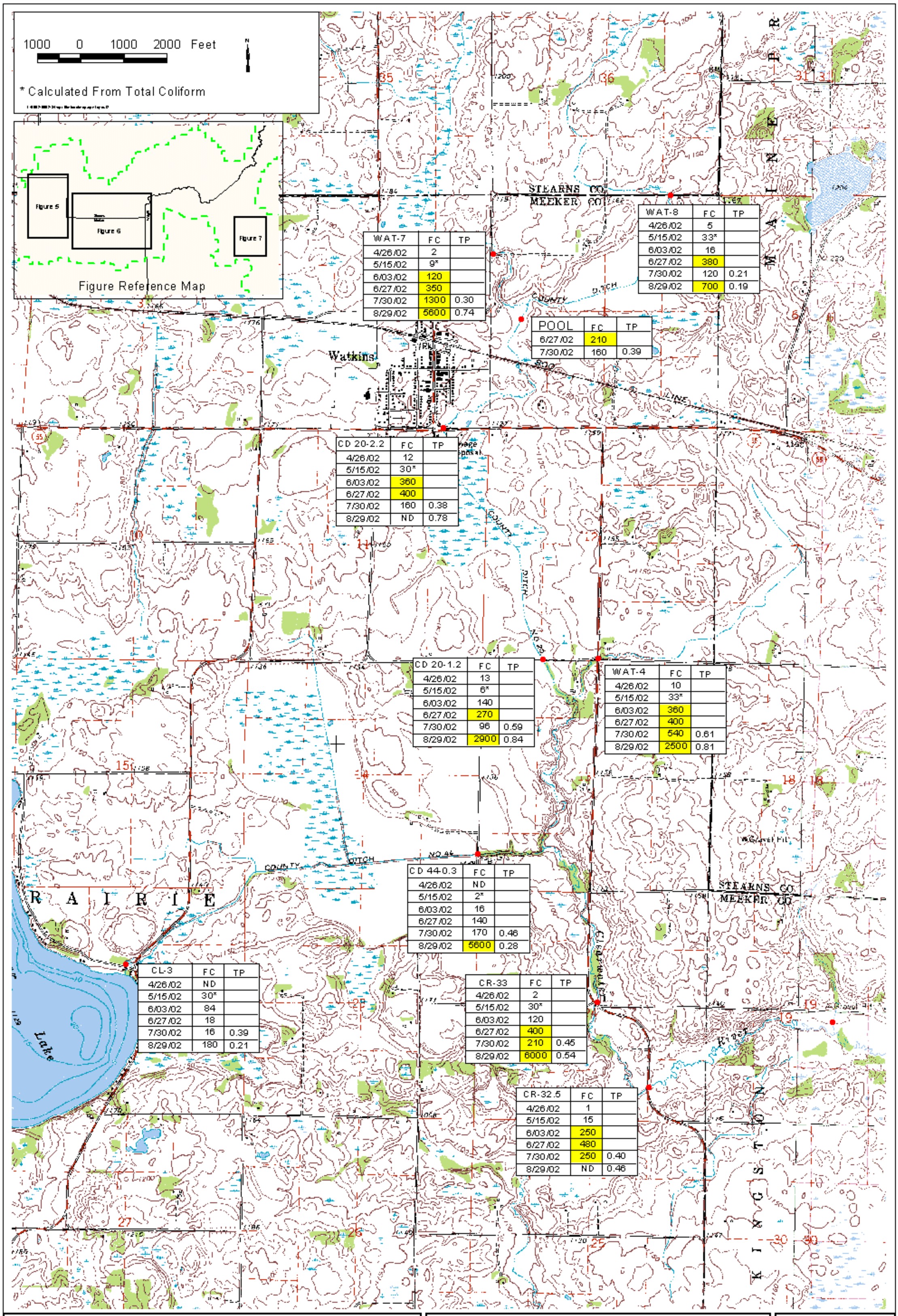

CLEARWATER RIVER WATERSHED DISTRICT

2002 Upper Watershed Monitoring Results

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Wenck Associates, Inc. Environmental Engineers
1800 Pioneer Creek Center Maple Plain, MN 55359-0249

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Figure 5

CLEARWATER RIVER WATERSHED DISTRICT

2002 Middle Watershed Monitoring Results

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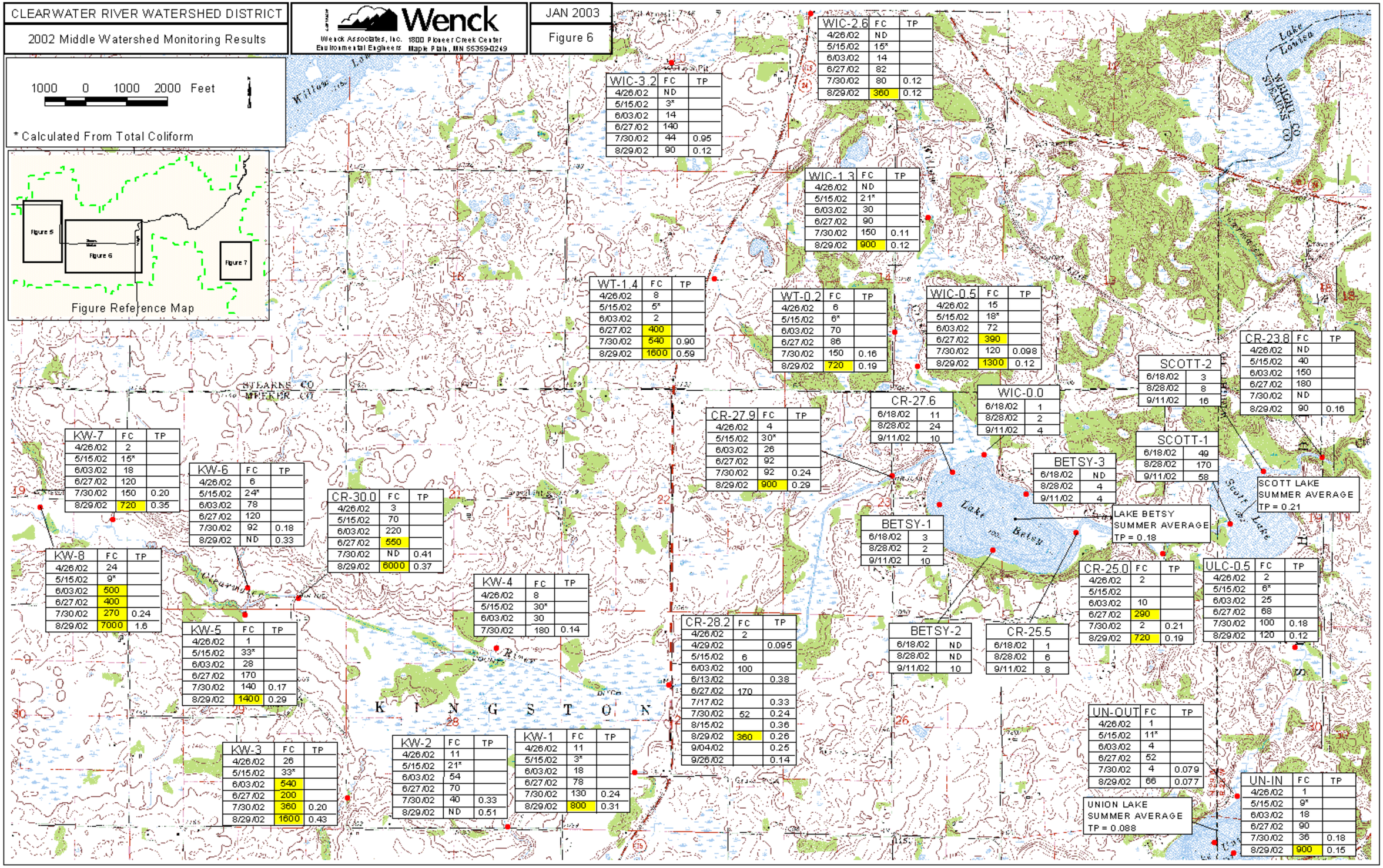
Figure 6



WIC-3.2	FC	TP
4/26/02	ND	
5/15/02	3*	
6/03/02	14	
6/27/02	140	
7/30/02	44	0.95
8/29/02	90	0.12

WIC-2.6	FC	TP
4/26/02	ND	
5/15/02	15*	
6/03/02	14	
6/27/02	82	
7/30/02	80	0.12
8/29/02	360	0.12

WIC-1.3	FC	TP
4/26/02	ND	
5/15/02	21*	
6/03/02	30	
6/27/02	90	
7/30/02	150	0.11
8/29/02	900	0.12

WT-1.4	FC	TP
4/26/02	8	
5/15/02	5*	
6/03/02	2	
6/27/02	400	
7/30/02	540	0.90
8/29/02	1600	0.59

WT-0.2	FC	TP
4/26/02	6	
5/15/02	6*	
6/03/02	70	
6/27/02	86	
7/30/02	150	0.16
8/29/02	720	0.19

WIC-0.5	FC	TP
4/26/02	15	
5/15/02	18*	
6/03/02	72	
6/27/02	390	
7/30/02	120	0.098
8/29/02	1300	0.12

CR-23.8	FC	TP
4/26/02	ND	
5/15/02	40	
6/03/02	150	
6/27/02	180	
7/30/02	ND	
8/29/02	90	0.16

SCOTT-2	
6/18/02	3
8/28/02	8
9/11/02	16

WIC-0.0	
6/18/02	1
8/28/02	2
9/11/02	4

CR-27.6	
6/18/02	11
8/28/02	24
9/11/02	10

CR-27.9	FC	TP
4/26/02	4	
5/15/02	30*	
6/03/02	26	
6/27/02	92	
7/30/02	92	0.24
8/29/02	900	0.29

SCOTT-1	
6/18/02	49
8/28/02	170
9/11/02	58

BETSY-3	
6/18/02	ND
8/28/02	4
9/11/02	4

KW-7	FC	TP
4/26/02	2	
5/15/02	15*	
6/03/02	18	
6/27/02	120	
7/30/02	150	0.20
8/29/02	720	0.35

KW-6	FC	TP
4/26/02	6	
5/15/02	24*	
6/03/02	78	
6/27/02	120	
7/30/02	92	0.18
8/29/02	ND	0.33

CR-30.0	FC	TP
4/26/02	3	
5/15/02	70	
6/03/02	220	
6/27/02	550	
7/30/02	ND	0.41
8/29/02	6000	0.37

BETSY-1	
6/18/02	3
8/28/02	2
9/11/02	10

KW-8	FC	TP
4/26/02	24	
5/15/02	9*	
6/03/02	500	
6/27/02	400	
7/30/02	270	0.24
8/29/02	7000	1.6

KW-4	FC	TP
4/26/02	8	
5/15/02	30*	
6/03/02	30	
7/30/02	180	0.14

CR-25.0	FC	TP
4/26/02	2	
5/15/02		
6/03/02	10	
6/27/02	290	
7/30/02	2	0.21
8/29/02	720	0.19

ULC-0.5	FC	TP
4/26/02	2	
5/15/02	6*	
6/03/02	25	
6/27/02	68	
7/30/02	100	0.18
8/29/02	120	0.12

CR-28.2	FC	TP
4/26/02	2	
4/29/02		0.095
5/15/02	6	
6/03/02	100	
6/13/02		0.38
6/27/02	170	
7/17/02		0.33
7/30/02	52	0.24
8/15/02		0.36
8/29/02	360	0.26
9/04/02		0.25
9/26/02		0.14

BETSY-2	
6/18/02	ND
8/28/02	ND
9/11/02	10

CR-25.5	
6/18/02	1
8/28/02	6
9/11/02	8

KW-5	FC	TP
4/26/02	1	
5/15/02	33*	
6/03/02	28	
6/27/02	170	
7/30/02	140	0.17
8/29/02	1400	0.29

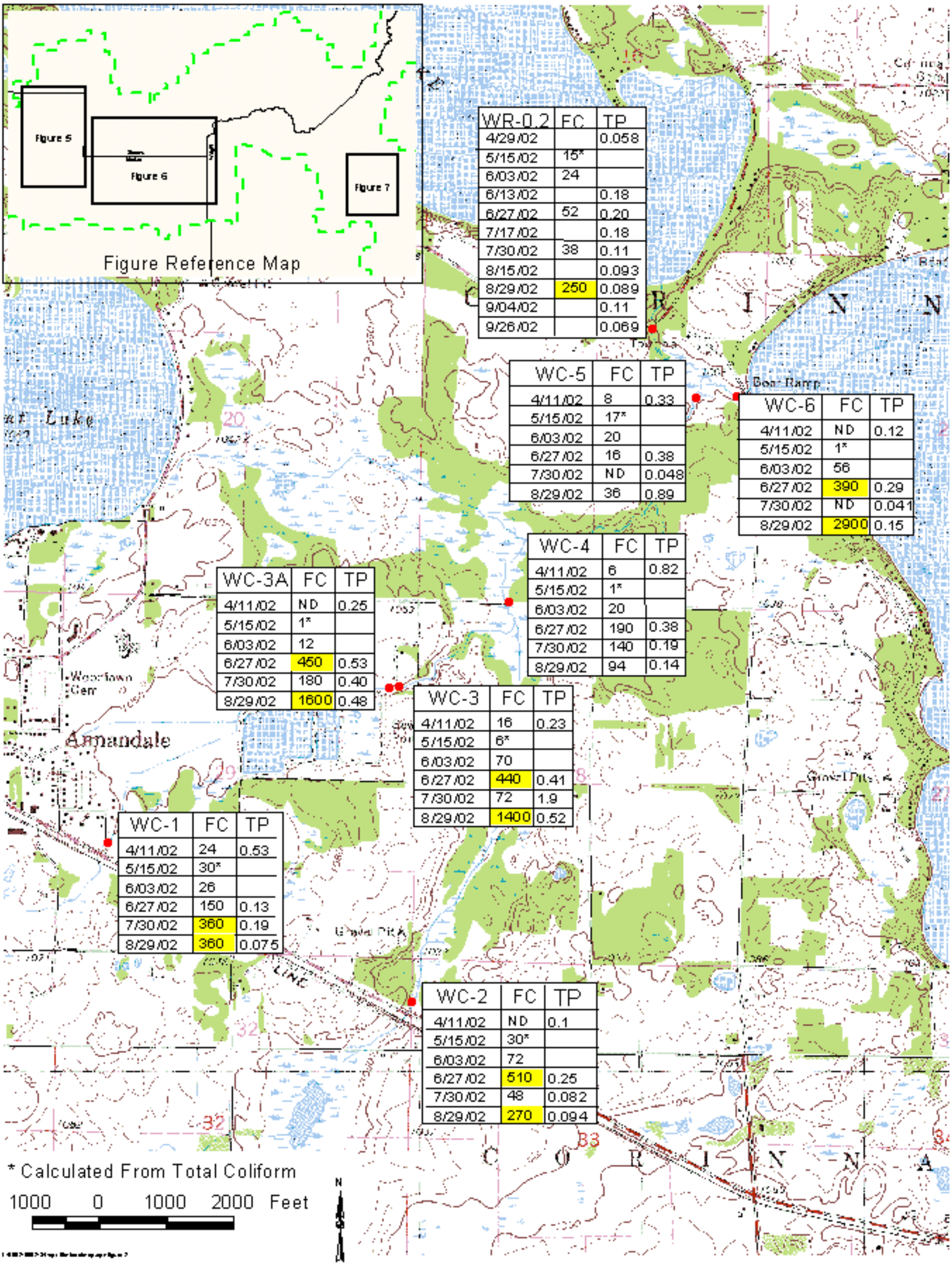
UN-OUT	FC	TP
4/26/02	1	
5/15/02	11*	
6/03/02	4	
6/27/02	52	
7/30/02	4	0.079
8/29/02	66	0.077

KW-3	FC	TP
4/26/02	26	
5/15/02	33*	
6/03/02	540	
6/27/02	200	
7/30/02	360	0.20
8/29/02	1600	0.43

KW-2	FC	TP
4/26/02	11	
5/15/02	21*	
6/03/02	54	
6/27/02	70	
7/30/02	40	0.33
8/29/02	ND	0.51

KW-1	FC	TP
4/26/02	11	
5/15/02	3*	
6/03/02	18	
6/27/02	78	
7/30/02	130	0.24
8/29/02	800	0.31

UN-IN	FC	TP
4/26/02	1	
5/15/02	9*	
6/03/02	18	
6/27/02	90	
7/30/02	36	0.18
8/29/02	900	0.15



WR-0.2	FC	TP
4/29/02		0.058
5/15/02	15*	
6/03/02	24	
6/13/02		0.18
6/27/02	52	0.20
7/17/02		0.18
7/30/02	38	0.11
8/15/02		0.093
8/29/02	250	0.089
9/04/02		0.11
9/26/02		0.069

WC-5	FC	TP
4/11/02	8	0.33
5/15/02	17*	
6/03/02	20	
6/27/02	16	0.38
7/30/02	ND	0.048
8/29/02	36	0.89

WC-6	FC	TP
4/11/02	ND	0.12
5/15/02	1*	
6/03/02	56	
6/27/02	390	0.29
7/30/02	ND	0.041
8/29/02	2900	0.15

WC-4	FC	TP
4/11/02	6	0.82
5/15/02	1*	
6/03/02	20	
6/27/02	190	0.38
7/30/02	140	0.19
8/29/02	94	0.14

WC-3A	FC	TP
4/11/02	ND	0.25
5/15/02	1*	
6/03/02	12	
6/27/02	450	0.53
7/30/02	180	0.40
8/29/02	1600	0.48

WC-3	FC	TP
4/11/02	16	0.23
5/15/02	6*	
6/03/02	70	
6/27/02	440	0.41
7/30/02	72	1.9
8/29/02	1400	0.52

WC-1	FC	TP
4/11/02	24	0.53
5/15/02	30*	
6/03/02	26	
6/27/02	150	0.13
7/30/02	360	0.19
8/29/02	360	0.075

WC-2	FC	TP
4/11/02	ND	0.1
5/15/02	30*	
6/03/02	72	
6/27/02	510	0.25
7/30/02	48	0.082
8/29/02	270	0.094

CLEARWATER RIVER WATERSHED DISTRICT

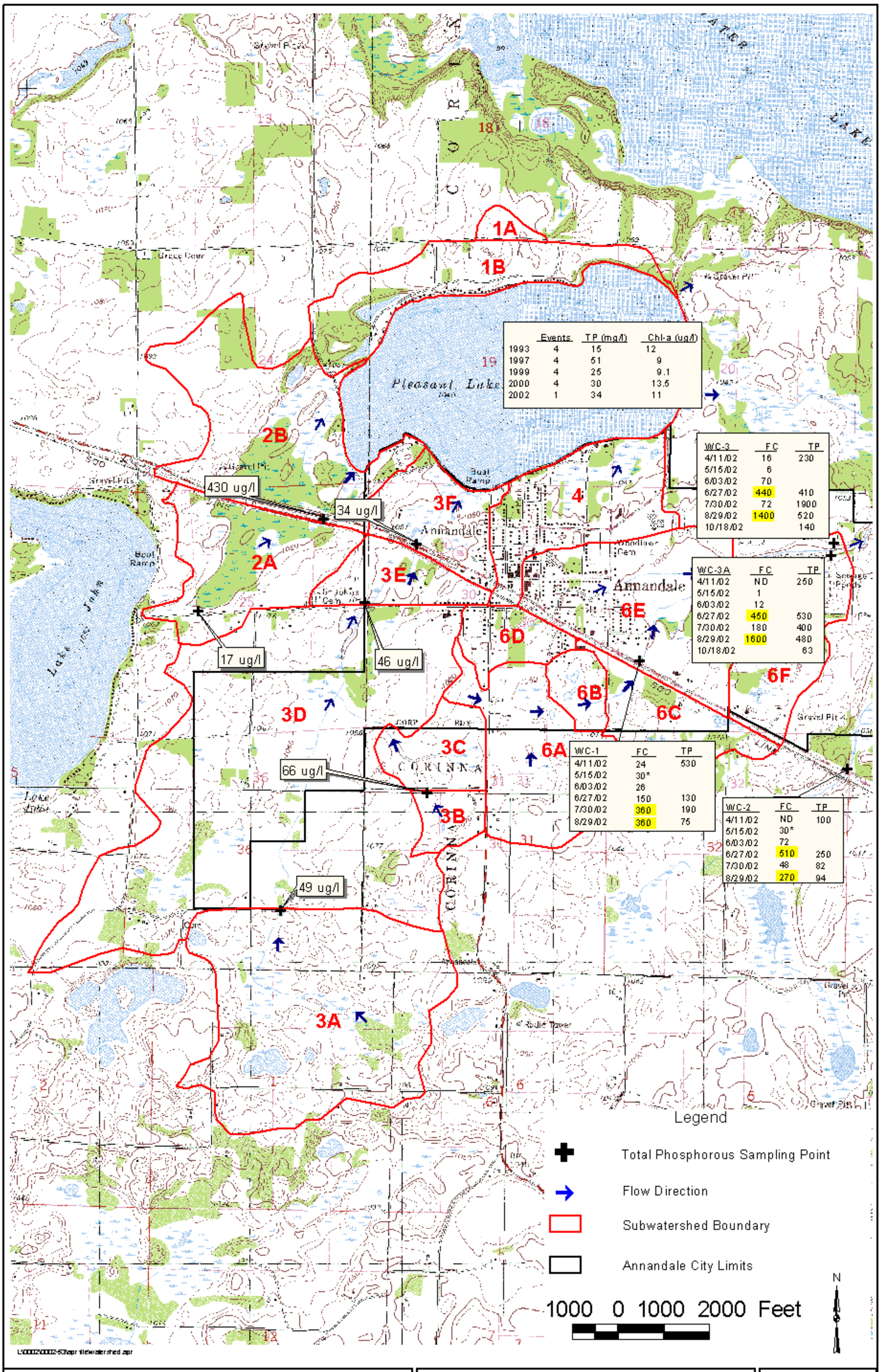
2002 Warner Creek Area Monitoring Results

Wenck

Wenck Associates, Inc. 1800 Pioneer Creek Center
Environmental Engineers Maple Plain, MN 55359-0249

JAN 2003

Figure 7



CLEARWATER RIVER WATERSHED DISTRICT

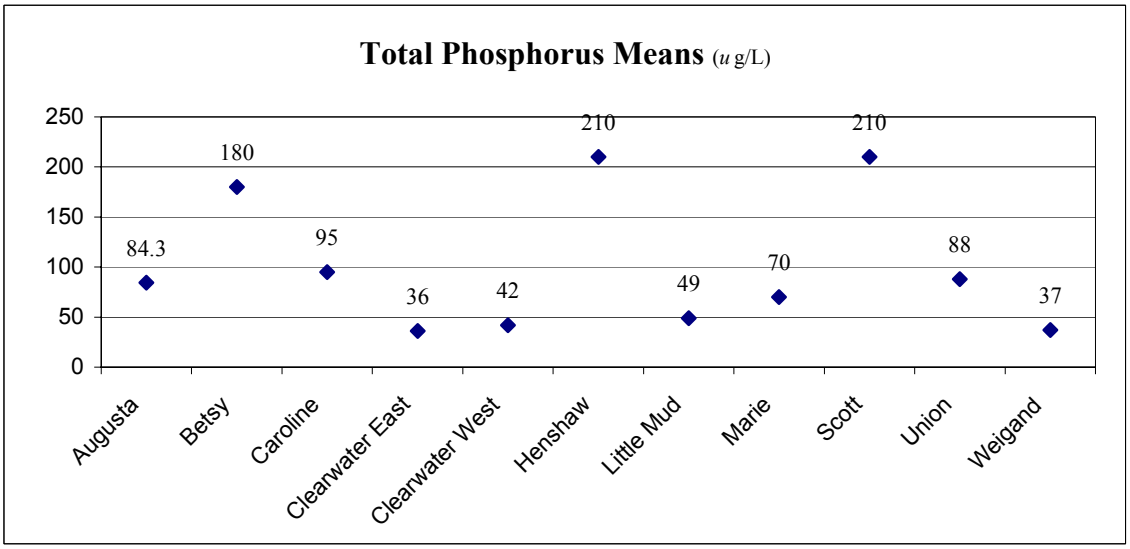
Annandale Area Sampling Results and Historical Pleasant Lake Data

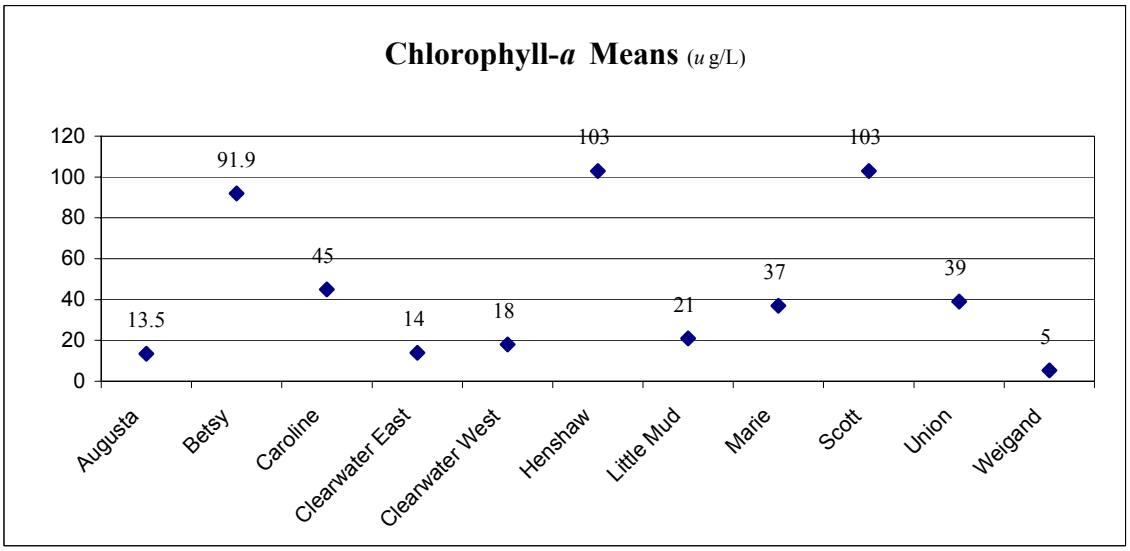
Wenck

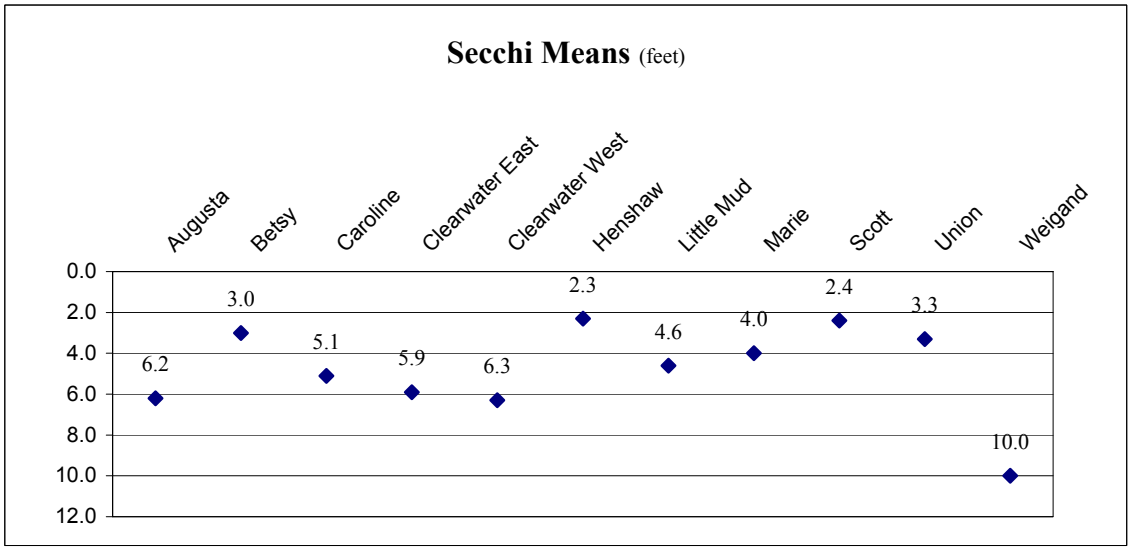
Wenck Associates, Inc. 1800 Pioneer Creek Center
Environmental Engineers Maple Plain, MN 55359-0429

JAN 2003

Figure 8

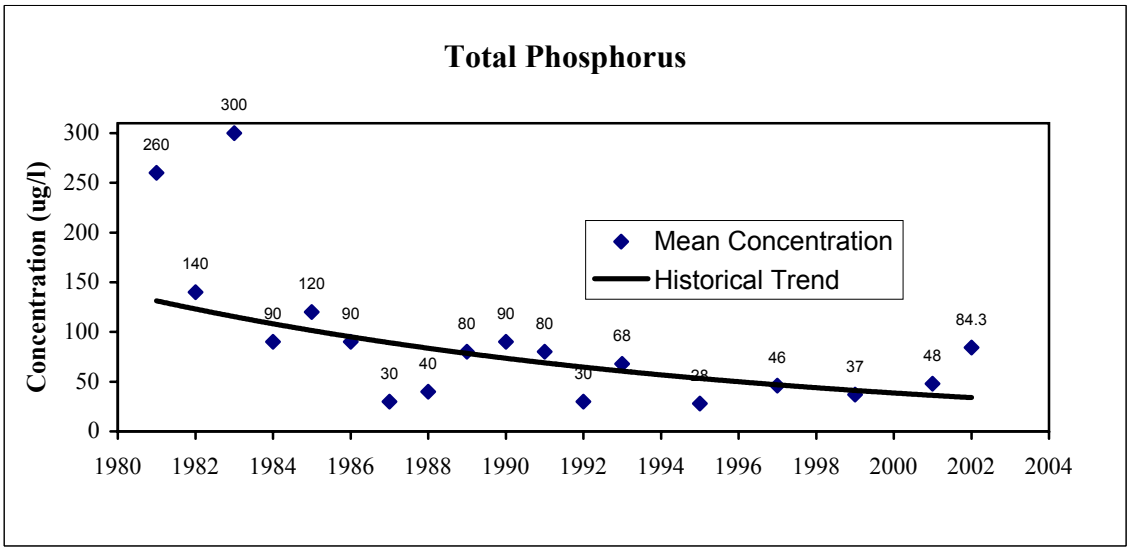


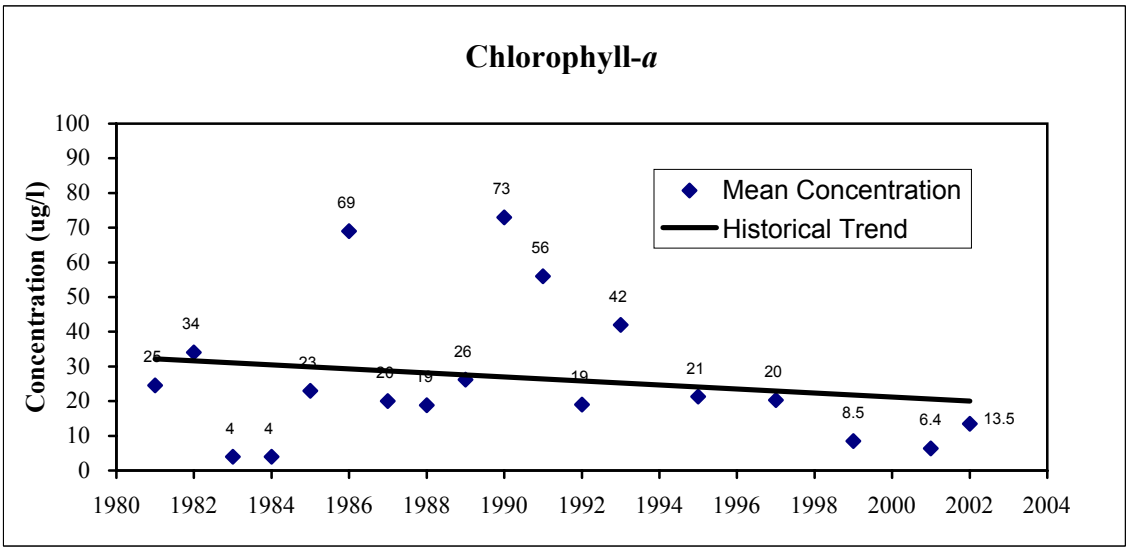


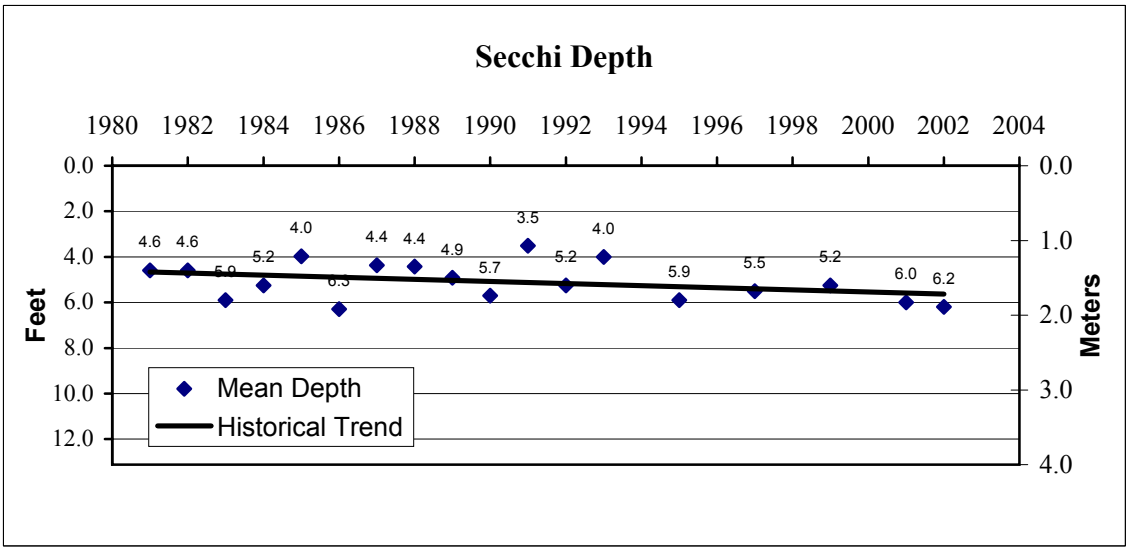


Clearwater River Watershed District	Wenck Wenck Associates, Inc. Environmental Engineers 1800 Pioneer Creek Center Maple Plain, MN 55359	Jan 2003
2002 Graphical Summary of Lake Water Quality		Figure 9

T:\0002\49\2002Report\LAKE_WQ_02.xls\Figure 9 All Lake Summary

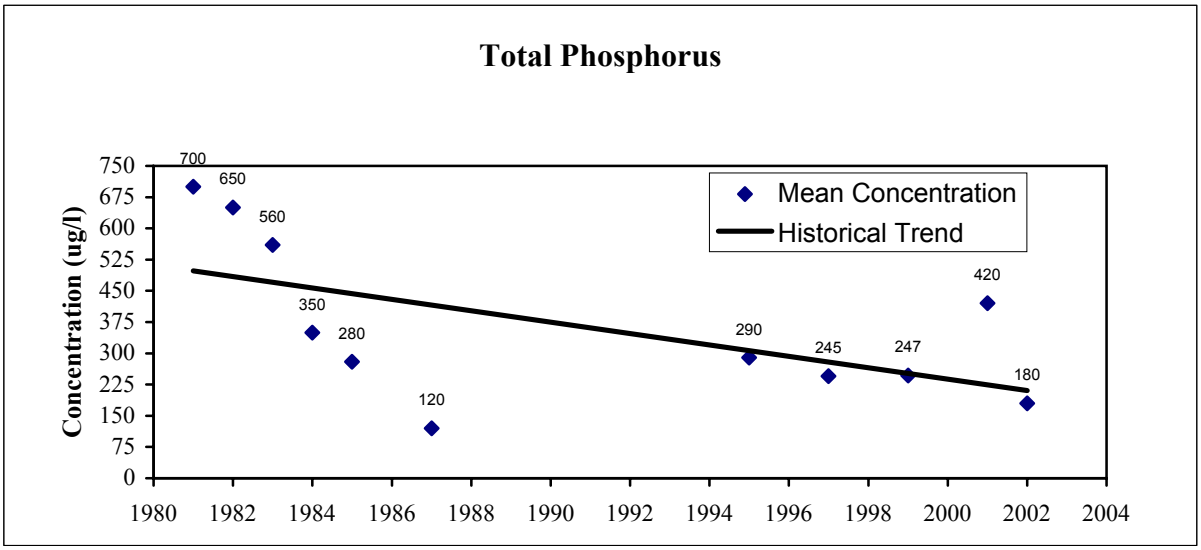


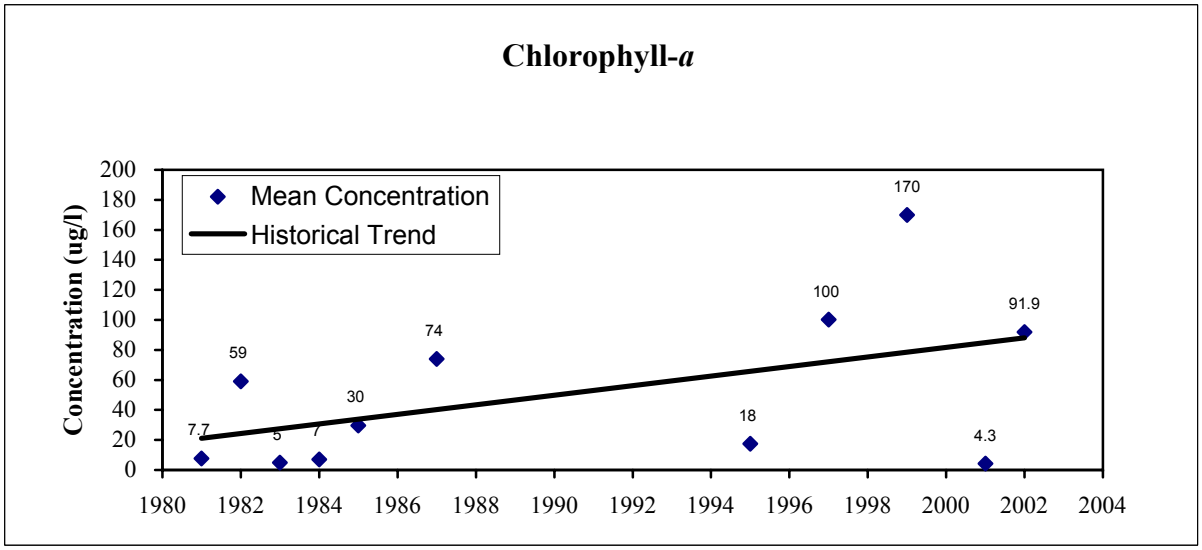


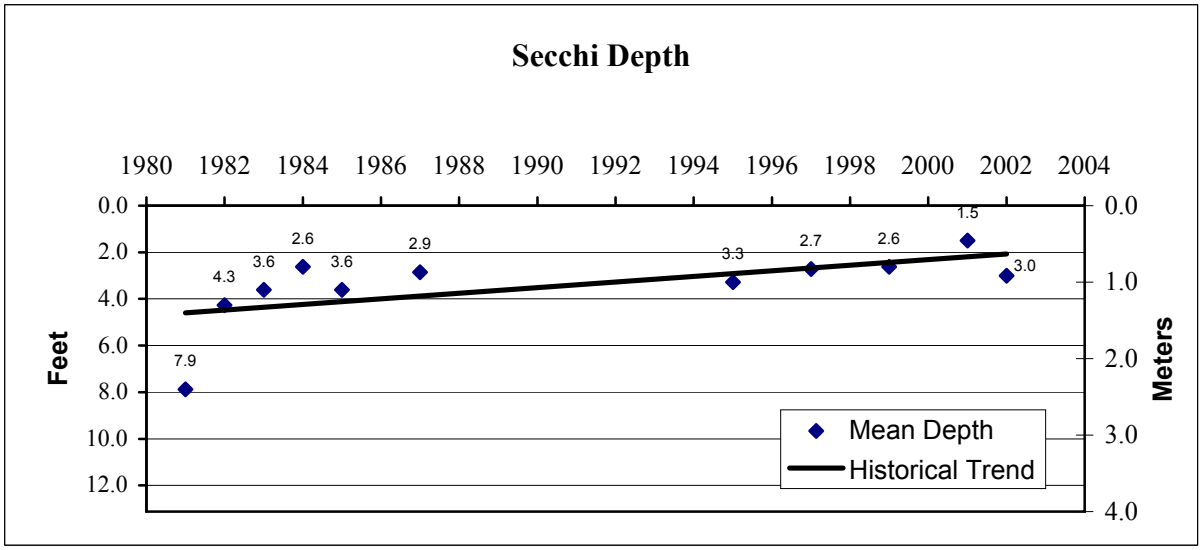


Clearwater River Watershed District	Wenck Associates, Inc. Environmental Engineers — Wenck — 1800 Pioneer Creek Center Maple Plain, MN 55359	Jan 2003
Lake Augusta Historical Data		Figure 10

T:\0002\49\LAKE_WQ_02.xls\Lake Augusta.xls

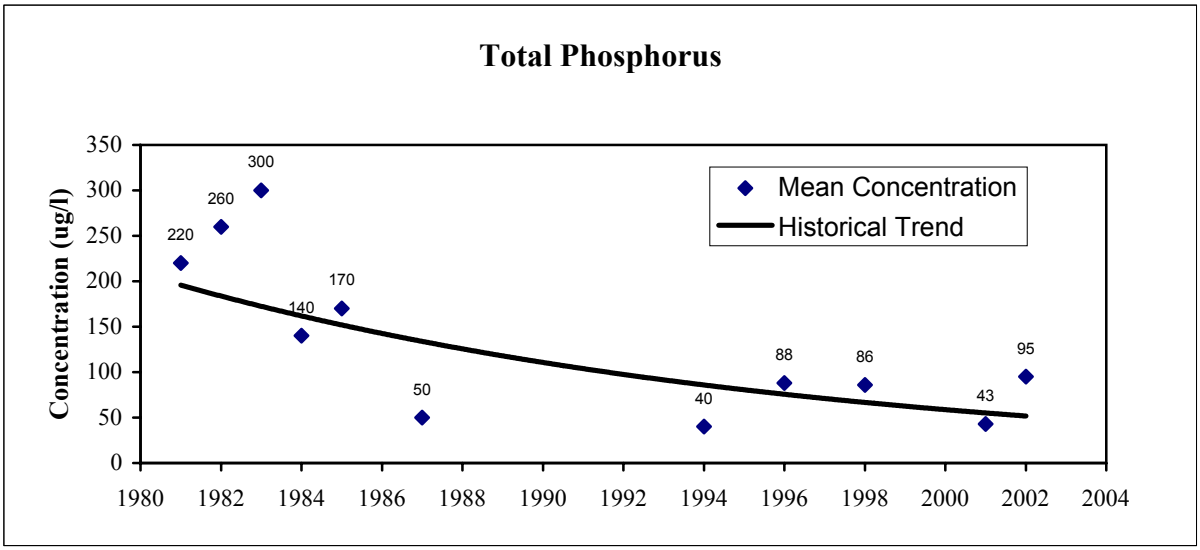


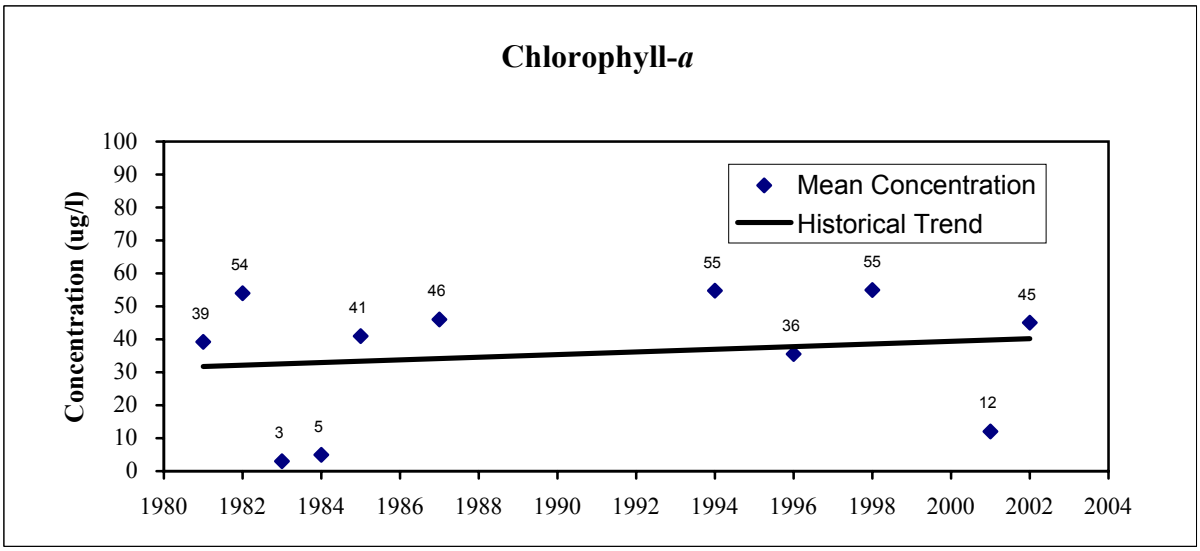


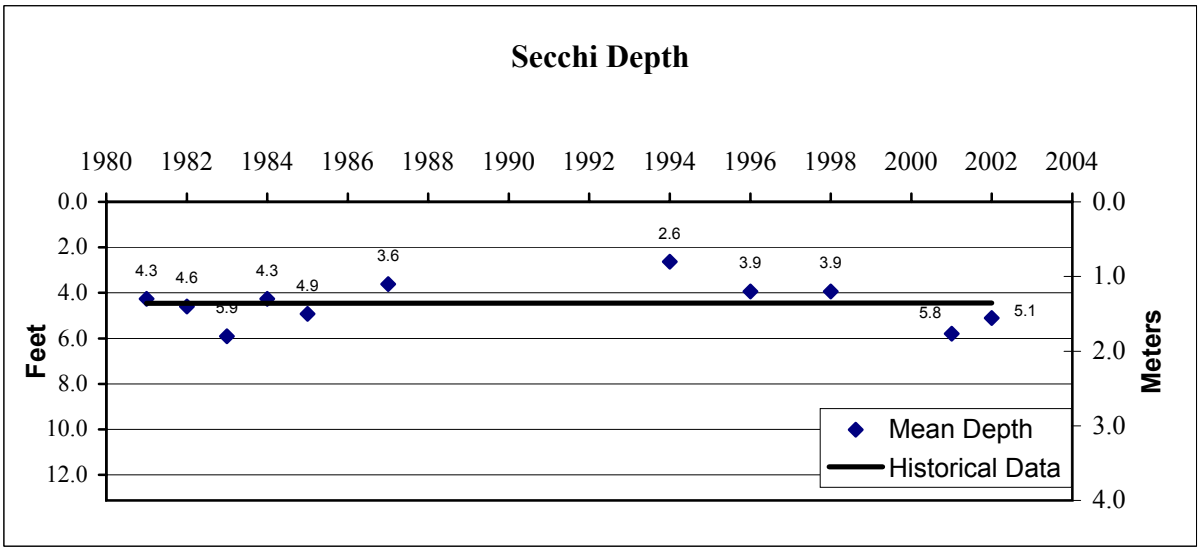


Clearwater River Watershed District	Wenck Associates, Inc. Environmental Engineers 1800 Pioneer Creek Center Maple Plain, MN 55359	Jan 2003
Lake Betsy Historical Data		Figure 11

T:\0002\49\LAKE_WQ_02.xls\Lake Betsy.xls

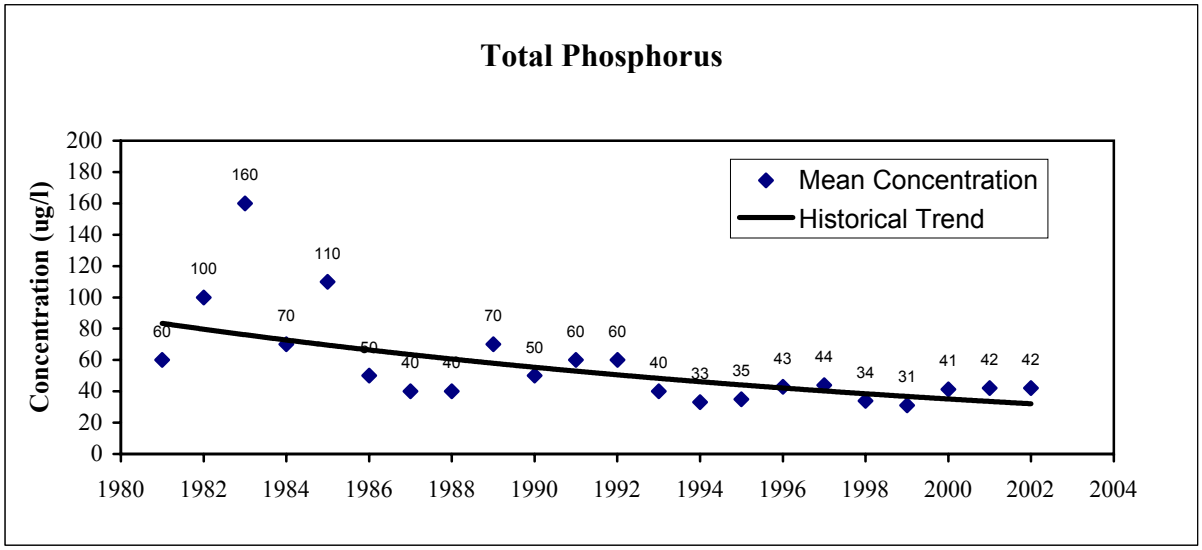


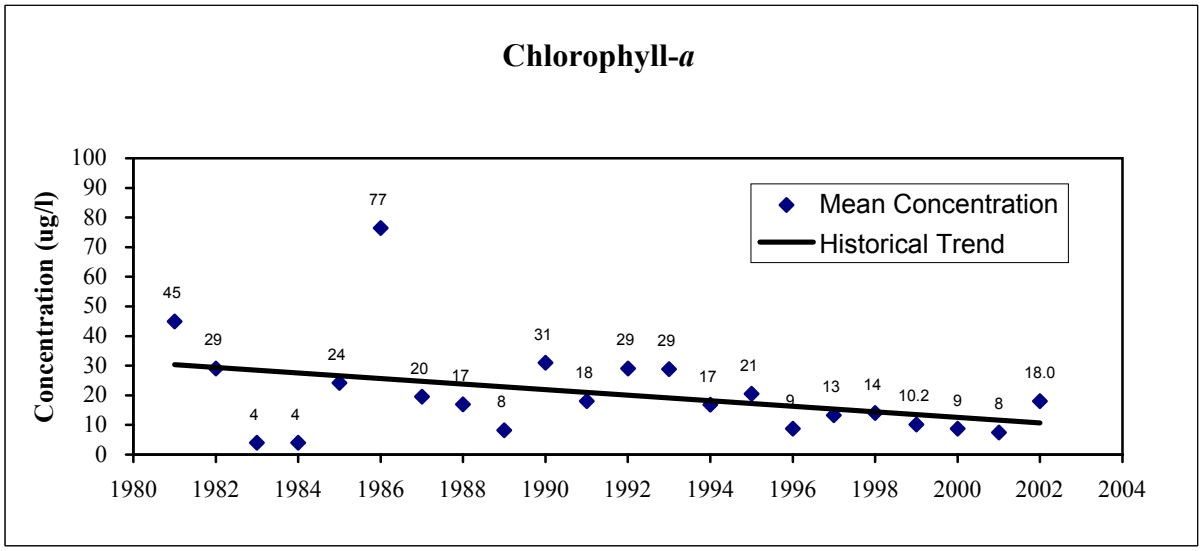


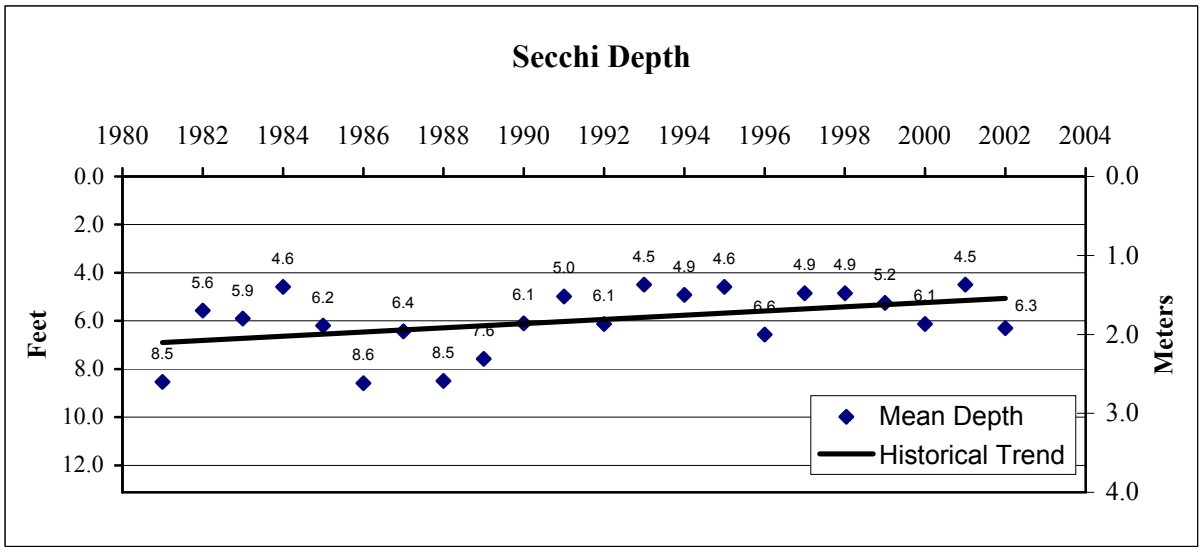


Clearwater River Watershed District	Wenck Wenck Associates, Inc. 1800 Pioneer Creek Center Environmental Engineers Maple Plain, MN 55359	Jan 2003
Lake Caroline Historical Data		Figure 12

T:\0002\49\LAKE_WQ_02.xls\Lake Caroline.xls

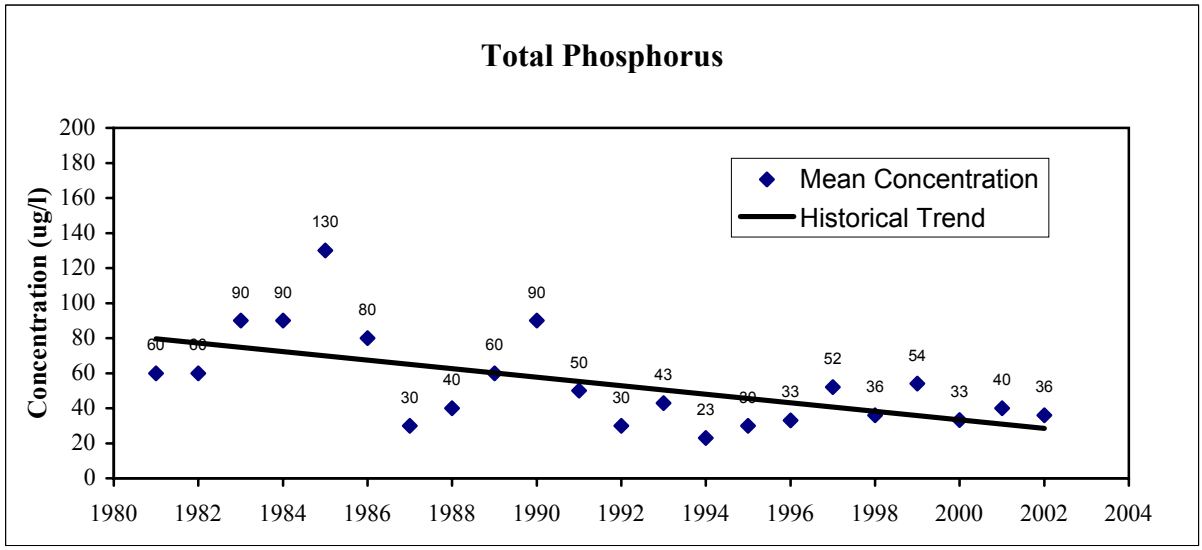


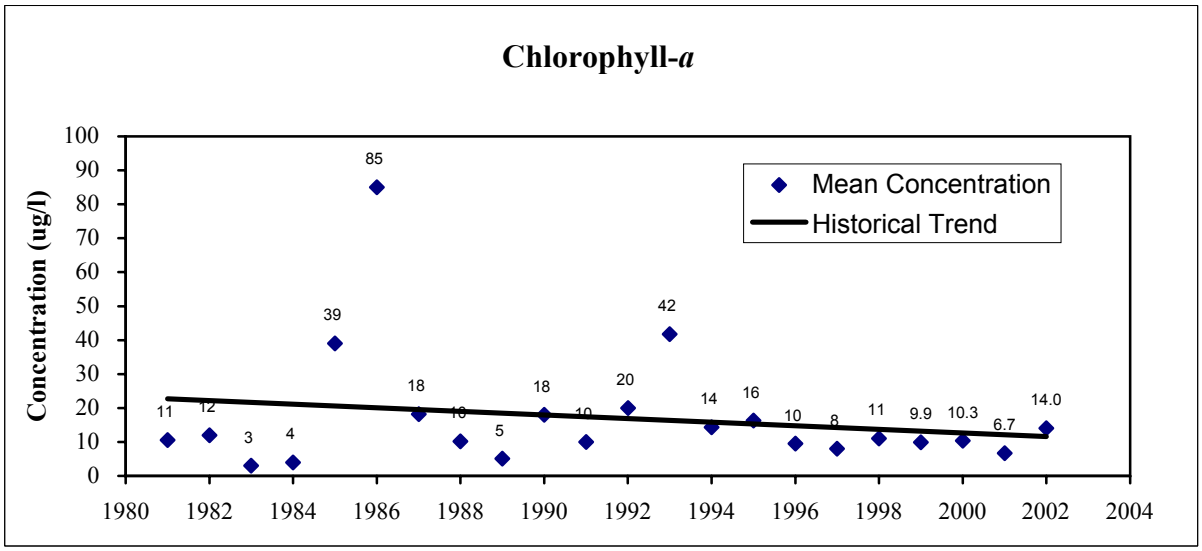


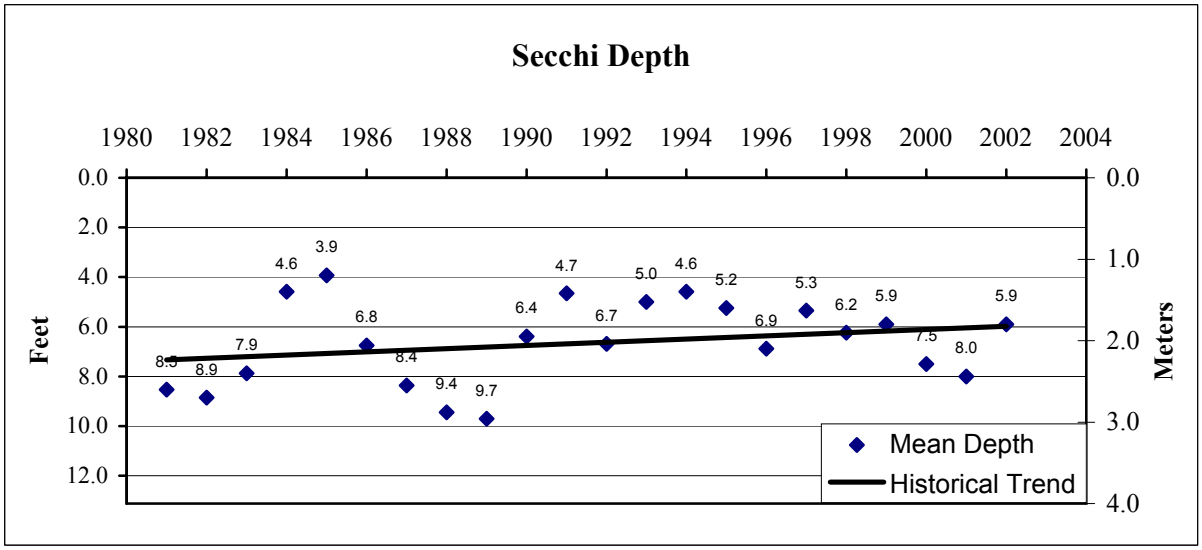


Clearwater River Watershed District	Wenck Associates, Inc. Environmental Engineers 1800 Pioneer Creek Center Maple Plain, MN 55359	Jan 2003
Clearwater Lake West Historical Data		Figure 13

T:\0002\49\LAKE_WQ_02.xls\Clearwater West.xls

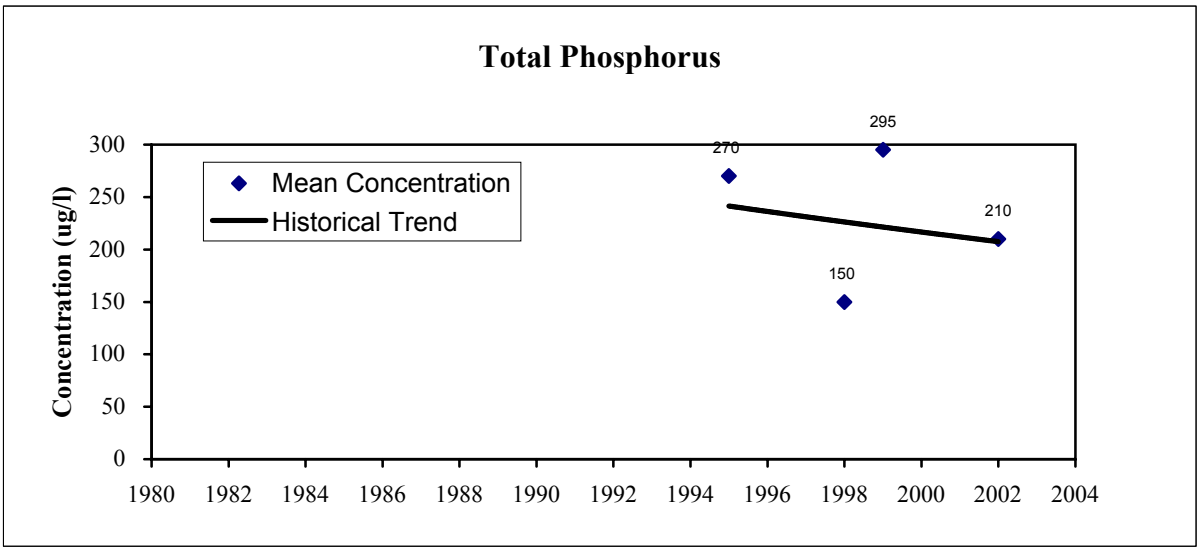


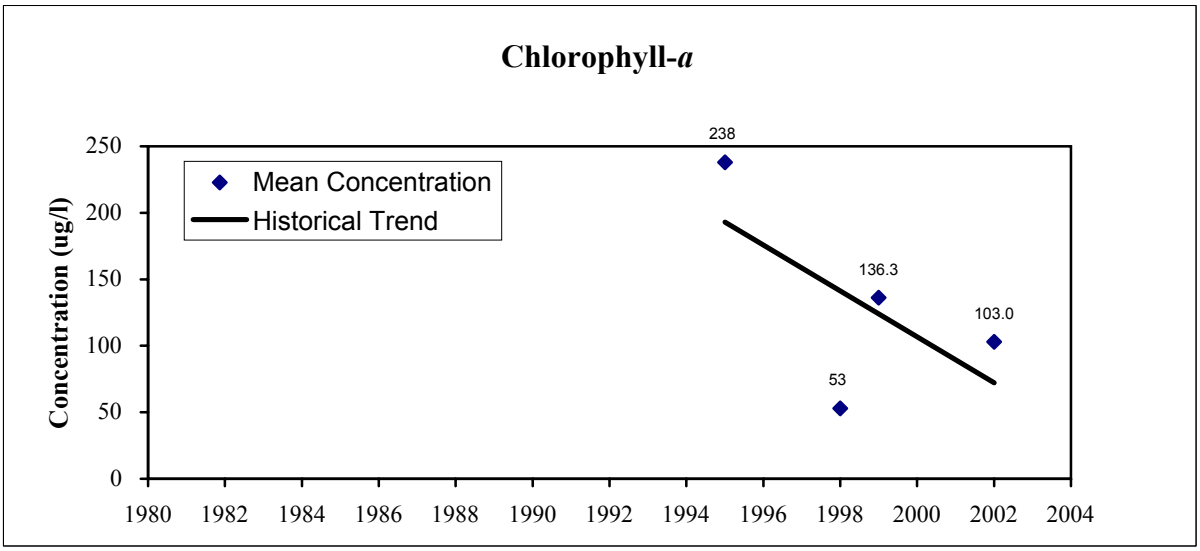


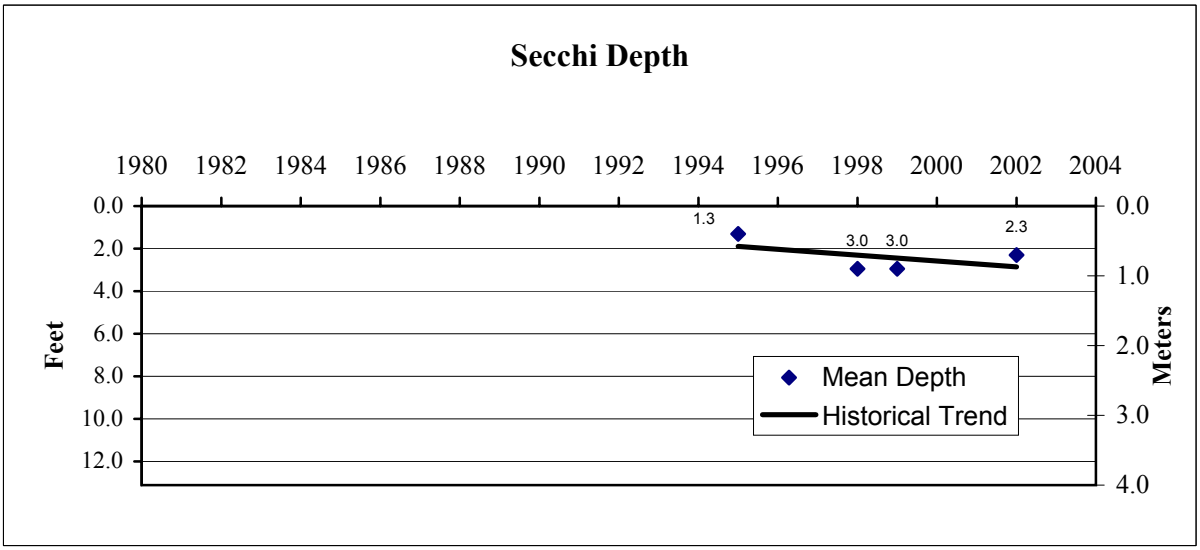


Clearwater River Watershed District	Wenck Wenck Associates, Inc. 1800 Pioneer Creek Center Environmental Engineers Maple Plain, MN 55359	Jan 2003
Clearwater Lake East Historical Data		Figure 14

T:\0002\49\LAKE_WQ_02.xls\Clearwater East.xls

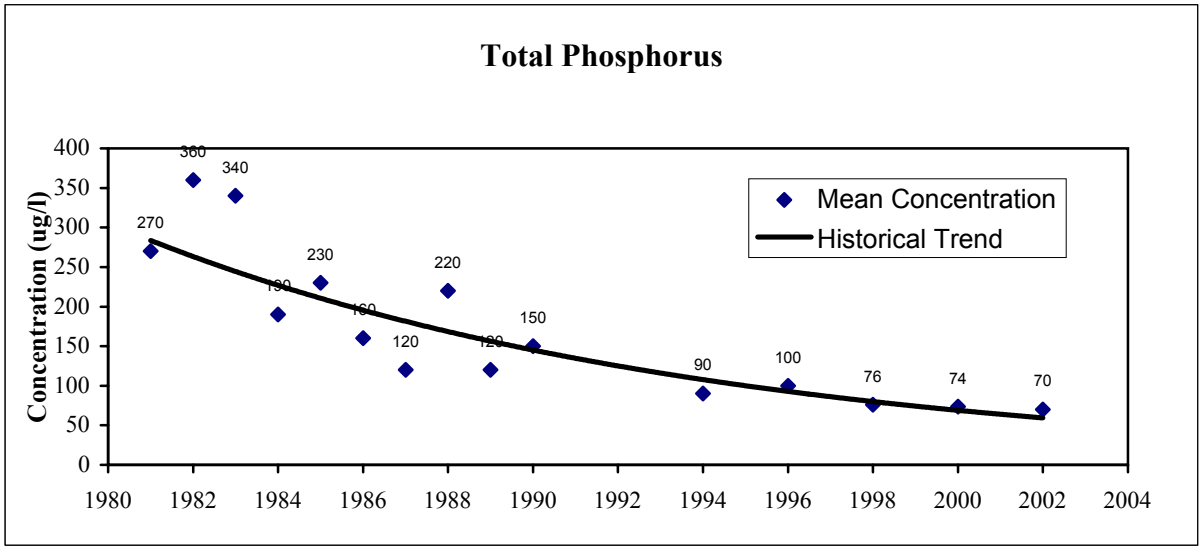


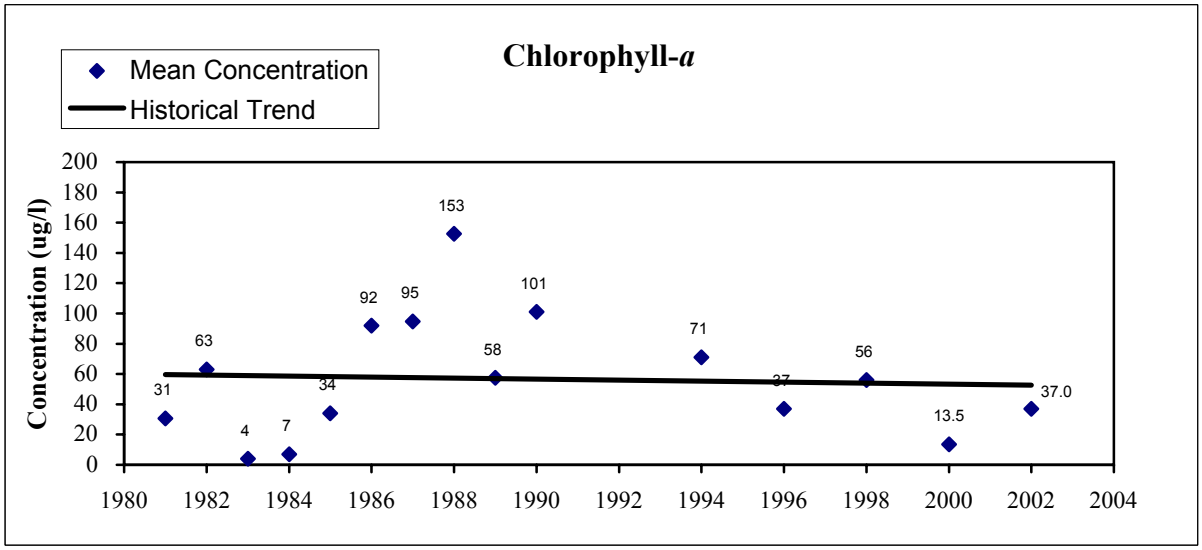


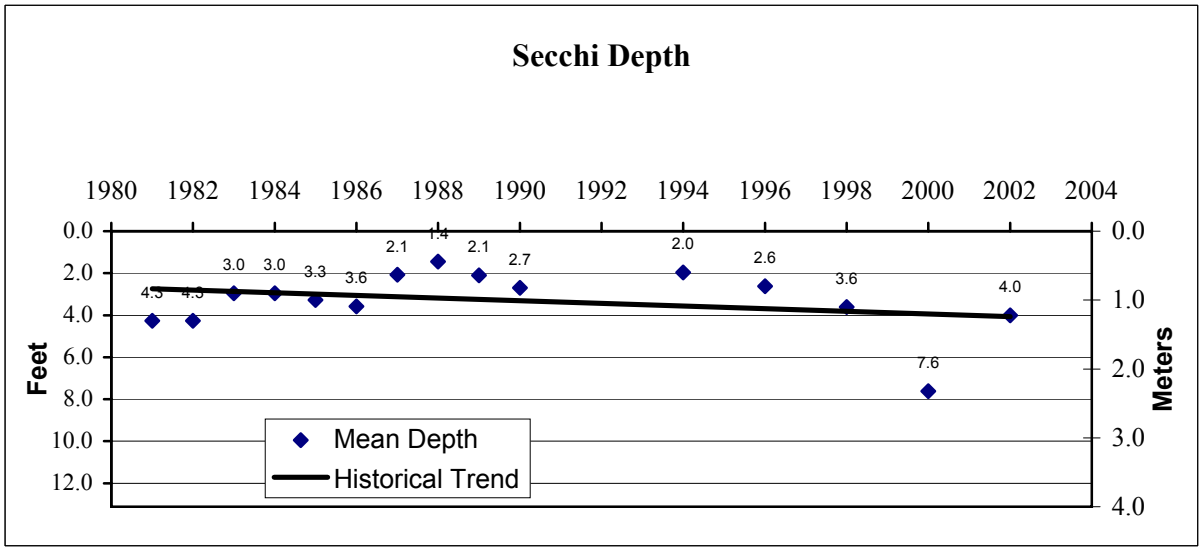


Clearwater River Watershed District	Wenck Associates, Inc. Environmental Engineers 1800 Pioneer Creek Center Maple Plain, MN 55359	Jan 2003
Henshaw Lake Historical Data		Figure 15

T:\0002\49\LAKE_WQ_02.xls\Henshaw.xls

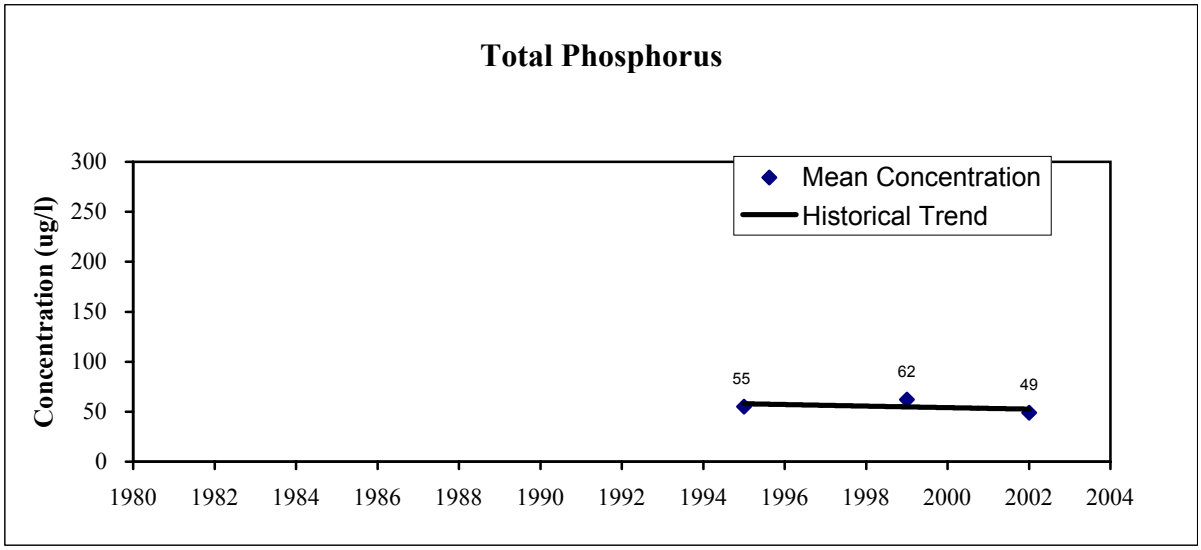


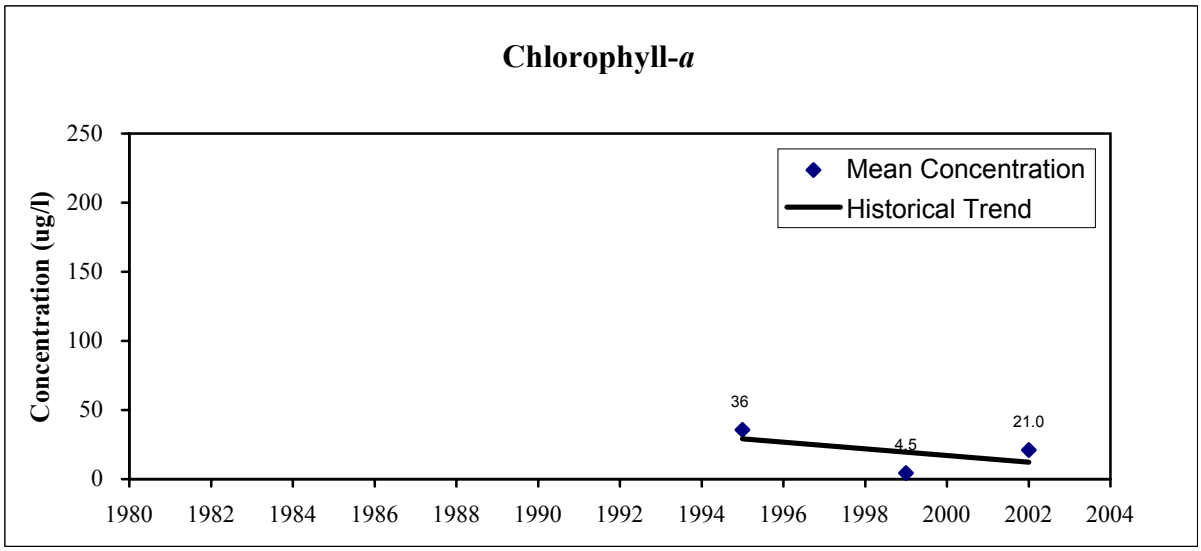


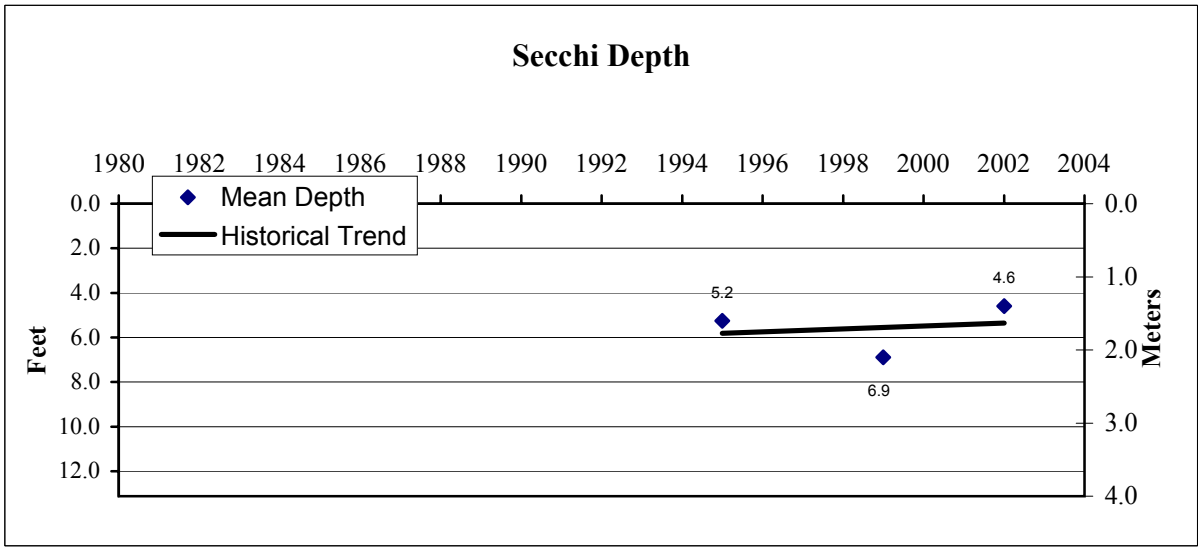


Clearwater River Watershed District	Wenck Associates, Inc. Environmental Engineers 1800 Pioneer Creek Center Maple Plain, MN 55359	Jan 2003
Lake Marie Historical Data		Figure 16

T:\0002\49\LAKE_WQ_02.xls\Marie.xls

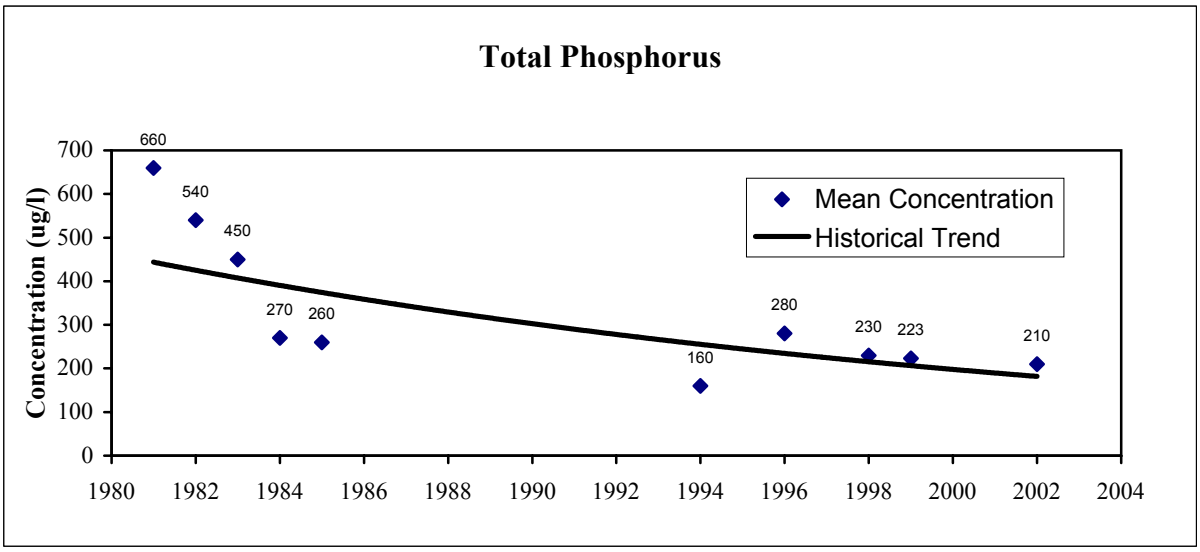


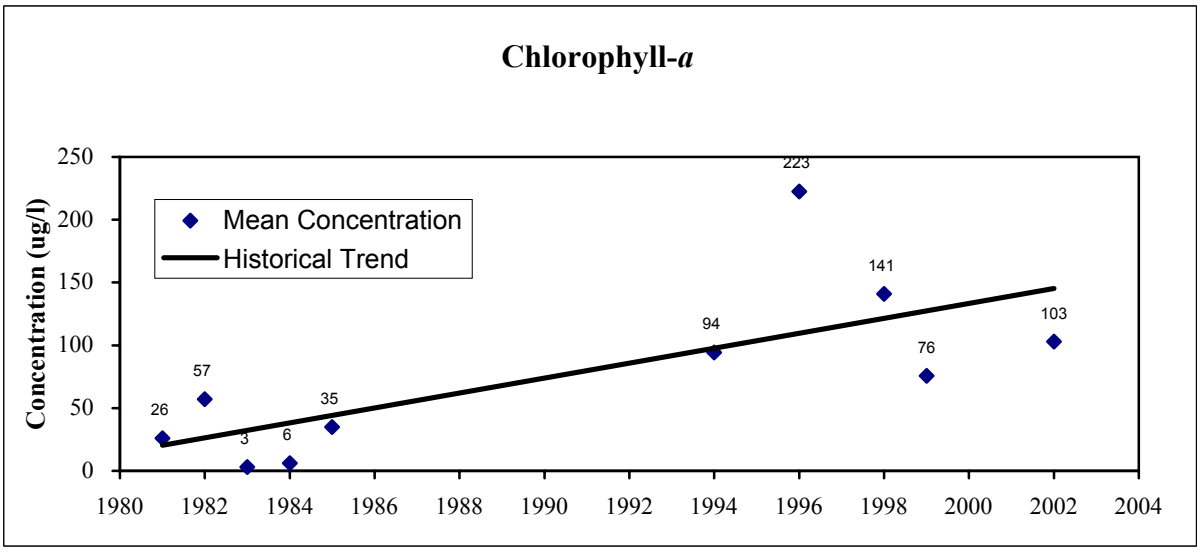


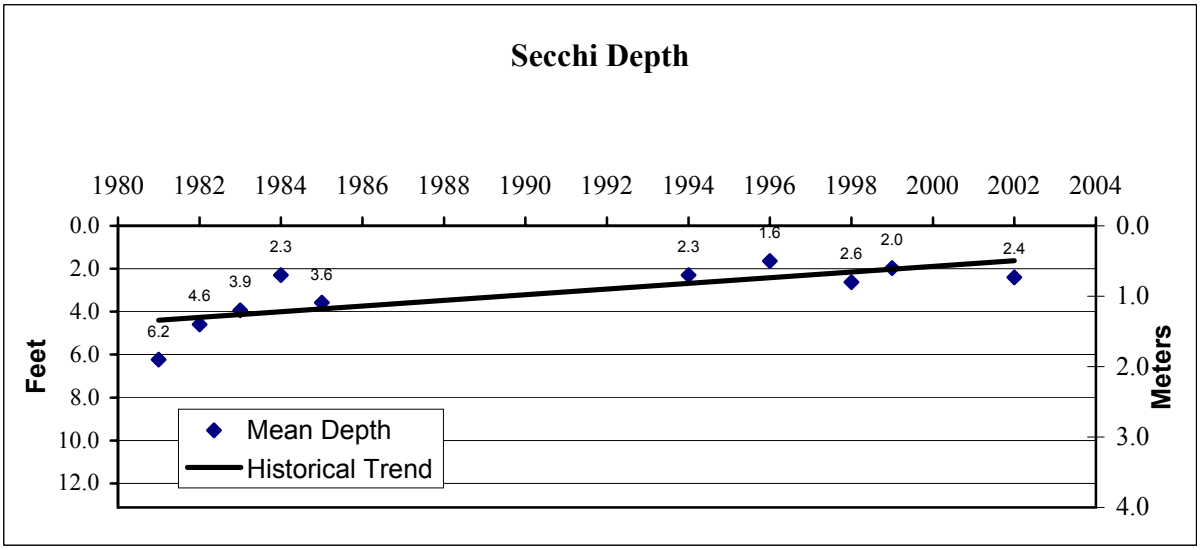


Clearwater River Watershed District	Wenck Wenck Associates, Inc. 1800 Pioneer Creek Center Environmental Engineers Maple Plain, MN 55359	Jan 2003
Little Mud Lake Historical Data		Figure 17

T:\0002\49\LAKE_WQ_02.xls\Little Mud.xls

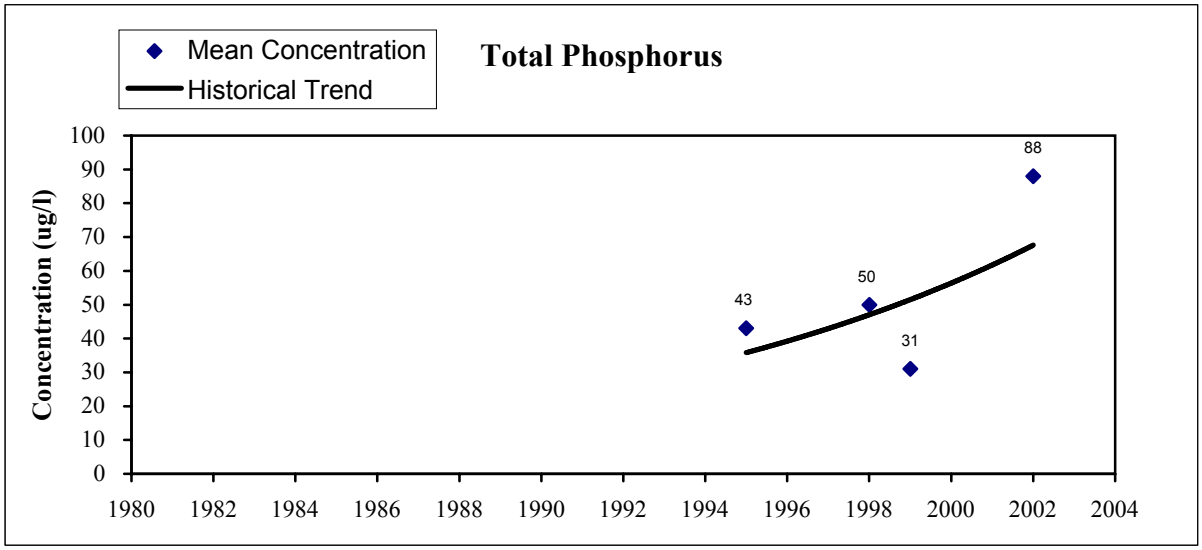


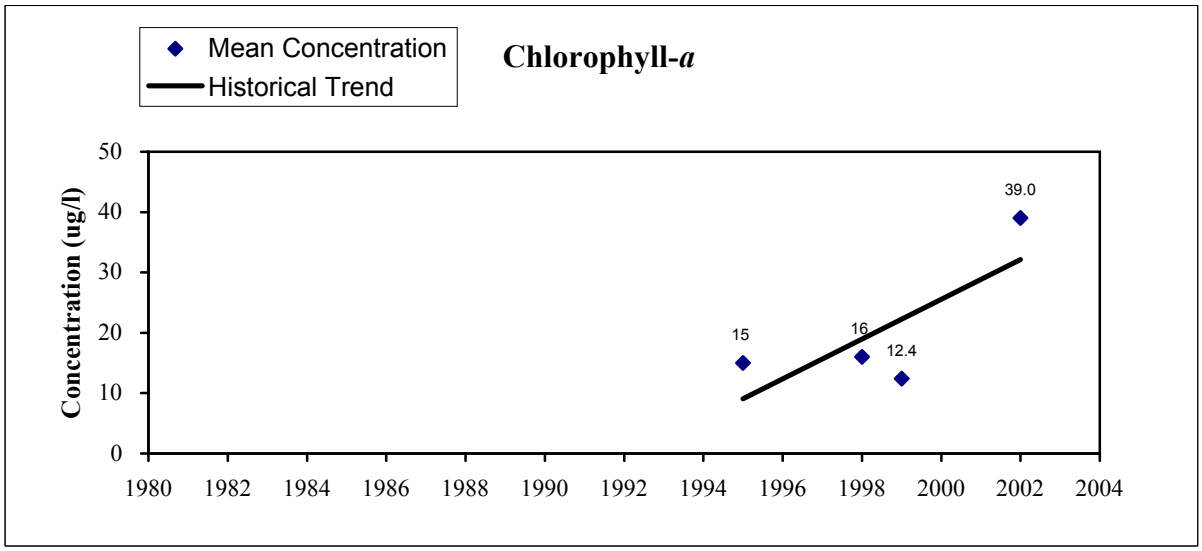


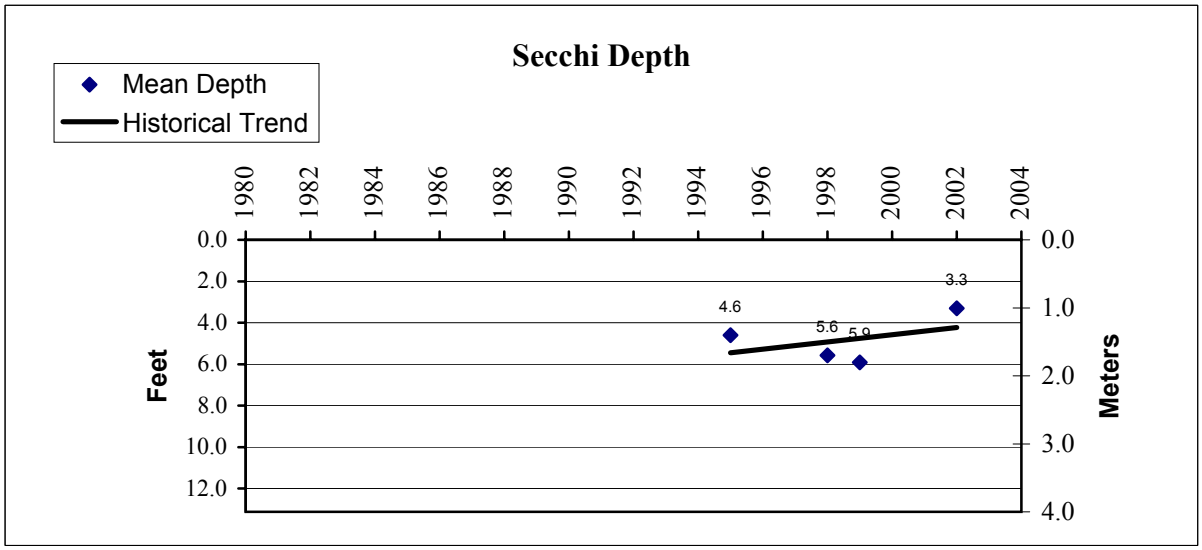


Clearwater River Watershed District	Wenck Associates, Inc. Environmental Engineers — 1800 Pioneer Creek Center Maple Plain, MN 55359	Jan 2003
Scott Lake Historical Data		Figure 18

T:\0002\49\LAKE_WQ_02.xls\Scott.xls

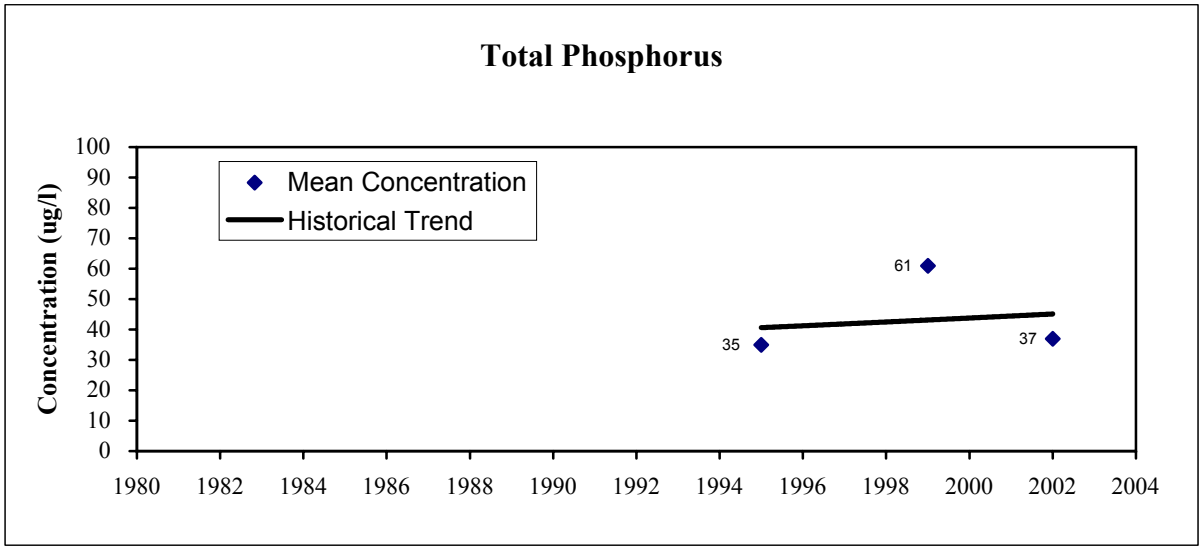


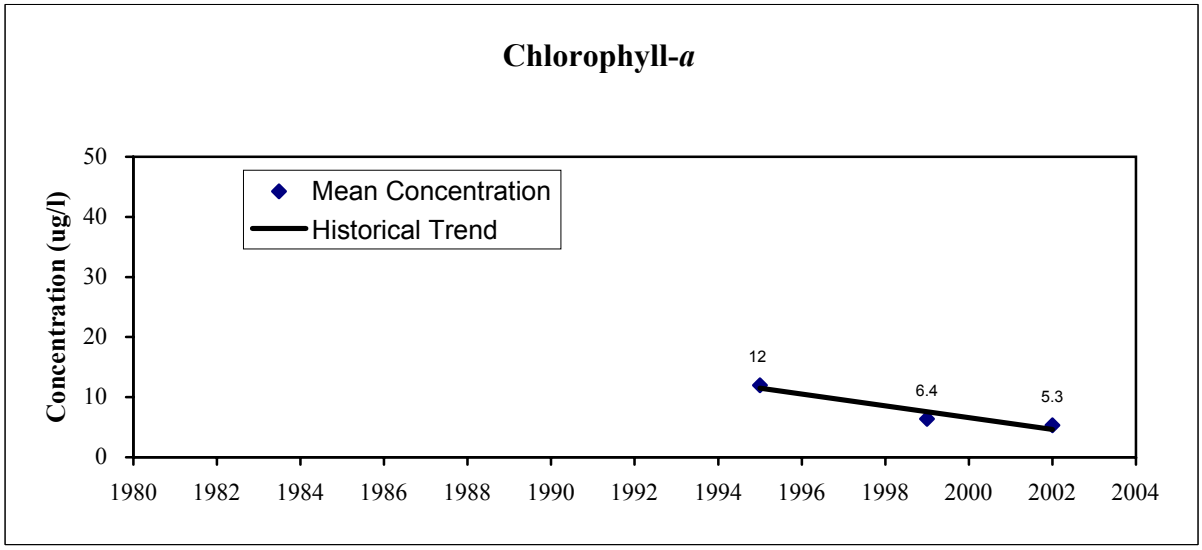


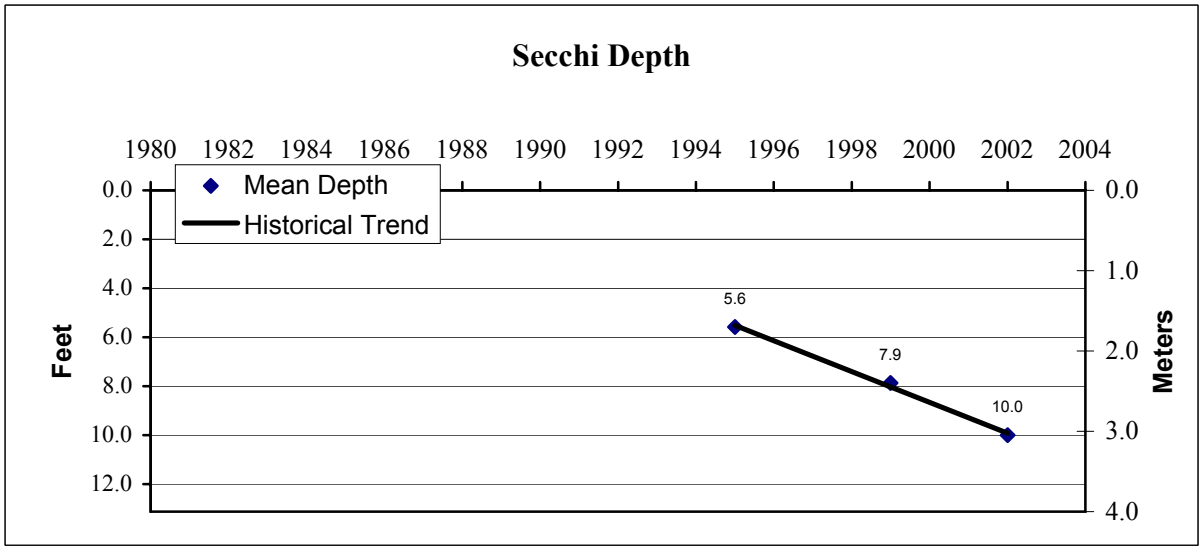


Clearwater River Watershed District	Wenck Wenck Associates, Inc. 1800 Pioneer Creek Center Environmental Engineers Maple Plain, MN 55359	Jan 2003
Union Lake Historical Data		Figure 19

T:\0002\49\LAKE_WQ_02.xls\Union.xls







Clearwater River Watershed District	Wenck Wenck Associates, Inc. 1800 Pioneer Creek Center Environmental Engineers Maple Plain, MN 55359	Jan 2003
Weigand Lake Historical Data		Figure 20

T:\0002\49\LAKE_WQ_02.xls\Weigand.xls

Appendix A

2002 Monitoring Plan Summary

Wenck Associates, Inc.
1800 Pioneer Creek Ctr.
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Wenck

MEMORANDUM

TO: **Clearwater River Watershed District Board of Managers**

FROM: **Norman C. Wenck**
Engineer for the District

DATE: **February 6, 2002**

RE: **Proposed 2002 Water Quality Monitoring Program**

Introduction

The Clearwater River Watershed District conducts annual water quality monitoring at selected lakes and selected locations on streams. Lake monitoring follows the long-term plan shown in Table 1, and stream monitoring sites together with laboratory and field parameters are shown in Table 2. Also shown in Table 2 are options for additional stream monitoring.

Lake Monitoring

The schedule for 2002 has Clearwater East and West being monitored and additional Main Stem Lakes of Scott, Caroline and Marie. Union, Henshaw, Little Mud and Wiegand Lakes will also be monitored. The total number of lakes is eight but nine stations are monitored since Clearwater Lake has two stations and the parameters to be monitored are shown on Table 2. Citizens monitor approximately 14 lakes for secchi depth also.

Stream Monitoring

The Clearwater River will be monitored at stations CR 28.2, CR10.5 and Warner Creek will be monitored at WR 0.2. The stations will be monitored six times for water quality and flow. Parameters are total phosphorus and soluble reactive phosphorus.

Cost

This proposed basic program is estimated to cost $13,400.

Option 1 – Fecal Coliform Monitoring on Five River Stations

Coliform contamination was found at all stations monitored during 2000 and 2001. Monitoring is again recommended at the same stations to monitor coliform levels. The cost of this option is $2,900.

Option 2 – Automatic Monitoring Station

An automatic monitoring station will be installed at one location (probably CR28.2). A pressure transducer and automated sampler will be installed in a stilling well within an

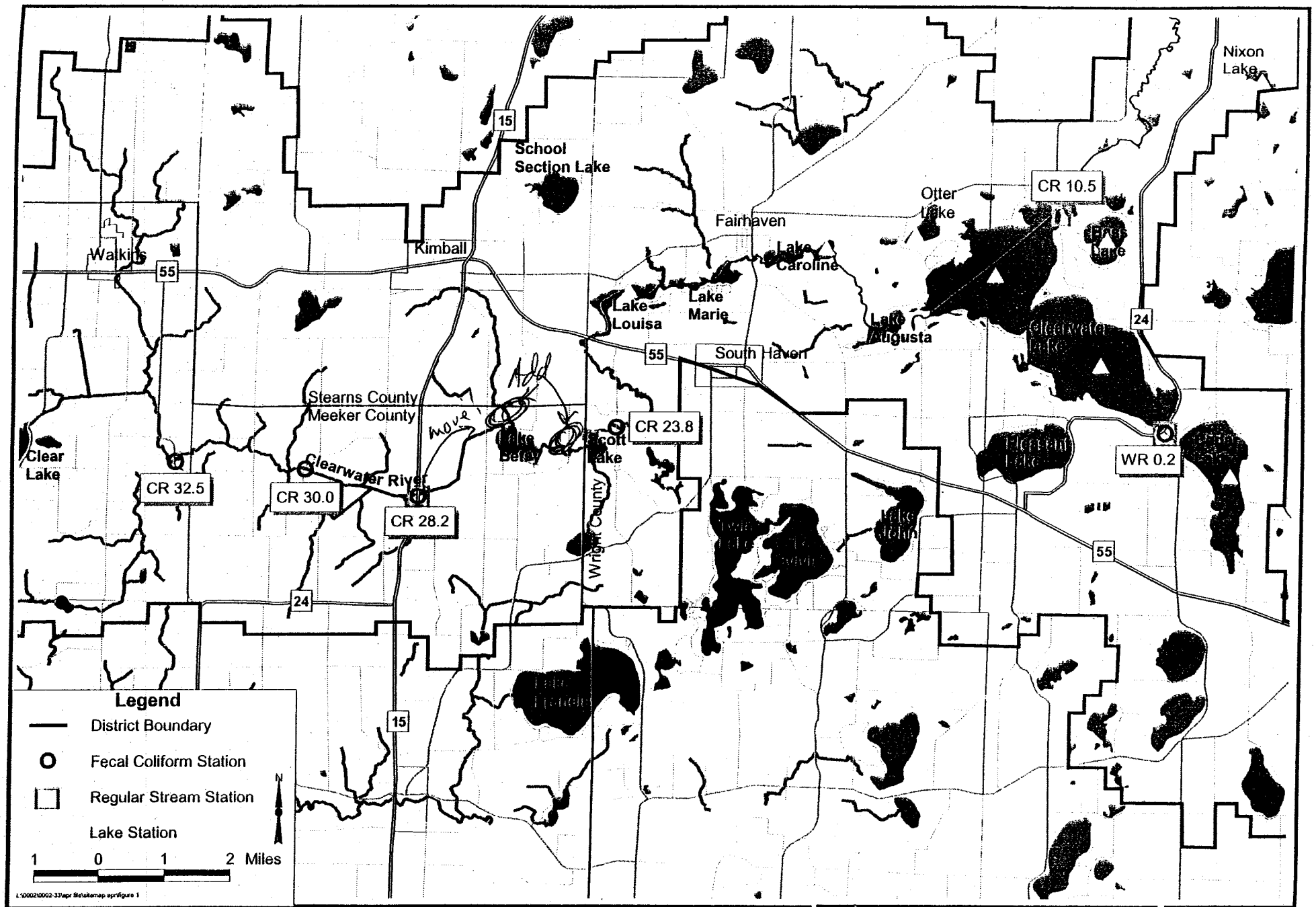
environmental enclosure. A lap top computer will be required to program the transducer and to download data as necessary.

Purchase and installation expenses $16,000 to $21,000 (depending on site and amount of work Kevin can do). Maintenance and sample collection including analytical expenses $4,000. The first year total costs will be $20,000 to $25,000 and following years will be $4,000 to $6,000.

Option 3 – Expanded Annandale Fecal Coliform
To further monitor the Warner Creek situation, it is proposed to sample the six 2001 sites from Annandale to Clearwater Lake during six events and analyze for fecal coliform. The cost of this option is $2,400.00.

Option 4 – Expanded Monitoring of the Other Four River Sites
To further investigate coliform occurrence at the other stations along Clearwater River, (CR32.5, CR30.0, CR28.2 and CR23.8), it is proposed that six additional upgradient sampling locations be selected at each site and monitored for fecal coliform during six events. The cost of this option is an additional $3,900.

Summary
The basic monitoring program continues the program in place since 1981. The remaining options are progressive and additive and can be modified as desired after you have an opportunity to review this proposal. It is requested that a decision on the scope of the program be made at the February 13, 2002 meeting. Please feel free to call me with any questions or comments that you may have before the meeting.



CLEARWATER RIVER WATERSHED DISTRICT

2001 Regular Stream and Lake Monitoring Locations

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Wenck Associates, Inc.
Environmental Engineers

1800 Pioneer Creek Center
Maple Plain, MN 55359-0429

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Figure 1

TABLE 1
PROPOSED LONG-TERM WATER QUALITY MONITORING PLAN FOR CRWD LAKES

LAKE STATIONS[1]	1997	1998	1999	2000	2001	2002	2003	2004
Clearwater Lake:								
Clearwater East	X	X	X	X	X	X	X	X
Clearwater West	X	X	X	X	X	X	X	X
Main Stem Lakes:								
Augusta	X		X		X		X	
Louisa	X		X		X		X	
Caroline		X				X		X
Scott		X	X			X		X
Marie		X		X		X		X
Betsy	X		X		X		X	
Other Lakes:								
Cedar			X		X		X	
Pleasant	X		X	X				X
School Section	X		X	X				X
Nixon	X		X		X			X
Otter	X		X		X			X
Bass		X	X		X			
Clear		X	X	X			X	
Union		X	X			X		
Henshaw		X	X			X		
Little Mud			X			X		
Wiegand			X			X		
Swart Watts			X				X	
Albion			X				X	
Grass			X				X	

Note: [1]Lake selection based on total lake size ranking scores (Lake Priority Ranking, 1990)

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TABLE 2

Proposed 2002 CRWD Monitoring Plan Summary

Category	Schedule	Station	Parameters
Lakes:	May 15 - June 5	Clearwater-East	Field: Secchi, DO and temperature profiles
	June 24 - July 5	Clearwater-West	
	Jul 24 - Aug 2	Caroline	
	Aug 26 - Sep 13	Scott	Lab: Total phosphorus, soluble reactive phosphorus and Chlorophyll-a
		Marie	
		Union	
		Henshaw	
		Little Mud	Citizen Secchi: Fourteen Sites
		Wiegand	
Streams:	April	CR28.2	Field: Flows, DO and temperature
	May	WRO.2	
	June	CR10.5	Lab: Total phosphorus, soluble reactive phosphorus
	July		
	August		
	September		
	Weekly	River Stage at CR10.5	
Precipitation:	Daily at three sites (Watkins, Maire Prairie and Corrinna)		
Option 1: Fecal Coliform Monitoring:			
	April	5 River Stations	Lab: Fecal Coliform
	May	CR32.5	
	June	CR30.0	
	July	CR28.2	
	August	CR23.8	
	September	WR0.2	
Option 2: Automatic Sampling Station (probably installed at CR28.2):			
	36 weekly samples for total phosphorus		
	12 samples for fecal coliforn		

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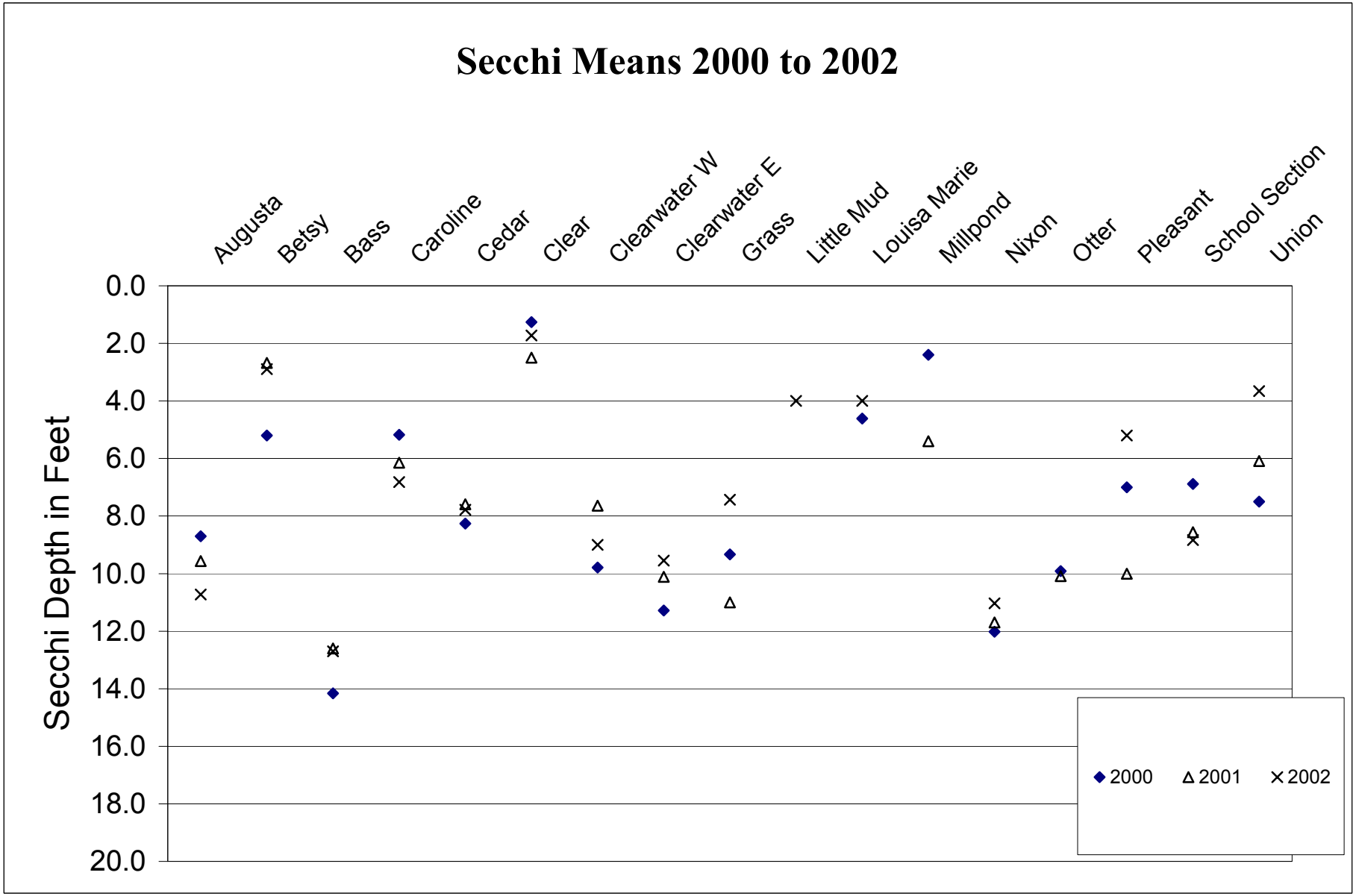
Appendix B

Citizen's Lake Monitoring Program – Secchi Data



CLEARWATER RIVER WATERSHED

Citizen Secchi Data -- 2002

Wenc

Wenck Associates, Inc. Environmental Engineers

1800 Pioneer Creek Center Maple Plain, MN 55359

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Figure B-1

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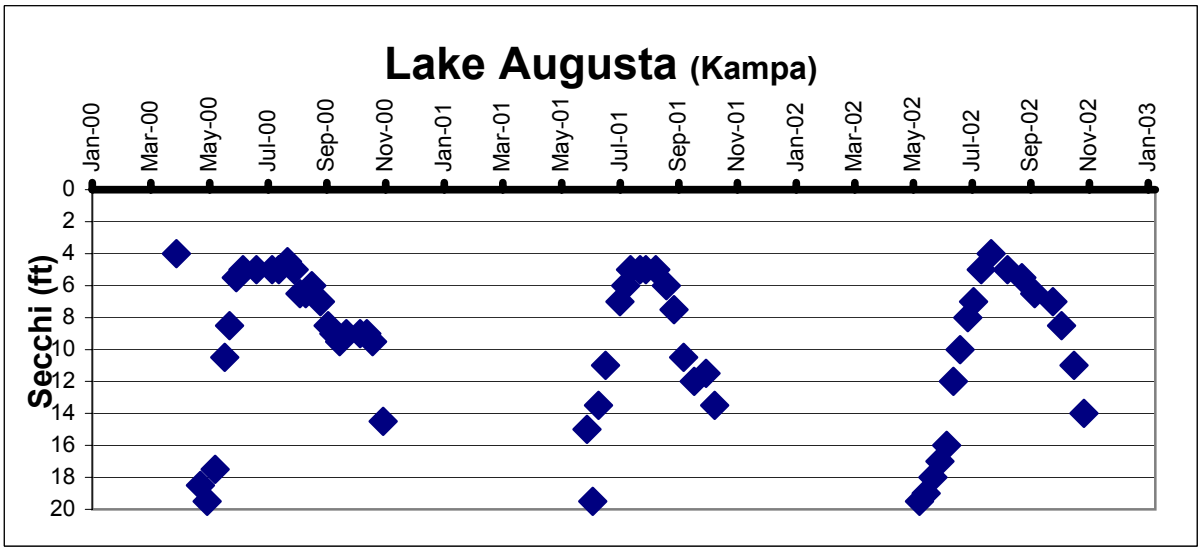

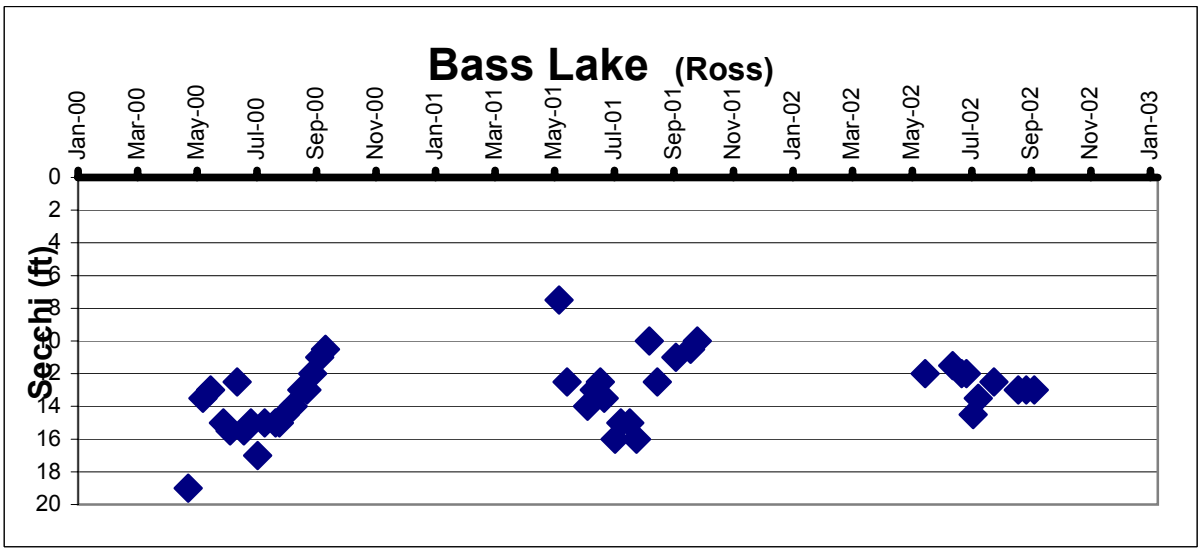

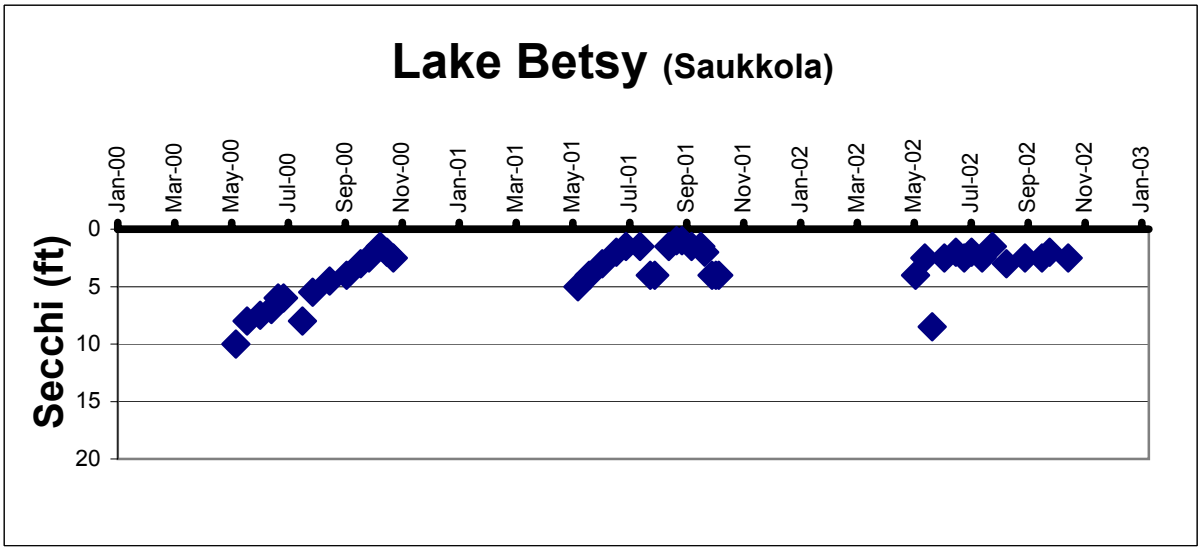

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Citizen Secchi Data -- 2002		Figure B-2

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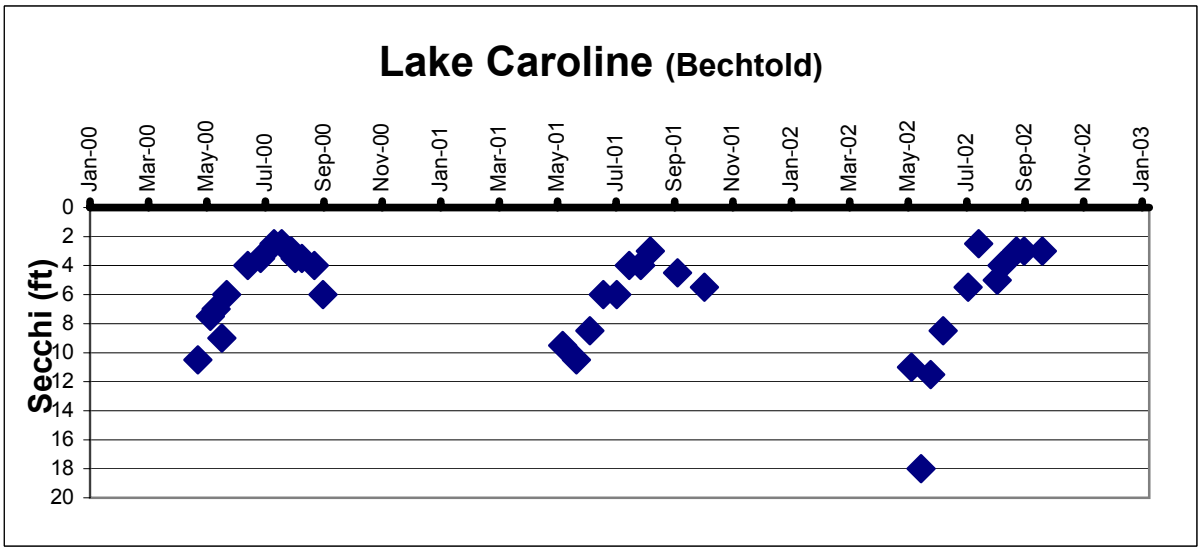

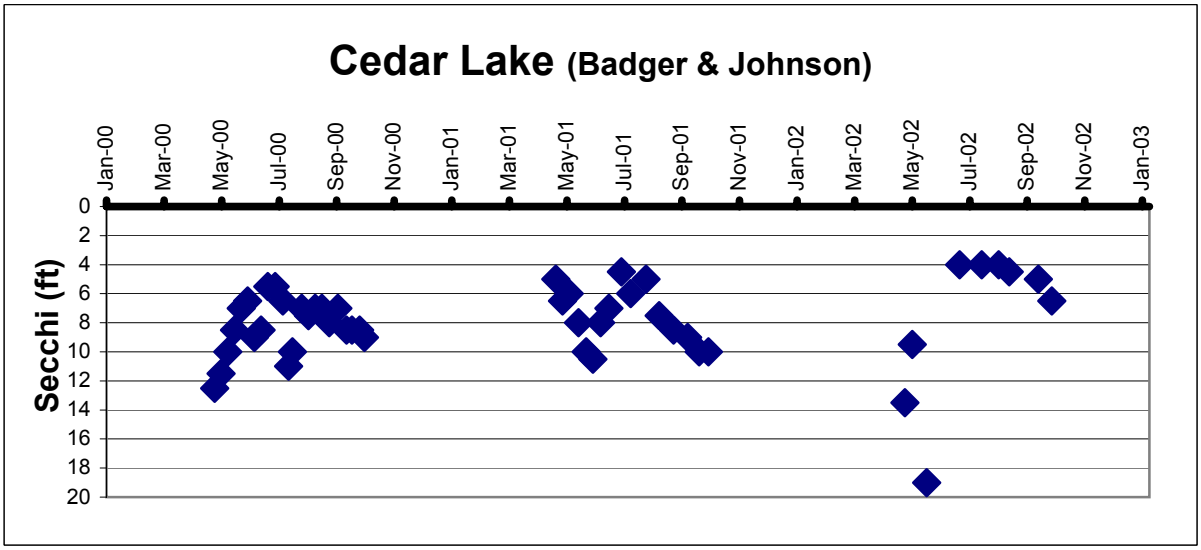

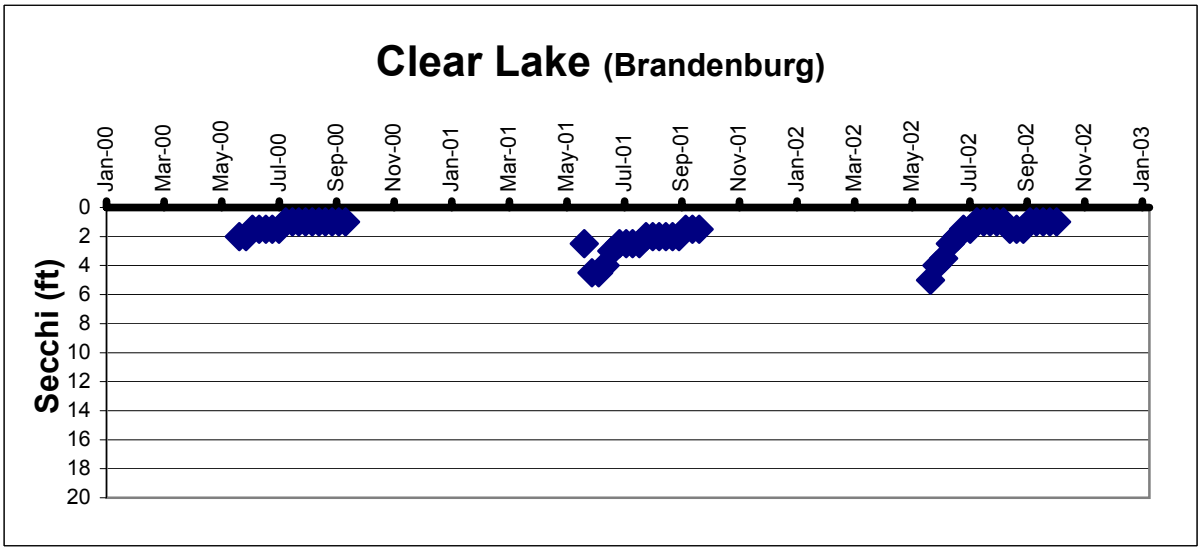

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Citizen Secchi Data -- 2002		Figure B-3

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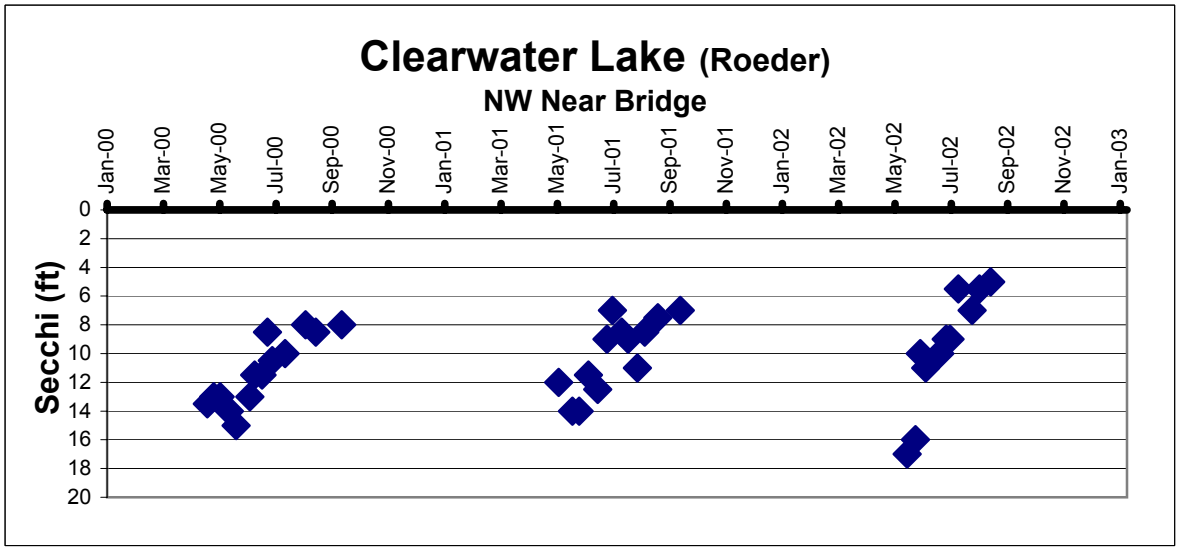

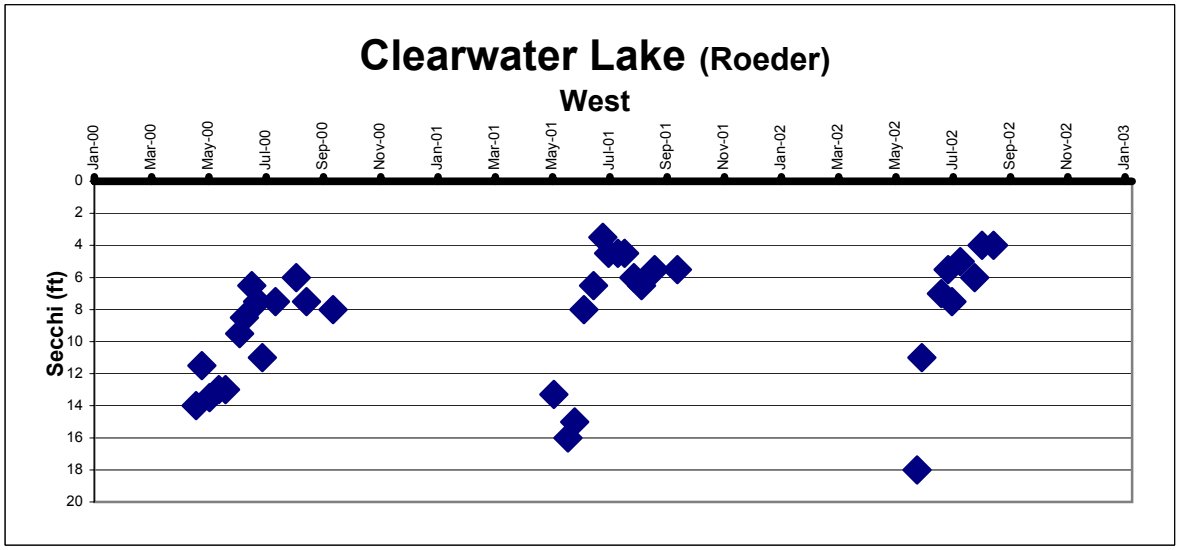

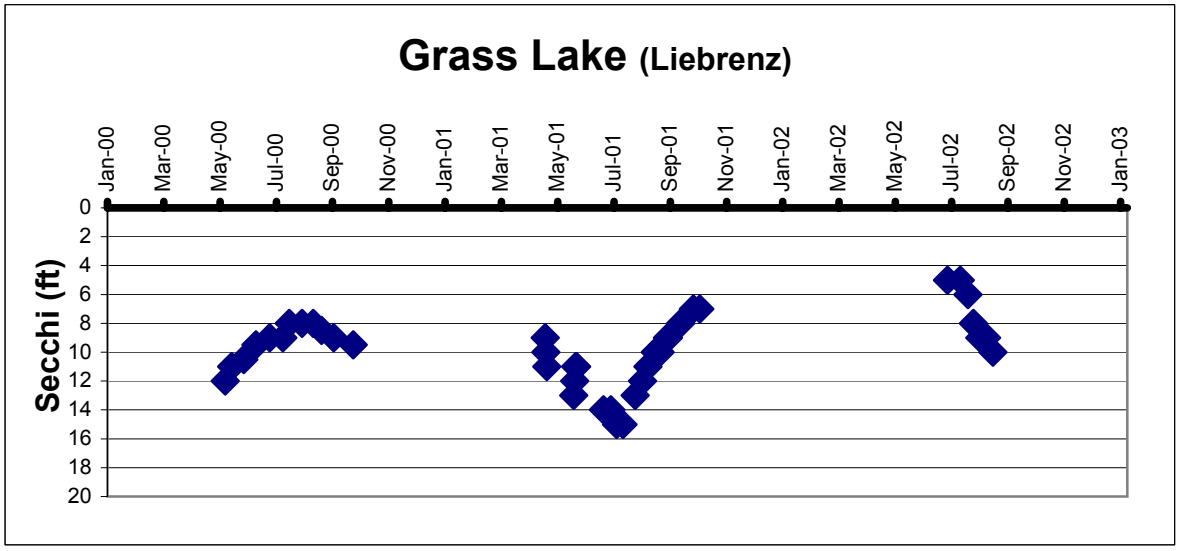

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Citizen Secchi Data -- 2002		Figure B-4

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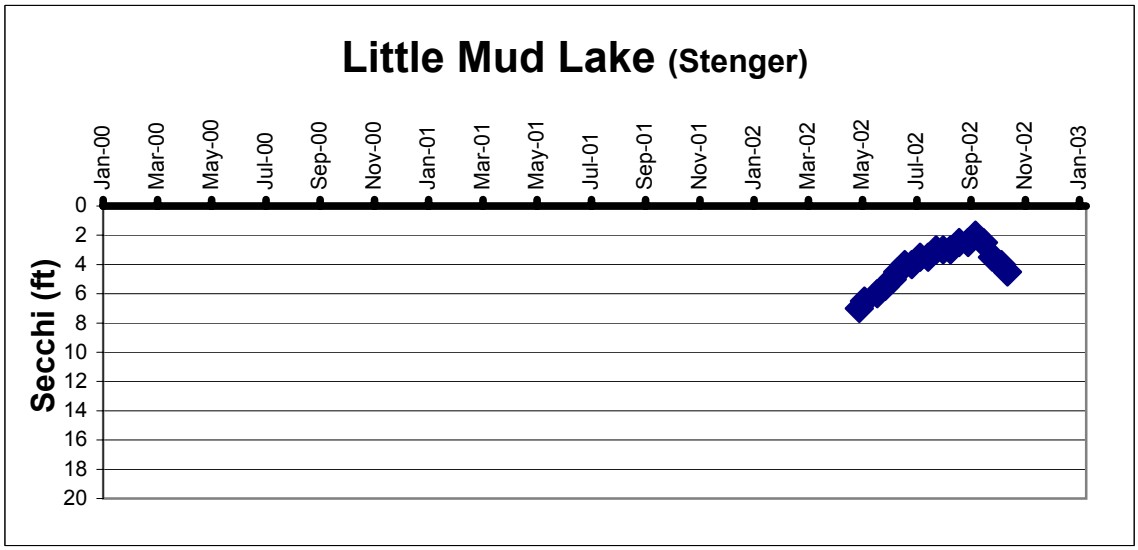

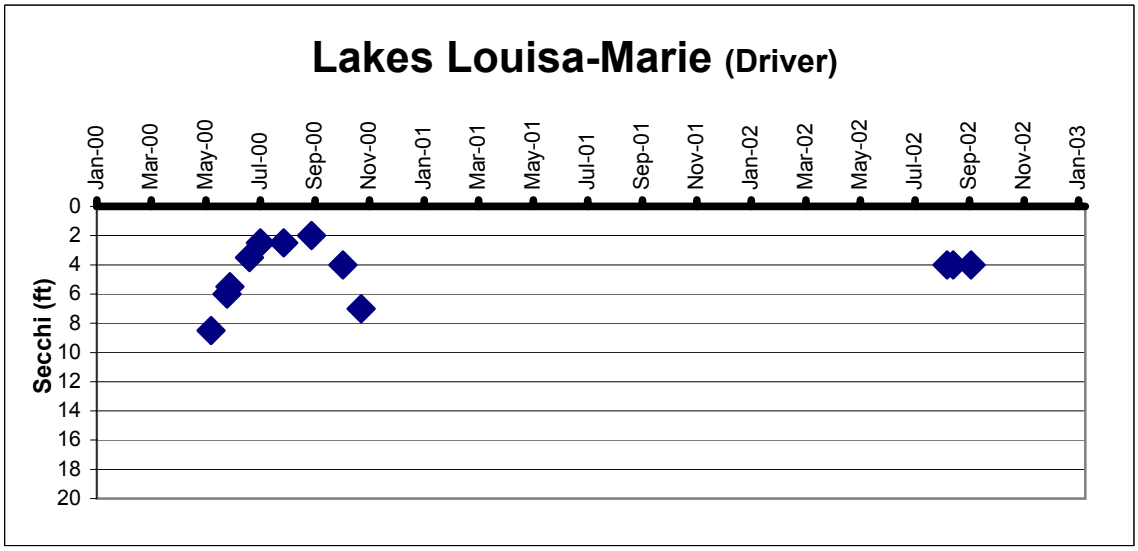

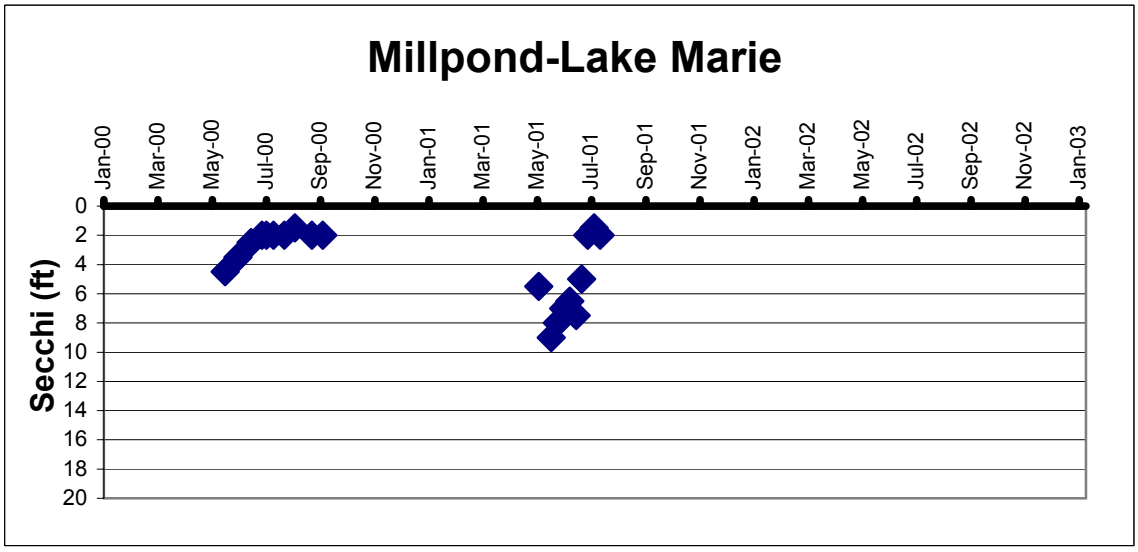

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Citizen Secchi Data -- 2002		Figure B-5

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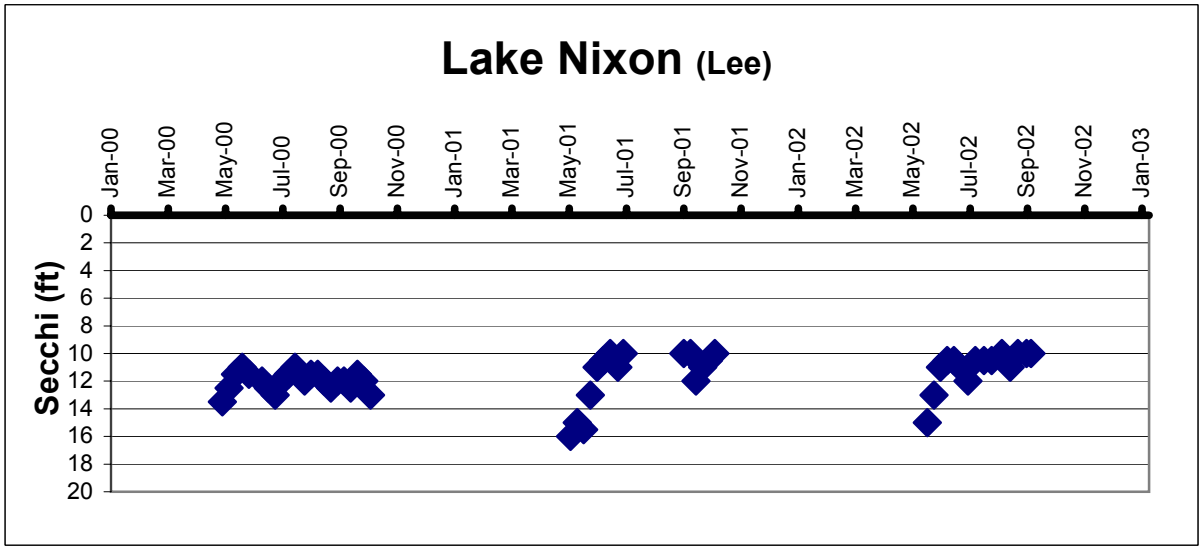

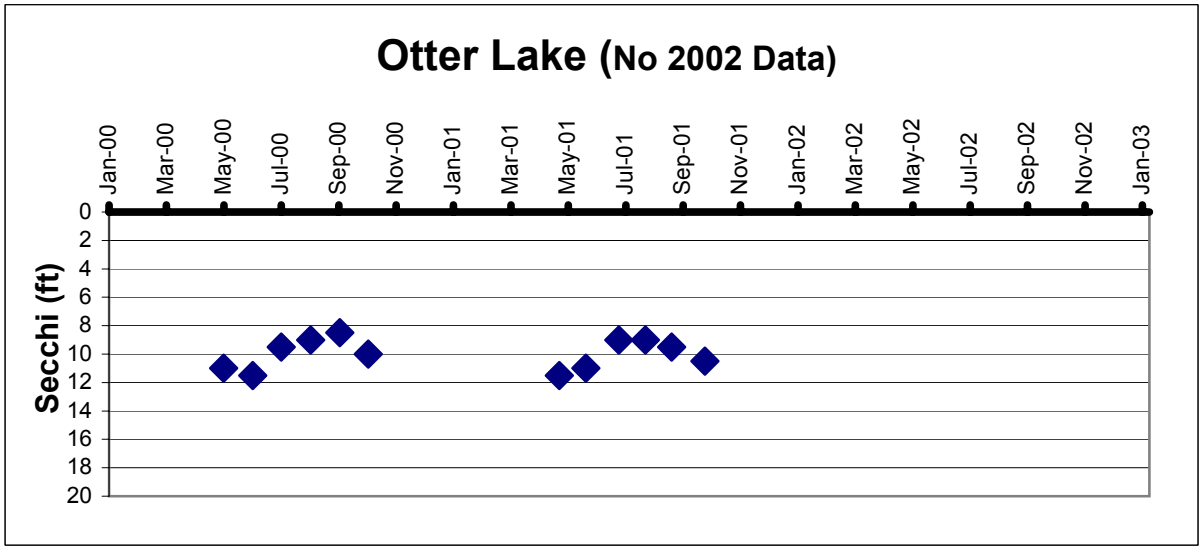

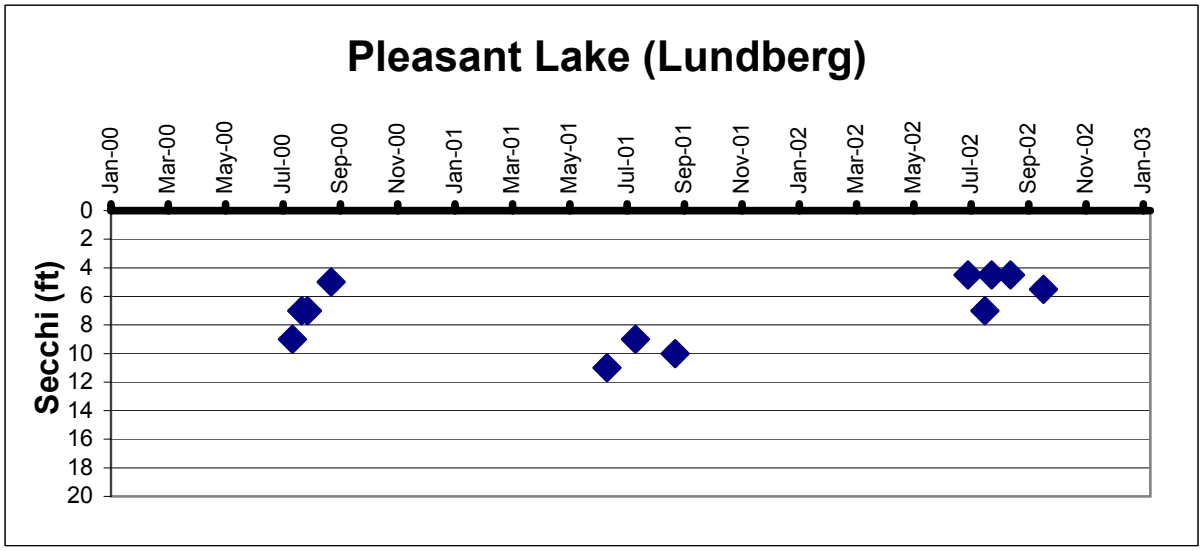

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Citizen Secchi Data -- 2002		Figure B-6

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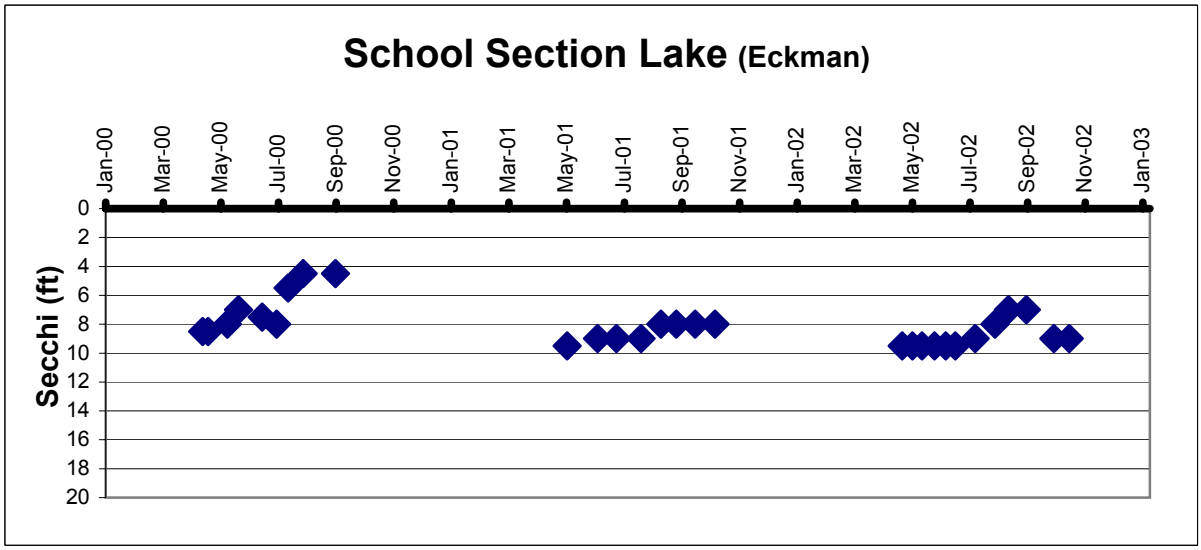

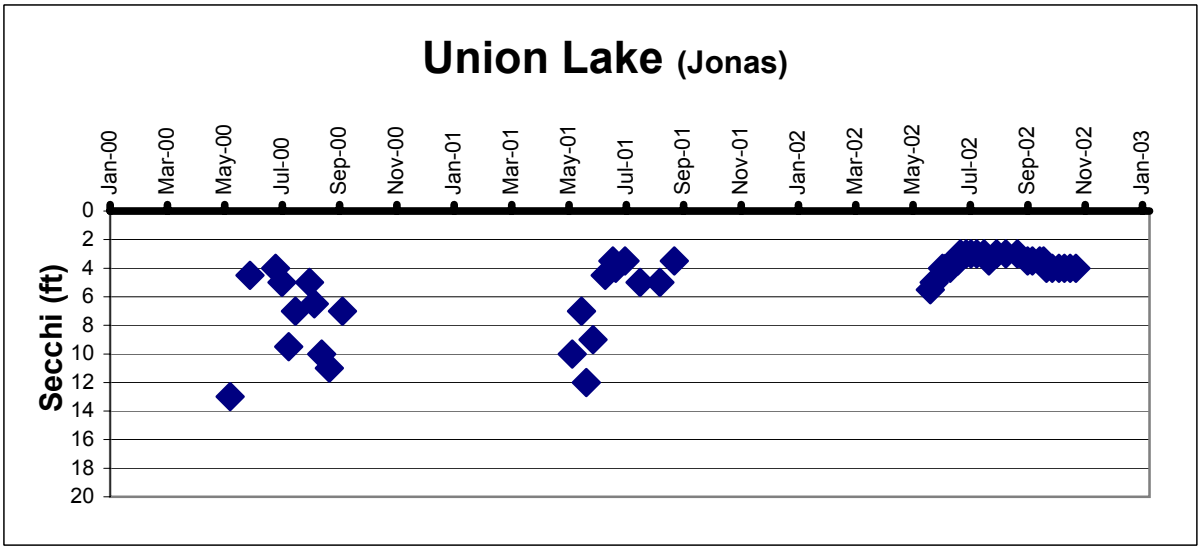

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Citizen Secchi Data -- 2002		Figure B-7

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Appendix C

2002 Water Quality Laboratory Reports and Data

To review Analytical Data please
contact Norm Wenck at
763-479-4200