



2004 WATER MONITORING REPORT

February 2005

Prepared for:

**South Washington
Watershed District**

Prepared by:



Memorandum

To: Matt Moore —South Washington Watershed District Administrator

From: Wendy Griffin, Karen Kill, Travis Thiel, and Erik Anderson--Washington Conservation District

Date: April 13, 2005

Re: SWWD 2004 Monitoring: MS1, MS2, Powers, 100th Street, Fox Run, Tamarack Road, Bailey Lift Station, 80th Street, 90th Street, Outlet of Cottage Grove Ravine Park Lake, Armstrong Lake, Powers Lake, Bailey Lake, Lake Gages, & Observation Wells

At the request of the South Washington Watershed District (SWWD), the Washington Conservation District (WCD) conducted stream monitoring at four existing stream monitoring stations (MS1, MS2, Powers, and 100th Street), monitored four stormwater sites (Fox Run, Tamarack Road, 80th Street, and 90th Street), monitored water quality and level on Armstrong Lake and Powers Lake, monitored level and precipitation on Bailey Lake (at the Lift Station), installed and read nine lake staff gages, and monitored seven groundwater observation wells with additional readings provided by Emmons & Oliver Resources, Inc. Additional flow monitoring was performed on the outlet of Cottage Grove Ravine Park Lake and lake gages were read for La Lake, Ria Lake, and Shepard's Pond within SWWD as part of the study Integrating Ground Water and Surface Water Management--Southern Washington County. The locations of the monitoring sites can be found in Figure 1. The following report summarizes our methods and results for monitoring conducted from January 1 - December 31, 2004. This report and the accompanying data will also be provided in an electronic format.

Stream Sites: MS1, MS2, Powers & 100th Street

Continuous stage, velocity, and discharge measurements were taken every 15 minutes at MS1 and Powers from March 25-November 3, 2004, at 100th Street from March 27-November 3, 2004, and periodic field stage and discharge measurements were taken at MS2 from March 10–October 4, 2004 because of construction at this site. Precipitation data was also continuously collected at each of these sites during the same time period with the exception of MS2 for 2004.

Staff gages were installed and read at each site. Field stage measurements were taken in the outflow culverts. Temperature, dissolved oxygen, and transparency tube measurements were also taken. Flow weighted storm event samples, storm event grab samples, snowmelt grab samples, baseflow composite samples, and baseflow grab samples were collected at all stream sites. In addition to these samples, fecal coliform grab samples were also taken or were attempted at all four sites. The samples were analyzed at the Metropolitan Council Environmental Services Lab.

Stage to discharge relationships were developed at all stream sites, if possible. When the area-velocity probe was covered with debris, erroneous velocity readings were given and stage to discharge relationships had to be used. MS1 and MS2 had backup level logger stage recorders that allowed for data collection during periods when the primary equipment was not recording.

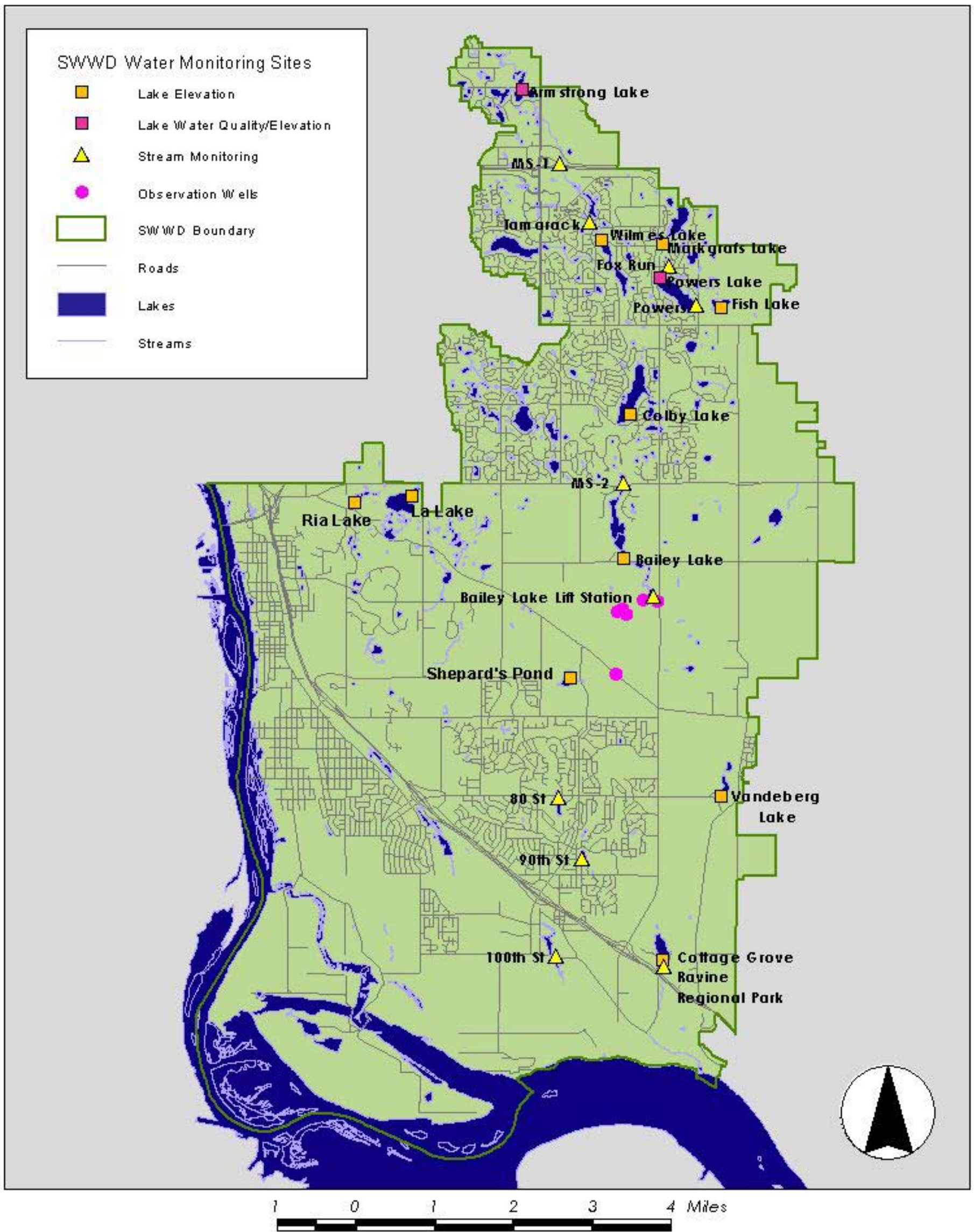


Figure 1. SWWD Water Monitoring Locations

MS1 (I94)

The hydrograph for the MS1 site shows flows between March 25–November 3, 2004 (Figure 2). Total discharge during this period was 9,111,817 cf or 210 acre-ft. The peak discharge—21.70 cfs, was on September 15, 2004 from daily precipitation of 2.04 inches. This was also the highest daily precipitation total for 2004.

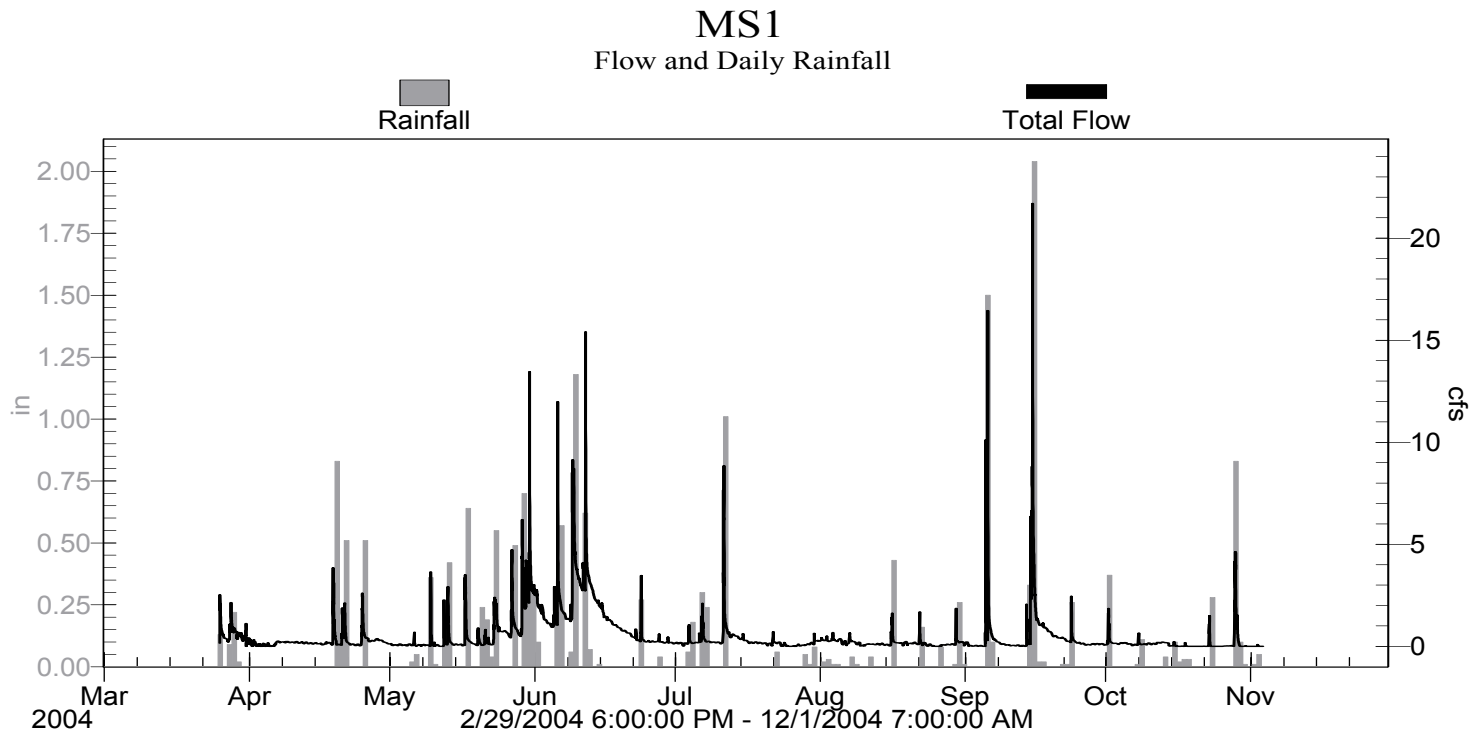


Figure 2. MS1 2004 Continuous Flow and Daily Rainfall

Grab and flow weighted composite samples were taken at the MS1 site to determine water quality. Samples were taken during snowmelt and storm runoff, as well as during base flow conditions. The total suspended solids (TSS), total Kjeldahl nitrogen (TKN), total phosphorus (TP), volatile suspended solids (VSS), chemical oxygen demand (COD), and Fecal Coliform concentrations from all collected samples are listed in Table 1. The highest TSS concentrations were collected in a storm composite on June 11, 2004. The highest TP concentrations were collected in a storm composite on May 9, 2004. The highest TKN concentration was also collected in a storm composite on May 9, 2004. Metals and other Nitrogen species chemical results are listed in Table 2.

Table 1. MS1 2004 Sample Chemistry Results

Sample Type	Start Date	Start Time	End Date	End Time	TSS (mg/L)	VSS (mg/L)	TKN (mg/L)	TP (mg/L)	Fecal Coliform (#/100 mL)	COD (mg/L)
Snowmelt Grab	3/1/04	11:20	3/1/04	11:20	40	8	1.90	0.63		63
Snowmelt Grab	3/11/04	11:00	3/11/04	11:00	33	10	2.50	0.29		76
Storm Composite	4/18/04	19:28	4/19/04	0:36	392	64	3.50	0.82		112
Storm Composite	4/20/04	18:35	4/21/04	10:15	28	7	1.30	0.25		39
Storm Composite	4/25/04	0:38	4/25/04	6:19	60	10	1.00	0.26		38
Storm Composite	5/9/04	17:11	5/9/04	18:03	958	130	4.50	1.05		161
Storm Composite	5/12/04	12:50	5/13/04	11:56	138	20	1.80	0.40		63
Storm Composite	5/16/04	23:46	5/17/04	6:29	106	15	1.40	0.38		51
Storm Composite	5/23/04	5:50	5/23/04	18:05	50	11	1.80	0.26		53
Storm Composite	5/26/04	22:21	5/27/04	5:19	151	19	1.30	0.29		58
Storm Composite	5/29/04	4:28	5/29/04	12:29	212	28	1.20	0.44		62
Storm Composite	5/30/04	1:28	5/30/04	4:23	288	32	1.40	0.43		70
Storm Composite	6/5/04	3:14	6/6/04	14:03	264	29	1.40	0.32		86
Fecal Grab	6/8/04	9:30	6/8/04	9:30					300	
Storm Composite	6/8/04	22:58	6/9/04	8:39	576	60	1.70	0.57		67
Storm Composite	6/11/04	17:48	6/11/04	22:55	1040	84				84
Storm Composite	7/11/04	5:04	7/11/04	9:34	173	33	1.90	0.92		108
Storm Composite	8/16/04	6:22	8/16/04	8:05			1.00	0.13		71
Storm Composite	9/14/04	3:04	9/15/04	12:17	275	21	1.40	0.45		60
Storm Composite	10/28/04	12:17	10/28/04	18:07	335	50	1.80	0.64		83
Average					284	35	1.82	0.47	300	74

Table 2. MS1 2004 Sample Metals and Nitrogen Species Chemical Results

Sample Type	Start Date	Start Time	End Date	End Time	Copper (mg/L)	Nickel (mg/L)	Lead (mg/L)	Zinc (mg/L)	Cadmium (mg/L)	Chromium (mg/L)	Chloride (mg/L)	Nitrite N (mg/L)	Nitrate N (mg/L)	Ammonia Nitrogen (mg/L)
Snowmelt Grab	3/1/04	11:20	3/1/04	11:20	0.0096	0.0033	0.00190	0.0270	0.00007	0.0031	95	0.05	0.76	0.44
Snowmelt Grab	3/11/04	11:00	3/11/04	11:00	0.0068	0.0056	0.00060	0.0101	0.00005	0.0014	40	0.15	4.12	0.26
Storm Composite	4/18/04	19:28	4/19/04	0:36	0.0198	0.0089	0.00800	0.0750	0.00090	0.0099	39	0.10	0.78	0.56
Storm Composite	4/20/04	18:35	4/21/04	10:15	0.0231	0.0035	0.00220	0.0230	0.00030	0.0053	56	0.06	0.33	0.24
Storm Composite	4/25/04	0:38	4/25/04	6:19	0.0089	0.0038	0.00260	0.0250	0.00010	0.0043	35	0.06	0.17	0.13
Storm Composite	5/9/04	17:11	5/9/04	18:03	0.0260	0.0166	0.01590	0.1210	0.00030	0.0178	22	0.10	0.64	0.56
Storm Composite	5/12/04	12:50	5/13/04	11:56	0.0131	0.0070	0.00490	0.0400	0.00020	0.0085	18	0.07	0.21	0.21
Storm Composite	5/16/04	23:46	5/17/04	6:29	0.0098	0.0051	0.00350	0.0280	0.00010	0.0052	26	0.03	0.25	0.19
Storm Composite	5/23/04	5:50	5/23/04	18:05	0.0081	0.0036	0.00170	0.0193	0.00010	0.0037	36	0.03	0.16	0.10
Storm Composite	5/26/04	22:21	5/27/04	5:19	0.0123	0.0067	0.00350	0.0260	0.00020	0.0066	41	0.03	0.20	0.13
Storm Composite	5/29/04	4:28	5/29/04	12:29	0.0155	0.0098	0.00550	0.0320	0.00030	0.0102	38	0.03	0.14	0.10
Storm Composite	5/30/04	1:28	5/30/04	4:23	0.0182	0.0110	0.00620	0.0340	0.00070	0.0106	49	0.03	0.17	0.06
Storm Composite	6/5/04	3:14	6/6/04	14:03	0.0124	0.0089	0.00540	0.0280	0.00120	0.0089	51	0.03	0.18	0.05
Fecal Grab	6/8/04	9:30	6/8/04	9:30										
Storm Composite	6/8/04	22:58	6/9/04	8:39	0.0189	0.0144	0.00880	0.0390	0.00030	0.0143	33	0.05	0.21	0.06
Storm Composite	6/11/04	17:48	6/11/04	22:55	0.0222	0.0182	0.01360	0.0500	0.00080	0.0170	42	0.03	0.27	0.09
Storm Composite	7/11/04	5:04	7/11/04	9:34	0.0280	0.0204	0.01570	0.0640	0.00050	0.0192	13	0.07	0.41	0.02
Storm Composite	8/16/04	6:22	8/16/04	8:05							5	0.03	0.11	0.02
Storm Composite	9/14/04	3:04	9/15/04	12:17	0.0127	0.0135	0.00590	0.0590	0.00170	0.0082	9	0.04	0.19	0.05
Storm Composite	10/28/04	12:17	10/28/04	18:07	0.0174	0.0133	0.01050	0.0470	0.00160	0.0131	9	0.04	0.64	0.22
Average					0.0157	0.0096	0.00647	0.0415	0.00052	0.0093	35	0.05	0.52	0.18

MS2 (Bailey)

The hydrograph for the MS2 site shows flow between March 11 – October 4, 2004 (Figure 3). Total volume of discharge during this period could not be calculated since continuous discharge was not collected. Estimates of total flow may be possible based on the collected data. The highest flow measured—16.50 cfs occurred on June 9, 2004, from a total rainfall of 1.33 inches recorded at the Powers Lake monitoring station.

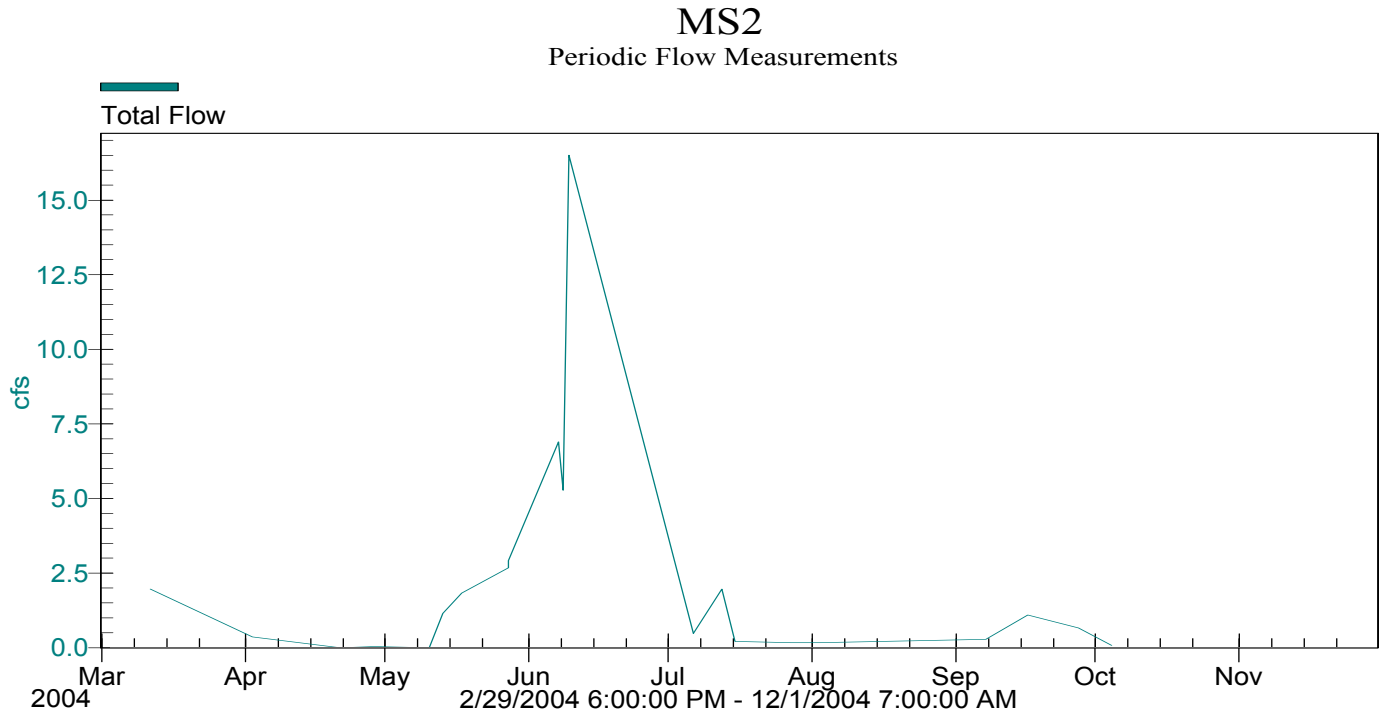


Figure 3. MS2 2004 Periodic Flow Measurements

Grab samples were taken at the MS2 site in 2004. The TSS, TKN, TP, VSS, COD and Fecal Coliform results from all collected samples are listed in Table 3. The highest TSS concentration of 111 mg/L was from the July 12, 2004 storm grab sample. TKN concentrations had a range of 0.83 to 3.40 mg/L. The highest TKN concentrations were from a July 6, 2004 storm grab sample (3.40 mg/L). The highest TP concentration (0.34 mg/L) was from a March 11, 2004 snowmelt grab sample. Metals and other Nitrogen species chemical results are listed in Table 4.

Table 3. MS2 2004 Sample Chemistry Results

Sample Type	Start Date	Start Time	End Date	End Time	TSS (mg/L)	VSS (mg/L)	TKN (mg/L)	TP (mg/L)	Fecal Coliform (#/100 mL)	COD (mg/L)
Snowmelt Grab	3/11/04	10:35	3/11/04	10:35	6	4	2.70	0.34		58
Storm Grab	5/17/04	12:30	5/17/04	12:30	2	1	1.10	0.08		22
Storm Grab	5/27/04	14:00	5/27/04	14:00	6	4	1.10	0.04		37
Storm Grab	6/7/04	9:30	6/7/04	9:30	6	3	1.20	0.05		35
Fecal Grab	6/8/04	9:00	6/8/04	9:00					4	
Storm Grab	6/9/04	14:45	6/9/04	14:45	9	5	1.20	0.09		36
Storm Grab	7/6/04	10:15	7/6/04	10:15	33	15	3.40	0.31		43
Storm Grab	7/12/04	13:15	7/12/04	13:15	111	40	0.83	0.08		28
Fecal Grab	7/15/04	9:00	7/15/04	9:00					6	
Base Grab	7/27/04	9:45	7/27/04	9:45	37	24	1.80	0.24		44
Storm Grab	9/7/04	9:30	9/7/04	9:30	12	8	1.10	0.09		37
Storm Grab	9/16/04	10:15	9/16/04	10:15	11	7	1.30	0.16		32
Fecal Grab	9/27/04	8:45	9/27/04	8:45					6	
Average					23	11	1.57	0.15	5	37

Table 4. MS2 2004 Sample Metals and Nitrogen Species Chemical Results

Sample Type	Start Date	Start Time	End Date	End Time	Copper (mg/L)	Nickel (mg/L)	Lead (mg/L)	Zinc (mg/L)	Cadmium (mg/L)	Chromium (mg/L)	Chloride (mg/L)	Nitrite N (mg/L)	Nitrate N (mg/L)	Ammonia Nitrogen (mg/L)
Snowmelt Grab	3/11/04	10:35	3/11/04	10:35	0.0048	0.0018	0.00040	0.0091	0.00004	0.0009	93	0.04	0.35	0.87
Storm Grab	5/17/04	12:30	5/17/04	12:30	0.0022	0.0020	0.00008	0.0047	0.00004	0.0003	65	0.03	0.30	0.26
Storm Grab	5/27/04	14:00	5/27/04	14:00	0.0021	0.0019	0.00020	0.0038	0.00004	0.0002	59	0.03	0.08	0.12
Storm Grab	6/7/04	9:30	6/7/04	9:30	0.0024	0.0018	0.00020	0.0027	0.00004	0.0005	63	0.03	0.05	0.04
Fecal Grab	6/8/04	9:00	6/8/04	9:00										
Storm Grab	6/9/04	14:45	6/9/04	14:45	0.0028	0.0017	0.00030	0.0032	0.00004	0.0007	58	0.03	0.10	0.10
Storm Grab	7/6/04	10:15	7/6/04	10:15	0.0024	0.0027	0.00050	0.0042	0.00004	0.0005	61	0.03	0.40	0.15
Storm Grab	7/12/04	13:15	7/12/04	13:15	0.0015	0.0020	0.00010	0.0019	0.00004	0.0002	54	0.03	0.29	0.02
Fecal Grab	7/15/04	9:00	7/15/04	9:00										
Base Grab	7/27/04	9:45	7/27/04	9:45	0.0114	0.0019	0.00060	0.0048	0.00004	0.0003	52	0.03	0.39	0.04
Storm Grab	9/7/04	9:30	9/7/04	9:30	0.0017	0.0016	0.00020	0.0022	0.00004	0.0002	37	0.03	0.05	0.06
Storm Grab	9/16/04	10:15	9/16/04	10:15	0.0019	0.0017	0.00030	0.0037	0.00004	0.0004	22	0.03	0.06	0.10
Fecal Grab	9/27/04	8:45	9/27/04	8:45										
Average					0.0033	0.0019	0.00029	0.0040	0.00004	0.0004	56	0.03	0.21	0.18

Powers Lake New East Tributary

The hydrograph for the Powers Lake site shows flow between March 25-November 3, 2004 (Figure 5). Total discharge during this period was 1,566,783 cf or 36 acre/ft. The highest discharge—3.55 cfs occurred on June 5, 2004 from a total rainfall of 2.69 inches or rainfall, which fell from May 25, 2004-June 5, 2004. The rainfall on September 15, 2004 was the highest daily rainfall for the monitoring period, yielding 1.75 inches of rain and a peak discharge of 3.51 cfs.

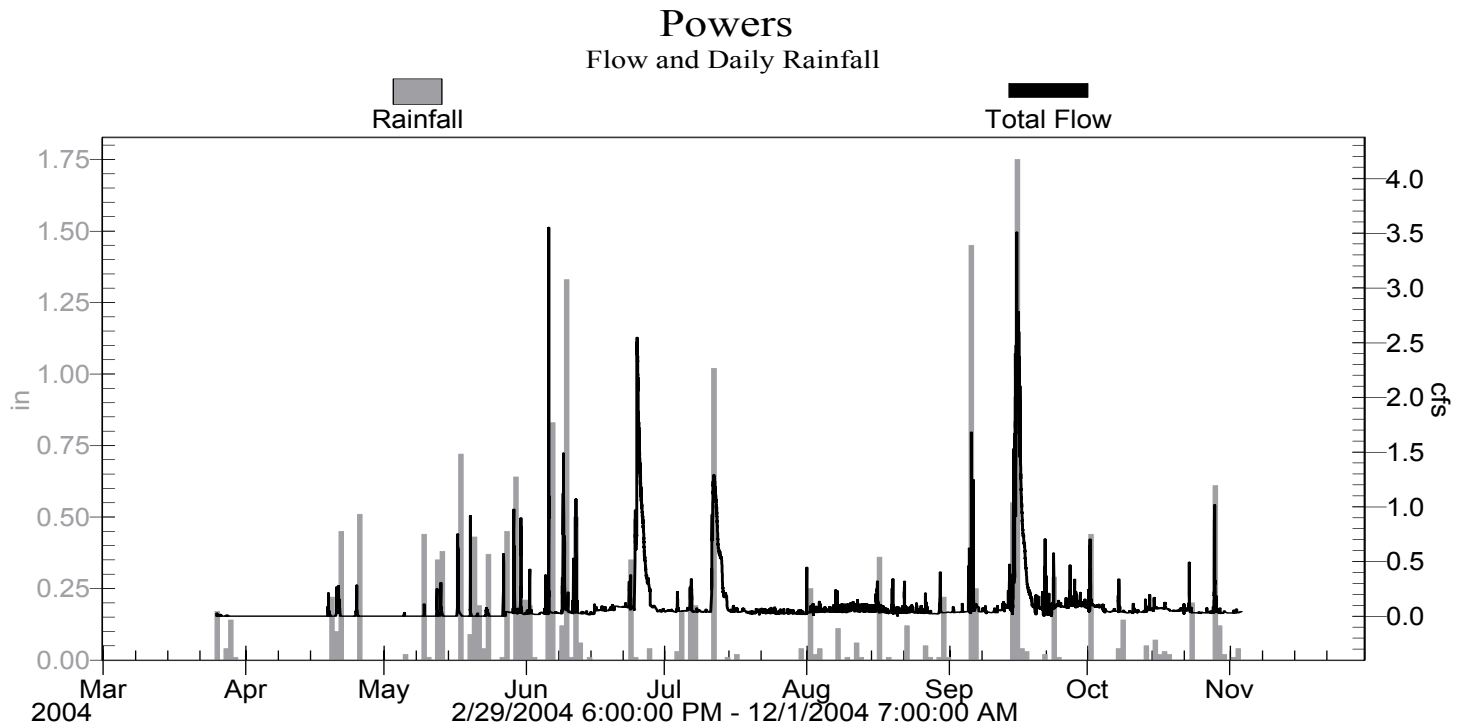


Figure 4. Powers 2004 Flow and Daily Rainfall

Grab and flow weighted composite samples were taken at the Powers site in 2004. The TSS, TKN, TP, VSS, and COD results from all collected samples are listed in Table 5. The highest TSS concentration of 4,220 mg/L was from the June 5, 2004 storm composite sample. TKN concentrations had a range of 1.80 to 13.00 mg/L. The highest TKN concentrations were from a May 19, 2004 storm composite sample (13.00 mg/L). The highest TP concentration (12.70 mg/L) was also from the May 19, 2004 storm composite sample. Metals and other Nitrogen species chemical results are listed in Table 6.

Table 5. Powers 2004 Sample Chemistry Results

Sample Type	Start Date	Start Time	End Date	End Time	TSS (mg/L)	VSS (mg/L)	TKN (mg/L)	TP (mg/L)	COD (mg/L)
Storm Composite	5/19/04	19:00	5/19/04	19:33	1910	240	13.00	12.70	463
Storm Composite	5/26/04	23:02	5/27/04	12:35	2360	240	4.80	3.31	214
Storm Composite	5/29/04	4:02	5/30/04	19:37	1590	150	4.90	2.50	153
Storm Composite	6/5/04	3:09	6/5/04	21:41	4220	280	3.90	2.08	122
Storm Composite	6/8/04	18:02	6/9/04	13:07	1040	115	2.00	1.31	98
Storm Composite	6/11/04	5:55	6/12/04	0:29	2620	210	3.80	3.52	180
Storm Composite	9/5/04	6:25	9/6/04	2:40	4120	330	5.50	3.98	286
Storm Composite	9/14/04	20:14	9/15/04	12:37	336	36	1.80	0.83	80
Average					2275	200	4.96	3.78	200

Table 6. Powers 2004 Sample Metals and Nitrogen Species Chemical Results

Sample Type	Start Date	Start Time	End Date	End Time	Copper (mg/L)	Nickel (mg/L)	Lead (mg/L)	Zinc (mg/L)	Cadmium (mg/L)	Chromium (mg/L)	Chloride (mg/L)	Nitrite N (mg/L)	Nitrate N (mg/L)	Ammonia Nitrogen (mg/L)
Storm Composite	5/19/04	19:00	5/19/04	19:33	0.1470	0.1330	0.16700	0.3210	0.00180	0.1360	545	0.27	0.05	0.18
Storm Composite	5/26/04	23:02	5/27/04	12:35	0.0530	0.0500	0.04700	0.1410	0.00090	0.0510	4	0.08	0.16	0.02
Storm Composite	5/29/04	4:02	5/30/04	19:37	0.0031	0.0277	0.02730	0.0750	0.00050	0.0293	5	0.06	0.10	0.38
Storm Composite	6/5/04	3:09	6/5/04	21:41	0.0470	0.0410	0.04500	0.1080	0.00050	0.0440	5	0.09	0.07	0.03
Storm Composite	6/8/04	18:02	6/9/04	13:07	0.0210	0.0184	0.01640	0.0490	0.00020	0.0204	7	0.03	0.21	0.02
Storm Composite	6/11/04	5:55	6/12/04	0:29	0.0400	0.0400	0.04500	0.1030	0.00080	0.0420	10	0.04	0.17	0.05
Storm Composite	9/5/04	6:25	9/6/04	2:40	0.0780	0.0570	0.06000	0.1560	0.00100	0.0600	7	0.04	0.05	0.02
Storm Composite	9/14/04	20:14	9/15/04	12:37	0.0148	0.0102	0.00860	0.0310	0.00050	0.0109	10	0.03	0.07	0.02
Average					0.0505	0.0472	0.05204	0.1230	0.00078	0.0492	74	0.08	0.11	0.09

100th Street (Cottage Grove)

The hydrograph for the 100th Street site shows flow recorded between April 19-November 3, 2004 (Figure 5). Total discharge during this period was 7,832,702 cf or 180 acre/ft. The highest discharge—11.53 cfs occurred on September 21, 2004, from a total rainfall of 4.02 inches, which fell between September 13-18, 2004. The rainfall on September 15, 2004 was the highest daily rainfall for the monitoring period, yielding 2.98 inches of rain.

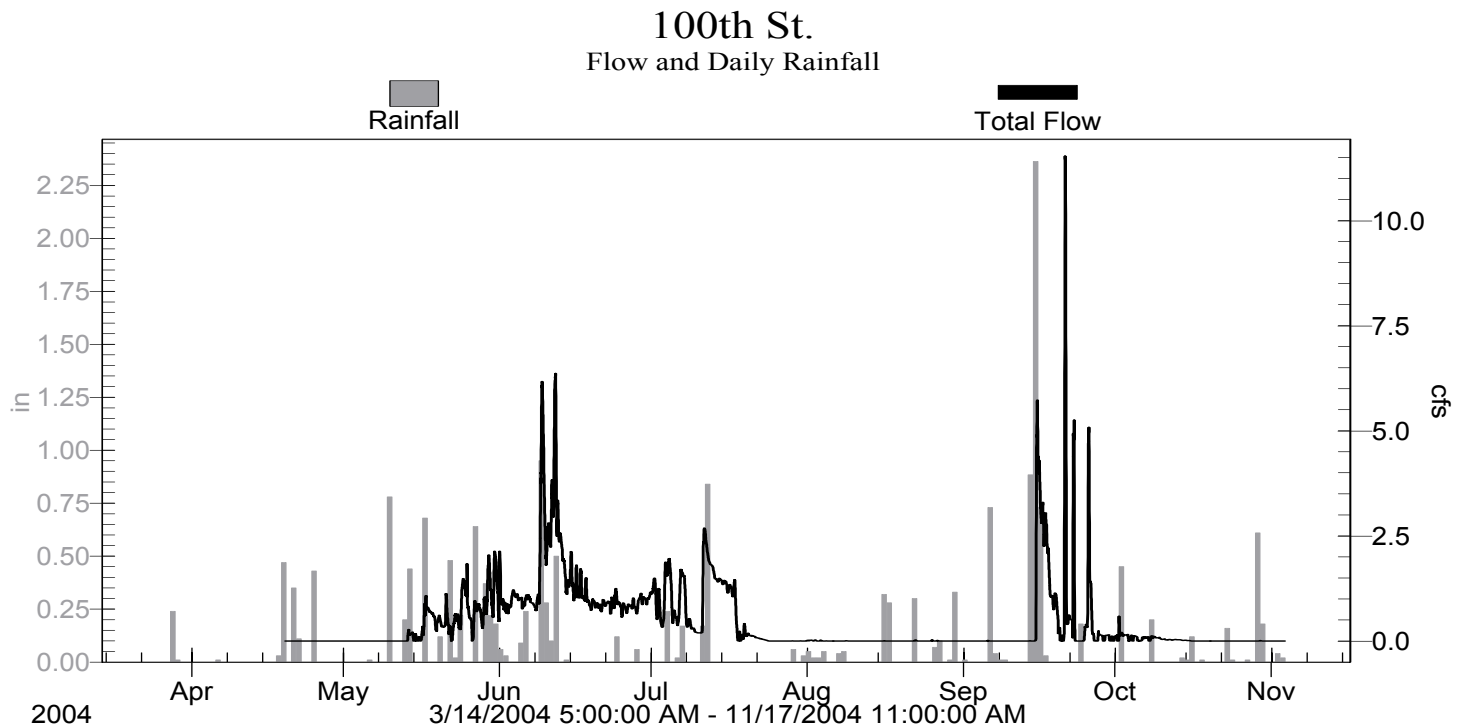


Figure 5. 100th Street 2004 Flow and Daily Rainfall

Grab samples and flow weighted composite samples were taken at the 100th Street site. The TSS, TKN, TP, VSS, and COD results from all collected samples are listed in Table 7. The highest TSS concentration of 18 mg/L was collected in a June 24, 2004 base composite sample. The highest TP concentrations were collected in a May 13, 2004 storm composite sample and a June 24, 2004 base composite sample (0.15 mg/L). The highest TKN concentration was 1.50 mg/L collected from a storm composite sample on May 13, 2004. Metals and other Nitrogen species chemicals are listed in Table 8.

Table 7. 100th Street 2004 Sample Chemistry Results

Sample Type	Start Date	Start Time	End Date	End Time	TSS (mg/L)	VSS (mg/L)	TKN (mg/L)	TP (mg/L)	COD (mg/L)	Fecal Coliform (#/100 mL)
Storm Composite	5/13/04	21:54	5/14/04	4:50			1.50	0.15	33	
Storm Composite	5/16/04	23:55	5/17/04	8:45	2	2	0.87	0.06	26	
Storm Composite	5/30/04	19:24	5/31/04	6:32	2	1	0.41	0.08	16	
Fecal Grab	6/8/04	8:45	6/8/04	8:45						27
Storm Composite	6/9/04	6:23	6/10/04	12:00	3	2	0.56	0.04	21	
Storm Composite	6/11/04	20:06	6/11/04	23:09			0.49	0.05	20	
Base Composite	6/24/04	10:14	6/27/04	19:55	18	8	0.87	0.15	22	
Fecal Grab	7/15/04	8:30	7/15/04	8:30						250
Storm Composite	9/15/04	7:23	9/15/04	22:14	8	5	0.60	0.05	22	
Average					7	4	0.76	0.08	23	139

Table 8. 100th Street 2004 Sample Metals and Nitrogen Species Chemical Results

Sample Type	Start Date	Start Time	End Date	End Time	Copper (mg/L)	Nickel (mg/L)	Lead (mg/L)	Zinc (mg/L)	Cadmium (mg/L)	Chromium (mg/L)	Chloride (mg/L)	Nitrite N (mg/L)	Nitrate N (mg/L)	Ammonia Nitrogen (mg/L)
Storm Composite	5/13/04	21:54	5/14/04	4:50	0.0067	0.0044	0.00010	0.0072	0.00040	0.0002	65	0.03	0.05	0.02
Storm Composite	5/16/04	23:55	5/17/04	8:45	0.0046	0.0039	0.00009	0.0048	0.00010	0.0002	79	0.03	0.05	0.03
Storm Composite	5/30/04	19:24	5/31/04	6:32	0.0052	0.0019	0.00010	0.0050	0.00010	0.0003	62	0.03	0.19	0.02
Fecal Grab	6/8/04	8:45	6/8/04	8:45										
Storm Composite	6/9/04	6:23	6/10/04	12:00	0.0028	0.0019	0.00020	0.0037	0.00010	0.0006	57	0.03	0.06	0.05
Storm Composite	6/11/04	20:06	6/11/04	23:09	0.0026	0.0016	0.00050	0.0047	0.00100	0.0006	32	0.04	0.2	0.05
Base Composite	6/24/04	10:14	6/27/04	19:55	0.0029	0.0024	0.00010	0.0050	0.00010	0.0002	61	0.03	0.13	0.08
Fecal Grab	7/15/04	8:30	7/15/04	8:30										
Storm Composite	9/15/04	7:23	9/15/04	22:14	0.0030	0.0022	0.00040	0.0097	0.00280	0.0007	22	0.04	0.36	0.02
Average					0.0040	0.0026	0.00021	0.0057	0.00066	0.0004	54	0.03	0.15	0.04

Stormwater Sites: Fox Run, Tamarack Road, 80th Street, 90th Street, Bailey Lake (at Lift Station), and Outlet of Cottage Grove Ravine Park Lake

Fox Run

The Fox Run stormwater site recorded stage, velocity, and flow between April 15-October 28, 2004 (Figure 6). The total discharge for this period was 290,431 cf or 6.7 acre-ft. The highest recorded flow was 2.13 cfs on June 9. There was no precipitation gage at this site and no chemistry data was collected at this site.

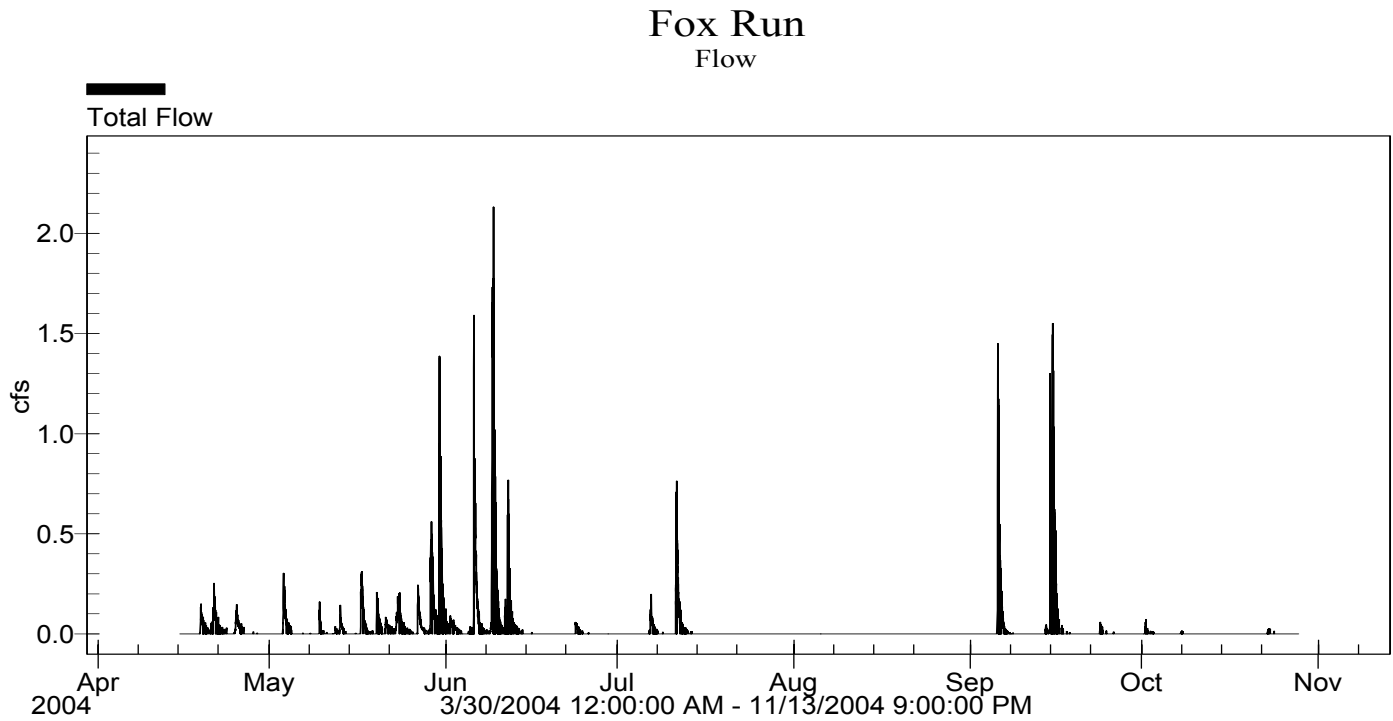


Figure 6. Fox Run 2004 Continuous Flow

Tamarack Road

The Tamarack Road stormwater site recorded stage, velocity, and flow between April 15-October 28, 2004 (Figure 7). The total discharge for this period was 1,545,293 cf or 35 acre-ft. The highest discharge at this site was 29.89 cfs on September 5, 2004. There was no precipitation gage at this site and no chemistry data was collected at this site.

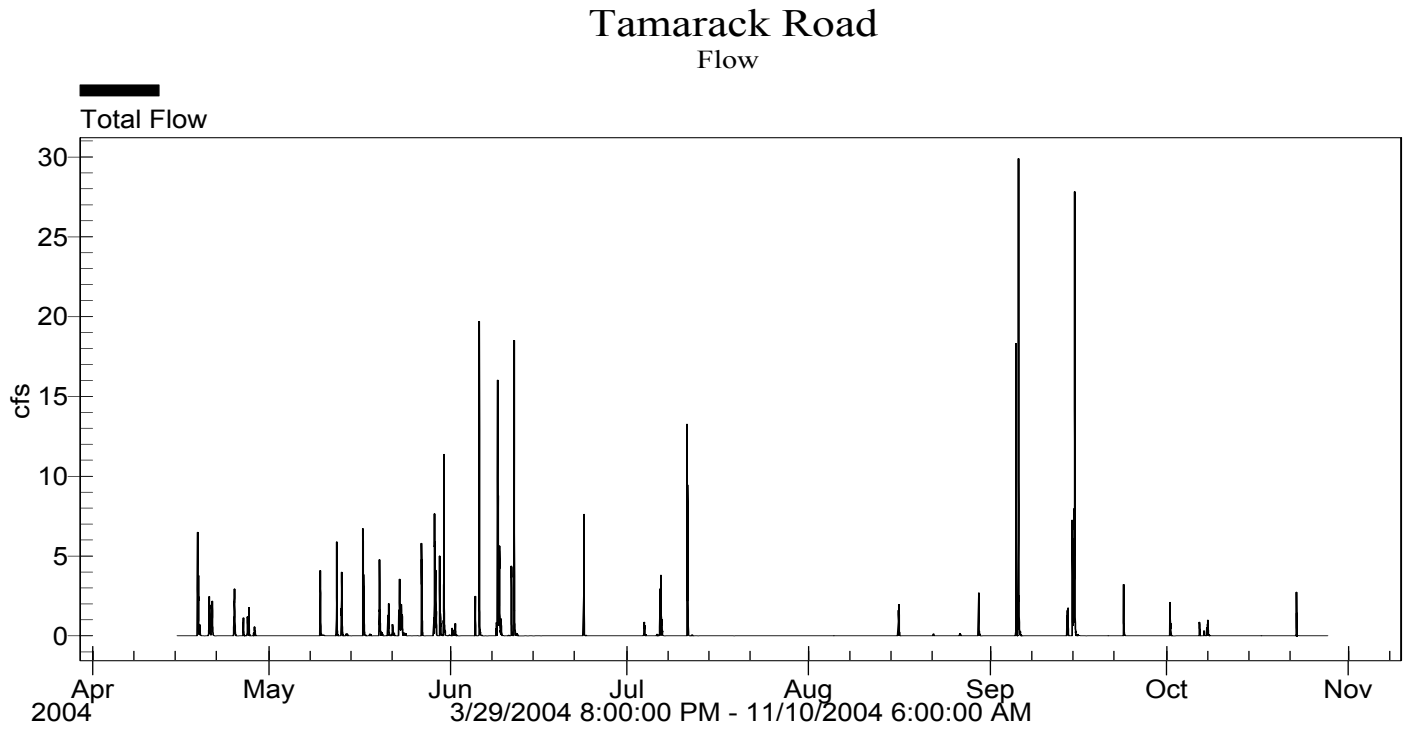


Figure 7. Tamarack Road 2004 Continuous Flow

80th Street

The 80th Street stormwater site recorded stage and flow between April 14-October 28, 2004 (Figure 8). The total discharge for this period was 2,731,410 cf or 62.70 acre-ft. The high flow at this site—13.62 cfs was on May 12, 2004. There was no precipitation gage at this site and no chemistry data was collected at this site.

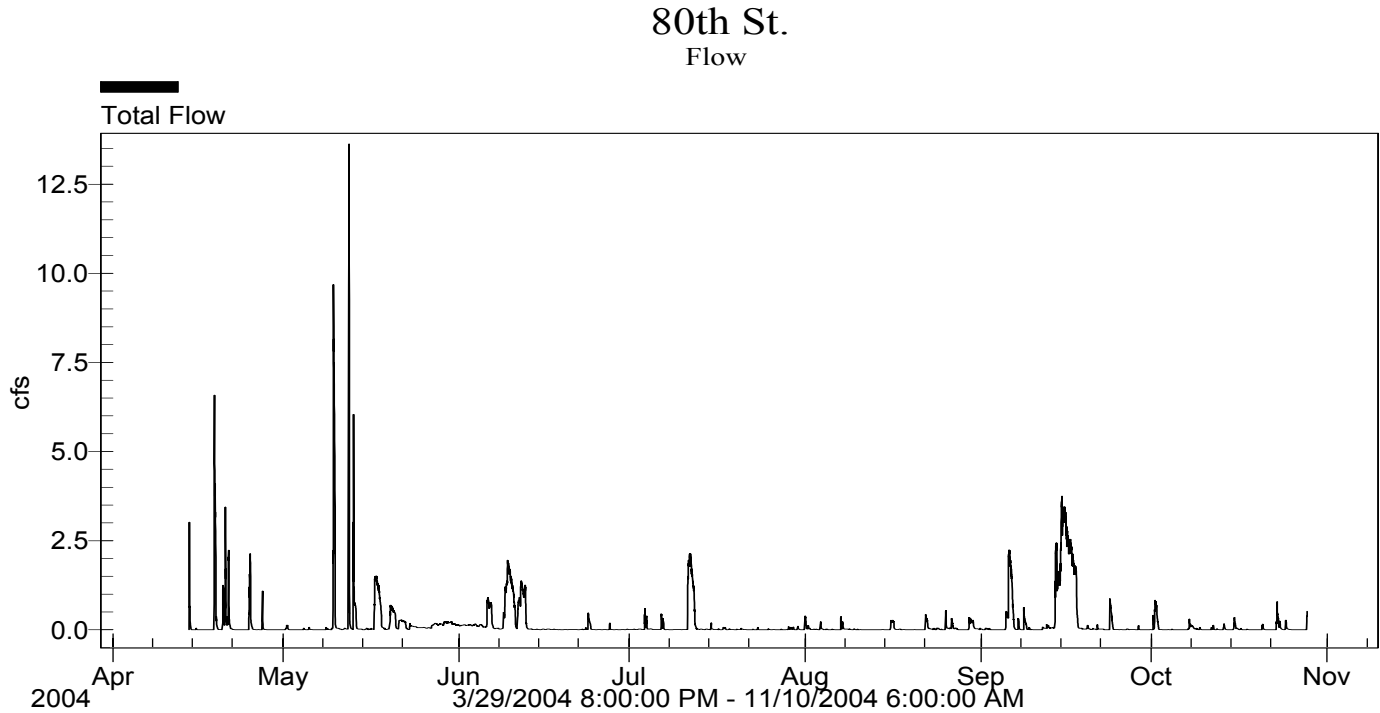


Figure 8. 80th Street 2004 Continuous Flow

90th Street

The 90th Street stormwater site recorded stage and flow between April 14-October 19, 2004 (Figure 9). The total discharge for this period was estimated at 3,076,961 cf or 71 acre-ft. Total discharge had to be estimated because of equipment failure between September 14-15. During this period flow was estimated (indicated by dashed line) using total flow from the 80th St. site. This number may be underestimating total discharge because of additional sources of input to the basin at 90th St. other than 80th St. contributions. The highest discharge estimated at this site—8.81 cfs was on September 15, 2004. There was no precipitation gage at this site. No chemistry data was collected at this site.

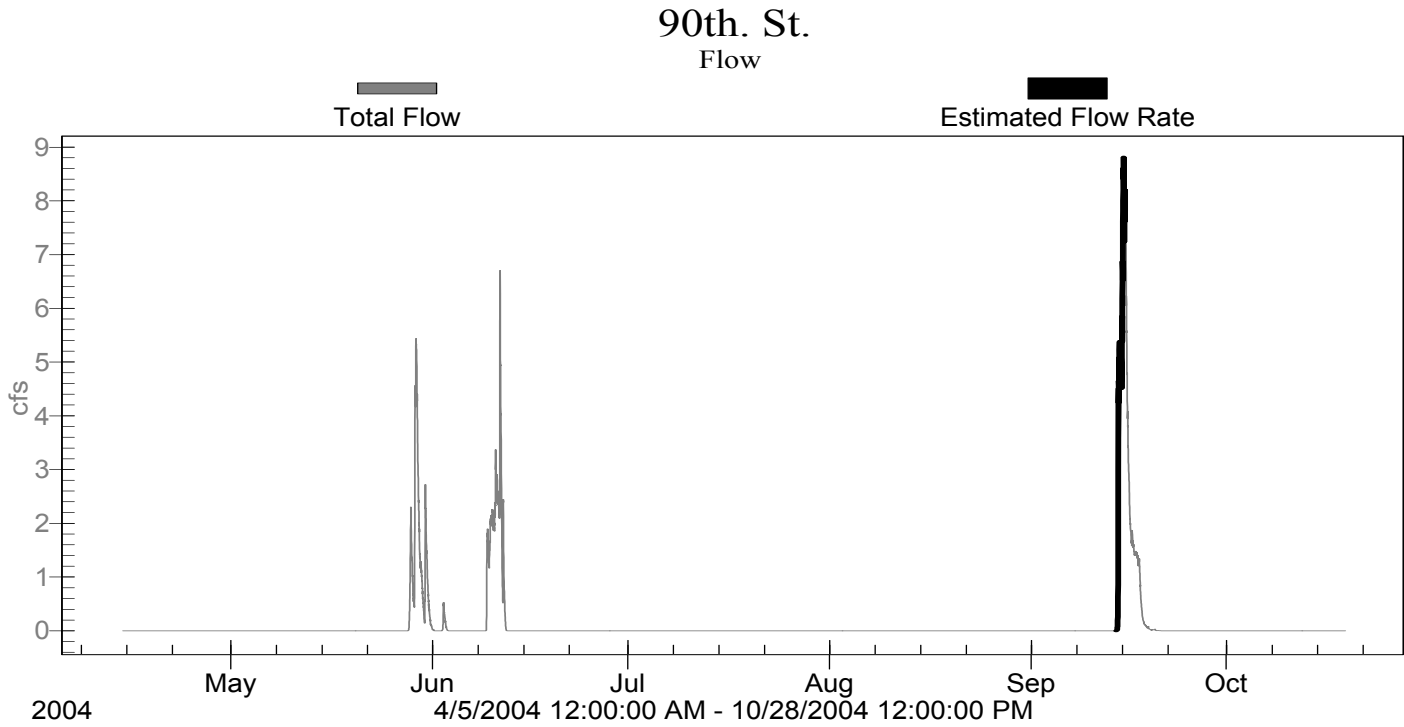


Figure 9. 90th Street 2004 Continuous Flow

Bailey Lake (at Lift Station)

Continuous stage and precipitation measurements were recorded between April 20-November 3, 2004 at this site (Figure 10). The highest recorded Elevation—870.72 ft., was recorded on June 16, 2004. The average stage during the monitoring season was 868.28 ft. The highest recorded daily precipitation—1.58 inches, was recorded on September 15, 2004. Construction occurred on the lift station during the monitoring season and equipment was moved to avoid damage. Because of limitations from length of data logger cord, the lowest elevation possible to be recorded was 865.69 ft. Any readings below this elevation were taken manually from the staff gage at the basin’s lowest point just in front of the lift station.

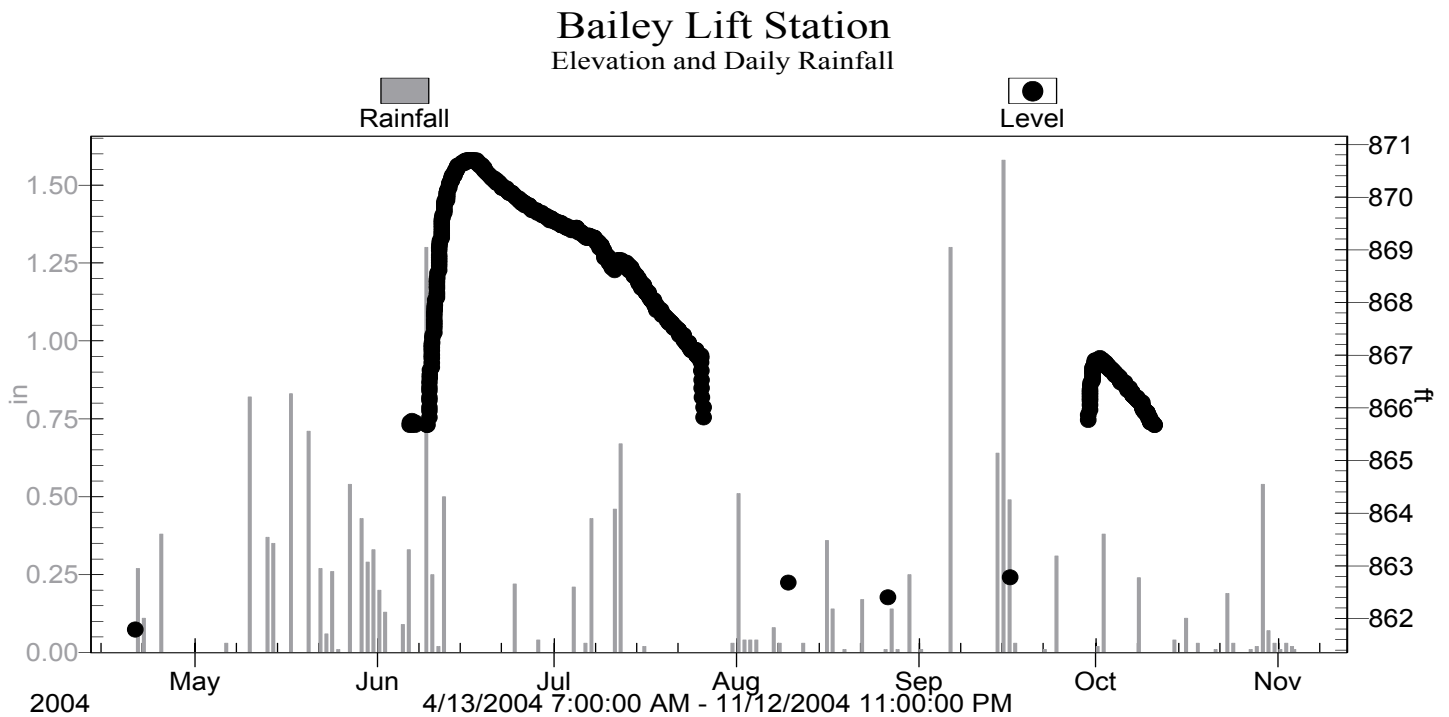


Figure 10. Bailey Lake (at Lift Station) 2004 Elevation and Daily Precipitation

Ravine Park (Outlet of Cottage Grove Ravine Park Lake)

The Ravine Park site was used as part of the study, Integrating Ground Water and Surface Water Management- Southern Washington County. The Ravine Park site recorded stage, flow, and temperature between May 6- November 4, 2004 (Figure 11). The total discharge for this period was estimated at 14,701,040 cf or 337 acre-ft. The highest discharge estimated at this site—6.56 cfs was on May 28, 2004. There was no precipitation gage at this site. No chemistry data was collected at this site. Many of the fluctuations in discharge were due to culverts at the outlet of the lake becoming clogged often during the monitoring season and not due to precipitation.

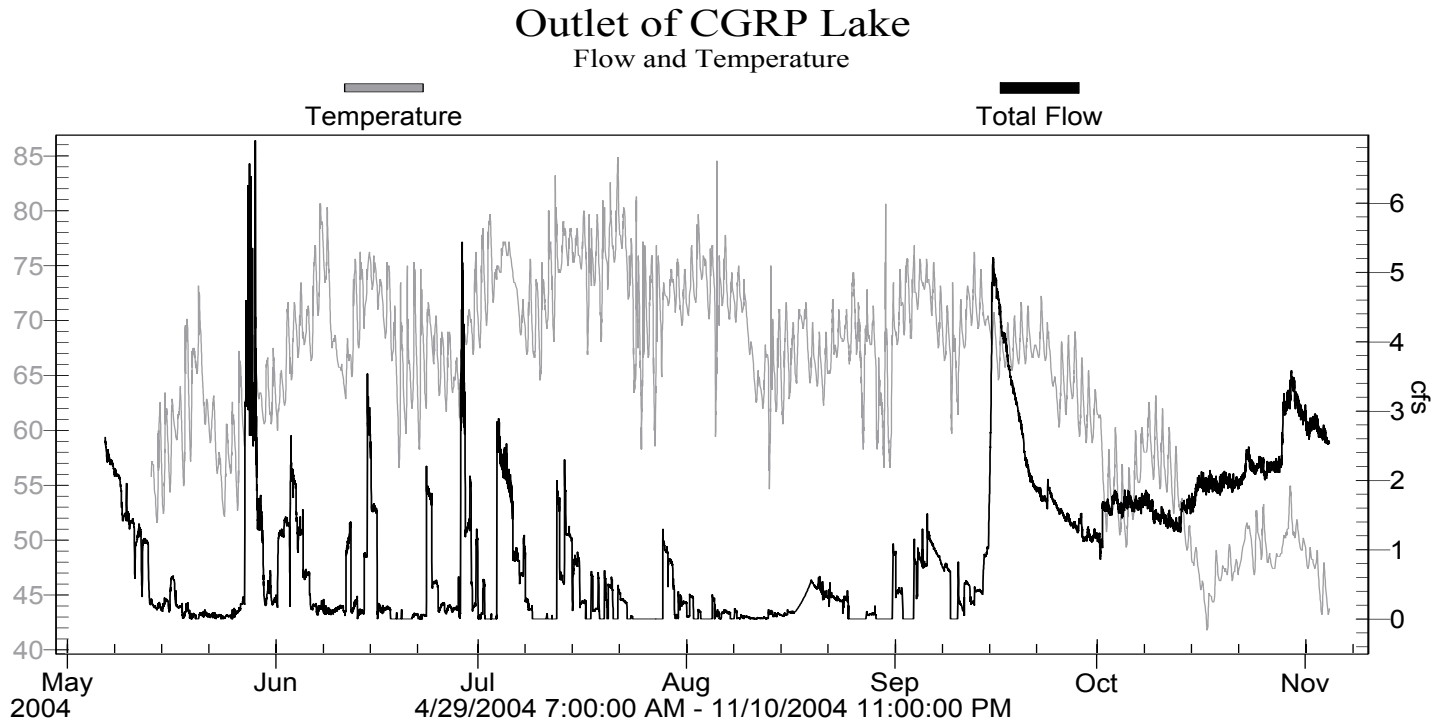


Figure 11. Outlet of Ravine Park Lake 2004 Continuous Discharge and Temperature

Armstrong Lake

Vital Statistics:

DNR ID #: 82-0116

LOCATION: NW^{1/4} Section 33 T29N-R21W

MUNICIPALITY: City of Lake Elmo

LAKE SIZE: 28.1 acres (North—7.3 acres, South—20.8 acres)

ORDINARY HIGH WATER MARK: 1019.1 ft

Armstrong Lake was monitored from April 19 to October 19, 2004, in accordance with the Metropolitan Council Citizen-Assisted Monitoring Program (CAMP). Monitoring consisted of 14 biweekly lake gage readings and samplings of Secchi disk, surface total phosphorus, surface total Kjeldahl nitrogen, surface chlorophyll-*a*, and surface total chloride ion. In addition, a temperature and dissolved oxygen profile was taken during each sampling round. The Metropolitan Council Lab analyzed the samples.

Table 9 gives the Armstrong Lake 2004 high, low, and average lake levels. Individual lake level readings are shown in Figure 12.

Table 9. Armstrong 2004 Lake Level

	High	High Date	Low	Low Date	Average
Lake Level (ft)	1019.37	5/27/04	1017.99	9/3/04	1018.71

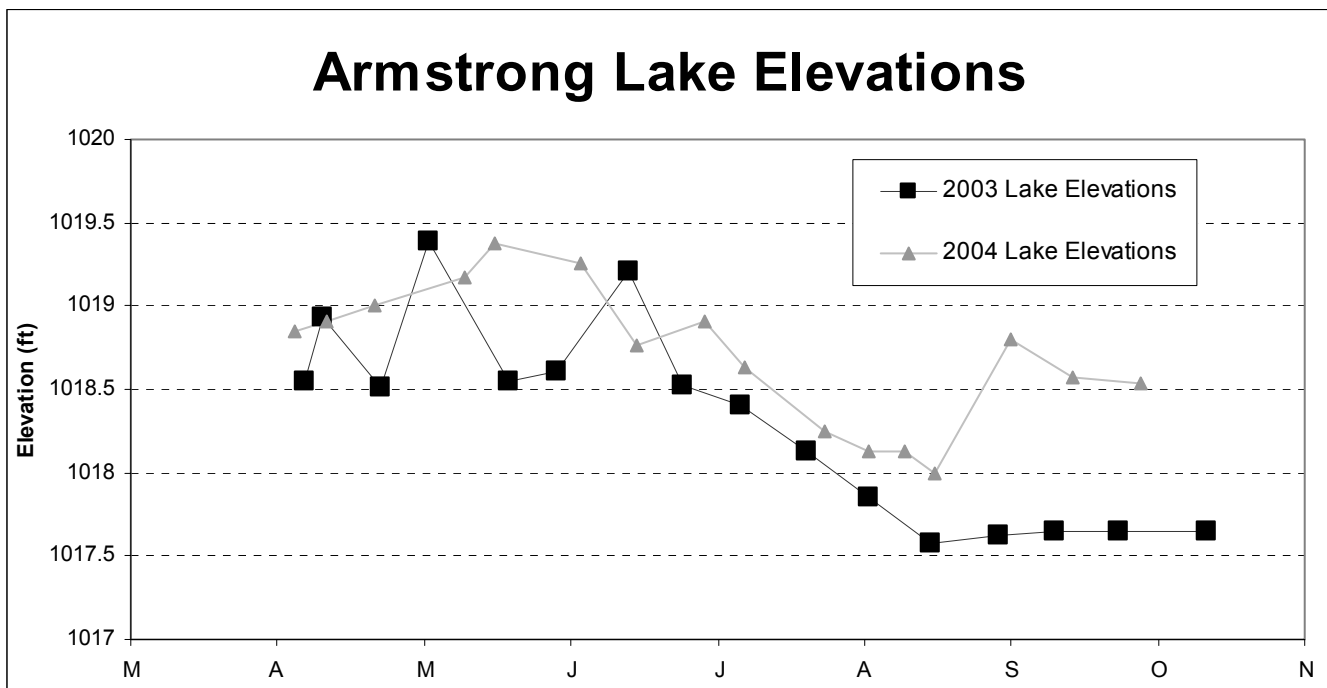


Figure 12. Armstrong Lake Elevations 2003-04

Table 10 gives the 2004 Armstrong Lake monitoring chemistry results and Secchi disk readings for the 2004 water-monitoring season.

Table 10. Armstrong Lake 2004 Monitoring Results

Date	Surface Total Phosphorus (mg/L)	Surface Total Kjeldahl Nitrogen (mg/L)	Chlorophyll <i>a</i> (ug/L)	Chloride (mg/L)	Secchi Disk (m)	Surface Dissolved Oxygen (mg/L)	Surface Temperature (C)
4/19/04	0.11	1.70	39.0	100	0.91	6.50	14.50
4/30/04	0.07	1.60	20.0	115	0.91	7.42	13.40
5/20/04	0.06	1.40	16.0	132	1.07	7.36	19.00
5/27/04	0.06	1.10	18.0	99	0.91	8.98	16.50
6/15/04	0.05	0.54	5.8	55	1.22	9.35	25.20
6/28/04	0.03	0.75	5.7	69	1.22	9.91	21.80
7/13/04	0.06	0.77	8.3	33	1.07	7.01	24.50
7/22/04	0.05	1.10	4.5	70	0.91	8.18	28.60
8/9/04	0.09	1.20	6.7	133	0.91	5.99	21.00
8/19/04	0.04	0.87	4.9	97	1.07	8.11	19.10
9/3/04	0.05	0.81	5.6	75	0.91	6.20	24.50
9/20/04	0.06	0.69	7.1	47	0.91	6.61	20.60
10/4/04	0.07	1.20	12.0	64	0.91	7.27	11.80
10/19/04	0.04	0.91	12.0	72	0.91	8.15	6.10
2004 Averages	0.06	1.05	11.8	83	0.99	7.65	19.04

Table 11 shows the Armstrong Lake Water Quality Summary. Armstrong Lake showed a slight improvement in water quality in 2004. The lake received an average lake grade of a C for 2004, compared to a C- in 2003.

Table 11. Lake Grade and Trophic Status.

	Trophic Status (2003 Average)	Lake Grade (2003 Average)	Trophic Status (2004 Average)	Lake Grade (2004 Average)
Total Phosphorus (mg/L)	Hypereutrophic	D	Eutrophic	C
Chlorophyll- <i>a</i> (ug/L)	Eutrophic	B-	Eutrophic	B
Secchi disk (ft)	Eutrophic	D	Eutrophic	D
Overall	Eutrophic	C-	Eutrophic	C

Figure 13-17 compare the lake chemistry data and Secchi disk readings. Although there were no statistically significant correlations between water quality parameters, general trends can be noted. There was a weak positive statistical relationship between TKN and TP ($r^2= 0.47$): as TKN increased, TP increased. A strong positive statistical correlation was found between TKN and CLA ($r^2= 0.62$). As TKN increased, CLA also increased. A weak positive statistical correlation was found between TKN and Total Chloride ions ($r^2= 0.49$). As TKN increased, Total Chloride ions increased as well. There was also a weak positive statistical relationship between CLA and TP ($r^2= 0.48$). As CLA increased, TP also increased. No correlation was found between Secchi and any other parameter. There were also no correlations found between TP and Total Chloride ions and no correlation found between CLA and Total Chloride ions. These correlations are further simplified in Table 12.

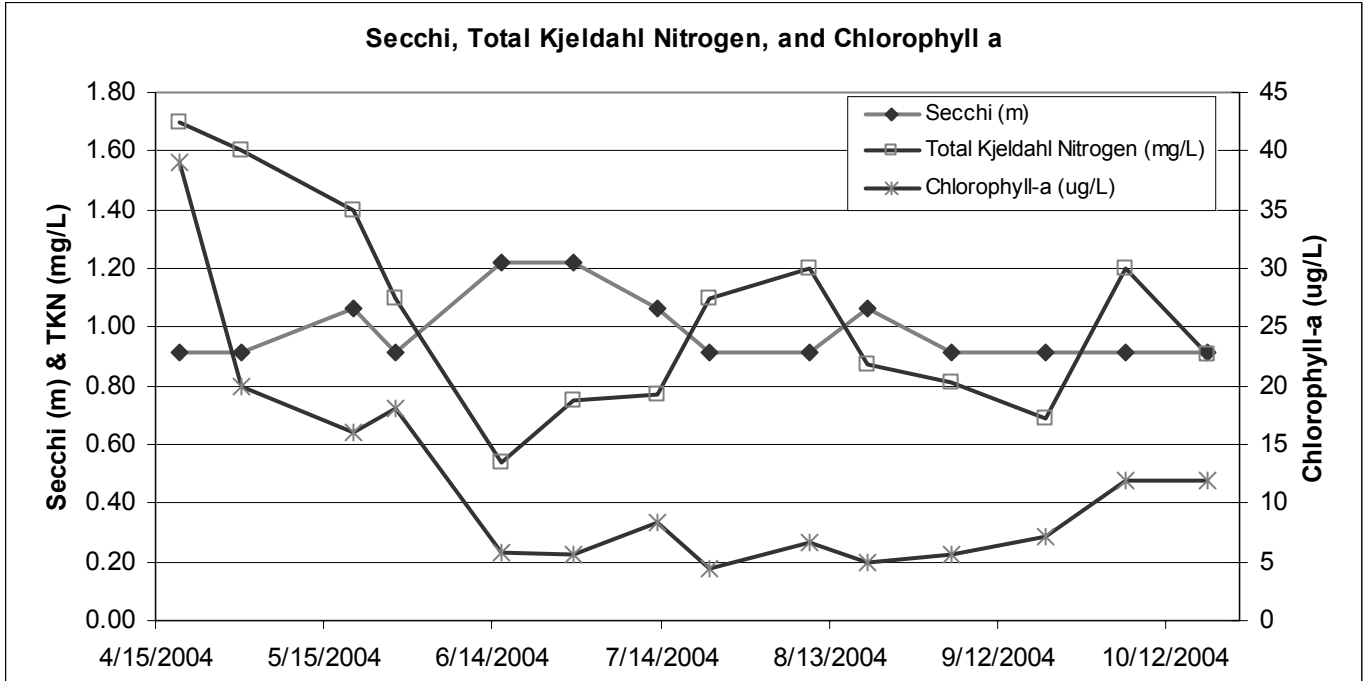


Figure 13. Secchi, Total Kjeldahl Nitrogen and Chlorophyll-a

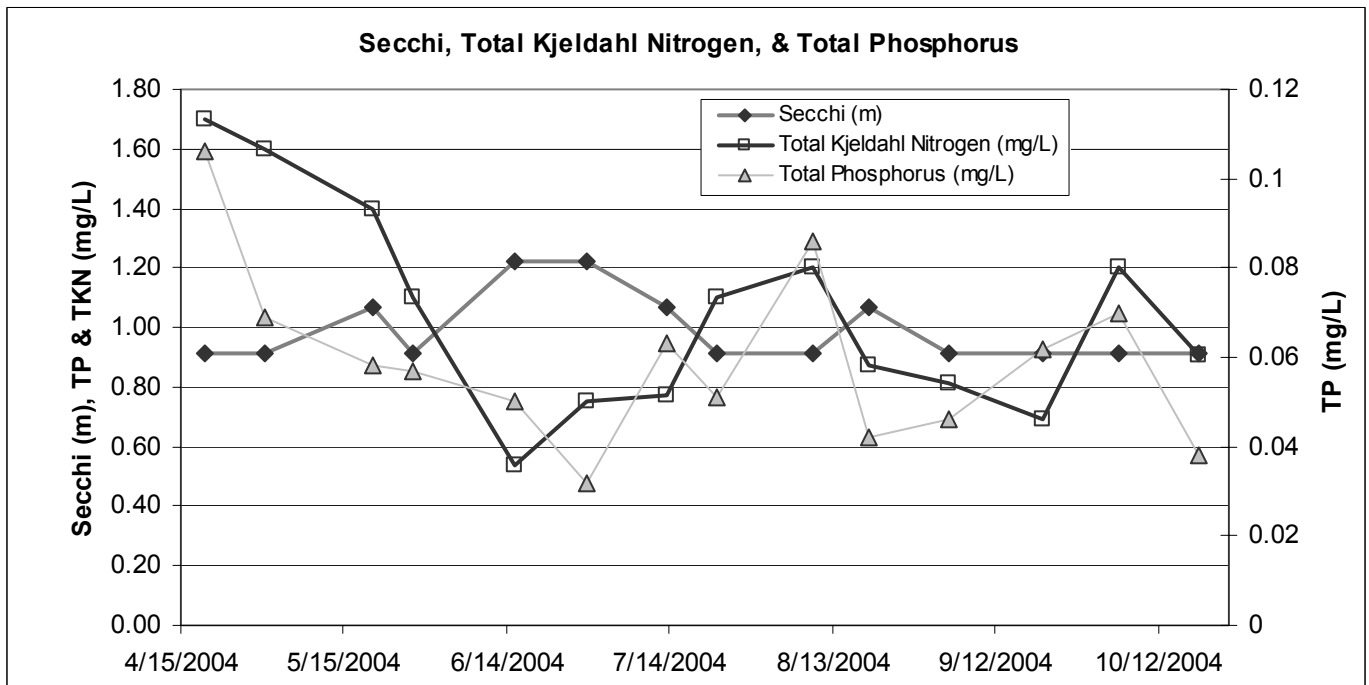


Figure 14. Secchi, Total Kjeldahl Nitrogen, and Total Phosphorus

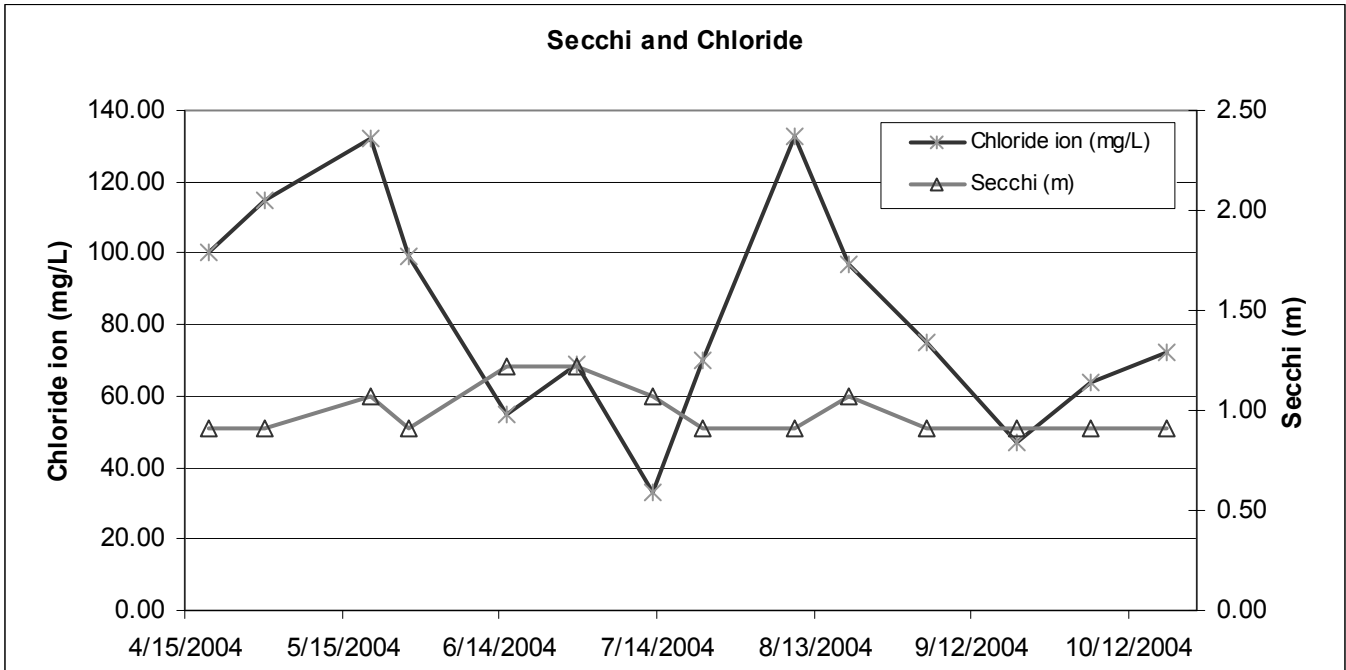


Figure 15. Secchi and Chloride ion

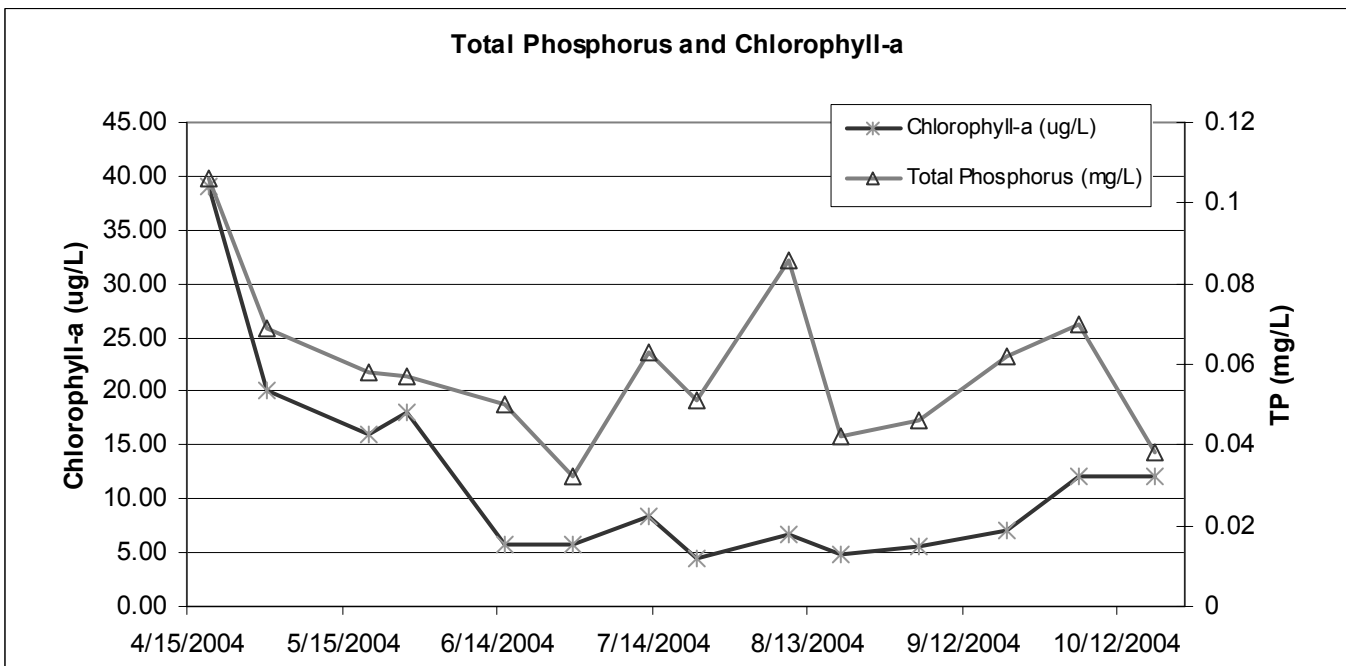


Figure 16. Total Phosphorous and Chlorophyll a

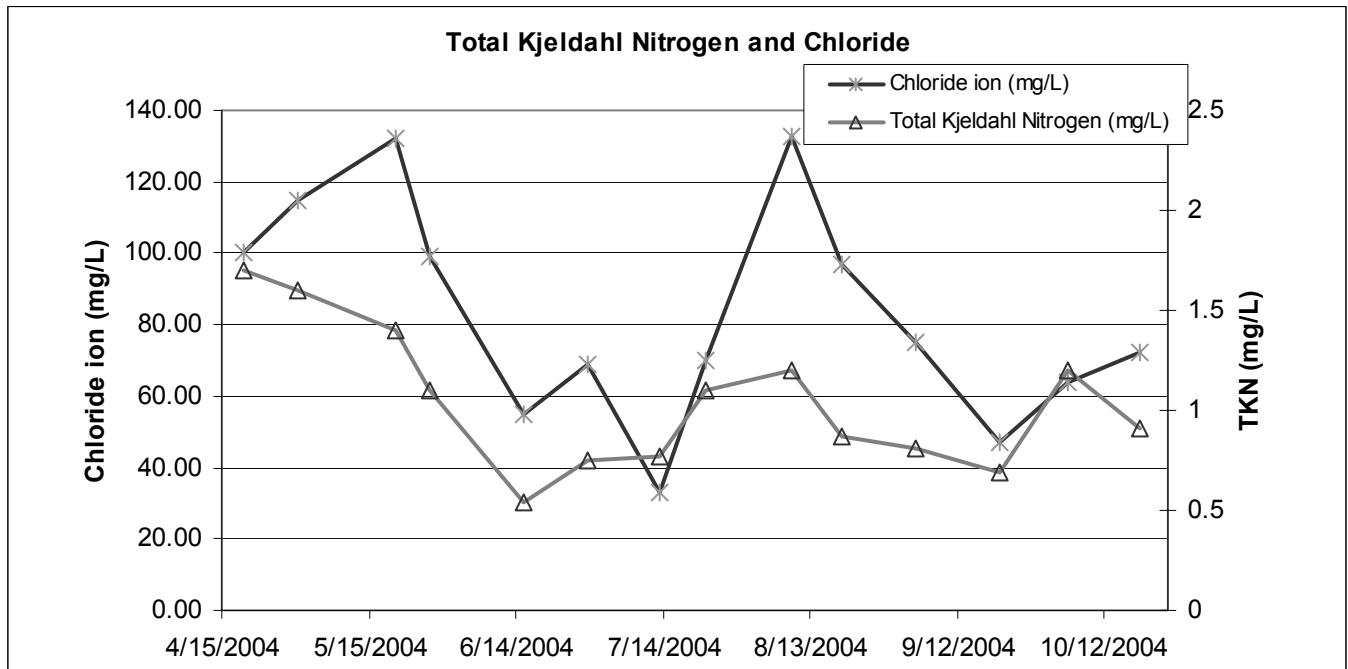


Figure 17. Total Kjeldahl Nitrogen and Chloride ion

Table 12. Lake Parameter Relationships

	Secchi	TKN	TP	CLA	Chloride
Secchi		None	None	None	None
TKN			+	+	+
TP				+	None
CLA					None
Chloride					

Table 13 lists the dissolved oxygen and temperature profiles. The maximum depth was between 1 and 2 meters. No thermocline was present in the lake. The surface dissolved oxygen and surface temperatures are shown in Figure 18.

Table 13. Dissolved Oxygen and Temperature Profiles

Date	4/19/2004 10:00		4/30/2004 8:15		5/20/2004 9:15		5/27/2004 13:30		6/15/2004 13:45		6/28/2004 14:15		7/13/2004 9:20	
Depth	D.O. (mg/L)	Temp (C)	D.O. (mg/L)	Temp (C)	D.O. (mg/L)	Temp (C)	D.O. (mg/L)	Temp (C)	D.O. (mg/L)	Temp (C)	D.O. (mg/L)	Temp (C)	D.O. (mg/L)	Temp (C)
Surface	6.50	14.50	7.42	13.40	7.36	19.00	8.98	16.50	9.35	25.20	9.91	21.80	7.01	24.50
1	6.45	14.60	7.09	13.30	6.93	19.00	7.30	16.00	1.42	20.80	7.21	18.10	0.84	21.60
2	4.86	14.70	0.07	13.30	0.08	18.40	0.06	15.90	0.04	20.40	0.18	18.10	0.18	21.50

Date	7/22/2004 15:00		8/9/2004 9:00		8/19/2004 14:15		9/3/2004 13:30		9/20/2004 15:00		10/4/2004 15:45		10/19/2004 9:00	
Depth	D.O. (mg/L)	Temp (C)	D.O. (mg/L)	Temp (C)	D.O. (mg/L)	Temp (C)	D.O. (mg/L)	Temp (C)	D.O. (mg/L)	Temp (C)	D.O. (mg/L)	Temp (C)	D.O. (mg/L)	Temp (C)
Surface	8.18	28.60	5.99	21.00	8.11	19.10	6.20	24.50	6.61	20.60	7.27	11.80	8.15	6.10
1	0.36	24.10	0.44	20.50	4.35	18.40	3.77	23.20	5.30	20.10	0.10	11.60	1.01	6.20
2	0.06	23.70			0.08	17.30								

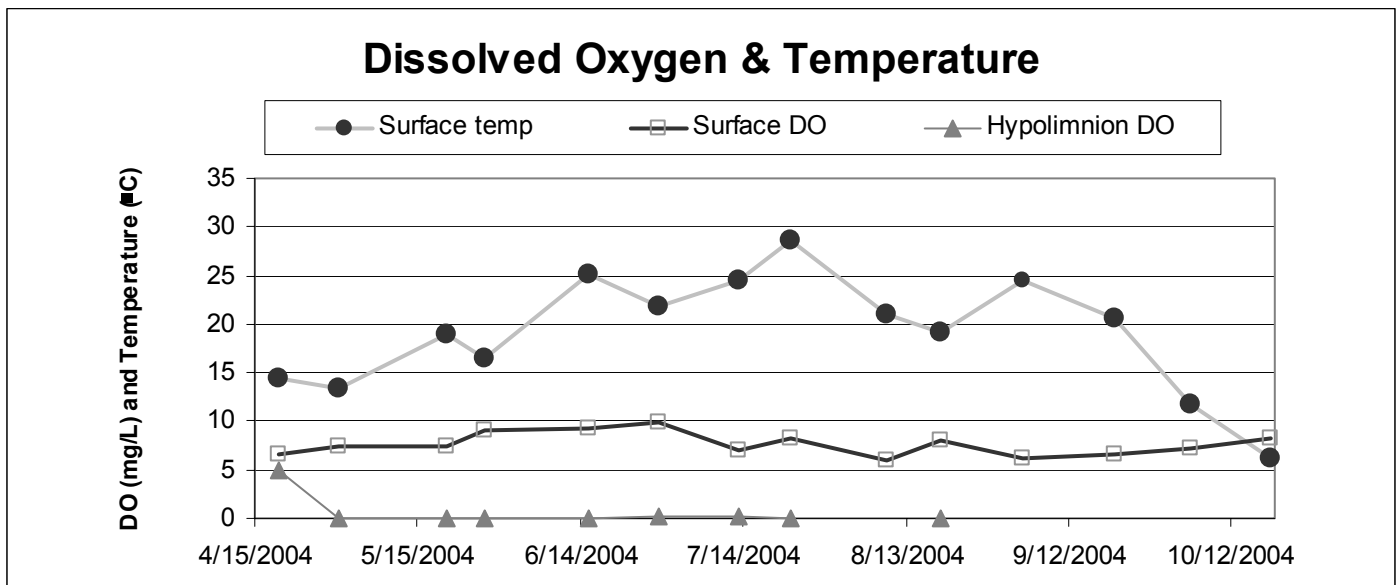


Figure 18. Surface Dissolved Oxygen and Surface Temperatures

Powers Lake

Vital Statistics:

DNR ID #: 82-0092
 LOCATION: SW^{1/4} Section 11 T28N-R21W
 MUNICIPALITY: City of Woodbury
 LAKE SIZE: 54 acres
 ORDINARY HIGH WATER MARK: 891.3 ft

Powers Lake was monitored from April 19 to October 19, 2004, in accordance with the Metropolitan Council Citizen-Assisted Monitoring Program (CAMP). Monitoring consisted of 14 biweekly lake gage readings and samplings of Secchi disk, surface total phosphorus, surface total Kjeldahl nitrogen, surface chlorophyll-*a*, and surface total chloride ion. In addition, a temperature and dissolved oxygen profile was taken during each sampling round. The Metropolitan Council Lab analyzed the samples.

Table 14 gives the Powers Lake 2004 high, low, and average lake levels. Individual lake level readings are shown in Figure 19.

Table 14. Powers 2004 Lake Level

	High	High Date	Low	Low Date	Average
Lake Level (ft)	886.22	6/15/04	884.74	11/5/04	885.41

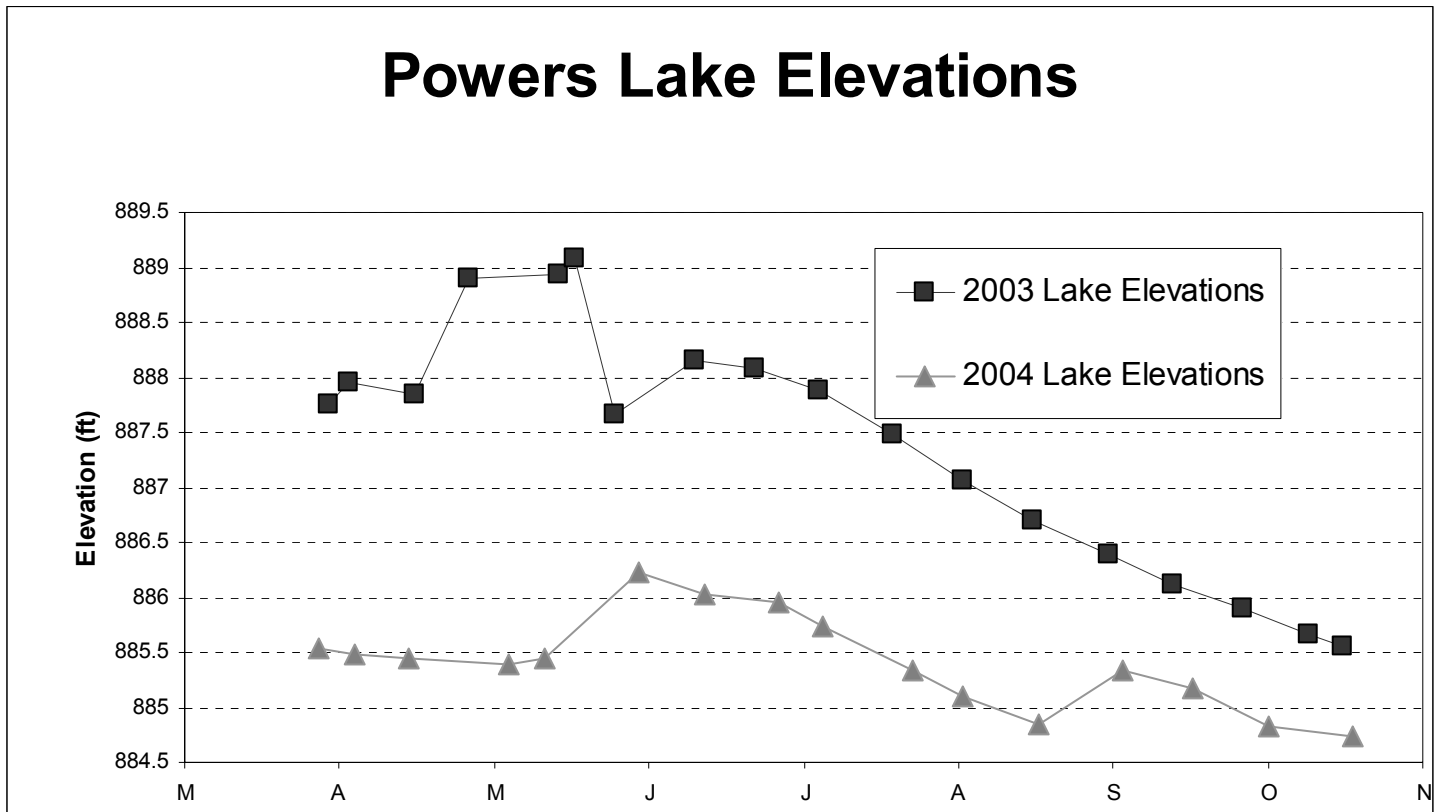


Figure 19. Powers Lake Elevations 2003-04

Table 15 gives the 2004 Powers Lake monitoring chemistry results and Secchi disk readings for the 2004 water-monitoring season.

Table 15. Powers 2004 Monitoring Results

Date	Surface Total Phosphorus (mg/L)	Surface Total Kjeldahl Nitrogen (mg/L)	Chlorophyll <i>a</i> (ug/L)	Chloride (mg/L)	Secchi Disk (m)	Surface Dissolved Oxygen (mg/L)	Surface Temperature (C)
4/19/04	0.04	1.00	14.0	19	2.13	11.04	11.70
4/30/04	0.03	1.10	8.2	30	2.44	10.09	12.40
5/20/04	0.04	1.20	16.0	30	2.29	10.71	17.60
5/27/04	0.03	0.93	18.0	16	1.83	10.85	16.80
6/15/04	0.03	0.89	5.3	30	2.90	8.43	23.10
6/28/04	0.03	0.85	13.0	30	1.83	8.01	20.30
7/13/04	0.04	1.50	56.0	11	0.91	11.74	25.30
7/22/04	0.03	1.60	31.0	23	1.07	7.80	27.30
8/9/04	0.03	1.10	24.0	42	1.68	8.36	23.70
8/19/04	0.03	0.89	9.2	43	3.05	6.65	20.60
9/3/04	0.05	0.96	12.0	27	2.29	7.75	23.50
9/20/04	0.04	1.00	35.0	29	1.37	7.33	20.90
10/4/04	0.04	0.85	16.0	18	2.29	5.38	15.70
10/19/04	0.06	1.30	14.0	32	1.83	4.37	11.10
2004 Averages	0.04	1.08	19.4	27	1.99	8.47	19.29

Table 16 shows the Powers Lake Water Quality Summary. Powers Lake received an average lake grade of a C+ for 2004.

Table 16. Lake Grade and Trophic Status

	Trophic Status (2003 Average)	Lake Grade (2003 Average)	Trophic Status (2004 Average)	Lake Grade (2004 Average)
Total Phosphorus (mg/L)	Eutrophic	C	Eutrophic	C
Chlorophyll-a (ug/L)	Eutrophic	C+	Eutrophic	B
Secchi disk (ft)	Mesotrophic	C+	Mesotrophic	C
Overall	Eutrophic	C	Eutrophic	C+

Figure 20-24 compare the lake chemistry data and Secchi disk readings. Although there were no statistically significant correlations between water quality parameters, general trends can be noted. There was a weak negative statistical relationship between secchi and TKN ($r^2= 0.46$): as secchi readings increased TKN decreased. There was a weak positive statistical relationship between CLA and TKN ($r^2= 0.42$): as CLA increased TKN increased. There was a strong negative statistical relationship between secchi and CLA ($r^2= 0.73$). As secchi decreased, CLA increased. No correlations were found between any other parameters. These correlations are further simplified in Table 17.

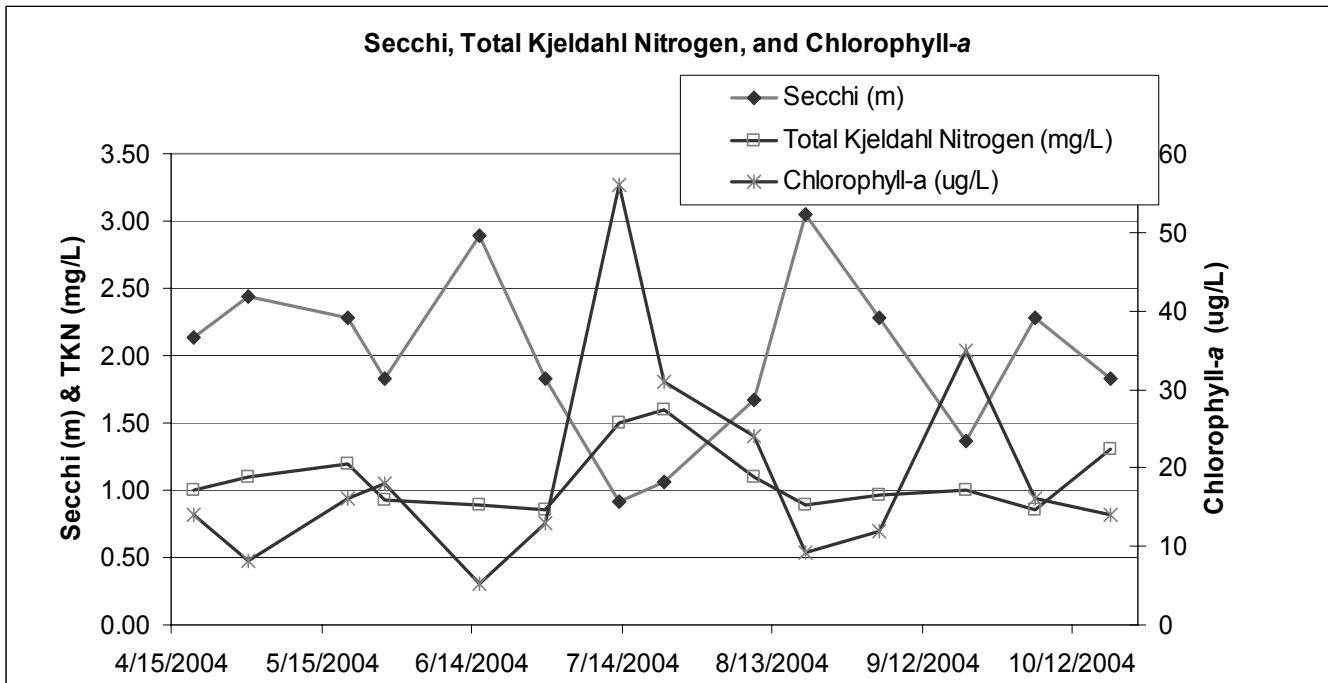


Figure 20. Secchi, Total Kjeldahl Nitrogen and Chlorophyll-a

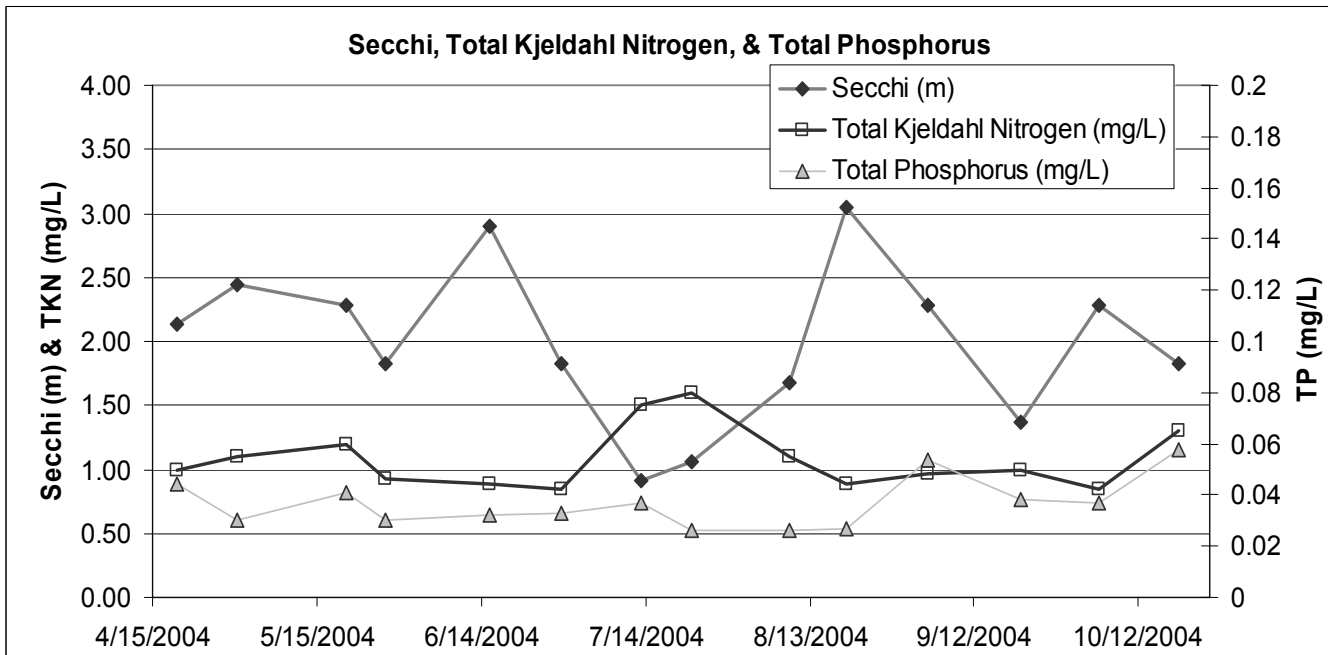


Figure 21. Secchi, Total Kjeldahl Nitrogen, and Total Phosphorus

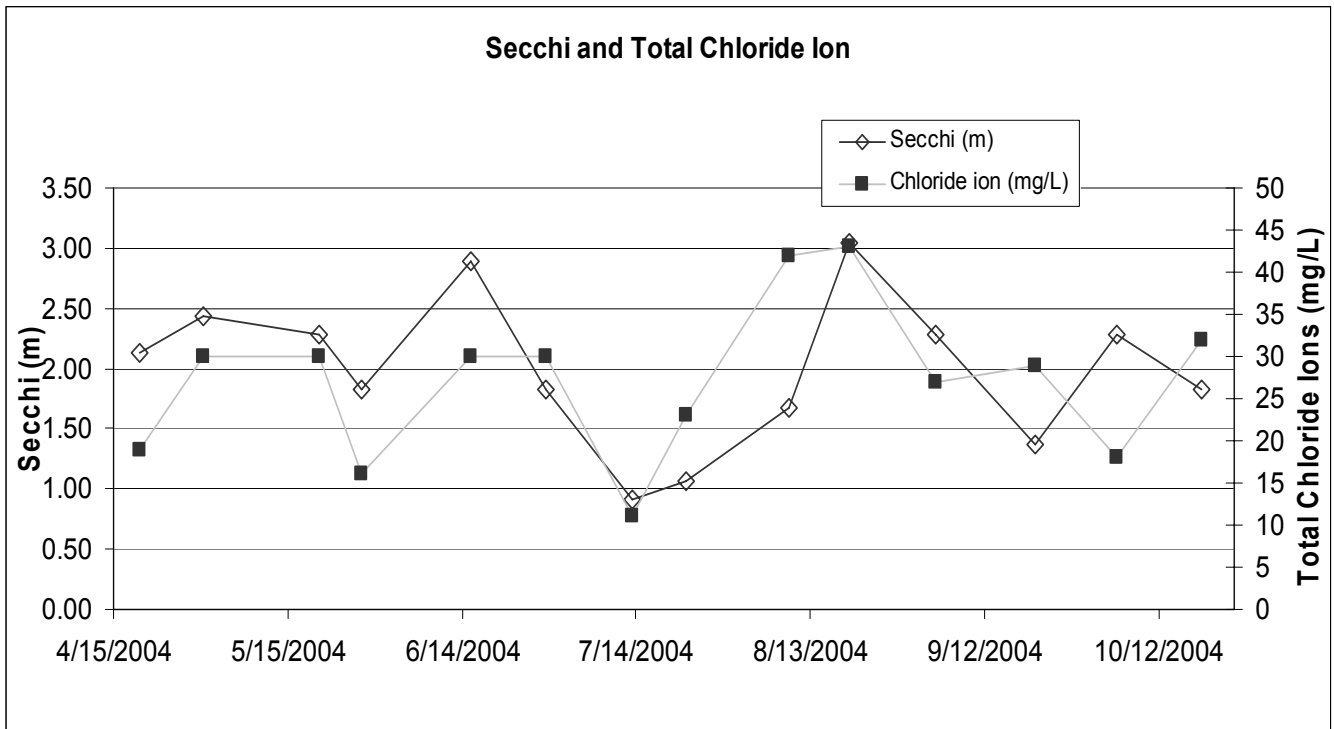


Figure 22. Secchi and Chloride ion

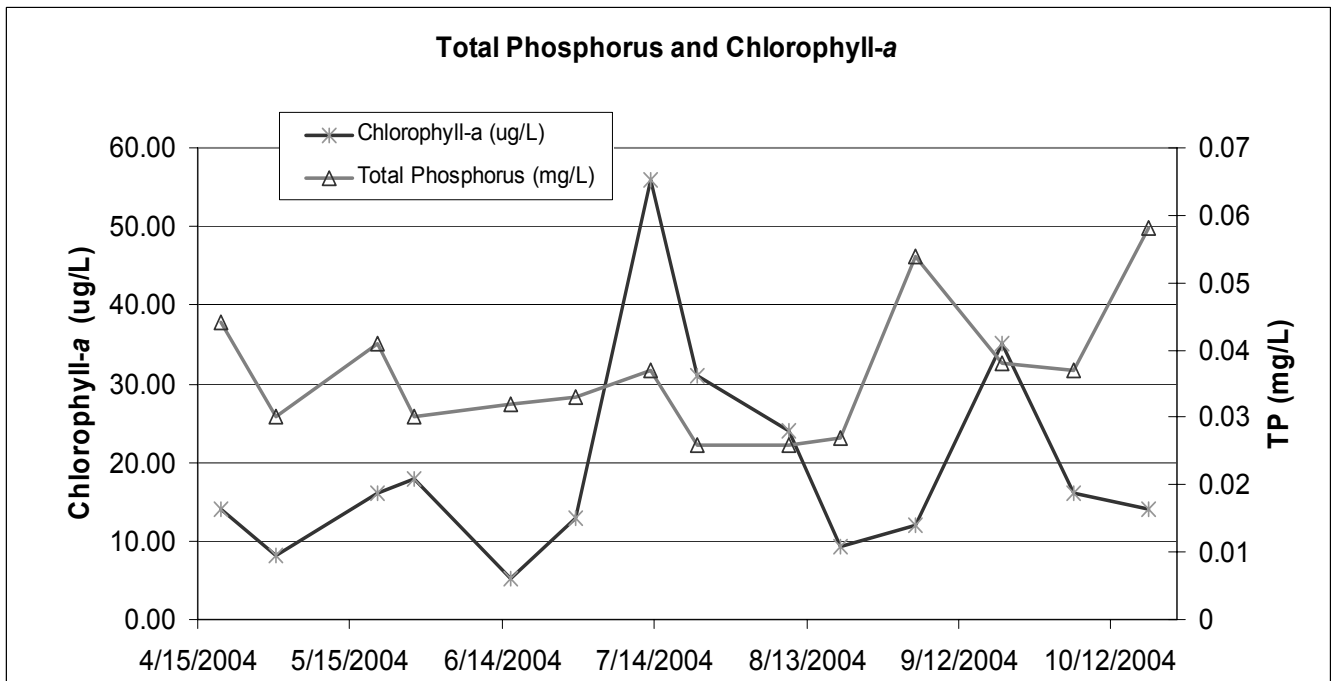


Figure 23. Total Phosphorous and Chlorophyll a

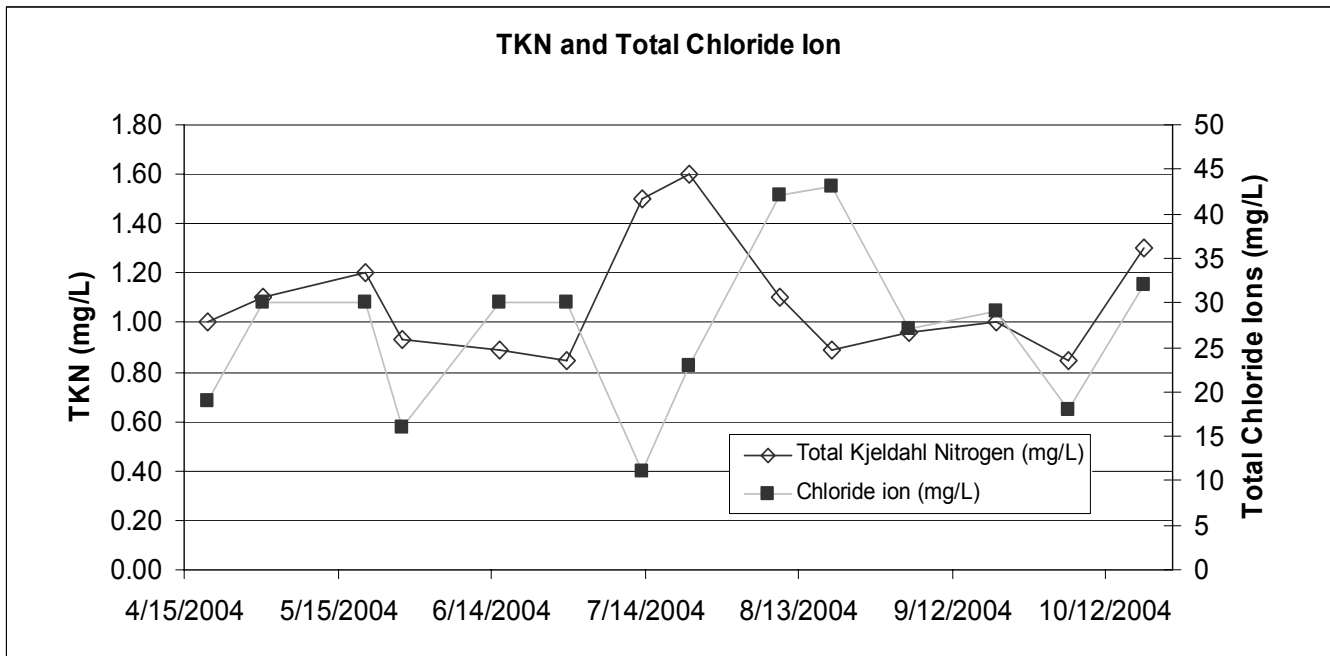


Figure 24. Total Kjeldahl Nitrogen and Chloride ion

	Secchi	TKN	TP	CLA	Chloride
Secchi		--	None	--	None
TKN			None	+	None
TP				None	None
CLA					None
Chloride					

Table 17. Lake Parameter Relationships

Table 18 lists the dissolved oxygen and temperature profiles. The maximum depth was approximately 12 meters depending on the level of the lake at the time of sampling. A thermocline was present between 5 and 6 meters during the majority of the monitoring season. The surface dissolved oxygen and surface temperatures are shown in Figure 25.

Date	4/19/2004 10:30		4/30/2004 10:30		5/20/2004 8:20		5/27/2004 14:00		6/15/2004 14:15		6/28/2004 13:15		7/13/2004 8:30	
Depth	D.O. (mg/L)	Temp (C)	D.O. (mg/L)	Temp (C)	D.O. (mg/L)	Temp (C)	D.O. (mg/L)	Temp (C)	D.O. (mg/L)	Temp (C)	D.O. (mg/L)	Temp (C)	D.O. (mg/L)	Temp (C)
Surface	11.04	11.7	10.09	12.5	10.71	17.7	10.85	16.9	8.43	23.3	8.01	20.4	11.74	25.6
1	10.48	11.7	9.75	12.4	10.11	17.6	10.52	16.8	8.63	23.1	7.86	20.3	12.74	25.3
2	10.4	11.5	10.11	12.3	10.16	17.5	10.6	16.7	8.87	22.6	7.93	20.3	10.25	23.7
3	11.06	10.7	9.77	12.3	10.4	17.0	10.5	16.1	8.23	20.3	7.98	20.2	6.27	22.3
4	10.63	9.2	8.72	12.2	9.64	16.0	10.45	15.6	10.64	18.2	7.76	19.7	2.63	20.6
5	8.70	7.4	9.30	11.8	8.25	15.2	8.92	15.1	3.65	16.4	1.97	18.2	0.34	18.0
6	7.51	6.9	73.85	10.4	4.86	12.7	5.50	14.3	0.30	14.3	0.35	14.3	0.34	15.0
7	7.34	6.8	5.90	8.5	2.75	10.9	0.24	10.7	0.13	11.4	0.20	11.7	0.26	12.2
8	6.61	6.6	4.42	7.5	0.15	9.1	0.09	8.9	0.03	10.3	0.19	10.3	0.27	10.7
9	6.42	6.5	3.62	7.1	0.07	8.4	0.08	8.5	0.06	9.6	0.20	9.7	0.26	9.9
10	6.17	6.4	3.45	6.9	0.06	8.0	0.05	8.3	0.06	9.3	0.18	9.3	0.33	9.5
11	0.02	6.4	2.50	6.7	0.05	7.8	0.05	8.1	0.05	9.2	0.19	9.0	0.26	9.4
12			0.03	6.6					0.06	8.9	0.17	8.8	0.27	9.2

Date	7/22/2004 13:45		8/9/2004 9:30		8/19/2004 14:45		9/3/2004 12:45		9/20/2004 14:30		10/4/2004 15:15		10/19/2004 9:30	
Depth (m)	D.O. (mg/L)	Temp (C)	D.O. (mg/L)	Temp (C)	D.O. (mg/L)	Temp (C)	D.O. (mg/L)	Temp (C)	D.O. (mg/L)	Temp (C)	D.O. (mg/L)	Temp (C)	D.O. (mg/L)	Temp (C)
Surface	7.8	27.7	8.36	23.7	6.65	20.6	7.75	23.7	7.33	20.9	5.38	15.7	4.37	11.1
1	7.97	27.3	8.16	23.7	6.60	20.6	7.54	23.5	6.94	20.9	5.00	15.7	4.30	11.1
2	5.02	24.8	7.40	23.7	6.62	20.4	8.15	22.9	6.88	20.8	4.69	15.7	4.23	11.1
3	2.15	22.9	6.75	23.4	6.03	20.2	8.00	21.4	6.77	20.7	4.72	15.6	4.29	11.1
4	0.45	20.8	2.02	22.5	5.67	20.1	4.85	20.6	6.53	20.5	4.55	15.5	4.35	11.1
5	0.23	17.7	0.83	18.4	3.96	19.3	1.60	19.9	6.45	20.5	4.48	15.4	4.37	11.1
6	0.15	15.1	0.37	14.6	0.24	15.4	0.29	18.5	0.14	18.1	4.51	15.4	4.34	11.1
7	0.15	12.4	0.38	12.4	0.13	12.5	0.09	13.5	0.08	14.3	3.80	15.3	4.38	11.1
8	0.15	11.0	0.38	10.7	0.09	11.4			0.06	11.8	0.28	12.0	4.07	11.1
9	0.16	10.1	0.40	10.0	0.07	10.3			0.04	10.7	0.07	11.0	4.11	11.1
10	0.15	9.7	0.40	9.7	0.06	10.0			0.04	10.3	0.07	10.4	4.14	11.1
11	0.15	9.6			0.07	9.7			0.04	10.1	0.07	10.0	2.06	10.9
12	0.15	9.4			0.06	9.6								

Table 18. Dissolved Oxygen and Temperature Profiles

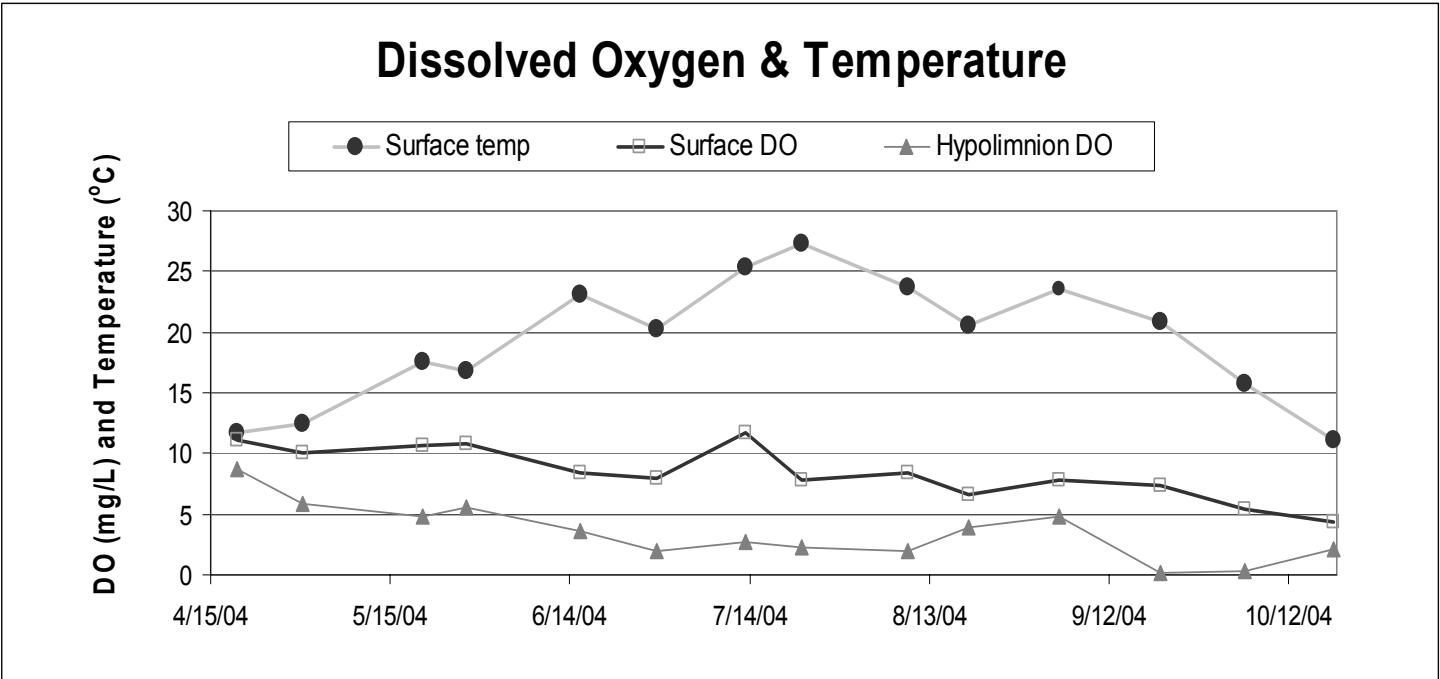


Figure 25. Surface Dissolved Oxygen and Surface Temperatures

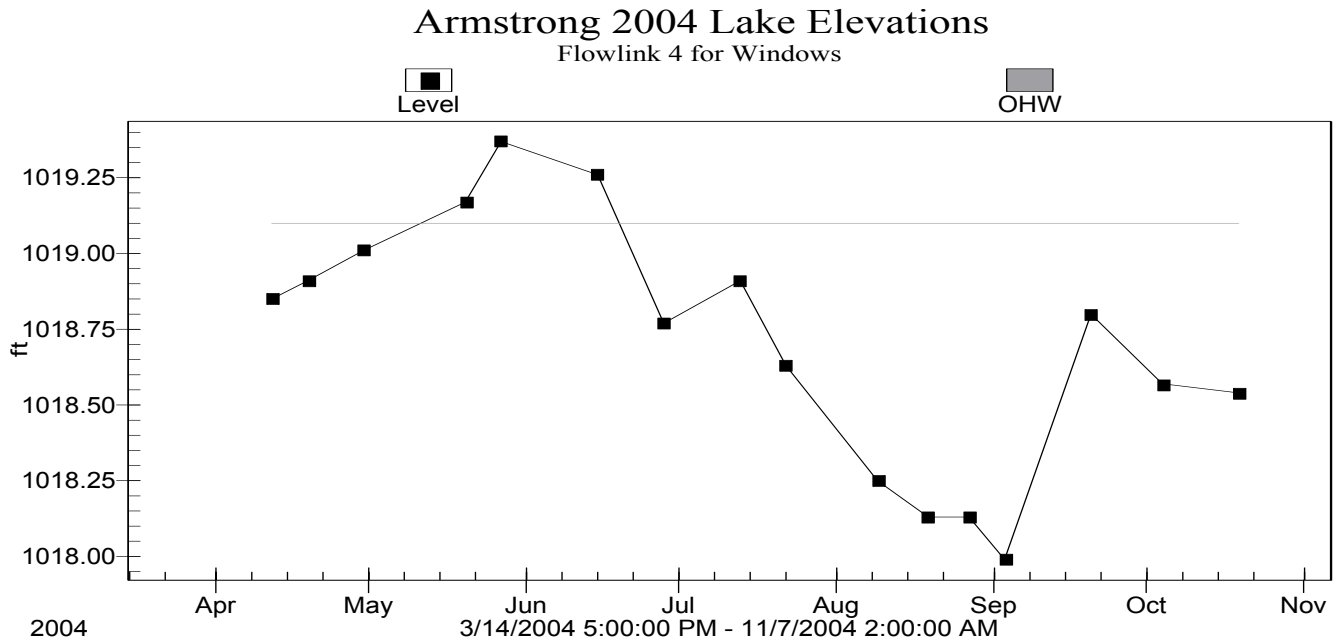
Lake Gages

Lake gages were read biweekly on twelve lakes in SWWD from April 7-November 5, 2004. Table 19 lists the high, low, range and average elevations for each lake monitored in 2004. Figure 26a-26l shows the fluctuation in elevation for each lake monitored in 2004.

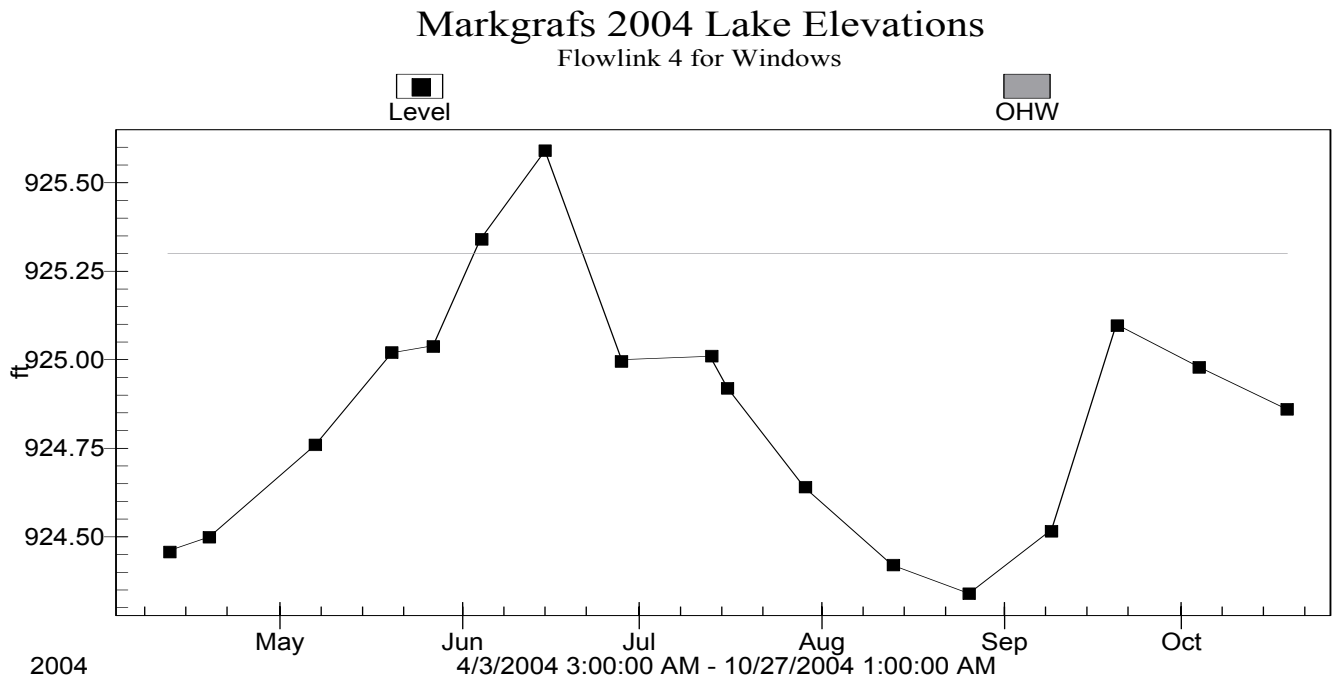
Lake Name	DNR ID#	Dates Monitored	# Readings	Lowest Reading (ft) Date	Highest Reading (ft) Date	Range (ft)	Average Elevation (ft)	OHW (ft)
Cottage Grove Ravine Park	82-0087	4/7/04-10/21/04	24	771.08	772.14	1.06	771.60	770.70
				10/7/04 and 10/21/04	5/27/2004			
Markgrafs	82-0089	4/12/04-10/19/04	17	924.34	925.59	1.25	924.85	925.30
				8/26/2004	6/15/2004			
Wilmes	82-0090	4/12/04 10/21/04	14	900.49	903.09	2.60	901.91	902.60
				8/27/2004	6/4/2004			
Powers	82-0092	4/12/04-11/5/04	16	884.74	886.22	1.48	885.41	891.30
				11/5/2004	6/15/2004			
Colby	82-0094	4/7/04-10/21/04	17	889.58	890.98	1.40	890.24	891.80
				8/26/2004	6/4/2004			
Bailey	82-0456	5/20/04-10/21/04	12	865.74	870.61	4.87	866.92	NA
				10/21/2004	6/17/2004			
Armstrong	82-0116-02	4/12/04-10/19/04	16	1017.99	1019.37	1.38	1018.70	1019.10
				9/3/2004	5/27/2004			
Vandeberg	82-0084	4/7/04-10/21/04	15	841.57	842.69	1.12	842.19	NA
				10/21/2004	6/18/2004			
Fish	82-0093	4/12/04-10/21/04	15	913.50	915.81	2.31	914.39	916.40
				5/12/2004	6/17/2004			
Ria Lake	82-0098	5/3/04-10/21/04	16	949.17	950.47	1.30	949.74	NA
				10/21/2004	6/17/2004			
La Lake	82-0097	5/11/04-10/21/04	14	999.15	1000.24	1.09	999.7	1000.60
				10/21/2004	6/17/2004			
Shepard's Pond	82-0083	5/3/04-10/21/04	17	919.33	920.70	1.37	919.93	NA
				10/21/2004	5/27/2004			

Table 19. SWWD 2004 Lake Gage Readings

Figure 26a-26l. SWWD 2004 Lake Elevations



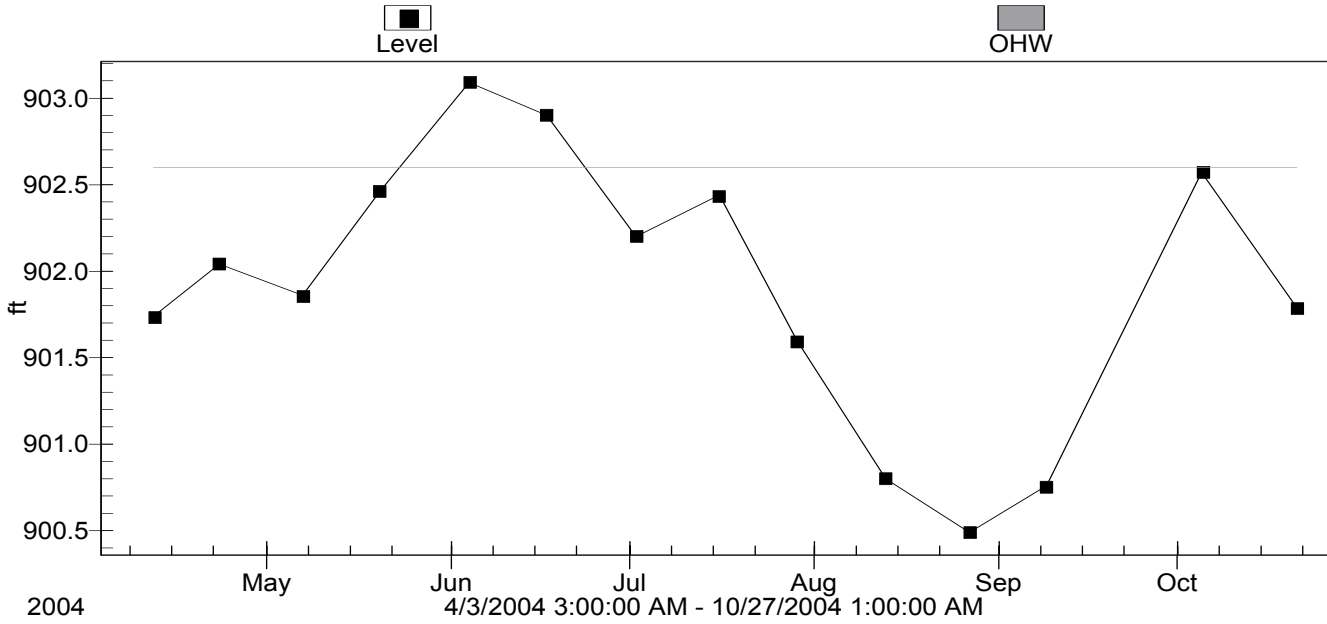
26a. Armstrong Lake Elevations and Ordinary High Water (OHW)



26b. Markgrafs Lake Elevations and Ordinary High Water (OHW)

Wilmes 2004 Lake Elevations

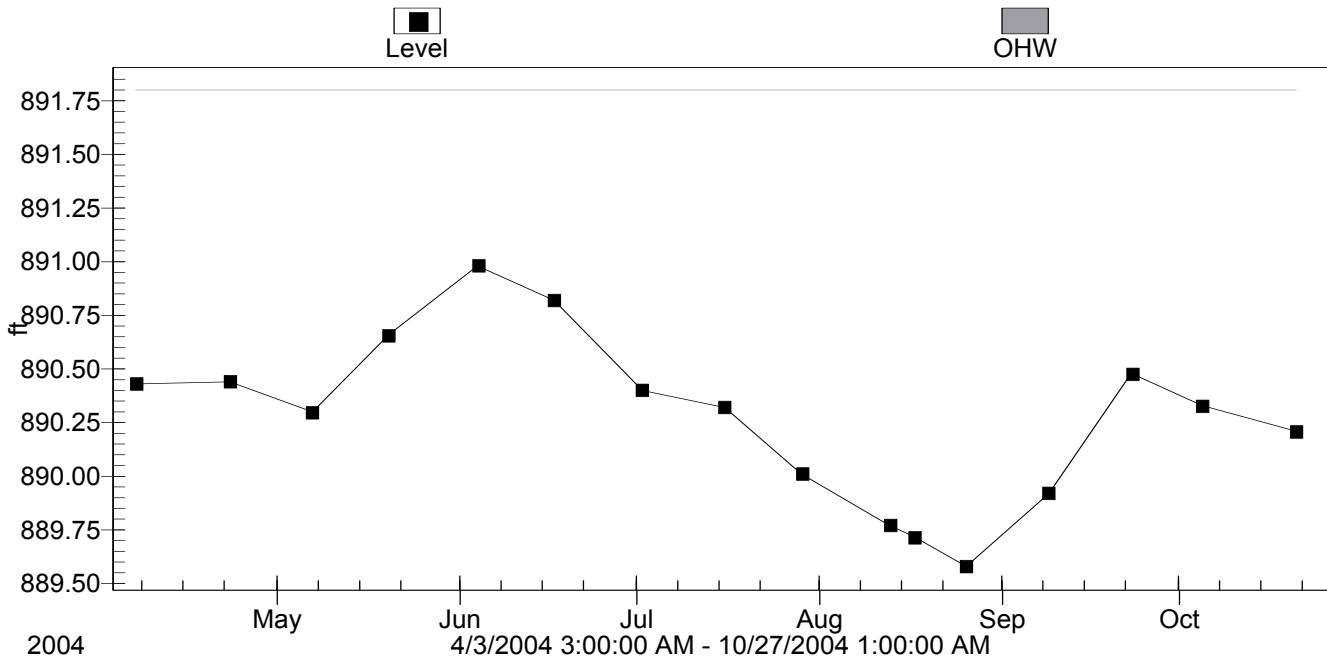
Flowlink 4 for Windows



26c. Wilmes Lake Elevations and Ordinary High Water (OHW)

Colby 2004 Lake Elevations

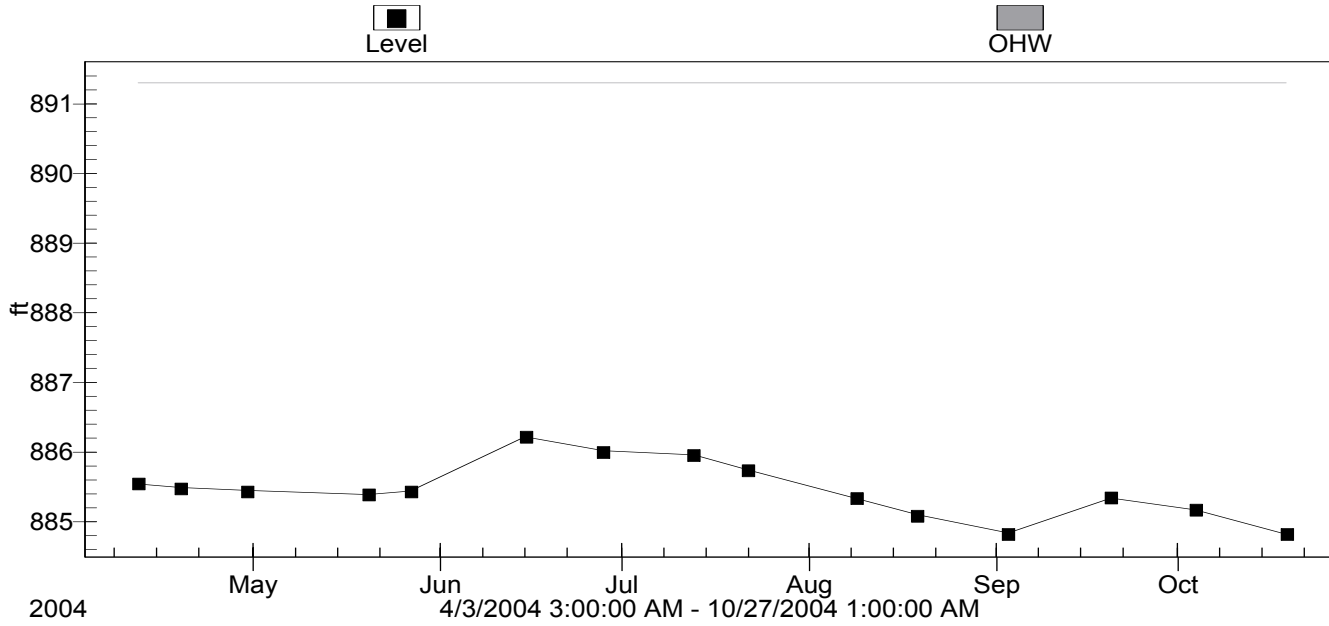
Flowlink 4 for Windows



26d. Colby Lake Elevations and Ordinary High Water (OHW)

Powers 2004 Lake Elevations

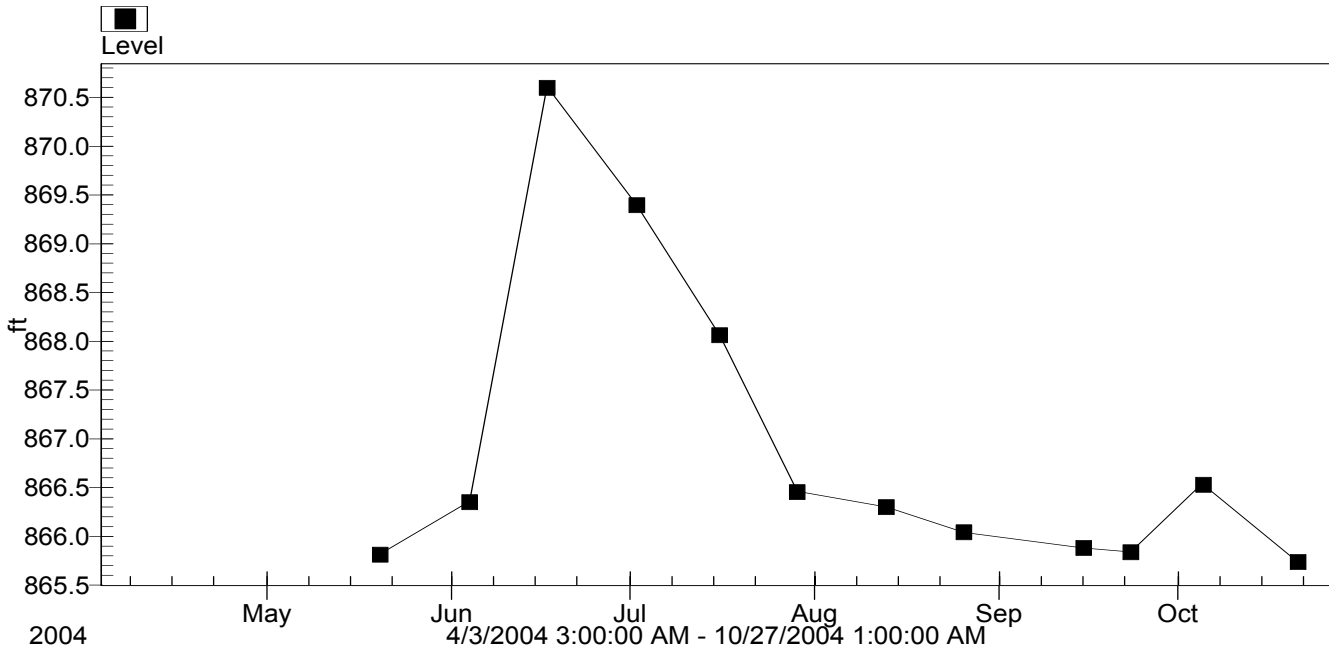
Flowlink 4 for Windows



26e. Powers Lake Elevations and Ordinary High Water (OHW)

Bailey 2004 Lake Elevations

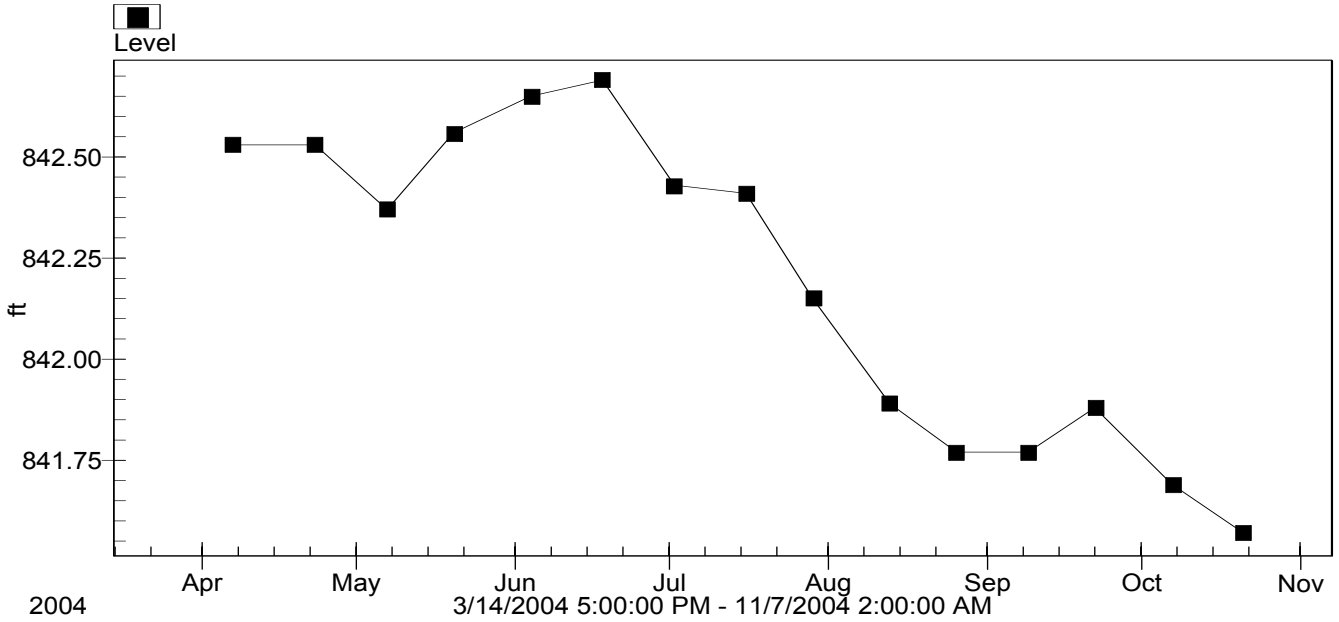
Flowlink 4 for Windows



26f. Bailey Lake Elevations

Vandenberg 2004 Lake Elevations

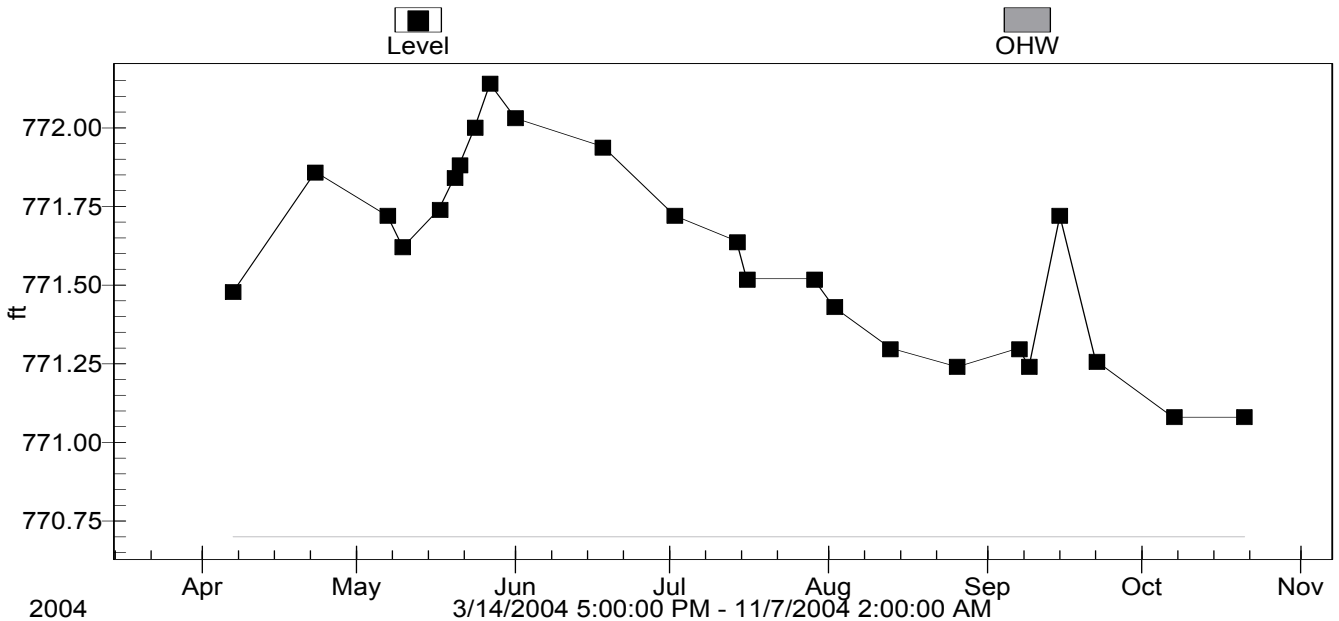
Flowlink 4 for Windows



26g. Vandenberg Lake Elevations

C.G. Ravine Park 2004 Lake Elevations

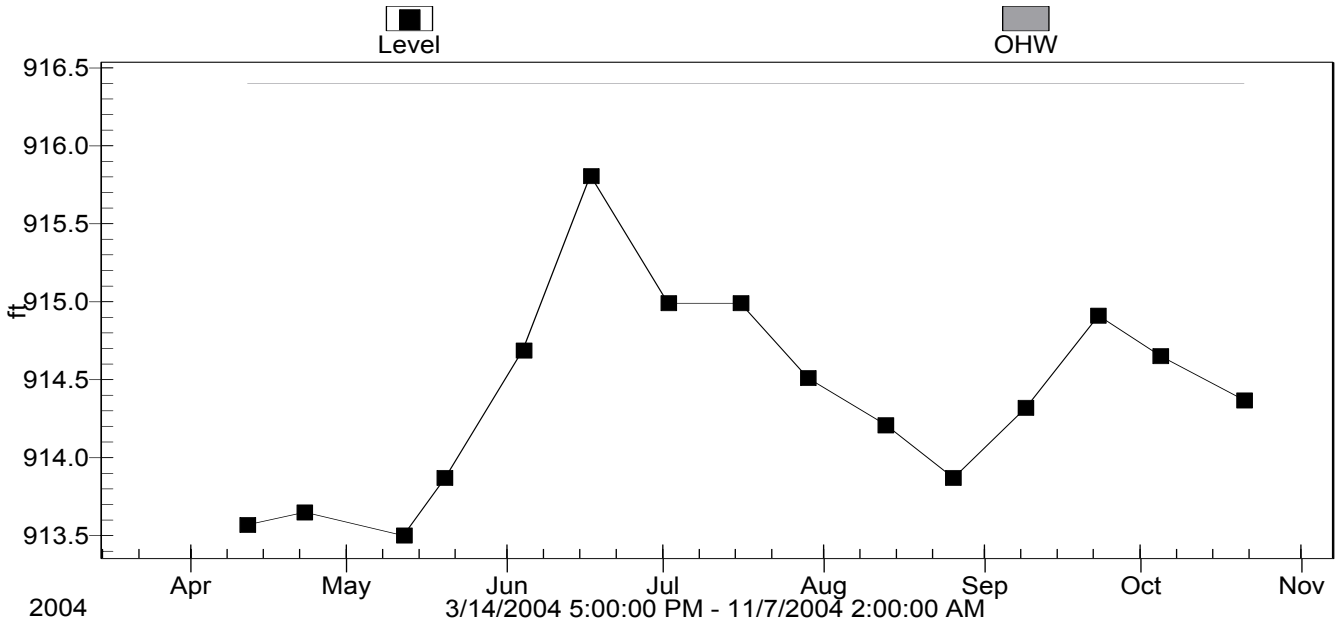
Flowlink 4 for Windows



26h. Cottage Grove Ravine Park Lake Elevations and Ordinary High Water (OHW)

Fish 2004 Lake Elevations

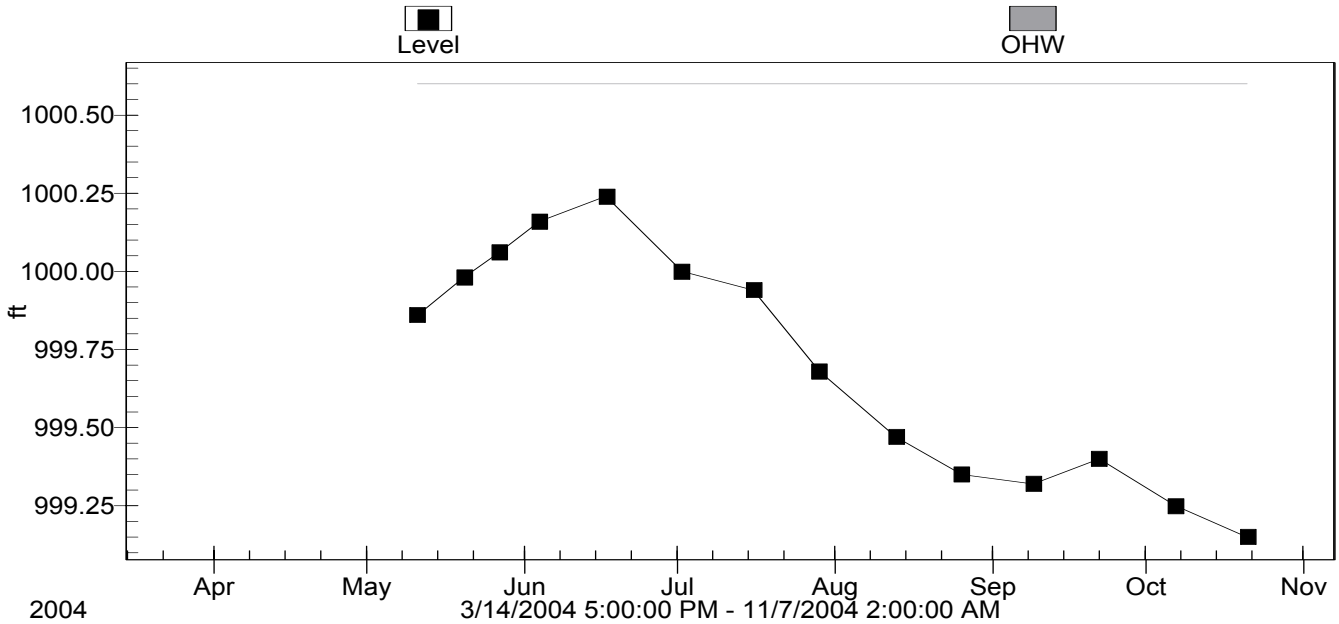
Flowlink 4 for Windows



26i. Fish Lake Elevations and Ordinary High Water (OHW)

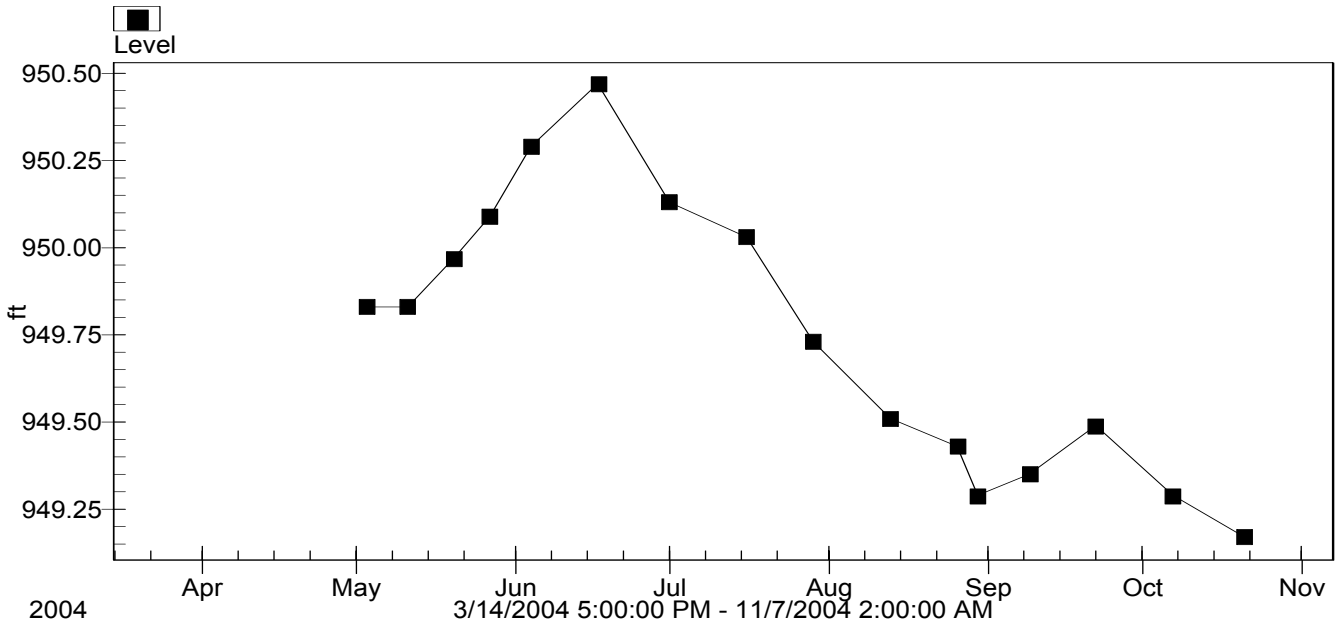
La 2004 Lake Elevations

Flowlink 4 for Windows



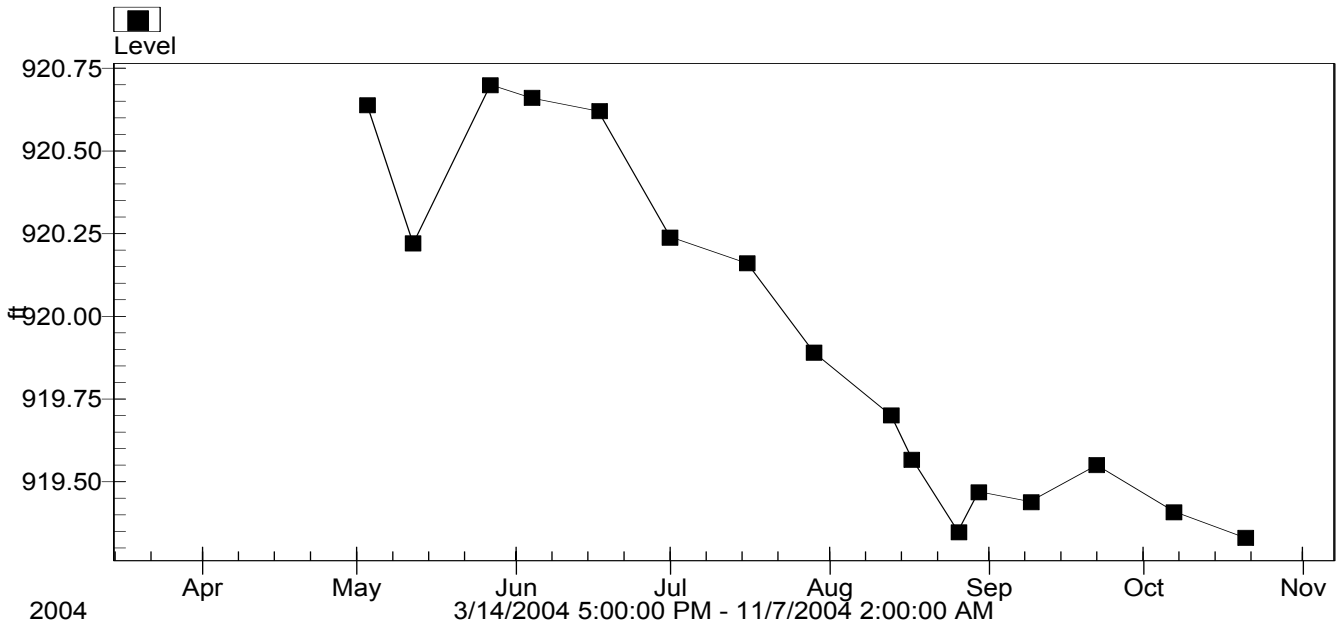
26j. La Lake Elevations and Ordinary High Water (OHW)

Ria 2004 Lake Elevations Flowlink 4 for Windows



26k. Ria Lake Elevations and Ordinary High Water (OHW)

Shepard's Pond 2004 Lake Elevations Flowlink 4 for Windows



26l. Shepard's Pond Elevations and Ordinary High Water (OHW)

Observation Wells

Seven observation wells were monitored concurrently by the Washington Conservation District and Emmons & Olivier Resources Inc. from February 4-December 14, 2004. Table 20 shows the high, low, range and average groundwater observations during the 2004 monitoring season. Figure 27 shows the fluctuation of the groundwater elevations for each well during the 2004 monitoring season. Water levels for observation wells were highest during different periods of the monitoring season, depending on the well, location, and other factors affecting the elevation. Low groundwater elevations occurred mainly during May, October, and December.

Well #	Dates Monitored	# Readings	Surface Elevation (ft)	Lowest Reading (ft) Date	Highest Reading (ft) Date	Range (ft)	Average Elevation (ft)
545602	2/4/04-12/14/04	20	904.39	864.39 12/14/04	868.97 3/23/04	2.92	838.08
545603	2/4/04-12/14/04	22	906.42	849.69 12/14/04	856.25 6/23/04	6.56	852.67
545604	2/4/04-12/14/04	19	886.60	818.26 12/14/04	821.18 3/23/04	6.65	849.41
616493	2/4/04-12/14/04	9	917.32	824.00 10/4/04	845.72 2/23/04	3.72	843.81
616494	2/4/04-12/14/04	20	916.61	840.80 12/14/04	845.97 2/4/04	5.17	843.41
616497	2/4/04-12/14/04	11	920.34	868.91 12/14/04	869.04 3/23/04, 6/23/04, 7/29/04, 8/31/04	0.13	869.00
616498	2/4/04-12/14/04	10	913.55	862.15 5/28/04	862.31 4/16/04	0.16	862.25

Table 20. SWWD 2004 Observation Well Elevations

SWWD 2004 Observation Wells

Flowlink 4 for Windows

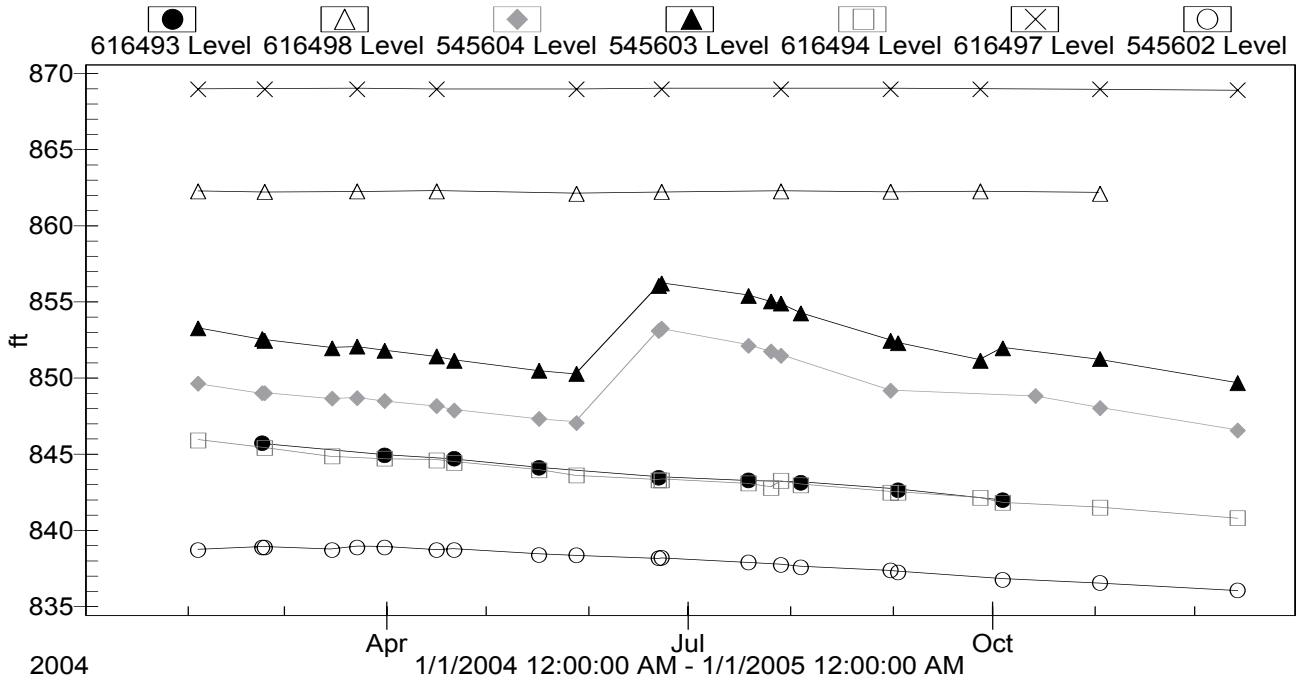


Figure 27. SWWD 2004 Observation Well Elevations