



2005 WATER MONITORING REPORT

April 2006

Prepared for:

**South Washington
Watershed District**

Prepared by:



Memorandum

To: Matt Moore —South Washington Watershed District Administrator

From: Wendy Griffin, Travis Thiel, Tim Sundby, and Erik Anderson--Washington Conservation District

Date: March 6, 2006

Re: SWWD 2005 Monitoring: MS1, MS2, Powers, 100th Street, Fox Run, Tamarack Road, Bailey Lift Station, 80th Street, 90th Street, North Ravine in Cottage Grove Ravine Park, East Ravine in Cottage Grove Ravine Park, Armstrong Lake, Powers Lake, Cottage Grove Ravine Park 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 North and East segments of Cottage Grove Regional Park Ravine 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, 2005. 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 100th Street from March 28-November 14, 2005, at Powers from March-October 7, 2005, at MS1 from March 30-October 4, 2005 and at MS2 from April 4-October 4, 2005. The MS1, MS2 and Powers sites were removed early due to a major storm in early October. Precipitation data was also continuously collected at each of these sites during the same time period for 2005.

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.

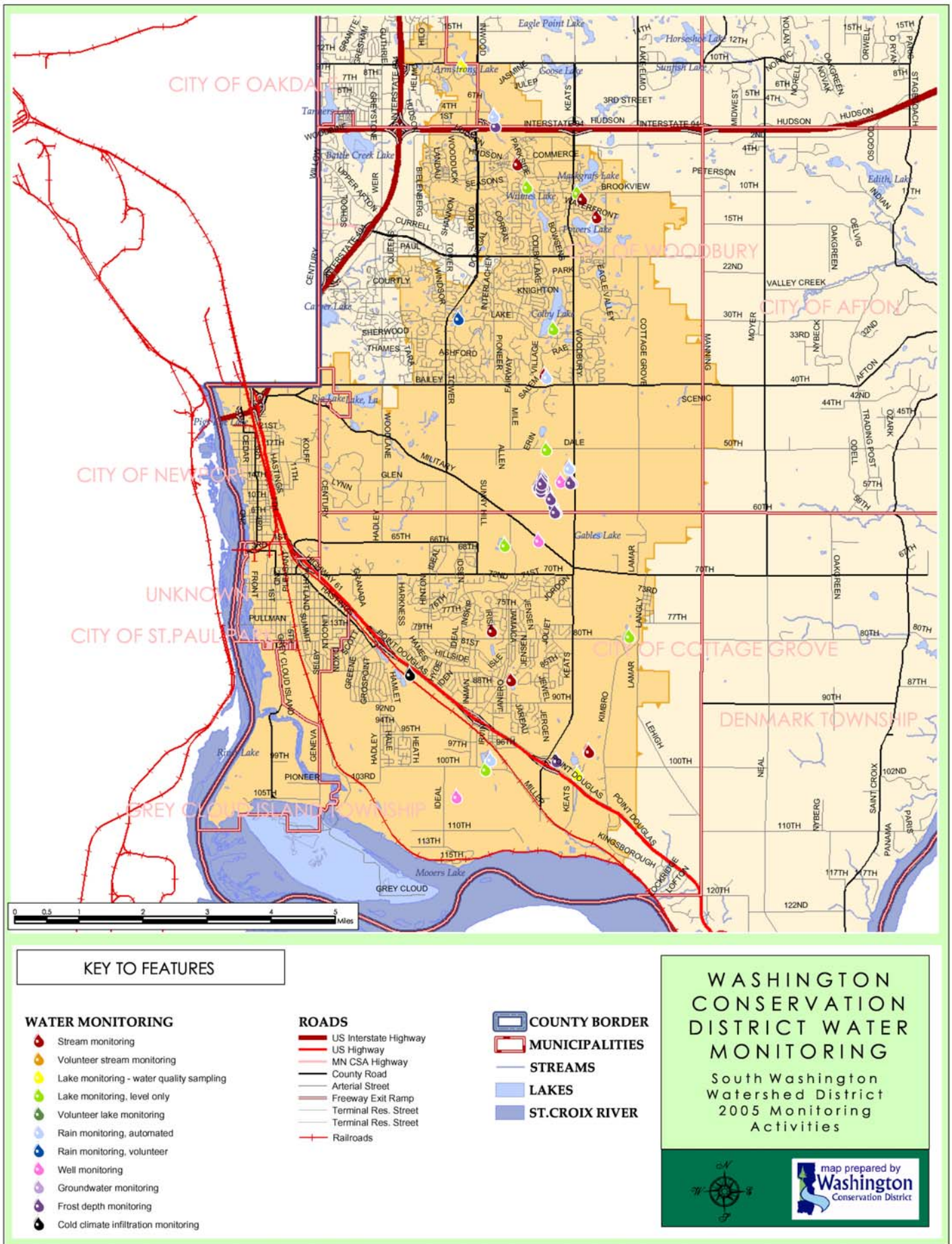


Figure 1. SWWD Water Monitoring Locations

MS1 (I94)

The hydrograph for the MS1 site shows flows from March 28–October 4, 2005 (Figure 2). Total discharge during this period was 16,656,740 cf or 382 acre-ft. The peak discharge—300 cfs, was estimated on October 4, 2005 from daily precipitation of 4.32 inches, the highest daily precipitation total for 2005. In-stream monitoring equipment was lost at that point and peak discharge could possibly have been higher. The rain gage remained installed and precipitation data was collected through October 20, 2005.

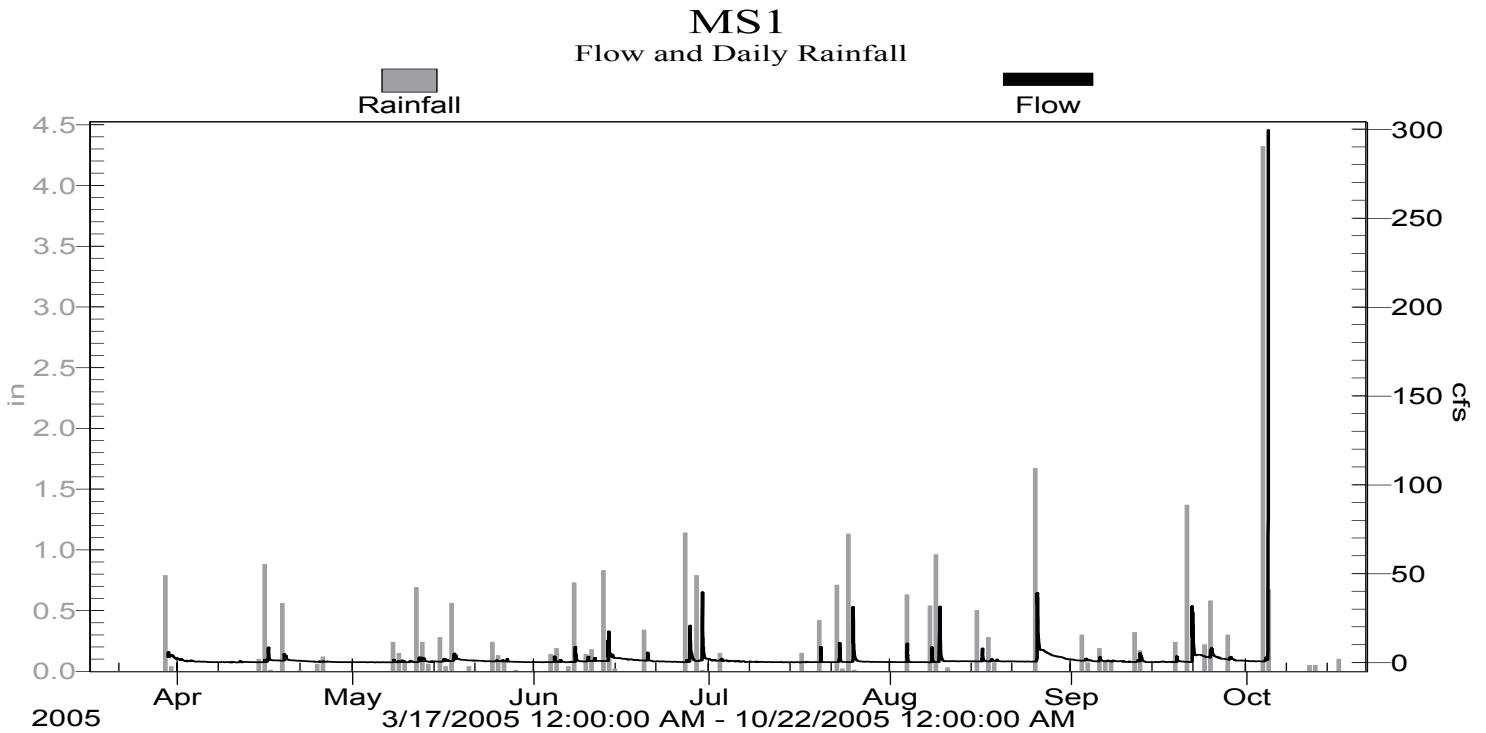


Figure 2. MS1 2005 Continuous Flow and Daily Rainfall

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), total dissolved phosphorus (TDP), 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 27, 2005. The highest TP concentrations were collected in a storm composite on June 20, 2005. The highest TKN concentration was collected in a snowmelt grab on February 3, 2005. Metals, Chloride, and other Nitrogen species chemical results are listed in Table 2.

Table 1. MS1 2005 Sample Chemistry Results

Sample Type	Start Date	End Date	TSS (mg/L)	VSS (mg/L)	TKN (mg/L)	TP (mg/L)	Fecal Coliform (#/100 mL)	COD (mg/L)	TDP (mg/L)
Snowmelt Grab	2/3/05 15:00	2/3/05 15:00	50	16	4.90	0.715		132	0.492
Storm Grab	3/31/05 12:00	3/31/05 12:00	21	~6	1.80	0.254		39	0.132
Storm Composite	4/16/05 14:22	4/16/05 17:07	100	~17	1.30	0.321		46	0.125
Base Grab	4/26/05 10:00	4/26/05 10:00	~1	<1	0.56	0.052		20	~0.023
Fecal Grab	5/5/05 9:30	5/5/05 9:30					320		
Base Grab	5/16/05 12:15	5/16/05 12:15	4	~2	0.68	0.075		22	0.05
Storm Composite	5/18/05 10:52	5/18/05 17:44	708	~60	2.10	0.887		96	0.05
Storm Grab	6/9/05 8:15	6/9/05 8:15	91	<7	0.94	0.209		35	0.05
Storm Composite	6/13/05 20:04	6/14/05 1:08	1370	<100	3.30	1.090		153	0.05
Storm Composite	6/20/05 14:31	6/20/05 14:40	85	~19	3.60	1.490			
Storm Composite	6/27/05 20:07	6/27/05 20:29	4100	350	2.50	0.990		130	0.077
Fecal Grab	7/13/05 10:15	7/13/05 10:15					1000		
Storm Composite	8/4/05 0:54	8/4/05 2:26	720	~51	1.80	0.596		59	0.11
Storm Composite	8/8/05 6:28	8/8/05 7:43	608	~50	2.30	0.602		69	~0.040
Storm Composite	8/9/05 15:35	8/9/05 19:34	204	~18	1.40	0.366		44	0.167
Fecal Grab	8/25/05 9:15	8/25/05 9:15					870		
Storm Composite	9/21/05 20:21	9/22/05 6:37	101	~13	1.60	0.369		40	0.218
Storm Composite	9/25/05 0:33	9/25/05 7:51	97	~12	0.96	0.191		32	0.072
Base Grab	10/19/05 10:30	10/19/05 10:30	~1	<1	0.30	0.074		~12	0.067
Fecal Grab	10/19/05 10:30	10/19/05 10:30					30		
Average			516	45	1.88	0.518	555	62	0.118

Table 2. MS1 2005 Sample Metals, Chloride, and Nitrogen Species Chemical Results

Sample Type	Start Date	End Date	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	2/3/05 15:00	2/3/05 15:00	0.0128	0.0063	0.0034	0.0490	0.0002	0.0057	2278	0.12	0.67	1.67
Storm Grab	3/31/05 12:00	3/31/05 12:00	0.0034	0.0025	0.0006	0.0096	<.00004	0.0016	75	<0.03	0.48	0.23
Storm Composite	4/16/05 14:22	4/16/05 17:07	0.0153	0.0042	0.0027	0.0240	0.0011	0.0045	85	0.04	0.23	<0.02
Base Grab	4/26/05 10:00	4/26/05 10:00	0.0010	0.0017	<.00007	0.0030	<.00004	0.0012	128	<0.03	0.05	<0.02
Fecal Grab	5/5/05 9:30	5/5/05 9:30										
Base Grab	5/16/05 12:15	5/16/05 12:15	0.0022	0.0022	0.0001	0.0068	<.00004	0.0011	123	<0.03	0.08	<0.02
Storm Composite	5/18/05 10:52	5/18/05 17:44	0.0310	0.0202	0.0139	0.0730	<.00004	0.0209	43	0.03	0.36	<0.02
Storm Grab	6/9/05 8:15	6/9/05 8:15	0.0083	0.0057	0.0025	0.0162	<.00004	0.0044	65	0.05	0.57	0.06
Storm Composite	6/13/05 20:04	6/14/05 1:08	0.0480	0.0250	0.0220	0.0710	0.0006	0.023	32	0.19	0.28	0.16
Storm Composite	6/20/05 14:31	6/20/05 14:40										
Storm Composite	6/27/05 20:07	6/27/05 20:29	0.0560	0.0330	0.0240	0.0880	0.0002	0.029	8	0.08	0.38	0.17
Fecal Grab	7/13/05 10:15	7/13/05 10:15										
Storm Composite	8/4/05 0:54	8/4/05 2:26	0.0370	0.0131	0.0093	0.0400	<.00004	0.0125	7	0.12	0.65	~0.04
Storm Composite	8/8/05 6:28	8/8/05 7:43	0.0260	0.0147	0.0114	0.0480	0.0002	0.014	5	0.06	0.62	0.26
Storm Composite	8/9/05 15:35	8/9/05 19:34	0.0170	0.0060	0.0040	0.0220	0.0004	0.0056	14	0.03	0.34	0.14
Fecal Grab	8/25/05 9:15	8/25/05 9:15										
Storm Composite	9/21/05 20:21	9/22/05 6:37	0.0260	0.0042	0.0023	0.0174	0.0003	0.0036	11	0.06	0.52	0.15
Storm Composite	9/25/05 0:33	9/25/05 7:51	0.0092	0.0038	0.0019	0.0150	0.0008	0.0034	19	<0.03	0.29	<0.02
Base Grab	10/19/05 10:30	10/19/05 10:30	0.0013	0.0019	0.0001	0.0063	<.00004	0.0005	37	<0.03	0.44	<0.02
Fecal Grab	10/19/05 10:30	10/19/05 10:30										
Average			0.0196	0.0096	0.0066	0.0326	0.0003	0.0087	195	0.06	0.40	0.20

MS2 (Bailey)

The hydrograph for the MS2 site shows flow from April 5 – October 4, 2005 (Figure 3). Total discharge during this period was 38,588,800 cf or 886 acre-ft. Peak discharge was 45.31 cfs on October 4, 2005 from daily precipitation of 4.30 inches, the highest daily precipitation for 2005. In-stream monitoring equipment was damaged from high flows on this date and the pond elevation rose significantly, causing the peak discharge to be higher.

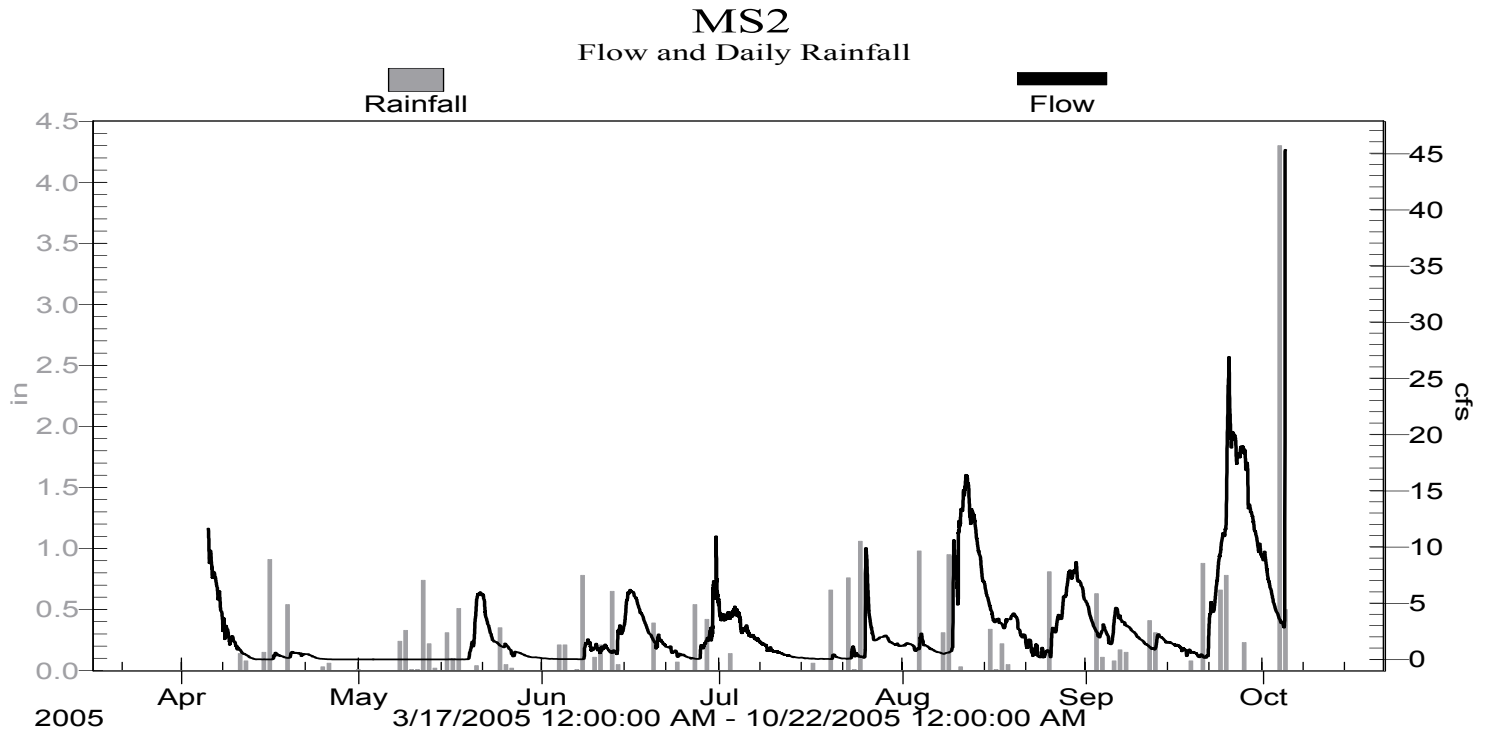


Figure 3. MS2 2005 Continuous Flow and Daily Rainfall

Grab and flow weighted composite samples were taken at the MS2 site to determine water quality. Samples were taken during snowmelt and storm runoff, as well as during base flow conditions. Grab samples were taken at the MS2 site in 2004. The TSS, TKN, TP, VSS, COD, TDP, and Fecal Coliform results from all collected samples are listed in Table 3. The highest TSS concentrations were collected in a storm composite on June 8, 2005 while the highest TP concentrations were collected in a base composite on August 25, 2005. The highest TKN concentrations were collected in base composites on August 25 and September 19, 2005. Metals, Chloride, and other Nitrogen species chemical results are listed in Table 4.

Table 3. MS2 2005 Sample Chemistry Results

Sample Type	Start Date	End Date	TSS (mg/L)	VSS (mg/L)	TKN (mg/L)	TP (mg/L)	Fecal Coliform (#/100 mL)	COD (mg/L)	TDP (mg/L)
Storm Grab	3/31/05 8:45	3/31/05 8:45	~10	~5	1.80	0.248		34	0.14
Base Grab	4/26/05 9:15	4/26/05 9:15	6	~4	1.10	0.105		30	~0.041
Storm Composite	6/8/05 11:41	6/9/05 5:57	560	~92	1.80	0.196		42	~0.035
Storm Composite	6/13/05 21:35	6/14/05 6:53	180	46	1.20	0.292		37	~0.023
Storm Composite	6/30/05 0:48	6/30/05 12:37	10	8	1.60	0.132		35	~0.018
Storm Composite	7/13/05 15:46	7/15/05 8:24	9	5	1.40	0.091		35	~0.049
Fecal Grab	7/13/05 9:45	7/13/05 9:45					25		
Storm Composite	8/9/05 16:35	8/10/05 22:00	30	~11	1.80	0.211		51	~0.043
Fecal Grab	8/25/05 8:45	8/25/05 8:45					4		
Base Composite	8/25/05 16:09	8/25/05 22:09	44	37	2.80	0.322		103	~0.030
Storm Composite	8/26/05 10:17	8/28/05 1:45	27	20	2.20	0.21		56	~0.041
Base Composite	9/19/05 10:27	9/21/05 8:36	59	50	2.80	0.283		94	~0.025
Storm Composite	9/21/05 23:13	9/22/05 17:01	31	24	2.50	0.233		60	~0.031
Storm Composite	10/4/05 21:17	10/5/05 11:40	54	~17	1.70	0.301		46	0.094
Base Grab	10/19/05 10:15	10/19/05 10:15	12	~5	0.96	0.17		20	0.108
Fecal Grab	10/19/05 10:15	10/19/05 10:15					60		
Average			79	25	1.8	0.215	30	49	0.052

Table 4. MS2 2005 Sample Metals, Chloride, and Nitrogen Species Chemical Results

Sample Type	Start Date	End Date	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 Grab	3/31/05 8:45	3/31/05 8:45	0.0039	0.0016	0.0005	0.0096	<.00004	0.0015	76	<0.03	0.25	0.33
Base Grab	4/26/05 9:15	4/26/05 9:15	0.0024	0.0016	0.0002	0.0028	<.00004	0.0011	84	<0.03	0.06	~0.05
Storm Composite	6/8/05 11:41	6/9/05 5:57	0.0230	0.0024	0.0008	0.0230	0.0004	0.0008	76	<0.03	0.09	0.14
Storm Composite	6/13/05 21:35	6/14/05 6:53	0.0055	0.0015	0.0003	0.0118	0.0004	0.0009	69	<0.03	0.07	<0.02
Storm Composite	6/30/05 0:48	6/30/05 12:37	0.0014	0.0013	0.0002	0.0046	0.0002	0.0005	77	<0.03	0.08	<0.02
Storm Composite	7/13/05 15:46	7/15/05 8:24	0.0022	0.0015	0.0002	0.0108	<.00004	0.0007	89	<0.03	<0.05	0.14
Fecal Grab	7/13/05 9:45	7/13/05 9:45										
Storm Composite	8/9/05 16:35	8/9/05 22:00	0.0040	0.0026	0.0009	0.0114	0.0009	0.0011	56	<0.03	0.09	~0.06
Fecal Grab	8/25/05 8:45	8/25/05 8:45										
Base Composite	8/25/05 16:09	8/25/05 22:09	0.0030	0.0018	0.0008	0.0220	0.0002	0.0004	75	<0.03	<0.05	<0.02
Storm Composite	8/26/05 10:17	8/28/05 1:45	0.0019	0.0015	0.0005	0.0068	<.00004	0.0002	71	<0.03	<0.05	~0.05
Base Composite	9/19/05 10:27	9/21/05 8:36	0.0028	0.0019	0.0008	0.0108	0.0001	0.0014	64	<0.03	0.06	<0.02
Storm Composite	9/21/05 23:13	9/22/05 17:01	0.0022	0.0015	0.0006	0.0046	<.00004	0.0006	54	0.12	<0.05	0.08
Storm Composite	10/4/05 21:17	10/5/05 11:40	0.0217	0.0045	0.0280	0.0880	0.0018	0.0042	18	<0.03	0.19	0.07
Base Grab	10/19/05 10:15	10/19/05 10:15	0.0016	0.0020	0.0004	0.0045	<.00004	0.0009	22	<0.03	0.30	0.10
Fecal Grab	10/19/05 10:15	10/19/05 10:15										
Average			0.0058	0.0020	0.0026	0.0162	0.0003	0.0011	64	0.04	0.11	0.08

Powers Lake New East Tributary

The hydrograph for the Powers Lake site shows flow between March 28-October 7, 2005 (Figure 5). Total discharge during this period was 5,357,799 cf or 123 acre/ft. The highest discharge—11.07 cfs occurred on October 5, 2005 from a total rainfall of 5.02 inches, which fell on October 4, 2005-October 5, 2005. The total rainfall on October 4th alone was 4.68 inches, the highest daily rainfall for the monitoring season.

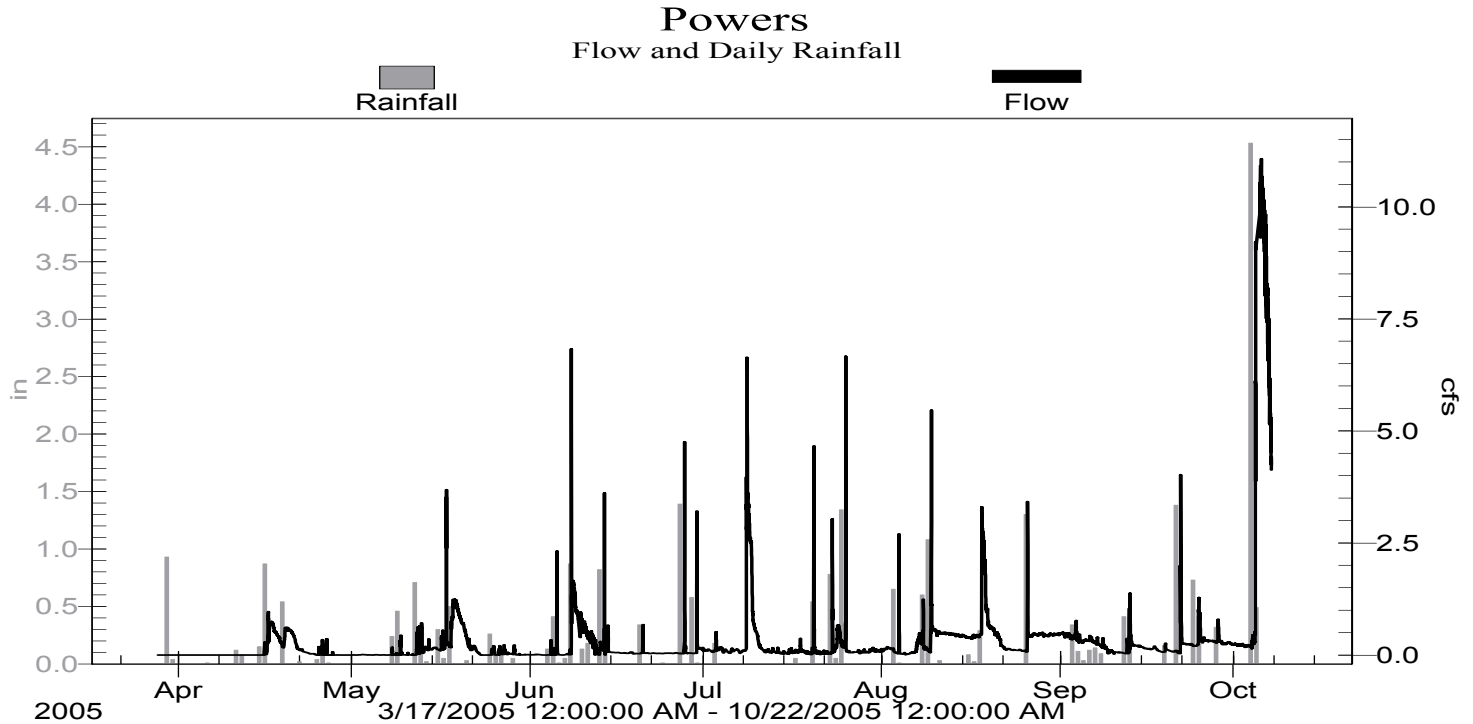


Figure 4. Powers 2005 Flow and Daily Rainfall

Grab and flow weighted composite samples were taken at the Powers site in 2005. The TSS, TKN, TP, VSS, COD, TDP, and Fecal Coliform results from all collected samples are listed in Table 5. The highest TSS concentration of 7,880 mg/L was from a June 13, 2005 storm composite sample. TKN concentrations had a range of 0.50 to 13.00 mg/L, with the highest concentration coming from the June 13, 2005 storm composite sample. The highest TP concentration (6.52 mg/L) was also from the June 13, 2005 storm composite sample. Metals, Chloride, and other Nitrogen species chemical results are listed in Table 6.

Table 5. Powers 2005 Sample Chemistry Results

Sample Type	Start Date	End Date	TSS (mg/L)	VSS (mg/L)	TKN (mg/L)	TP (mg/L)	Fecal Coliform (#/100 mL)	COD (mg/L)	TDP (mg/L)
Storm Grab	3/31/05 11:15	3/31/05 11:15	16	<4	1.10	0.112		24	~0.038
Storm Grab	4/18/05 11:30	4/18/05 11:30	4	~2	0.81	0.063		25	~0.022
Base Grab	5/16/05 11:00	5/16/05 11:00	~4	~2	0.73	0.051		25	~0.026
Storm Composite	5/17/05 11:13	5/17/05 11:59	524	~22	0.50	0.169		30	~0.019
Storm Grab	6/9/05 9:45	6/9/05 9:45	16	~4	0.90	0.075		30	~0.022
Storm Composite	6/13/05 20:19	6/13/05 21:06	7880	~720	13.00	6.520		363	0.230
Storm Composite	6/27/05 18:39	6/27/05 19:05	5420	400	8.70	5.880		336	0.155
Fecal Grab	7/13/05 10:00	7/13/05 10:00					62		
Storm Composite	7/23/05 10:02	7/23/05 10:22	55	~20	4.20	0.877		132	0.122
Storm Composite	7/25/05 17:18	7/26/05 1:43	399	32	1.60	0.567		59	0.064
Storm Composite	8/8/05 12:12	8/9/05 6:24	536	266	0.98	0.097		51	~0.029
Base Grab	8/11/05 11:45	8/11/05 11:45	4	3	0.92	0.068		22	~0.014
Fecal Grab	8/25/05 8:30	8/25/05 8:30					10		
Base Composite	9/19/05 15:33	9/20/05 21:02	23	~7	1.30	0.138		45	~0.032
Storm Composite	9/21/05 19:03	9/21/05 21:22	1430	156	5.40	2.960		210	0.283
Storm Composite	10/5/05 13:38	10/6/05 10:12	104	~15	0.70	0.249		30	~0.042
Average			1173	118	2.92	1.273	36	99	0.078

Table 6. Powers 2005 Sample Metals, Chloride, and Nitrogen Species Chemical Results

Sample Type	Start Date	End Date	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 Grab	3/31/05 11:15	3/31/05 11:15	0.0022	0.0015	0.0003	0.0074	<.00004	0.0011	26	<0.03	<0.05	~0.04
Storm Grab	4/18/05 11:30	4/18/05 11:30	0.0019	0.0014	<.00007	0.0028	<.00004	0.0003	46	<0.03	<0.05	<0.02
Base Grab	5/16/05 11:00	5/16/05 11:00	0.0015	0.0017	<.00007	0.0084	0.0006	0.0008	49	<0.03	0.11	<0.02
Storm Composite	5/17/05 11:13	5/17/05 11:59	0.04	0.0177	0.0026	0.026	0.0004	0.0038	14	<0.03	0.1	<0.02
Storm Grab	6/9/05 9:45	6/9/05 9:45	0.0018	0.0017	0.0002	0.0041	<.00004	0.0006	56	<0.03	0.08	<0.02
Storm Composite	6/13/05 20:19	6/13/05 21:06	0.069	0.066	0.101	0.145	0.00005	0.065	27	0.06	<0.05	<0.02
Storm Composite	6/27/05 18:39	6/27/05 19:05	0.207	0.105	0.101	0.253	0.0007	0.097	15	0.06	0.11	<0.02
Fecal Grab	7/13/05 10:00	7/13/05 10:00										
Storm Composite	7/23/05 10:02	7/23/05 10:22	0.042	0.0124	0.0089	0.127	0.003	0.0107	12	0.03	<0.05	0.19
Storm Composite	7/25/05 17:18	7/26/05 1:43	0.0238	0.0107	0.0076	0.027	<.00004	0.01	33	0.04	0.05	<0.02
Storm Composite	8/8/05 12:12	8/9/05 6:24	0.0071	0.0024	0.0009	0.0112	0.00004	0.0021	29	<0.03	<0.05	<0.02
Base Grab	8/11/05 11:45	8/11/05 11:45	0.0011	0.0012	0.00009	0.0098	0.0003	0.0003	26	<0.03	0.08	<0.02
Fecal Grab	8/25/05 8:30	8/25/05 8:30										
Base Composite	9/19/05 15:33	9/20/05 21:02	0.0088	0.0028	0.0005	0.023	0.0001	0.0015	20	<0.03	0.18	<0.02
Storm Composite	9/21/05 19:03	9/21/05 21:22	0.045	0.036	0.048	0.102	0.0002	0.037	5	0.3	0.29	0.18
Storm Composite	10/5/05 13:38	10/6/05 10:12	0.0091	0.0052	0.0035	0.0134	<.00004	0.0051	6	<0.03	0.07	<0.02
Average			0.0329	0.0190	0.0196	0.0543	0.0004	0.0168	26	0.05	0.09	0.05

100th Street (Cottage Grove)

The hydrograph for the 100th Street site shows flow recorded between March 28-November 14, 2005 (Figure 5). Total discharge during this period was 10,187,210 cf or 234 acre/ft. The highest discharge—30.38 cfs occurred on October 4, 2005 from the daily rainfall of 2.74 inches, the highest daily rainfall in 2005.

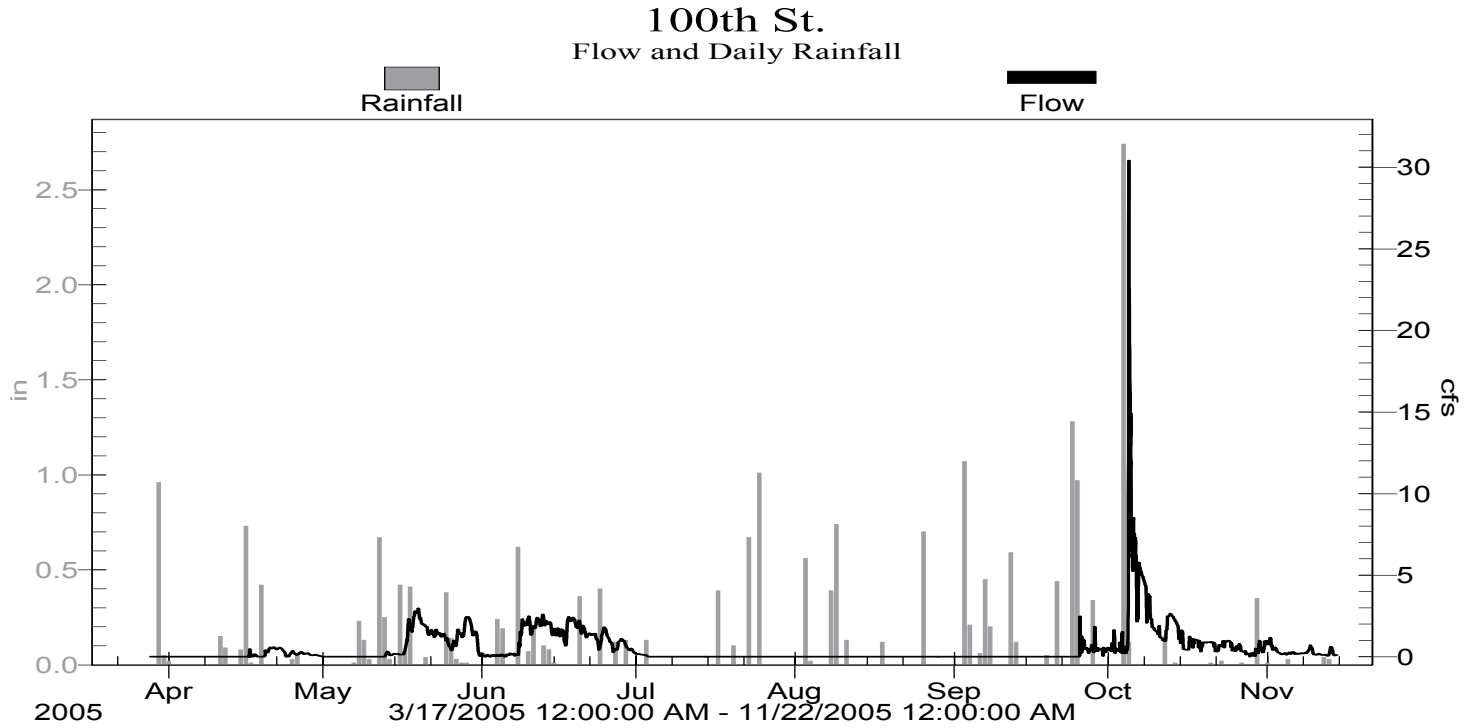


Figure 5. 100th Street 2005 Flow and Daily Rainfall

Grab samples and flow weighted composite samples were taken at the 100th Street site. The TSS, TKN, TP, VSS, COD, TDP, and Fecal Coliform results from all collected samples are listed in Table 7. The highest TSS concentration of 43 mg/L was collected in a September 25, 2005 storm composite sample. The highest TP and TKN concentrations were collected from the same September 25, 2005 storm sample, 0.23 mg/L and 1.90 mg/L, respectively. Metals and other Nitrogen species chemicals are listed in Table 8.

Table 7. 100th Street 2005 Sample Chemistry Results

Sample Type	Start Date	End Date	TSS (mg/L)	VSS (mg/L)	TKN (mg/L)	TP (mg/L)	Fecal Coliform (#/100 mL)	COD (mg/L)	TDP (mg/L)
Base Grab	4/26/05 8:30	4/26/05 8:30	~1	<1	0.47	~0.029		14	<0.010
Storm Grab	5/16/05 8:45	5/16/05 8:45	~2	~1	0.42	0.054		16	~0.013
Storm Grab	6/9/05 9:00	6/9/05 9:00	~6	<4	0.38	0.072		15	~0.015
Storm Composite	9/25/05 12:10	9/26/05 13:55	43	29	1.90	0.23		54	~0.012
Storm Composite	10/4/05 21:06	10/5/05 0:07	~13	~6	1.10	0.121		21	~0.042
Base Grab	10/19/05 9:45	10/19/05 9:45	~1	~1	0.22	~0.045		6	0.055
Fecal Grab	10/19/05 9:45	10/19/05 9:45					29		
Average			11	7	0.75	0.092	29	21	0.025

Table 8. 100th Street 2005 Sample Metals, Chloride, and Nitrogen Species Chemical Results

Sample Type	Start Date	End Date	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)
Base Grab	4/26/05 8:30	4/26/05 8:30	0.0012	0.0029	<.00007	0.0027	<.00004	0.0004	162	<0.03	0.05	0.30
Storm Grab	5/16/05 8:45	5/16/05 8:45	0.0007	0.0034	<.00007	0.0042	<.00004	0.0005	160	<0.03	0.07	<0.02
Storm Grab	6/9/05 9:00	6/9/05 9:00	0.0009	0.0025	0.0001	0.0033	<.00004	0.0002	108	<0.03	0.10	<0.02
Storm Composite	9/25/05 12:10	9/26/05 13:55	0.0078	0.0042	0.0004	0.0063	0.0004	0.0031	77	<0.03	0.11	<0.02
Storm Composite	10/4/05 21:06	10/5/05 0:07	0.0051	0.0020	0.0007	0.0062	0.0002	0.0008	41	0.06	0.35	0.30
Base Grab	10/19/05 9:45	10/19/05 9:45	0.0010	0.0021	0.0001	0.0028	<.00004	0.0002	41	<0.03	0.12	<0.02
Fecal Grab	10/19/05 9:45	10/19/05 9:45										
Average			0.0028	0.0029	0.0002	0.0043	0.0001	0.0009	98	0.04	0.13	0.11

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

Fox Run

The Fox Run stormwater site recorded stage, velocity, and flow between March 28-October 31, 2005 (Figure 6). The total discharge for this period was 413,251 cf or 9.5 acre-ft. The highest recorded flow was 3.79 cfs on October 6, 2005. Logger failure occurred between August 3-August 25, 2005, and flow was unable to be calculated during this time period. There was no precipitation gage at this site and no chemistry data was collected at this site.

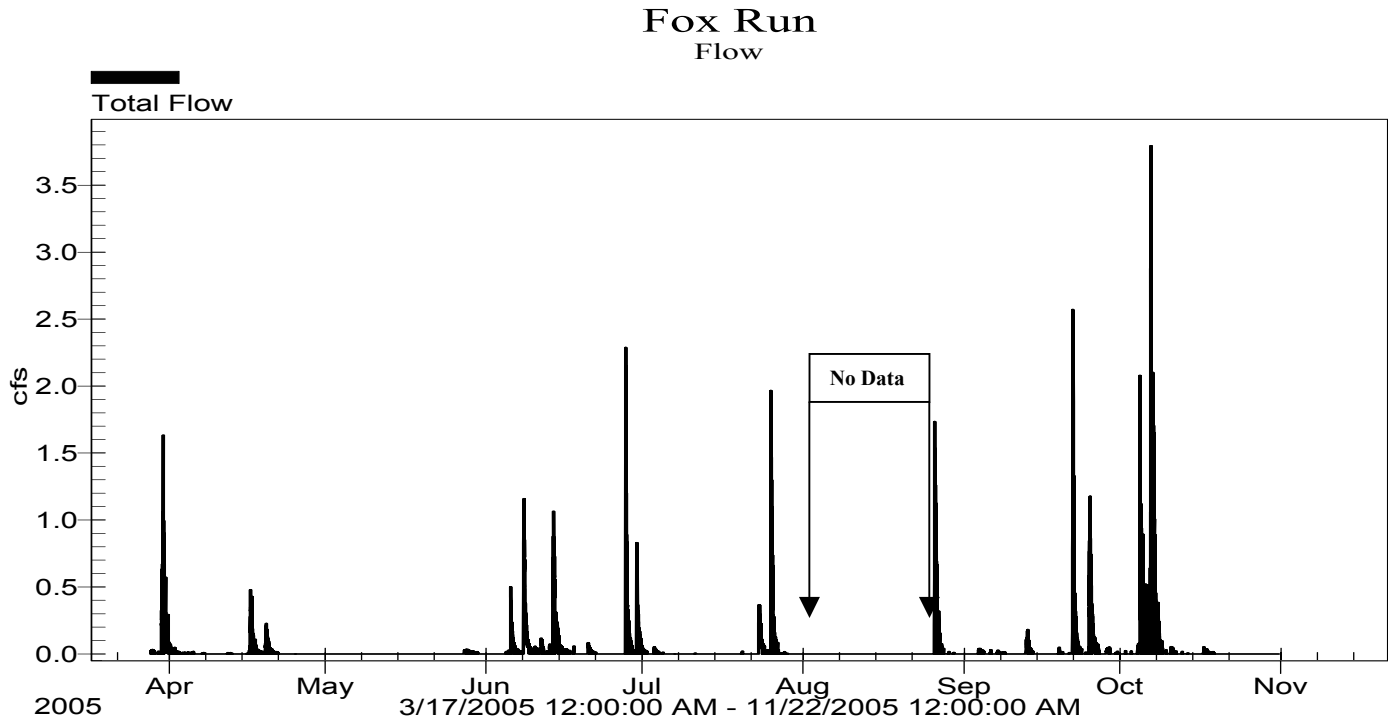


Figure 6. Fox Run 2005 Continuous Flow

Tamarack Road

The Tamarack Road stormwater site recorded stage, velocity, and flow between March 28-October 31, 2005 (Figure 7). The total discharge for this period was 1,783,465 cf or 41 acre-ft. The highest discharge at this site was 70.86 cfs on October 4, 2005. There was no precipitation gage at this site and no chemistry data was collected at this site.

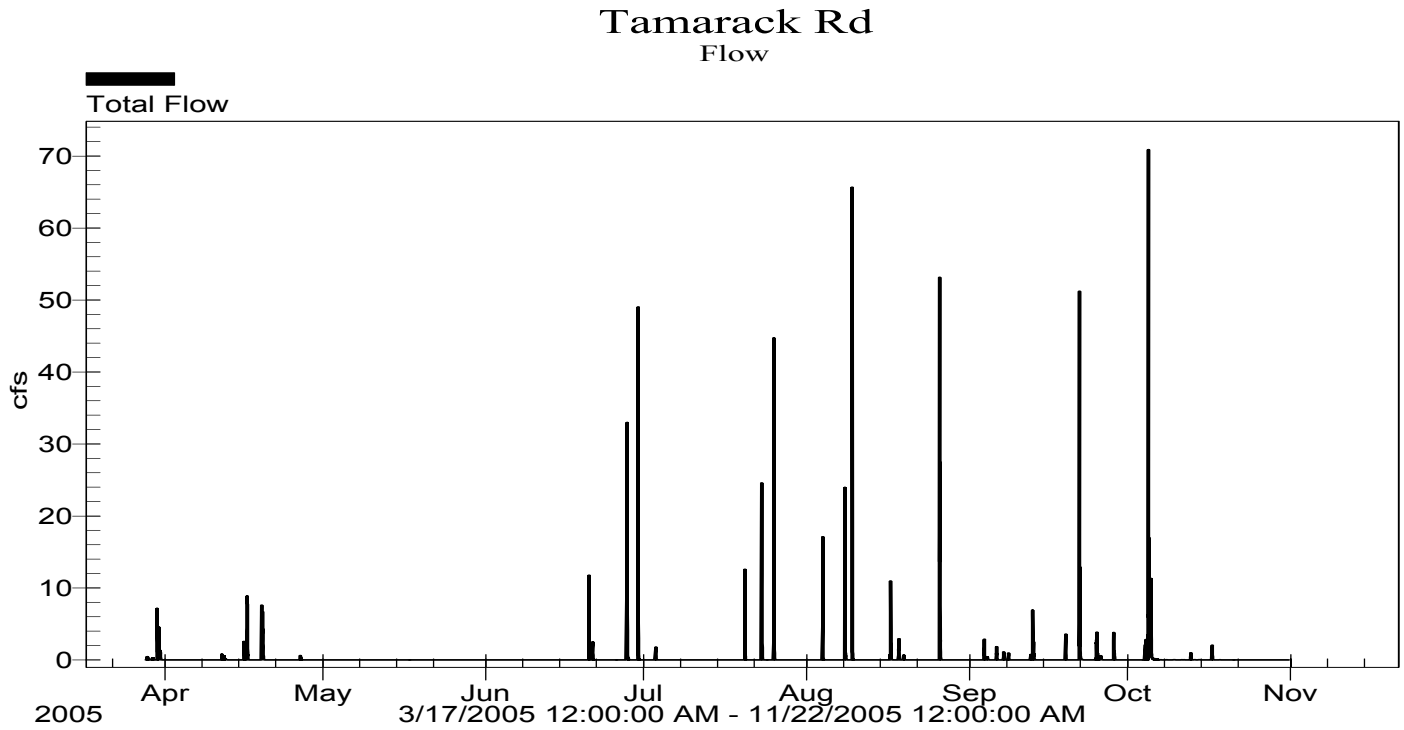


Figure 7. Tamarack Road 2005 Continuous Flow

80th Street

The 80th Street stormwater site recorded stage and flow between March 28-October 31, 2005 (Figure 8). The total discharge for this period was 7,051,059 cf or 162 acre-ft. The high flow at this site—8.47 cfs was on October 5, 2005. There was no precipitation gage at this site and no chemistry data was collected at this site.

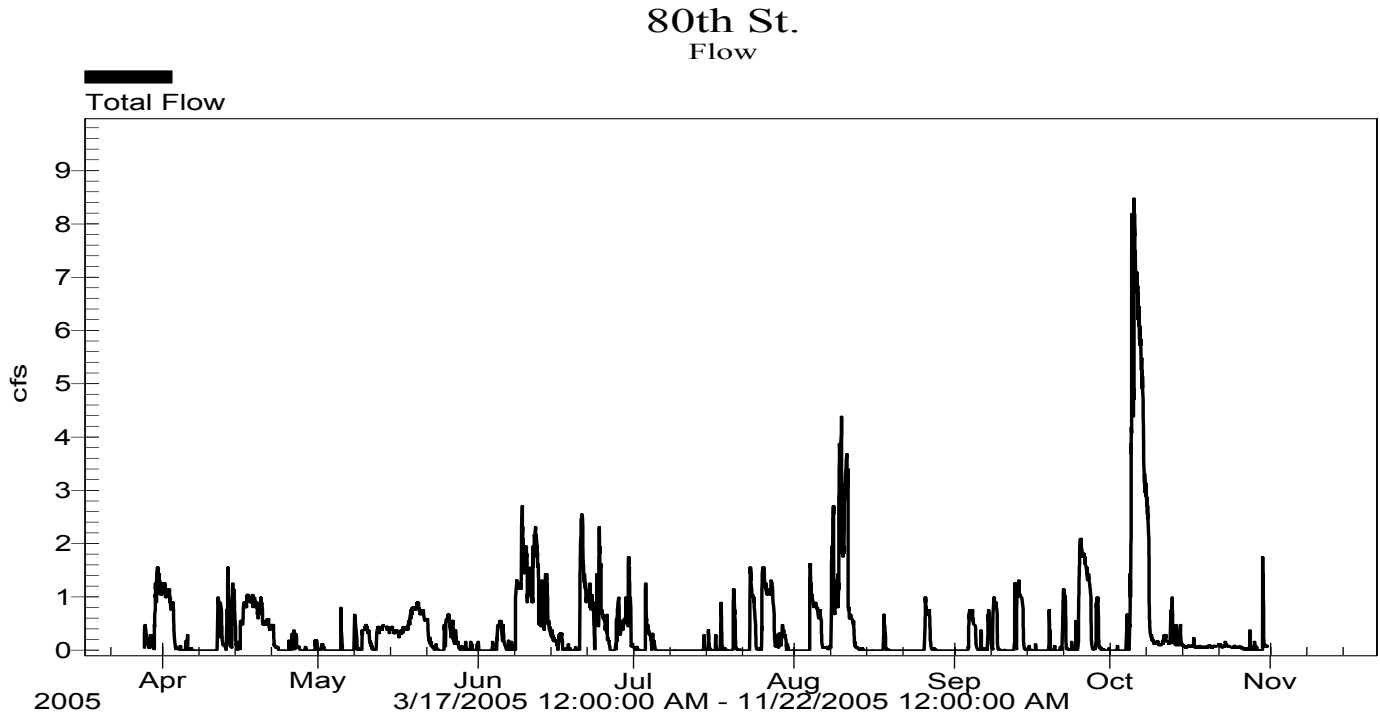


Figure 8. 80th Street 2005 Continuous Flow

90th Street

The 90th Street stormwater site recorded stage and flow between March 28-October 31, 2005 (Figure 9). The total discharge for this period was 5,279,553 cf or 121 acre-ft. The highest discharge at this site was 75.56 cfs on October 4, 2005. There was no precipitation gage at this site. No chemistry data was collected at this site.

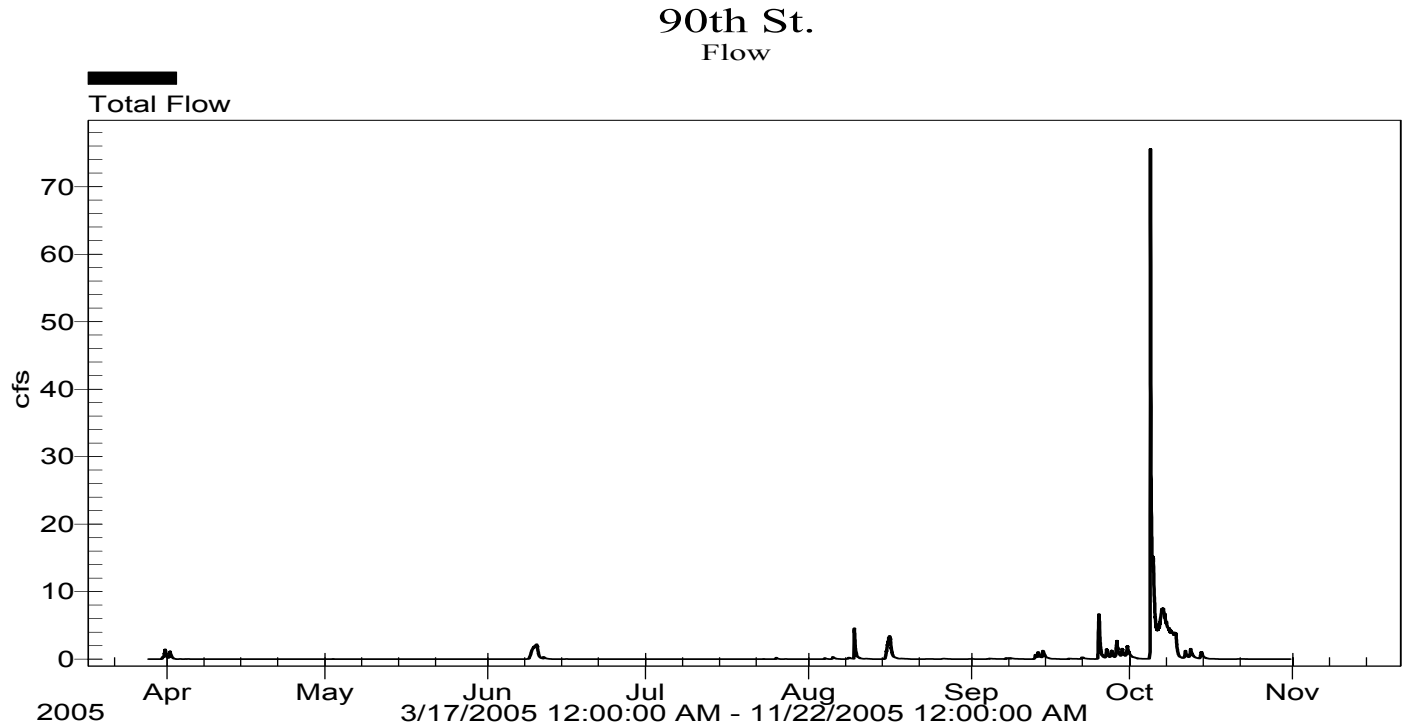


Figure 9. 90th Street 2005 Continuous Flow

Bailey Lake (at Lift Station)

Continuous stage and precipitation measurements were recorded between March 31-November 15, 2005 at this site (Figure 10). The highest recorded Elevation—874.15 ft., was recorded on October 13, 2005. The average stage during the monitoring season was 862.43 ft. The highest recorded daily precipitation—3.99 inches, was recorded on October 4, 2005.

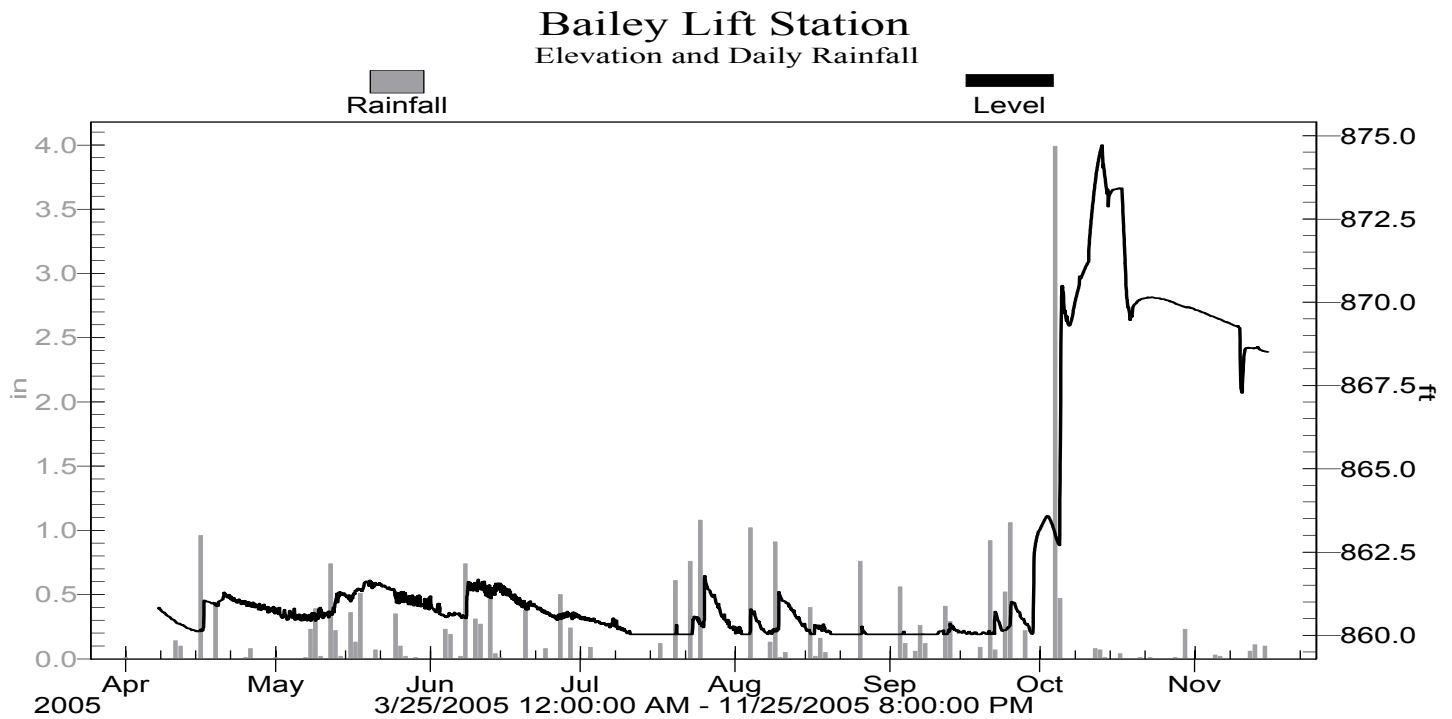


Figure 10. Bailey Lake (at Lift Station) 2005 Elevation and Daily Precipitation

North Ravine (N. Ravine of East Inlet to Cottage Grove Ravine Park Lake)

The North Ravine site recorded stage between March 30-October 31, 2005 (Figure 11), with the highest stage of 3.88 ft recorded on October 4, 2005. Total discharge wasn't calculated for this site because a usable and accurate stage to discharge relationship could not be developed. A stage recorder was installed in a nearby smaller ravine during the same time period, however the site remained dry for the year with the exception of two events where stage narrowly registered on the datalogger. Therefore, no data for this site is presented in this report.

N. Ravine of East Inlet to CGRP Lake Level

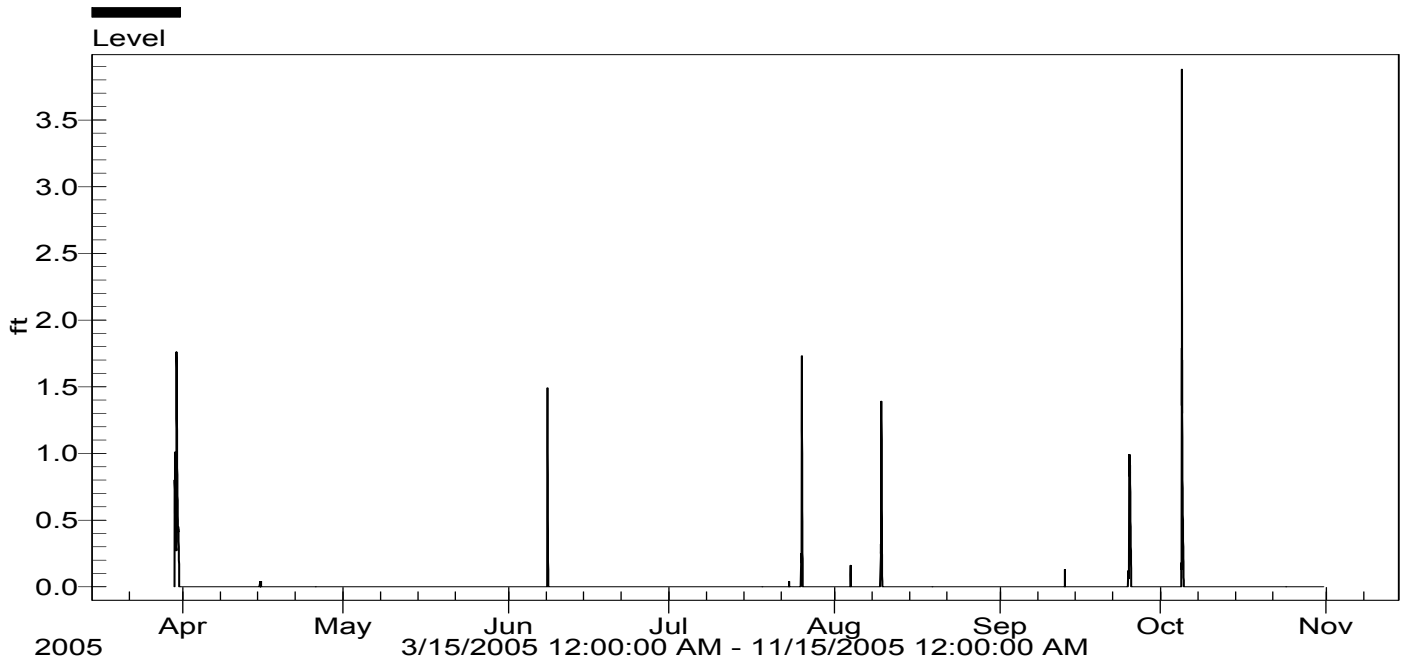


Figure 11. North Ravine of East Inlet to Ravine Park Lake 2005 Continuous Level

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 13, 2005, 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 2005 high, low, and average lake levels. Individual lake level readings are shown in Figure 12.

Table 9. Armstrong 2005 Lake Level

	High	High Date	Low	Low Date	Average
Lake Level (ft)	1020.45	10/6/05	1018.49	7/18/05	1019.12

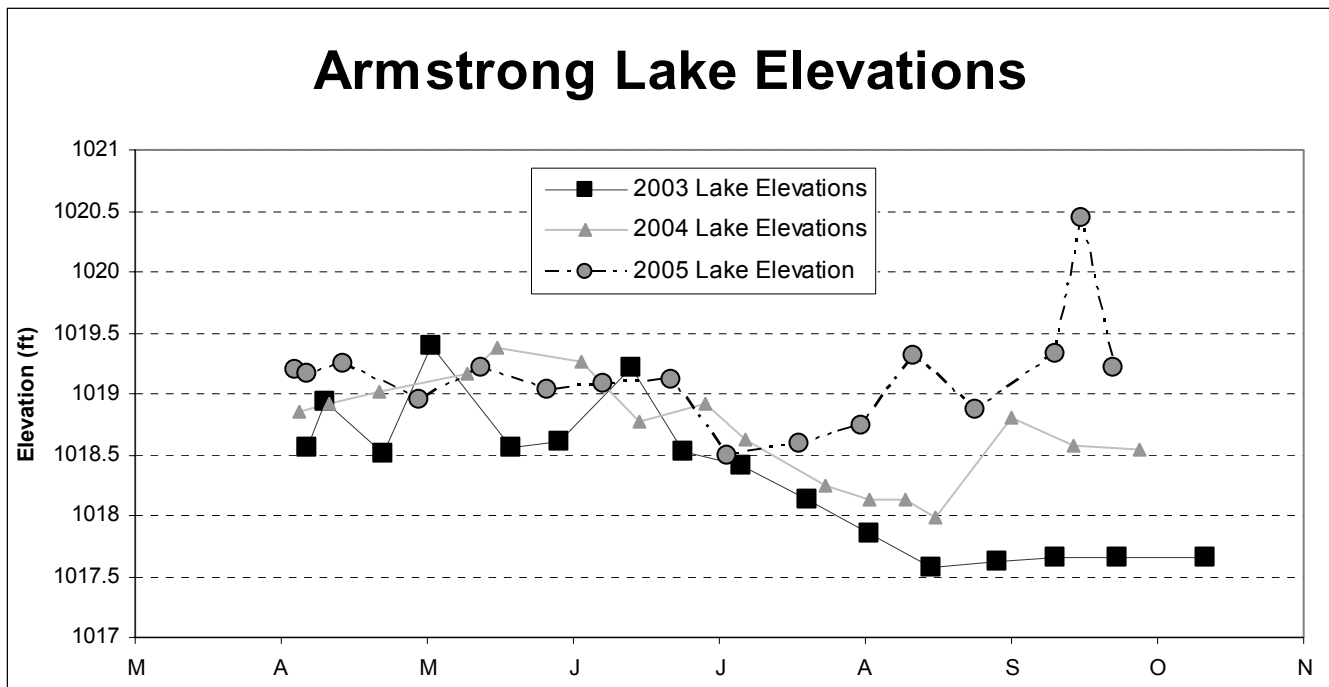


Figure 12. Armstrong Lake Elevations 2003-05

Table 10 gives the 2005 Armstrong Lake monitoring chemistry results and Secchi disk readings for the 2005 water-monitoring season.

Table 10. Armstrong Lake 2005 Monitoring Results

Date & Time	Secchi (m)	Surface TP (mg/L)	Surface TKN (mg/L)	Surface CLA (ug/L)	Surface Chloride (mg/L)	Surface Temperature (C)	Surface Dissolved Oxygen (mg/L)
4/11/2005	0.9	0.058	0.86	15.0	86	13.5	4.78
4/22/2005	1.4	0.051	0.70	9.9	98	15.1	5.32
5/9/2005	0.9	0.062	1.00	96.0	89	17.8	5.69
5/23/2005	1.4	0.031	0.87	6.9	96	16.2	5.30
6/7/2005	1.1	0.025	0.57	6.0	38	26.3	5.91
6/20/2005	0.9	0.062	0.80	4.4	26	24.2	6.48
7/5/2005	0.9	0.072	0.78	3.9	69	21.3	2.62
7/18/2005	0.9	0.081	1.20	9.9	98	25.1	4.50
8/3/2005	1.1	0.040	0.86	11.0	17	26.2	5.00
8/17/2005	0.9	0.044	0.76	10.0	55	24.1	8.84
8/29/2005	0.9	0.063	1.20	8.2	25	24.0	4.70
9/12/2005	1.2	0.041	0.92	9.1	46	22.6	4.79
9/30/2005	1.2	0.058	0.77	11.0	22	14.6	8.48
10/13/2005	1.1	0.093	0.68	11.0	26	14.1	7.49
2005 Averages	1.1	0.056	0.86	15.2	57	20.4	5.71

Table 11 shows the Armstrong Lake Water Quality Summary. Armstrong Lake showed no change in water quality in 2005. The lake received an average lake grade of a C for 2005, which was consistent with 2004.

Table 11. Lake Grade and Trophic Status.

	Trophic Status (2004 Average)	Lake Grade (2004 Average)	Trophic Status (2005 Average)	Lake Grade (2005 Average)
Total Phosphorus (mg/L)	Eutrophic	C	Eutrophic	C
Chlorophyll-a (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, some general trends can be noted. Secchi correlations with TKN and TP were the only trends that are discernible for the 2005 monitoring season. A slight negative correlation exists between Secchi and TP ($r^2=0.19$): as Secchi readings increase, TP concentrations decreased. Also, a slight negative correlation was found for Secchi and TKN ($r^2=0.12$): as Secchi readings increased, TKN concentrations decreased. Other correlations between parameters could not be established this monitoring season. These correlations are further simplified in Table 12.

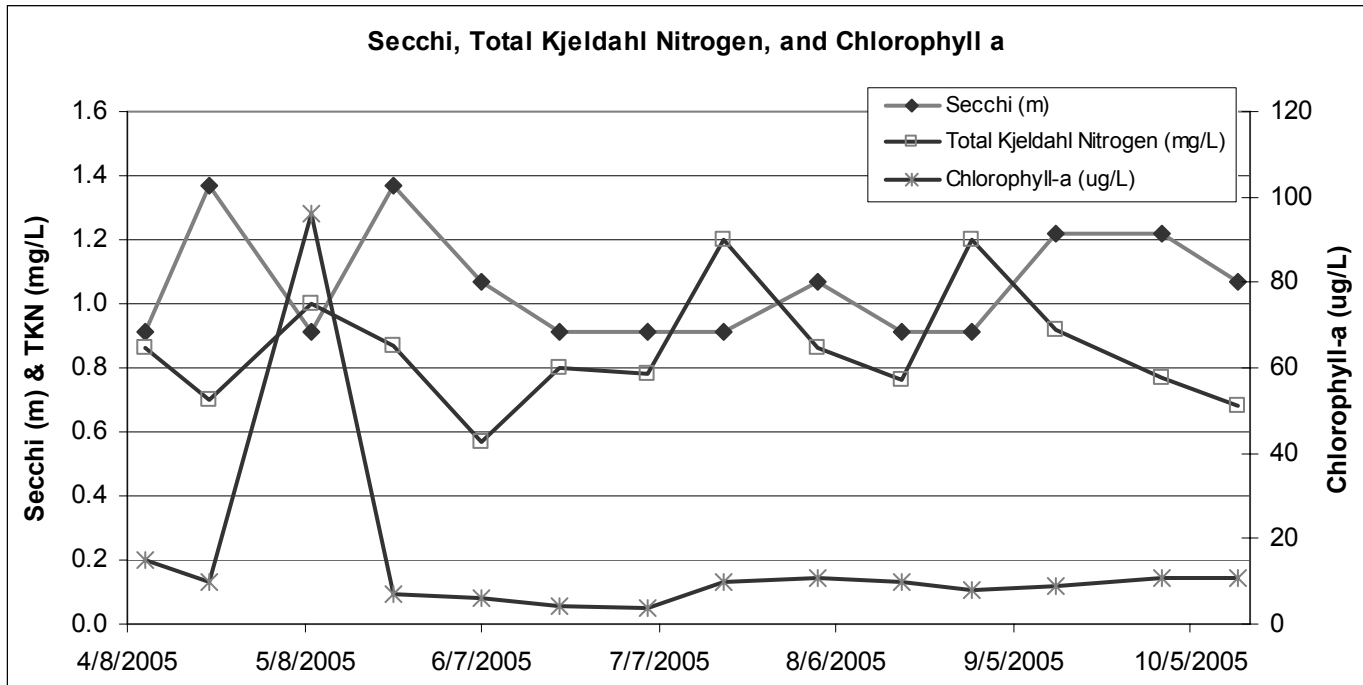


Figure 13. Secchi, Total Kjeldahl Nitrogen and Chlorophyll-a

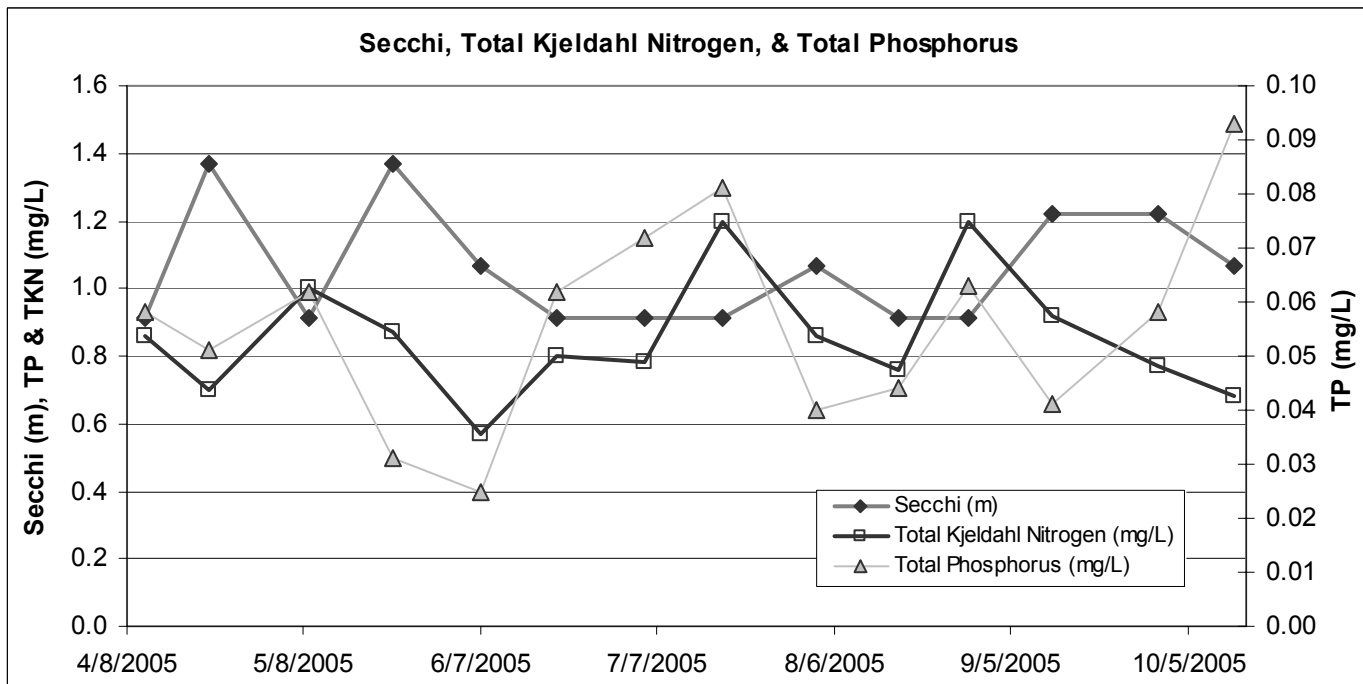


Figure 14. Secchi, Total Kjeldahl Nitrogen, and Total Phosphorus

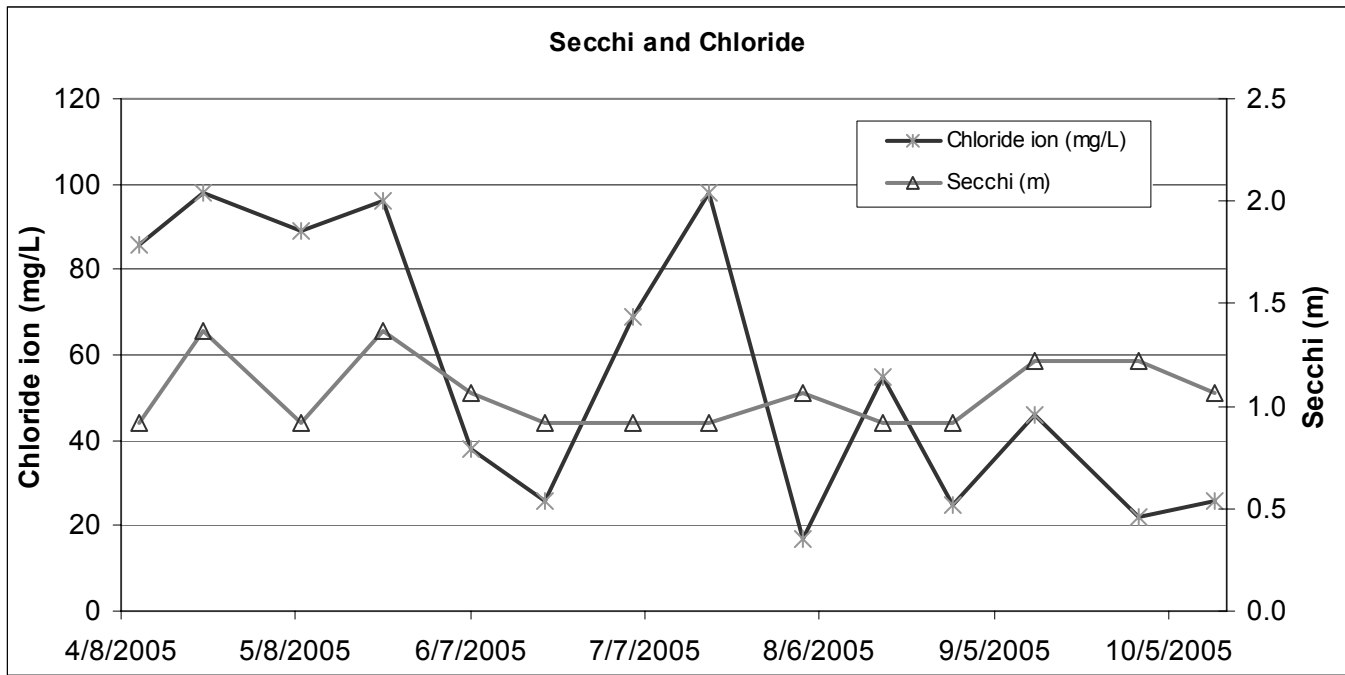


Figure 15. Secchi and Chloride ion

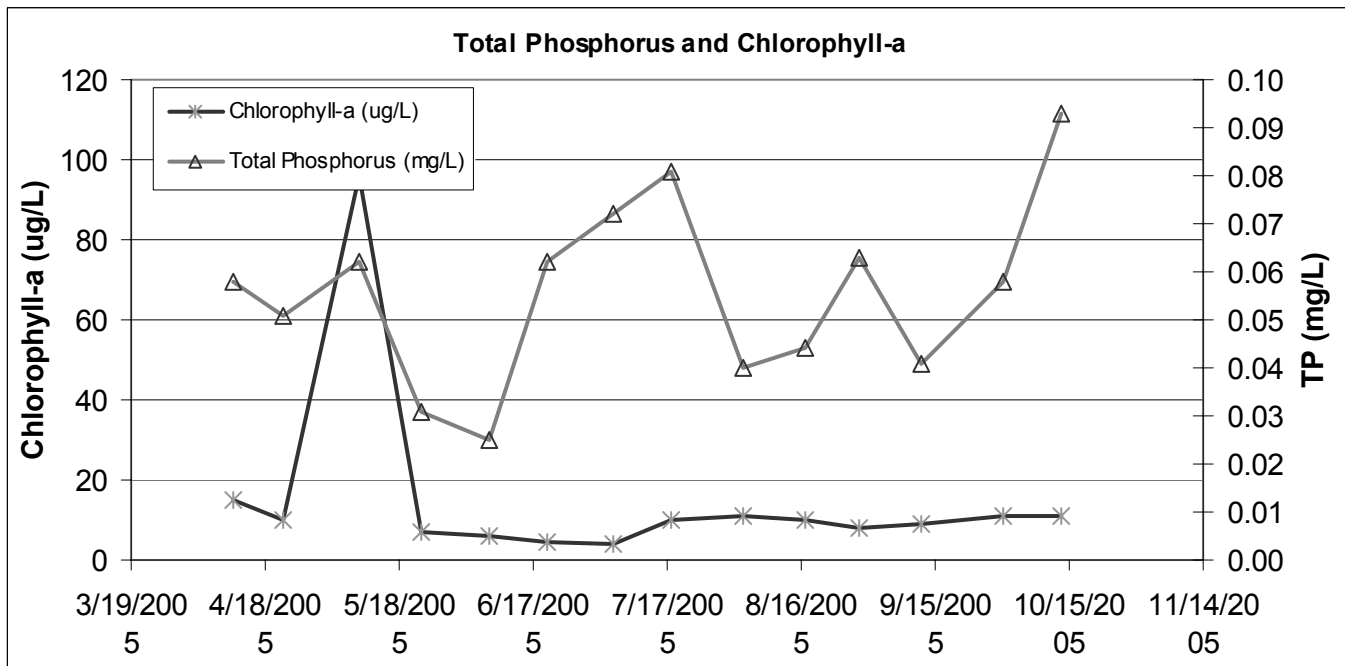


Figure 16. Total Phosphorous and Chlorophyll a

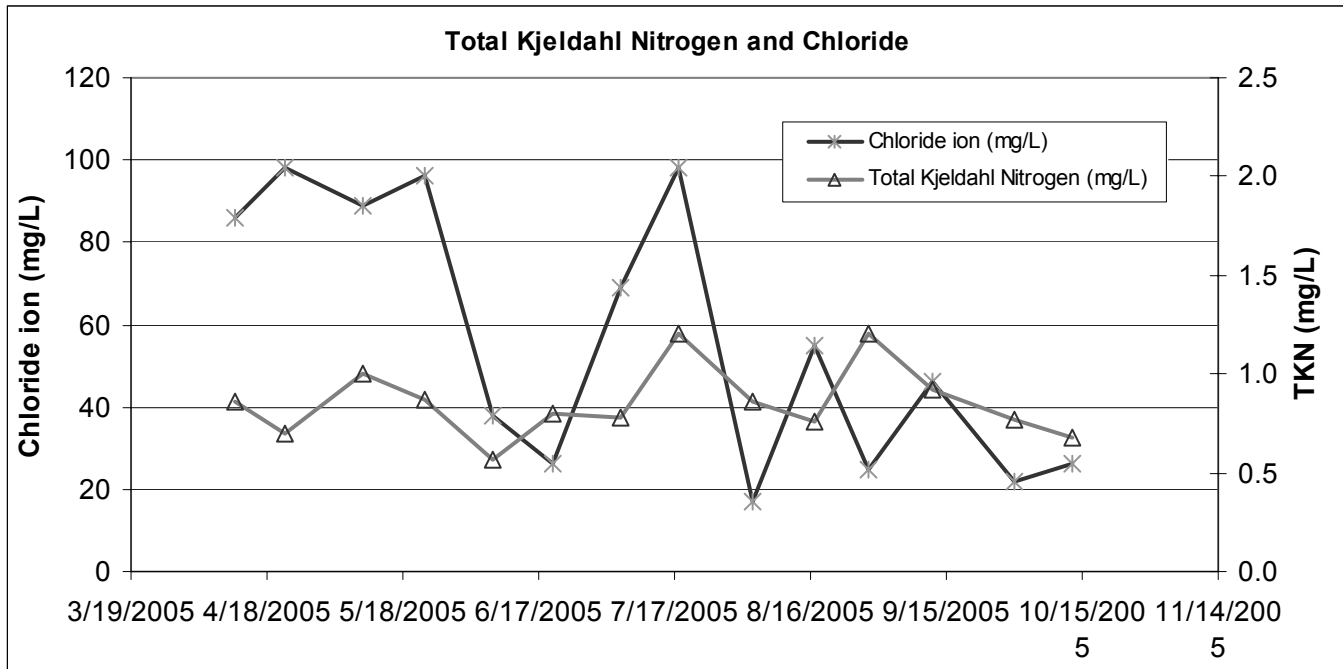


Figure 17. Total Kjeldahl Nitrogen and Chloride ion

Table 12. Lake Parameter Relationships

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

Table 13 lists the dissolved oxygen and temperature profiles for Armstrong Lake. The maximum depth was 1 meter. 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	4/11/2005 0:00		4/22/2005 0:00		5/9/2005 0:00		5/23/2005 0:00		6/7/2005 0:00		6/20/2005 0:00		7/5/2005 0:00	
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)
0	4.78	13.5	5.32	15.1	5.69	17.8	5.30	16.2	5.91	26.3	6.48	24.2	2.62	21.3
1	4.57	13.5	5.04	15.1	5.32	17.6	6.04	15.9	6.34	22.7	2.64	23.5	0.16	20.5

Date	7/18/2005 0:00		8/3/2005 0:00		8/17/2005 0:00		8/29/2005 0:00		9/12/2005 0:00		9/30/2005 0:00		10/13/2005 0:00	
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)
0	4.50	25.1	5.00	26.2	8.84	24.1	4.70	24.0	4.79	22.6	8.48	14.6	7.49	14.1
1	2.78	25.1	0.46	24.1	7.42	23.9	2.04	20.5	4.53	22.6	8.08	14.4	7.20	14.0

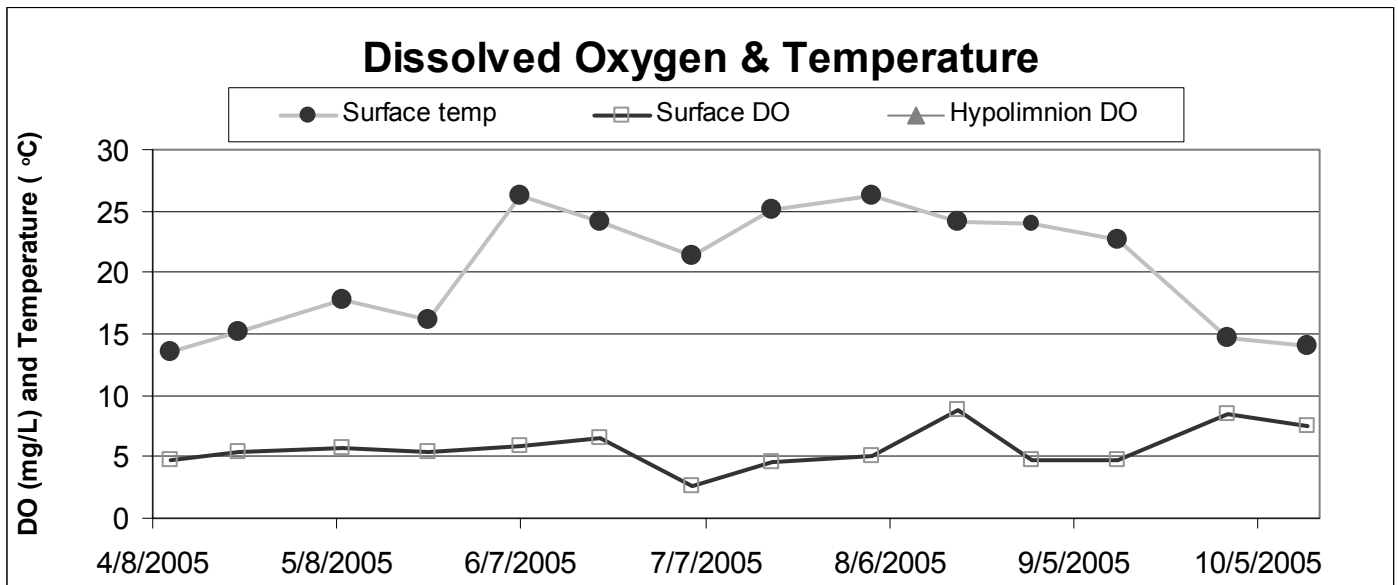


Figure 18. Surface Dissolved Oxygen and Surface Temperatures

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 11 to October 13, 2005, 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 2005 high, low, and average lake levels. Individual lake level readings are shown in Figure 19.

Table 14. Powers 2005 Lake Level

	High	High Date	Low	Low Date	Average
Lake Level (ft)	885.74	9/30/05	883.91	5/9/05	884.64

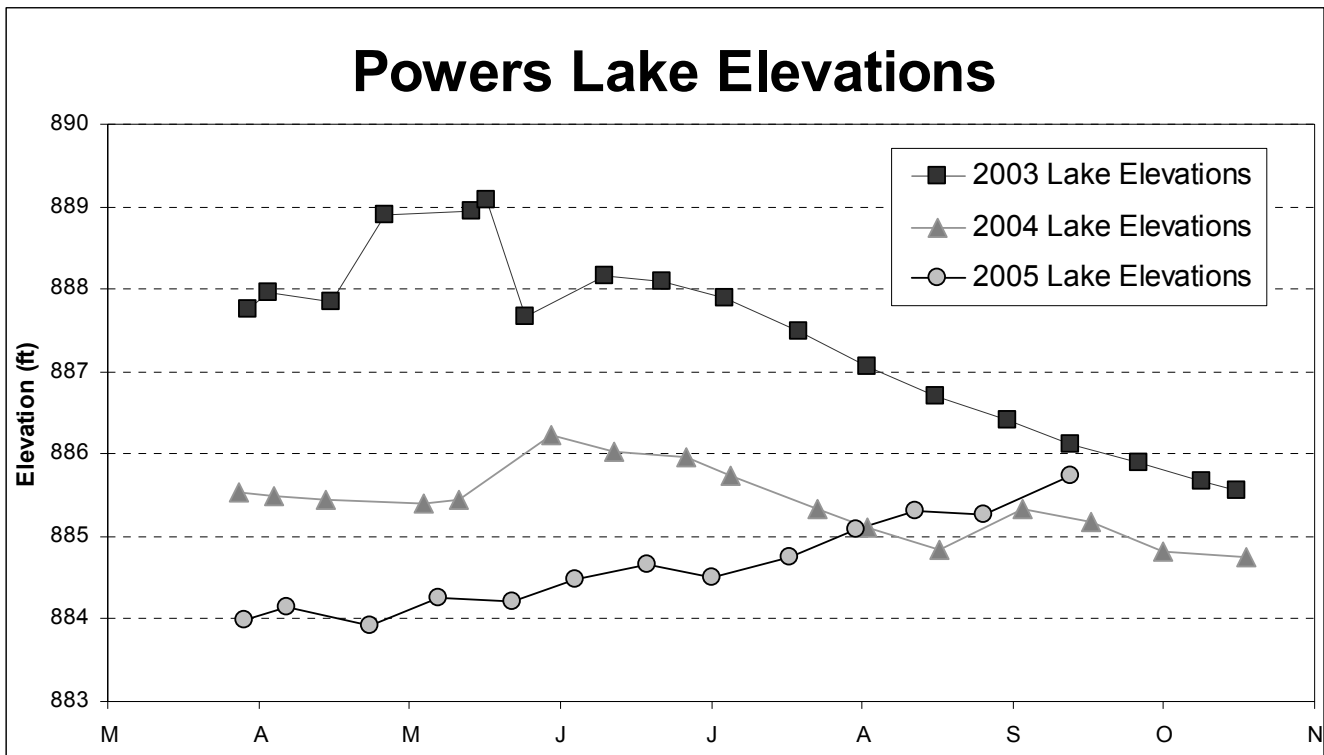


Figure 19. Powers Lake Elevations 2003-05

Table 15 gives the 2005 Powers Lake monitoring chemistry results and Secchi disk readings for the 2005 water-monitoring season.

Table 15. Powers 2005 Monitoring Results

Date & Time	Secchi (m)	Surface TP (mg/L)	Surface TKN (mg/L)	Surface CLA (ug/L)	Surface Chloride	Surface Temperature (C)	Surface Dissolved Oxygen
4/11/2005	2.1	0.053	1.1	9	24	9.8	6.73
4/22/2005	2.6	0.040	1.2	8	28	15.2	7.37
5/9/2005	3.4	0.038	0.8	7	21	15.1	7.43
5/23/2005	2.6	0.032	1.0	13	26	14.5	5.90
6/7/2005	1.2	0.038	1.3	35	18	22.9	5.69
6/20/2005	1.1	0.037	1.5	32	16	26.2	9.42
7/5/2005	1.1	0.045	1.3	47	34	23.3	8.21
7/18/2005	1.4	0.040	1.4	43	37	28.3	9.50
8/3/2005	0.8	0.047	1.7	56	20	27.5	8.23
8/17/2005	0.6	0.149	2.2	72	25	25.5	12.39
8/29/2005	0.9	0.047	1.8	39	17	24.1	5.88
9/12/2005	2.0	0.042	1.7	21	27	23.5	5.95
9/30/2005	1.7	0.028	1.2	16	13	18.5	6.30
10/13/2005	1.4	0.165	1.7	42	21	15.3	8.72
2005 Averages	1.6	0.057	1.4	31	23	20.7	7.69

Table 16 shows the Powers Lake Water Quality Summary. Powers Lake received an average lake grade of a C for 2005.

Table 16. Lake Grade and Trophic Status

	Trophic Status (2004 Average)	Lake Grade (2004 Average)	Trophic Status (2005 Average)	Lake Grade (2005 Average)
Total Phosphorus (mg/L)	Eutrophic	C	Eutrophic	C
Chlorophyll-a (ug/L)	Eutrophic	B	Hypereutrophic	C
Secchi disk (ft)	Mesotrophic	C	Eutrophic	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. The strongest correlations occurred within relationships linked to Secchi readings. A strong correlation statistical relationship was noted between Secchi and CLA ($r^2 = 0.77$). Also, a strong statistical relationship between Secchi and TKN was noted ($r^2 = 0.63$). A weak statistical relationship between Secchi and TP was noticed ($r^2 = 0.12$). There was a strong positive statistical relationship between CLA and TKN ($r^2 = 0.65$): as CLA increased TKN increased. Total phosphorous had weak positive statistical relationships between both TKN ($r^2 = 0.38$) and CLA ($r^2 = 0.30$). In both both of these instances, if TP would increase, TKN and CLA would increase. There were no statistical correlations related to Chloride ions and other parameters. These correlations are further simplified in Table 17.

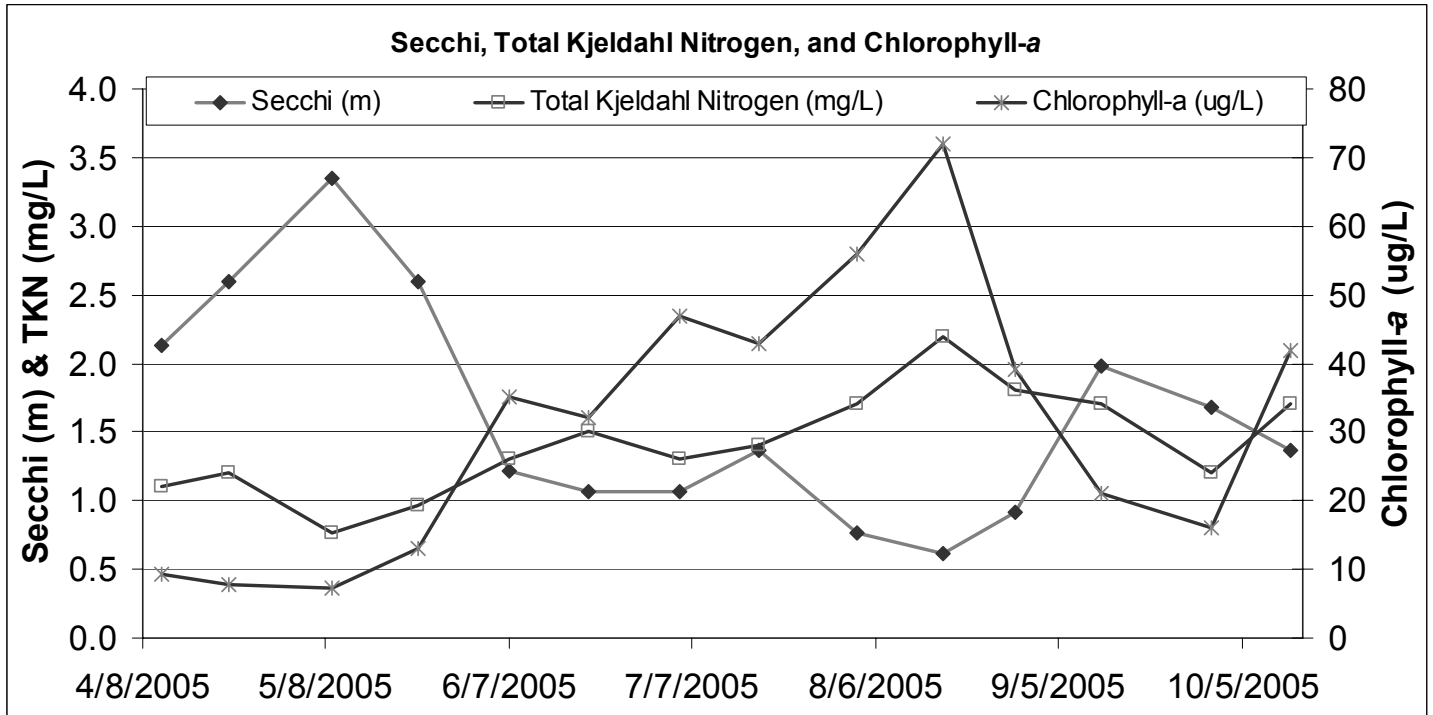


Figure 20. Secchi, Total Kjeldahl Nitrogen and Chlorophyll-a

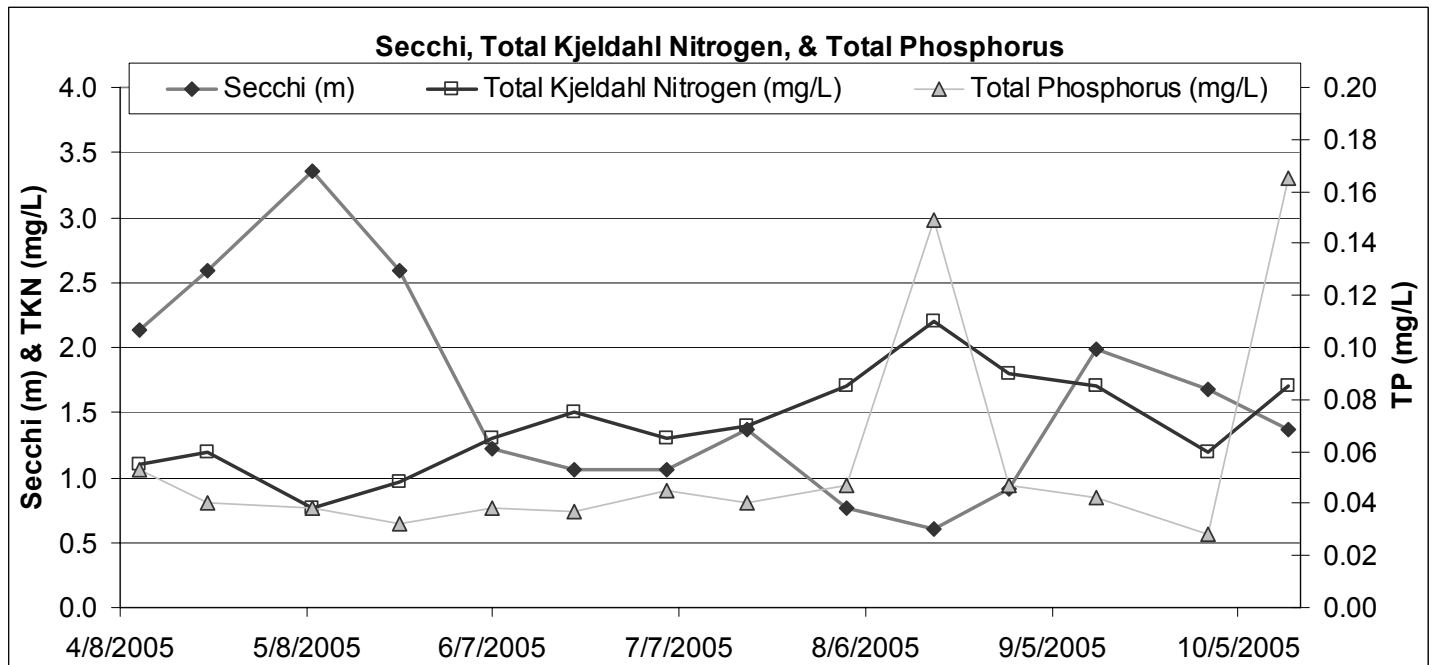


Figure 21. Secchi, Total Kjeldahl Nitrogen, and Total Phosphorus

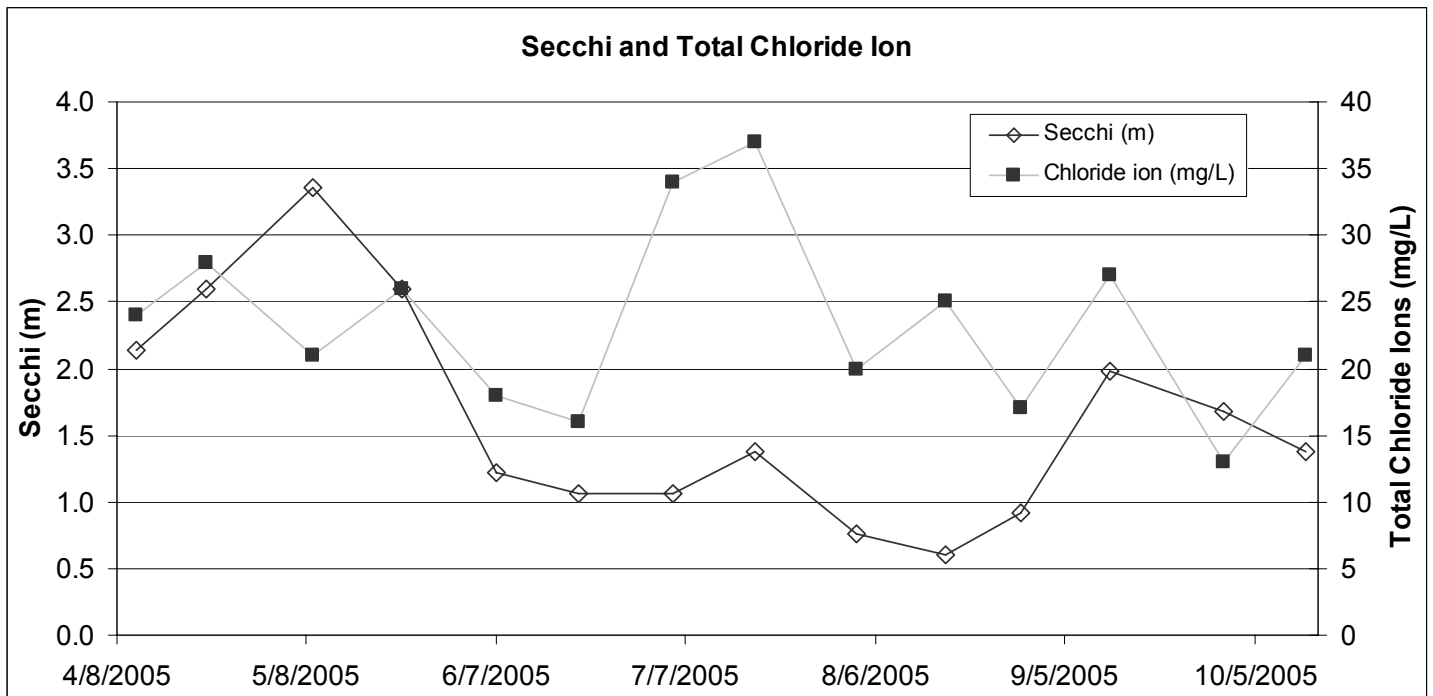


Figure 22. Secchi and Chloride ion

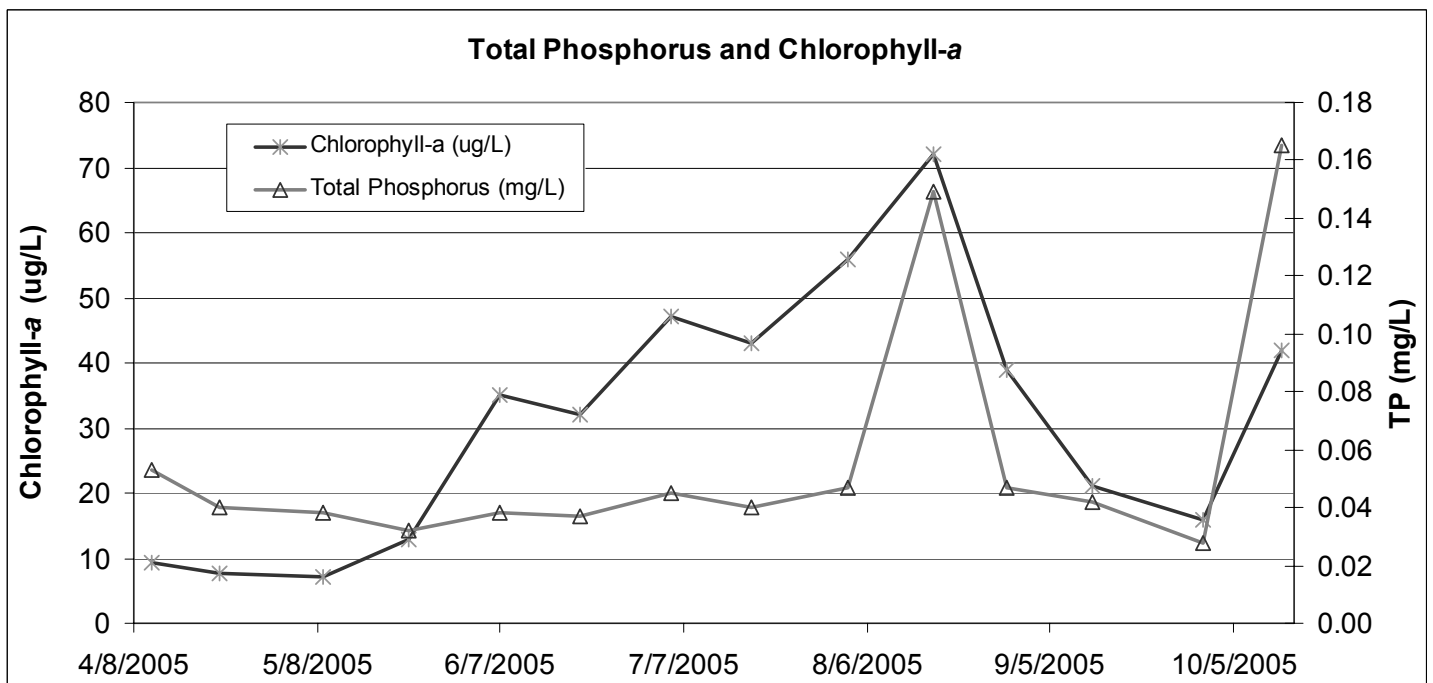


Figure 23. Total Phosphorous and Chlorophyll a



Figure 24. Total Kjeldahl Nitrogen and Chloride ion

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

Table 17. Lake Parameter Relationships

Table 18 lists the dissolved oxygen and temperature profiles in Powers Lake. The maximum depth was approximately 15 meters depending on the level of the lake at the time of sampling. A thermocline was present between 3 and 4 meters during the majority of the monitoring season. The surface dissolved oxygen and surface temperatures are shown in Figure 25.

Date	4/11/2005 0:00		4/22/2005 0:00		5/9/2005 0:00		5/23/2005 0:00		6/7/2005 0:00		6/20/2005 0:00		7/5/2005 0:00	
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)
0	6.73	9.8	7.37	15.2	7.43	15.1	5.90	14.5	5.69	22.9	9.42	26.2	8.21	23.3
1	6.68	9.8	7.57	15.2	7.26	15.0	5.76	14.5	5.41	22.8	9.58	25.9	7.44	23.3
2	6.57	9.7	7.48	15.1	7.04	14.7	5.84	14.5	5.75	22.4	8.03	24.2	8.31	23.2
3	6.35	9.6	8.09	14.0	7.09	14.4	5.78	14.4	7.33	18.4	4.42	20.8	3.02	22.3
4	6.24	9.3	7.63	10.3	7.45	12.2	5.52	14.3	5.30	15.9	5.56	16.5	0.32	20.3
5	6.16	8.5	5.87	9.3	7.78	10.0	5.28	13.3	3.47	13.7	3.27	14.0	0.19	15.4
6	4.98	7.2	4.36	8.2	6.35	9.4	3.46	11.2	2.25	12.1	0.55	12.0	0.16	12.8
7	4.56	6.6	2.26	7.1	5.52	9.0	2.00	9.3	0.33	10.1	0.53	10.8	0.16	11.5
8	2.37	5.4	1.66	6.5	2.75	7.9	0.71	8.5	0.30	9.3	0.54	10.1	0.14	10.7
9	0.95	4.7	1.33	6.3	0.88	7.1	0.32	8.0	0.31	8.6	0.56	9.6	0.15	10.3
10	0.47	4.7	0.56	6.0	0.85	6.8	0.29	7.6	0.32	8.2	0.57	9.3	0.13	10.1
11			0.19	5.7	0.86	6.4	0.28	7.4	0.32	7.8	0.58	9.1	0.13	10.0
12							0.27	7.0						
13														
14														
15														

Date	7/18/2005 0:00		8/3/2005 0:00		8/17/2005 0:00		8/29/2005 0:00		9/12/2005 0:00		9/30/2005 0:00		10/13/2005 0:00	
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)
0	9.50	28.3	8.23	27.5	12.39	25.5	5.88	24.1	5.95	23.5	6.30	18.5	8.72	15.3
1	9.65	28.3	8.53	27.5	11.98	24.9	5.87	23.9	5.61	23.6	6.00	18.4	8.23	15.3
2	9.78	28.3	7.10	26.2	10.46	24.4	5.20	23.0	5.29	23.5	5.86	18.2	7.63	15.3
3	6.06	25.2	3.47	24.6	3.22	23.7	3.54	22.6	4.65	23.1	5.54	17.8	7.66	15.2
4	1.33	20.3	0.39	22.4	0.29	22.3	2.47	22.2	2.50	22.4	5.43	17.7	5.39	15.1
5	0.80	16.3	0.43	16.8	0.32	17.7	0.40	18.7	0.41	20.6	5.57	17.7	4.68	15.0
6	0.74	13.4	0.47	13.3	0.37	14.1	0.38	13.8	0.53	14.7	5.02	17.5	4.33	14.9
7	0.71	11.4	0.47	11.5	0.39	12.3	0.37	12.4	0.51	12.8	0.65	13.5	4.55	14.9
8	0.79	10.5	0.48	10.8	0.41	11.2	0.44	11.1	0.55	11.4	0.59	11.7	3.76	14.8
9			0.48	10.4	0.42	10.5	0.43	10.6	0.54	10.8	0.59	11.1	0.56	14.3
10			0.50	10.3	0.41	10.3	0.43	10.4	0.55	10.3	0.59	10.6	0.54	13.2
11			0.50	10.1	0.41	10.2	0.43	10.2	0.55	10.2	0.59	10.5	0.53	11.5
12			0.50	9.9			0.43	10.1			0.59	10.4	0.53	11.0
13											0.58	10.4	0.52	10.7
14													0.52	10.5
15													0.52	10.3

Table 18. Dissolved Oxygen and Temperature Profiles

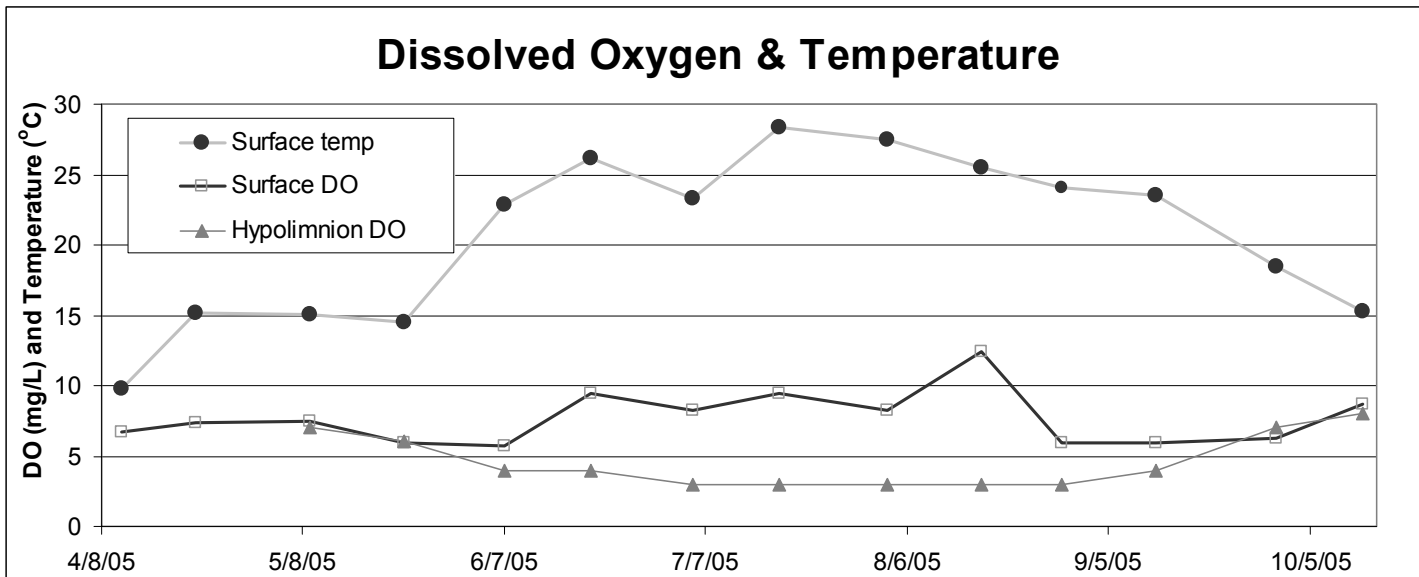


Figure 25. Surface Dissolved Oxygen and Surface Temperatures

Cottage Grove Ravine Regional Park Lake

Vital Statistics:

DNR ID #: 82-0116
 LOCATION: SW^{1/4} Section 23 T26&27N-R21W
 MUNICIPALITY: Cottage Grove Ravine Regional Park
 LAKE SIZE: 24.7 acres
 ORDINARY HIGH WATER MARK: 770.7 ft

Cottage Grove Ravine Lake was monitored from April 11 to October 13, 2005, 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 19 gives the Cottage Grove Ravine Lake 2005 high, low, and average lake levels. Individual lake level readings are shown in Figure 26.

Table 119. Cottage Grove Ravine Lake 2005 Lake Level

	High	High Date	Low	Low Date	Average
Lake Level (ft)	771.16	10/13/05	770.88	8/17/05 & 8/29/05	770.99

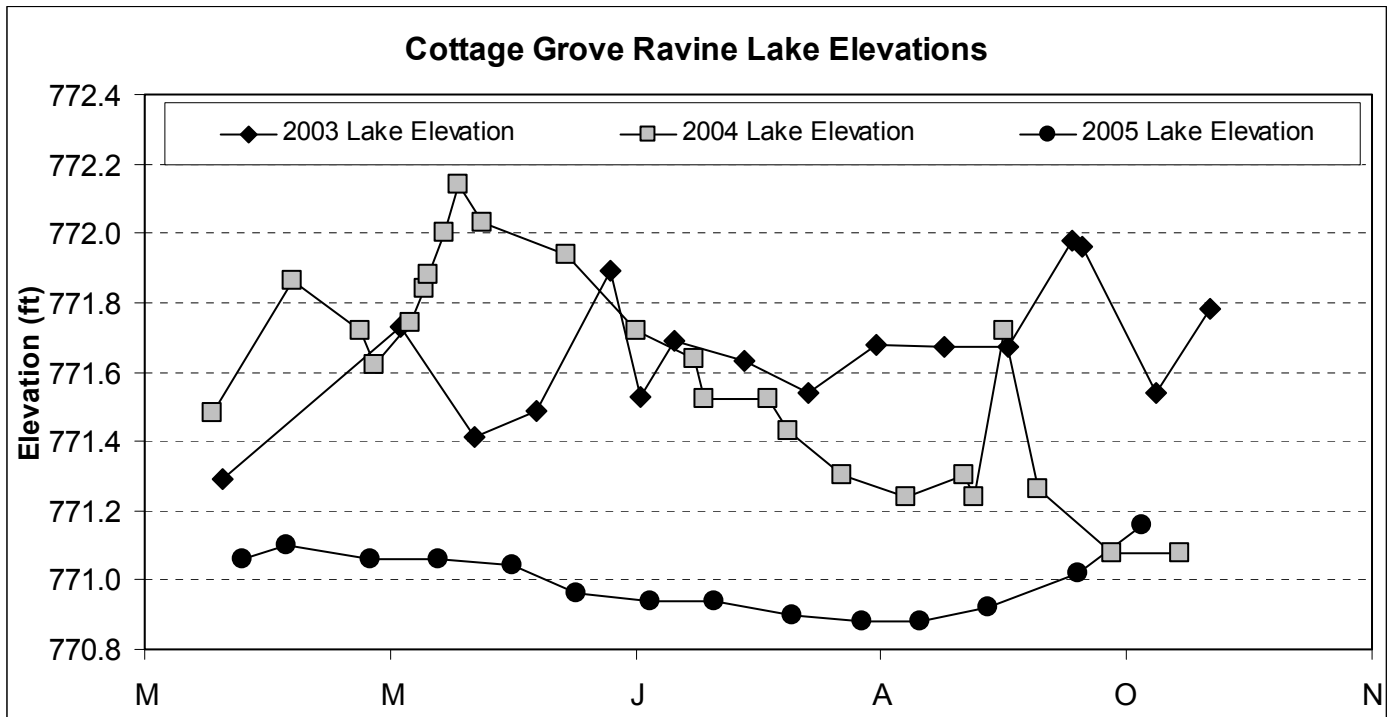


Figure 26. Cottage Grove Ravine Lake Elevations 2003-05

Table 20 gives the 2005 Cottage Grove Ravine Lake monitoring chemistry results and Secchi disk readings for the 2005 water-monitoring season.

Table 20. Cottage Grove Ravine Lake 2005 Monitoring Results

Date & Time	Secchi (m)	Surface TP (mg/L)	Surface TKN (mg/L)	Surface CLA (ug/L)	Surface Chloride	Surface Temperature (C)	Surface Dissolved Oxygen
4/11/2005	1.2	0.058	0.72	19	11	13.8	7.08
4/22/2005	1.2	0.062	0.81	19	15	15.9	6.55
5/9/2005	2.4	0.037	0.80	7	12	16.6	7.63
5/23/2005	2.4	0.041	0.84	5	12	16.5	5.89
6/7/2005	2.7	0.039	0.58	3	6	23.3	4.63
6/20/2005	1.7	0.041	0.84	26	6	24.6	11.58
7/5/2005	0.9	0.069	1.00	50	16	22.8	10.08
7/18/2005	1.1	0.082	1.20	67	18	27.0	8.23
8/3/2005	1.5	0.057	0.92	25	4	26.7	7.70
8/17/2005	1.8	0.045	0.80	31	9	23.9	8.45
8/29/2005	1.7	0.053	1.00	11	6	23.8	4.78
9/12/2005	3.0	0.046	0.98	10	9	22.3	6.01
9/30/2005	1.8	0.026	0.74	26	8	16.6	8.10
10/13/2005	1.4	0.045	0.91	6	11	14.9	6.84
2005 Averages	1.8	0.050	0.87	22	10	20.6	7.40

Table 21 shows the Cottage Grove Ravine Lake Water Quality Summary. Cottage Grove Ravine Lake received an average lake grade of a C for 2005.

Table 21. Lake Grade and Trophic Status

	Trophic Status (2005 Average)	Lake Grade (2005 Average)
Total Phosphorus (mg/L)	Eutrophic	C
Chlorophyll-a (ug/L)	Eutrophic	C
Secchi disk (ft)	Eutrophic	C
Overall	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. Correlations were linked between all parameters for the 2005 monitoring season. The strongest statistical relationships were related to TP and CLA. The strongest positive correlation was between TP and CLA ($r^2= 0.49$): as TP concentrations increased, so did CLA concentrations. Other strong positive correlations include; TKN to TP ($r^2= 0.46$), TKN to CLA ($r^2= 0.36$), TP to Chloride Ion ($r^2= 0.36$), and CLA to Chloride ($r^2= 0.27$). In all of these instances, if one concentration would increase, so would the other. Secchi readings had weak negative correlations with all parameters. As before both TP and CLA had the strongest correlation with Secchi ($r^2= 0.43$) and ($r^2= 0.42$), respectively. Chloride had a weak negative correlation with Secchi ($r^2= 0.18$). Chloride had another weak positive statistical relationship with TKN ($r^2= 0.18$). These relationships can be viewed easily by looking at Table 22.

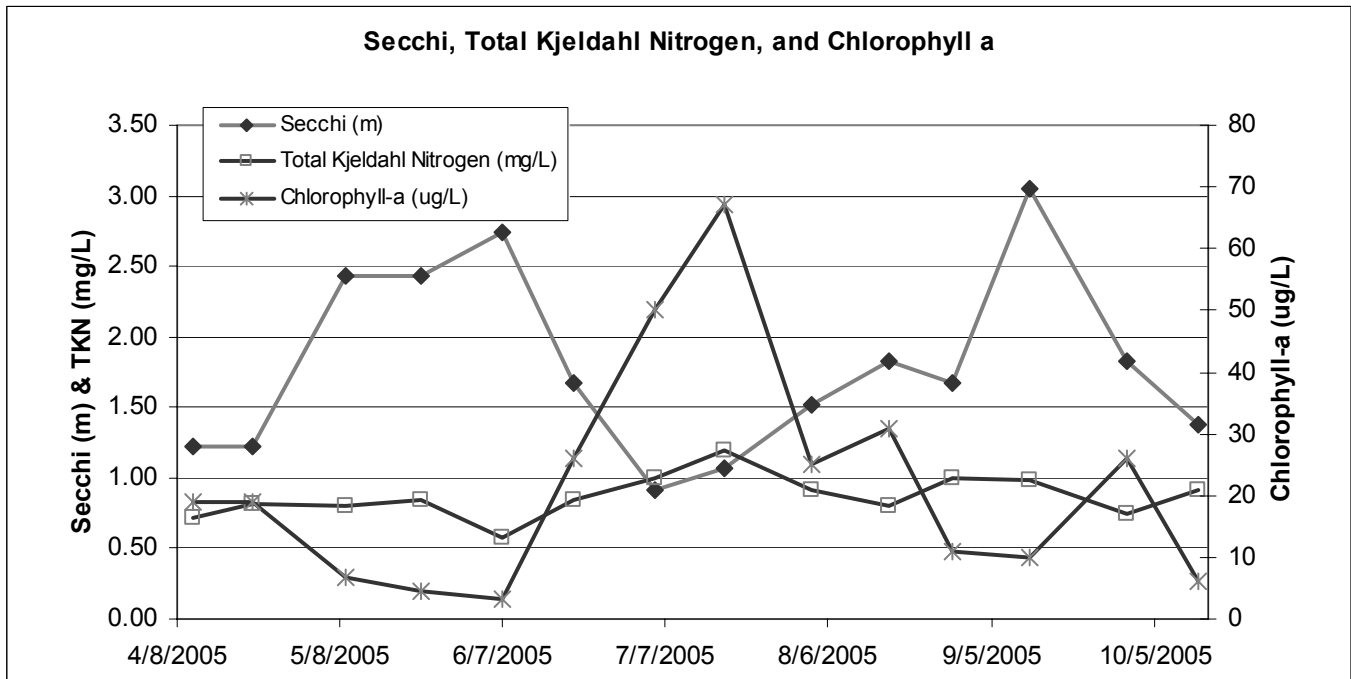


Figure 27. Secchi, Total Kjeldahl Nitrogen and Chlorophyll-a

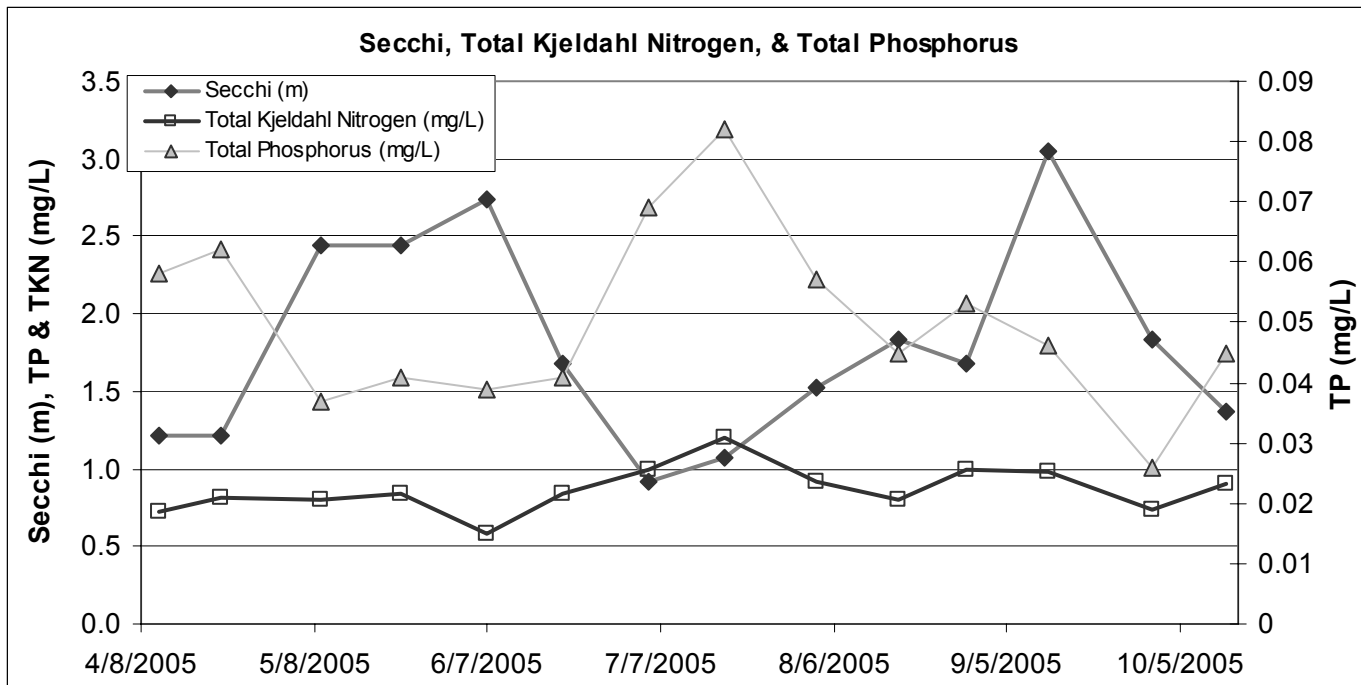


Figure 28. Secchi, Total Kjeldahl Nitrogen, and Total Phosphorus

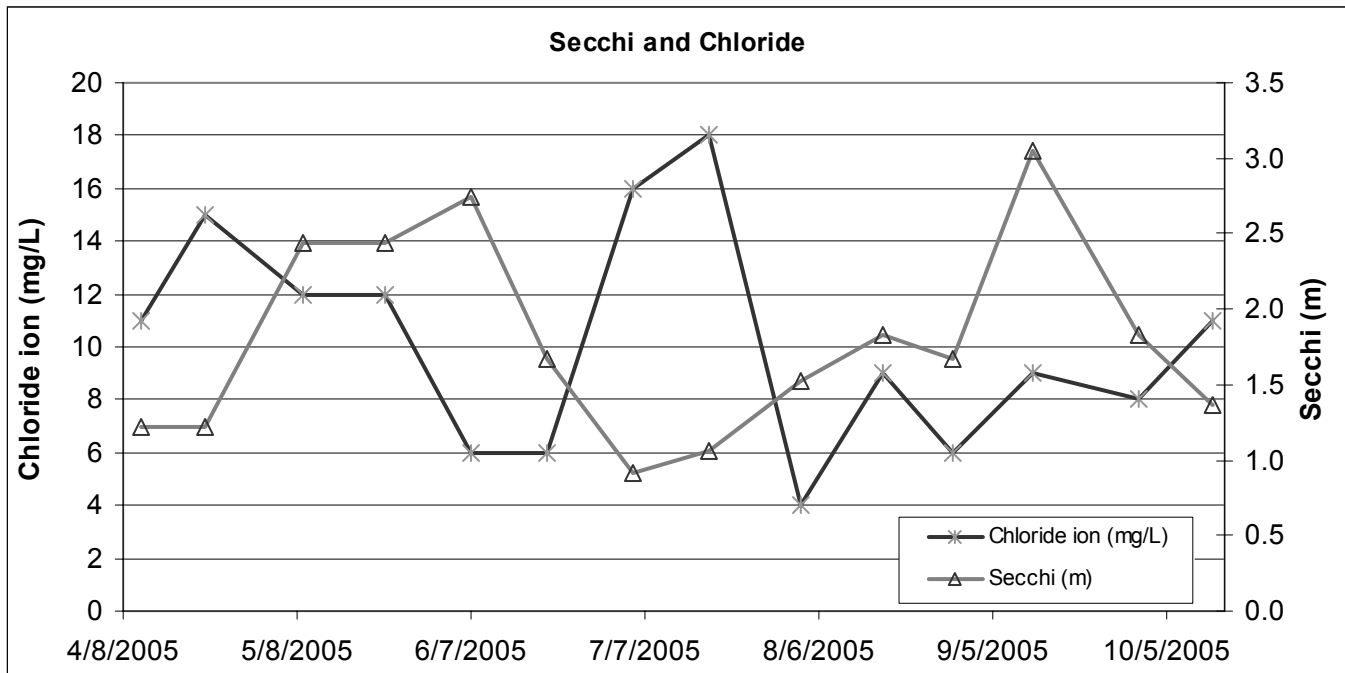


Figure 29. Secchi and Chloride ion

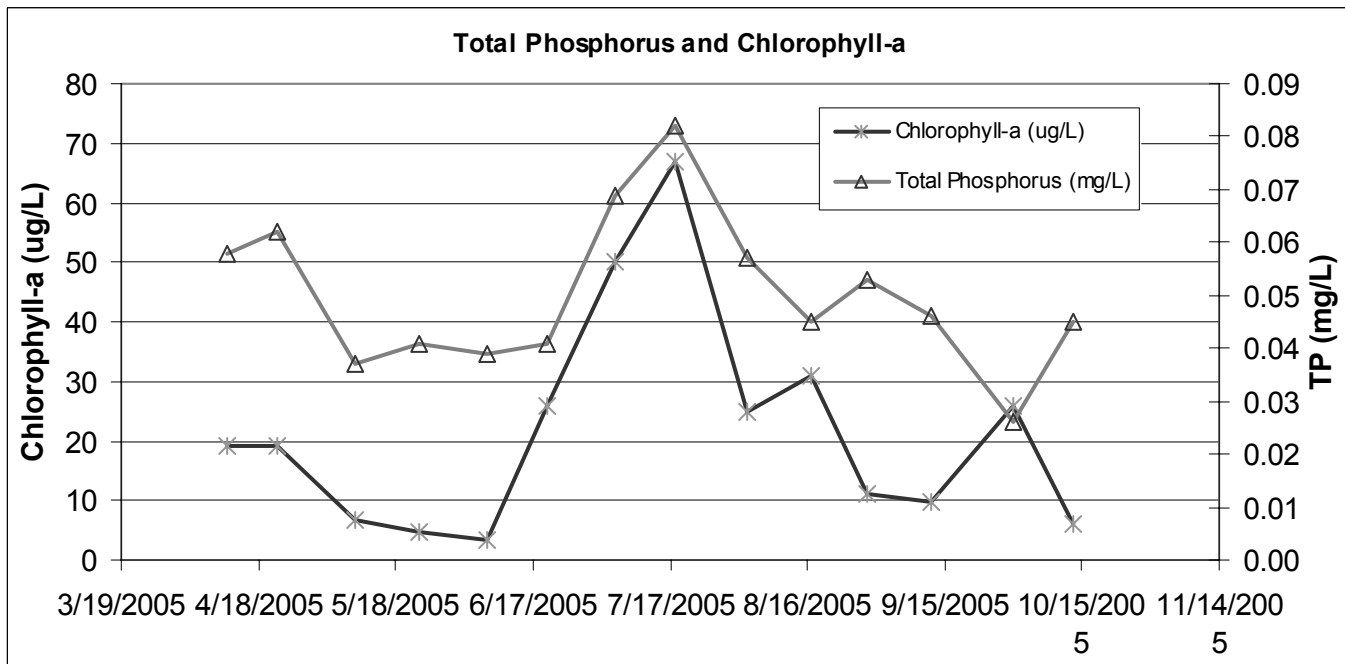


Figure 30. Total Phosphorous and Chlorophyll a

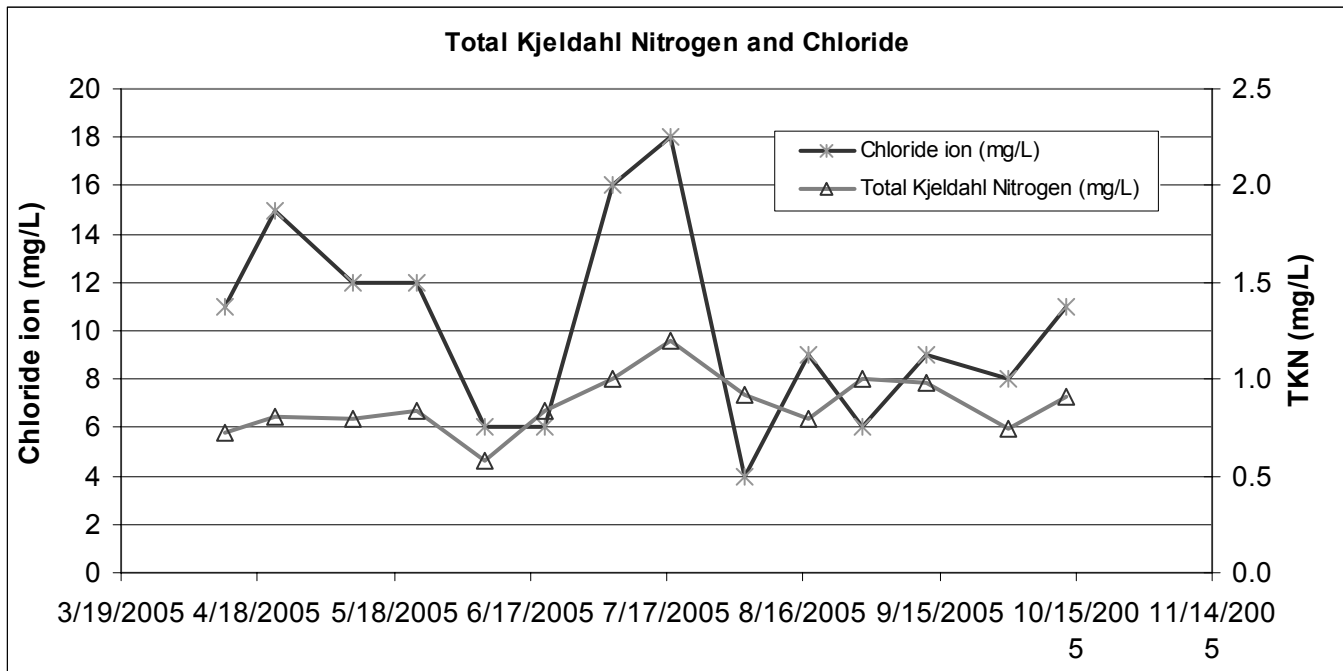


Figure 31. Total Kjeldahl Nitrogen and Chloride ion

Table 22. Lake Parameter Relationships

	Secchi	TKN	TP	CLA	Chloride
Secchi		-	-	-	-
TKN			+	+	+
TP				+	+
CLA					+
Chloride					

Table 23 lists the dissolved oxygen and temperature profiles for Cottage Grove Ravine Lake. The maximum depth was 5 meters. A thermocline was present between 3 and 4 meters in the lake. The surface dissolved oxygen and surface temperatures are shown in Figure 32.

Table 23. Dissolved Oxygen and Temperature Profiles

Date	4/11/2005 0:00		4/22/2005 0:00		5/9/2005 0:00		5/23/2005 0:00		6/7/2005 0:00		6/20/2005 0:00		7/5/2005 0:00	
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)
0	7.08	13.8	6.55	15.9	7.63	16.6	5.89	16.5	4.63	23.3	11.58	24.6	10.08	22.8
1	6.70	13.8	6.87	15.9	7.34	16.5	5.34	16.5	4.63	23.1	11.13	24.5	9.43	22.8
2	6.40	13.8	6.95	15.9	7.39	16.5	5.65	16.5	3.34	21.1	7.33	22.8	1.60	22.1
3	4.47	11.4	6.88	15.9	7.05	13.4	4.37	14.5	4.15	18.8	7.26	21.0	0.45	21.1
4	1.20	6.0	0.20	8.0	4.45	8.9	0.86	11.5	0.88	14.6	0.93	16.9	0.25	18.4
5			0.16	7.4	1.59	8.0	0.27	9.3	0.27	11.6	0.50	13.4	0.28	15.0

Date	7/18/2005 0:00		8/3/2005 0:00		8/17/2005 0:00		8/29/2005 0:00		9/12/2005 0:00		9/30/2005 0:00		10/13/2005 0:00	
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)
0	8.23	27.0	7.70	26.7	8.45	23.9	4.78	23.8	6.01	22.3	8.10	16.6	6.84	14.9
1	8.34	27.0	7.60	26.6	8.34	23.8	4.84	23.7	5.96	22.2	7.60	16.6	6.24	14.6
2	5.10	24.2	1.14	23.8	4.60	22.5	4.23	23.6	2.16	20.9	7.78	16.5	4.84	13.5
3	0.35	22.7	0.55	22.7	3.53	22.0	3.87	22.1	0.60	20.1	6.84	15.7	3.38	13.1
4	0.14	18.4	0.56	19.2	0.33	19.7	0.90	18.8	0.53	19.5	6.21	15.4	3.37	12.9
5	0.13	15.0	0.61	15.4	0.31	15.9	0.36	16.7	0.57	17.7	6.00	15.1	2.87	12.9

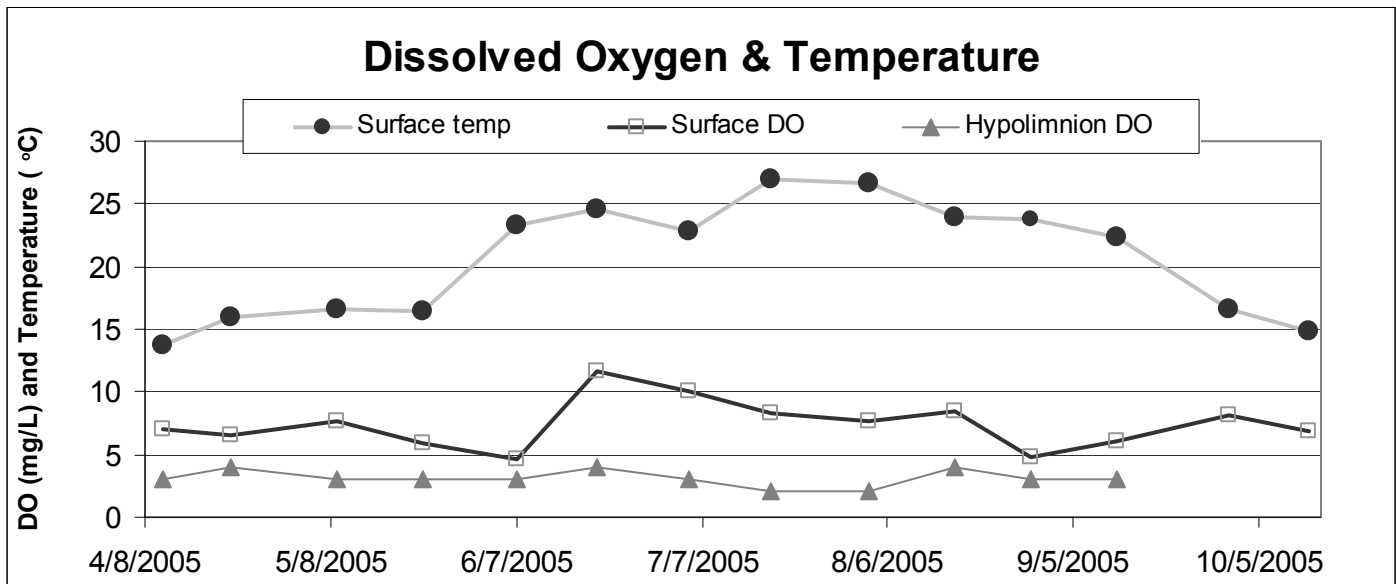


Figure 32. Surface Dissolved Oxygen and Surface Temperatures

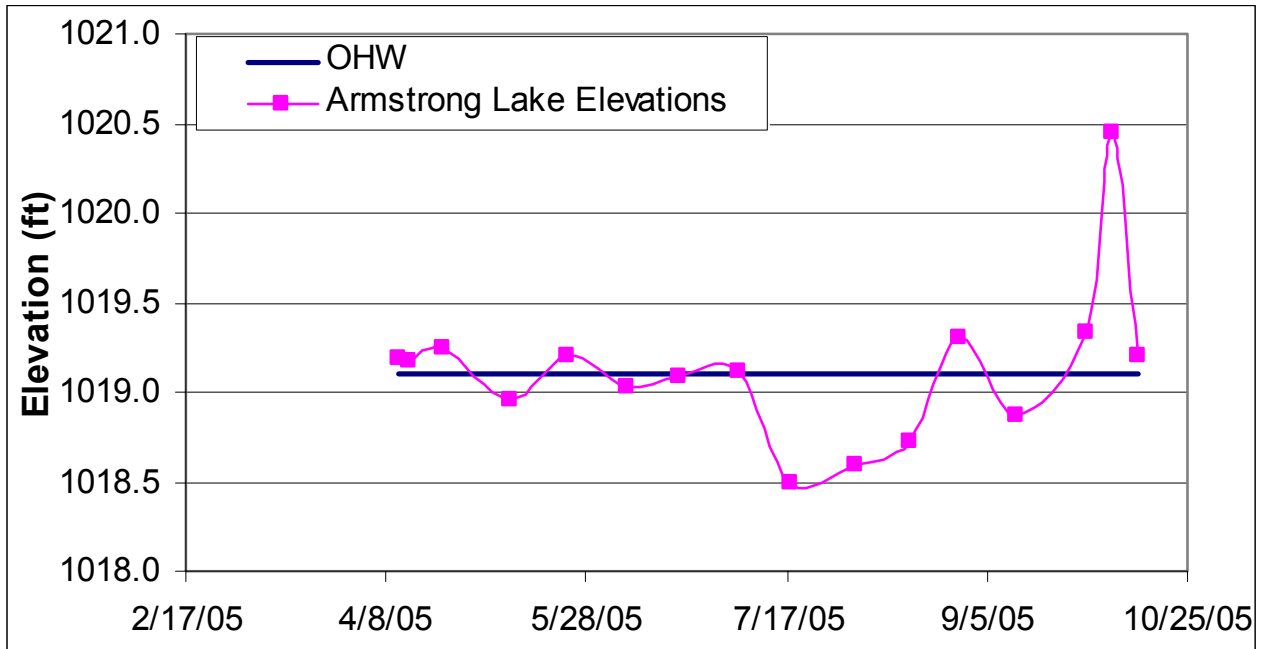
Lake Gages

Lake gages were read biweekly on twelve lakes in SWWD from April 11-October 31, 2005. Table 19 lists the high, low, range and average elevations for each lake monitored in 2005. Figure 26a-26l shows the fluctuation in elevation for each lake monitored in 2005.

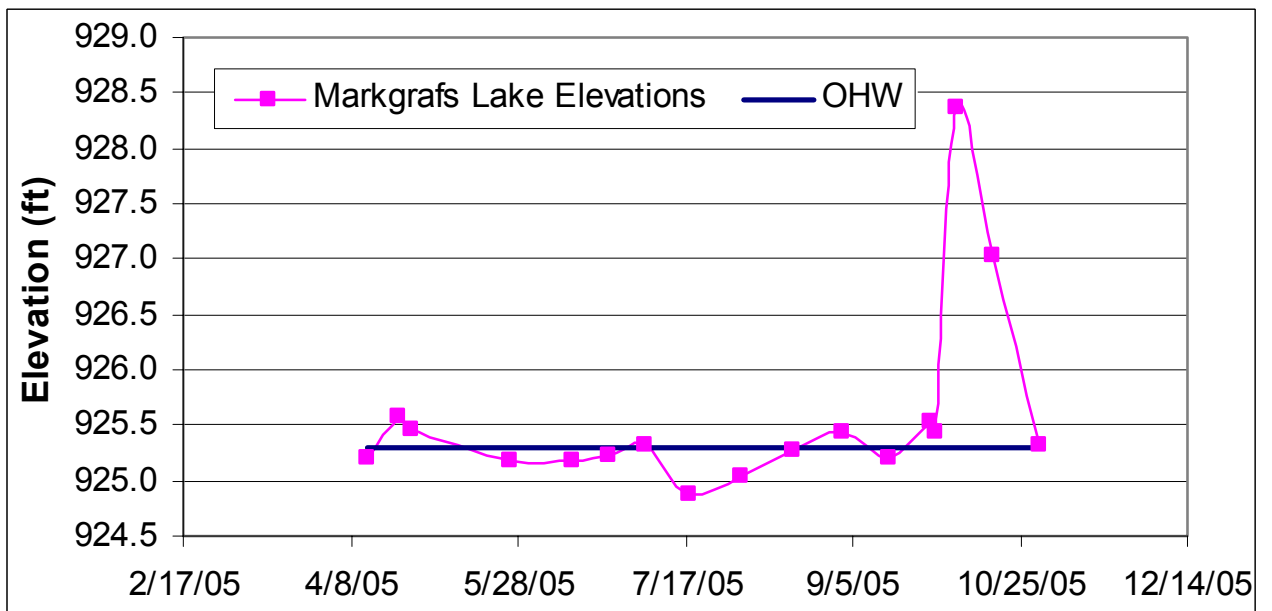
Lake Name	DNR ID#	Dates Monitored	# Readings	Lowest Reading (ft) Date	Highest Reading (ft) Date	Range (ft)	Average Elevation (ft)	OHW (ft)
Cottage Grove Ravine Park	82-0087	4/13/05-10/13/05	14	770.88	771.16	0.28	770.99	770.70
				8/17/05 and 8/29/05	10/13/2005			
Markgrafs	82-0089	4/13/05-10/31/05	17	924.87	928.36	3.49	925.57	925.30
				7/18/2005	10/6/2005			
Wilmes	82-0090	4/13/05 10/31/05	14	902.3	903.75	1.45	903.15	902.60
				7/20/2005	9/28/2005			
Powers	82-0092	4/13/05-9/30/05	13	883.91	885.74	1.83	884.64	891.30
				5/9/2005	9/30/2005			
Colby	82-0094	4/13/05-10/17/05	14	890.33	894.06	3.73	890.88	891.80
				7/20/2005	10/6/2005			
Bailey	82-0456	4/26/05-10/31/05	7	865.76	869.5	3.74	866.34	NA
				5/9/2005	10/31/2005			
Armstrong	82-0116-02	4/11/05-10/13/05	16	1018.49	1020.45	1.96	1019.12	1019.10
				7/18/2005	10/6/2005			
Vandeberg	82-0084	4/13/05-10/17/05	13	839.22	841.23	2.01	840.21	NA
				9/16/2005	4/13/2005			
Fish	82-0093	4/13/05-10/17/05	11	912.78	913.39	0.61	913.08	916.40
				7/20/2005	8/18/2005			
Ria Lake	82-0098	4/14/05-10/17/05	13	949.34	950.98	1.64	949.9	NA
				9/16/2005	10/17/2005			
La Lake	82-0097	4/14/05-10/17/05	13	998.65	999.41	0.76	998.98	1000.60
				9/2/05 and 9/16/05	10/17/2005			
Shepard's Pond	82-0083	4/13/05-10/17/05	14	919.92	922.00	2.08	920.9	NA
				9/16/2005	4/13/2005			

Table 20. SWWD 2005 Lake Gage Readings

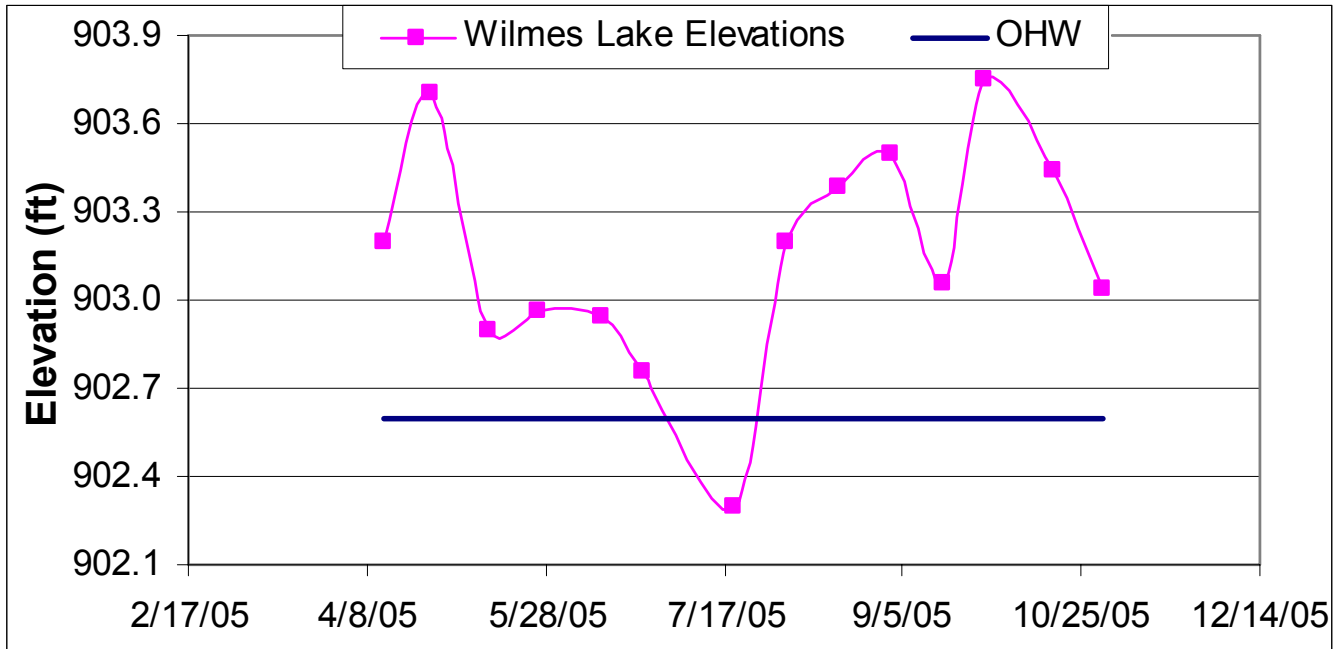
Figure 26a-26l. SWWD 2005 Lake Elevations



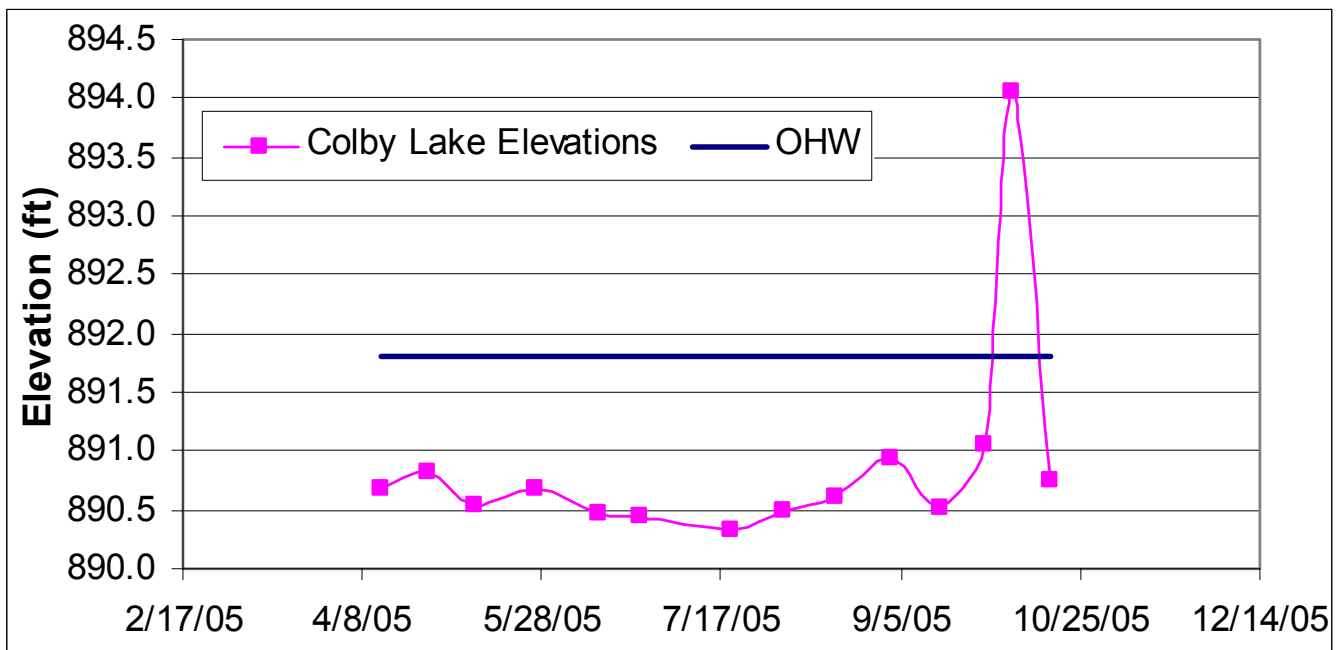
26a. Armstrong Lake Elevations and Ordinary High Water (OHW)



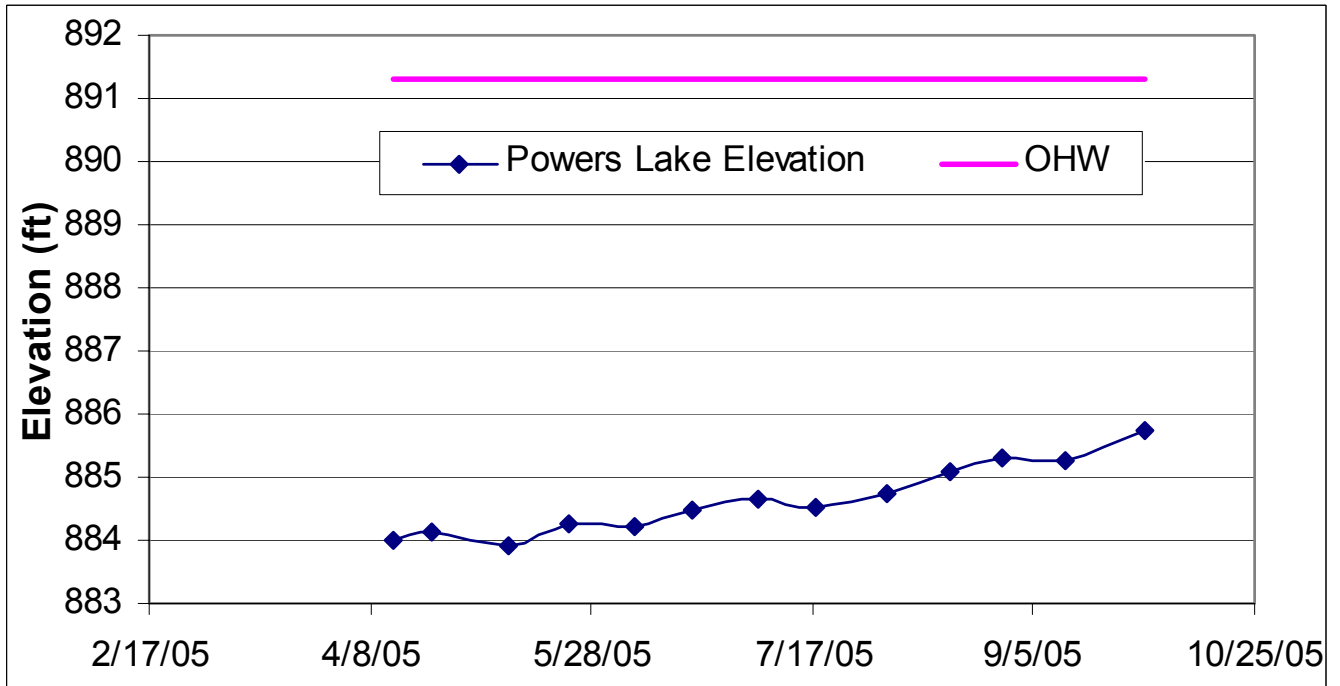
26b. Markgrafs Lake Elevations and Ordinary High Water (OHW)



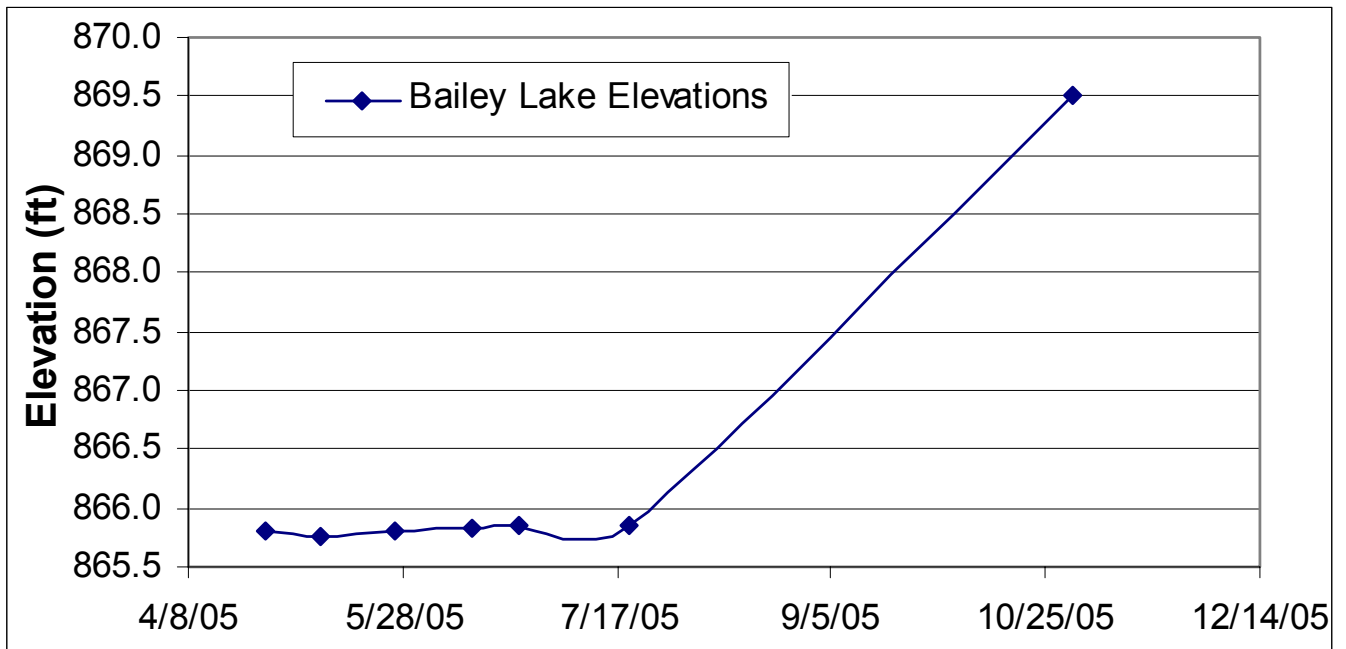
26c. Wilmes Lake Elevations and Ordinary High Water (OHW)



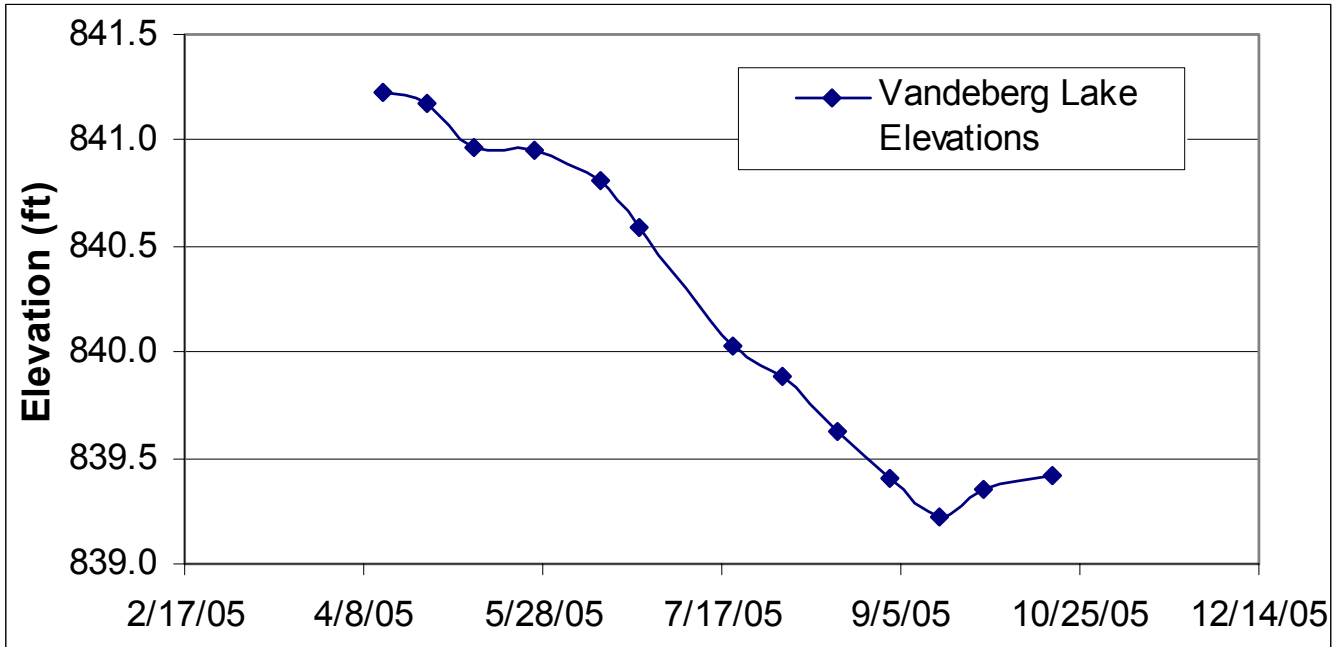
26d. Colby Lake Elevations and Ordinary High Water (OHW)



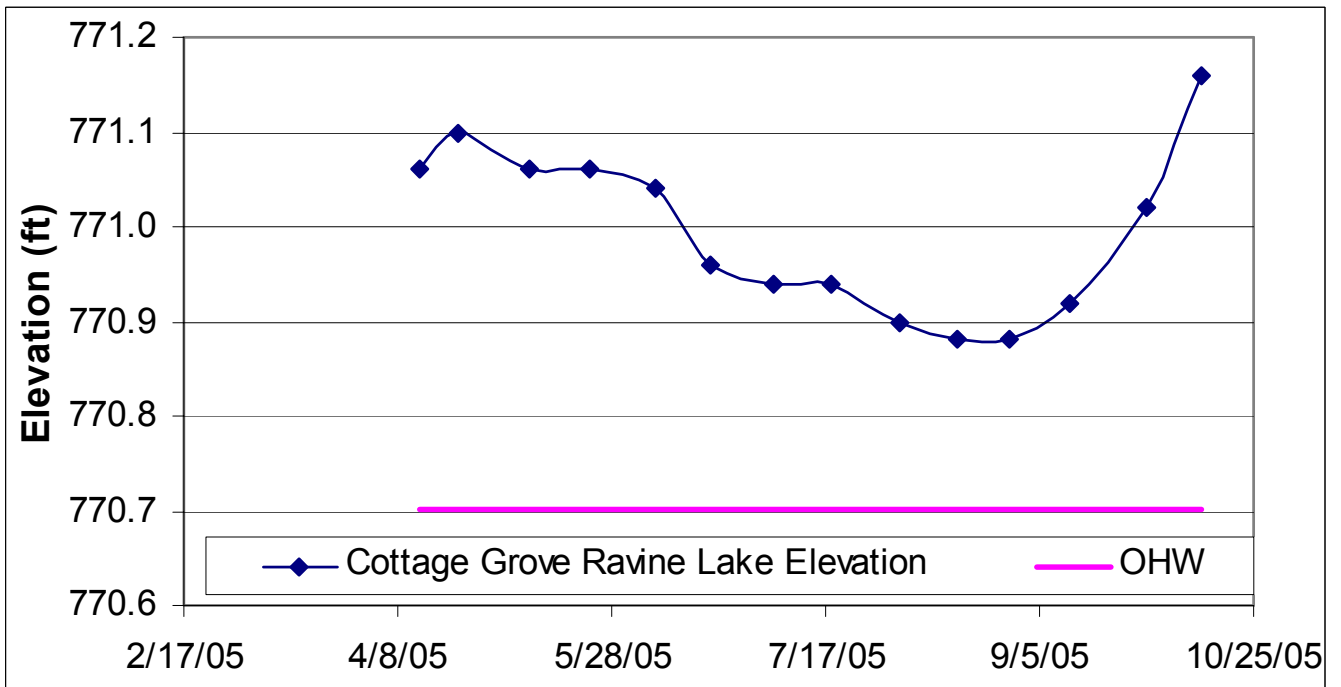
26e. Powers Lake Elevations and Ordinary High Water (OHW)



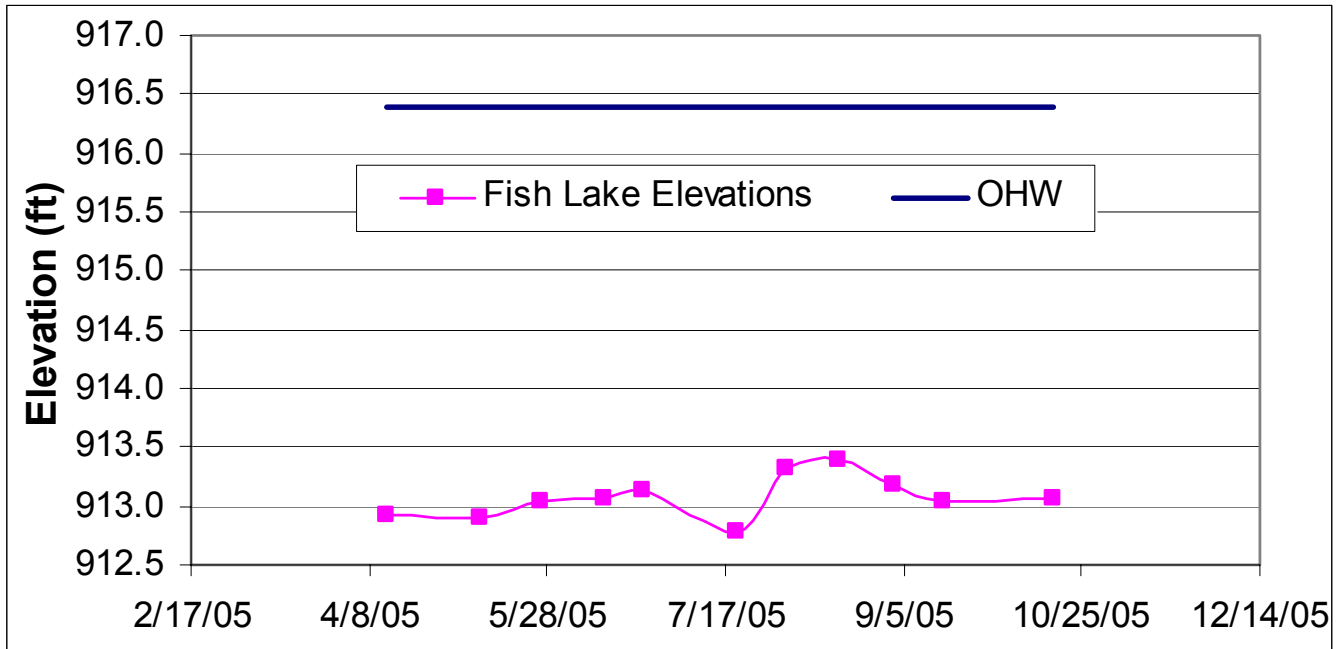
26f. Bailey Lake Elevations



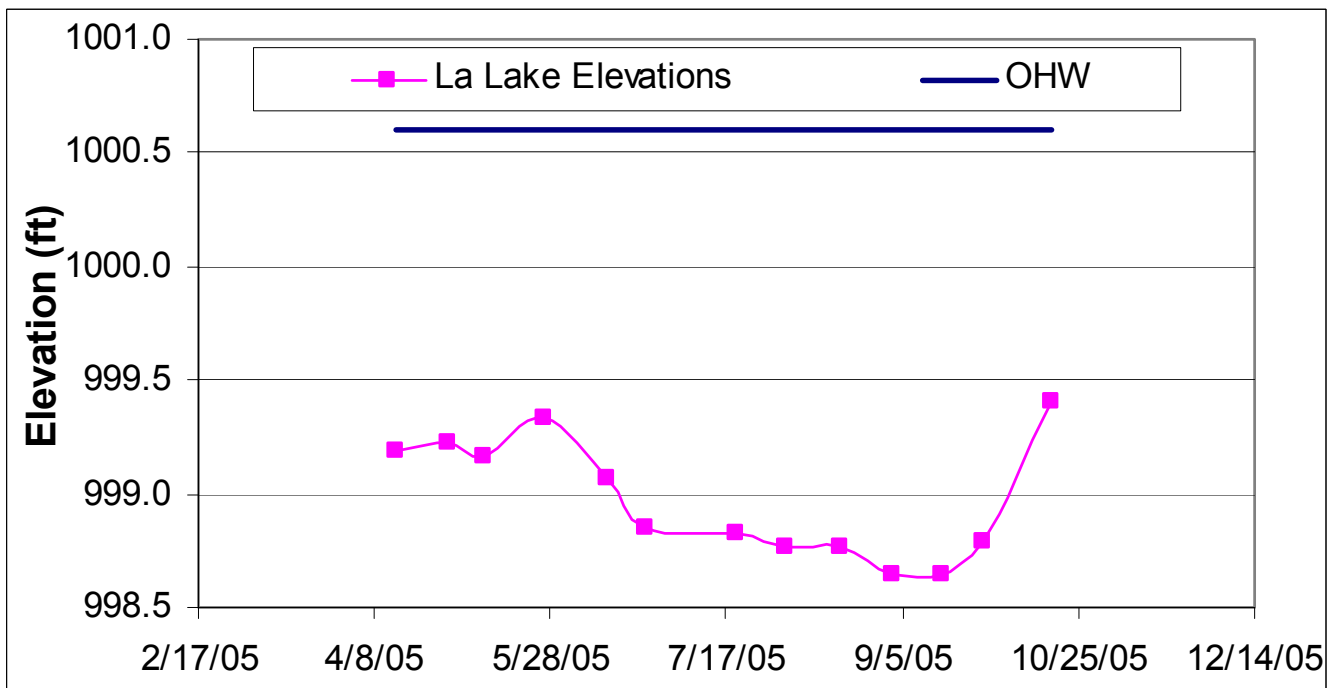
26g. Vandenberg Lake Elevations



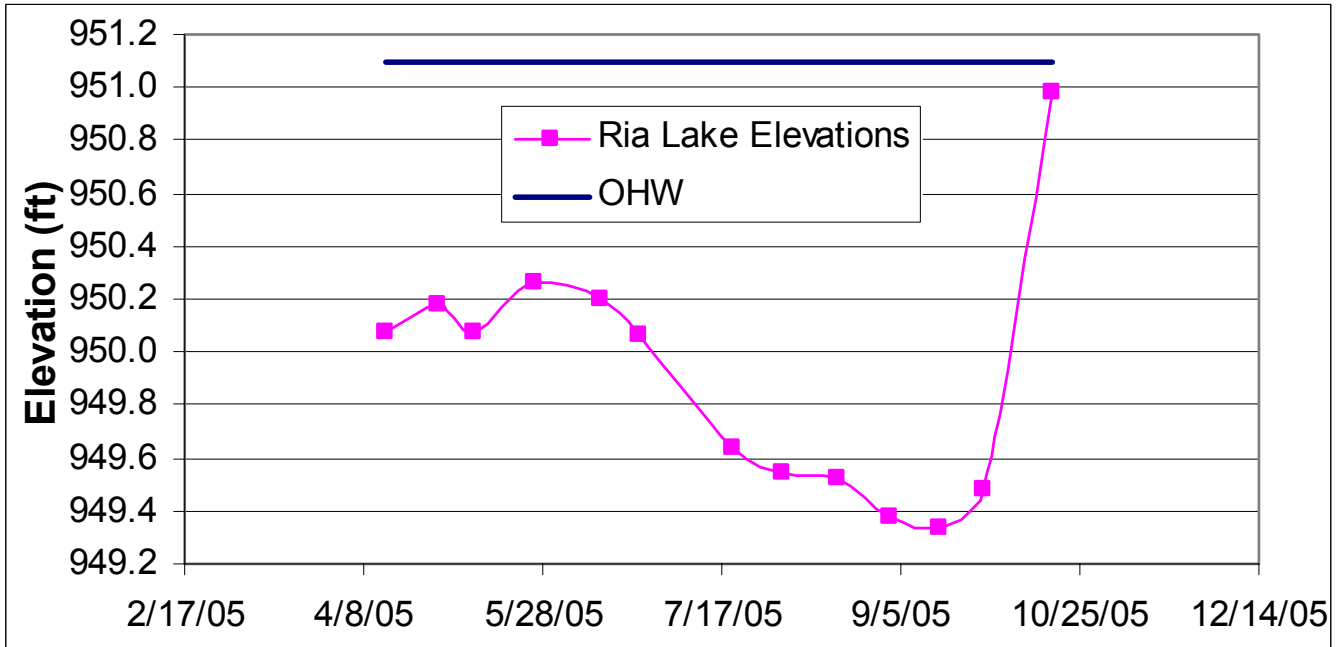
26h. Cottage Grove Ravine Park Lake Elevations and Ordinary High Water (OHW)



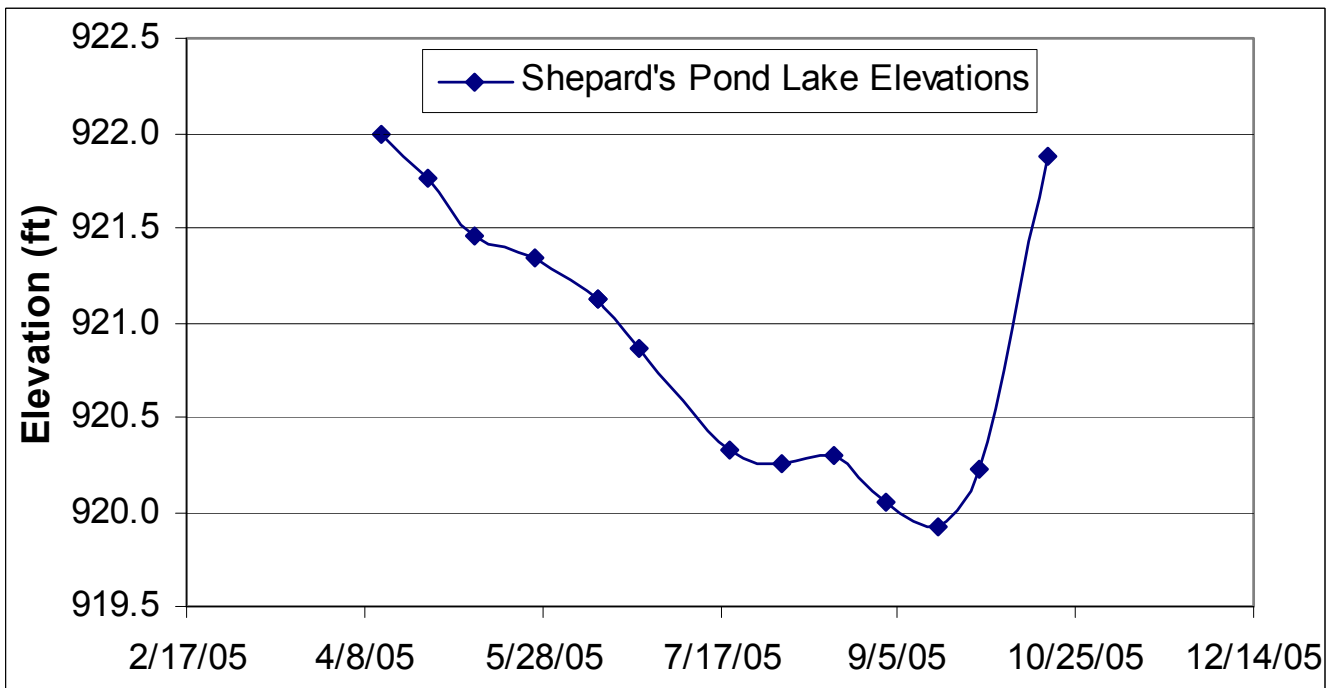
26i. Fish Lake Elevations and Ordinary High Water (OHW)



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



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



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

Observation Wells

The Washington Conservation District from January 6, 2005-December 21, 2005, monitored seven observation wells. Table 21 shows the high, low, range and average groundwater observations during the 2005 monitoring season. Figure 27 shows the fluctuation of the groundwater elevations for each well during the 2005 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 September and October 2005. Well 616498 was removed during a construction project and was unable to be read for the remainder of the year. Well 616493 lacked in readings due to a datalogger inhibiting the measurement of the water elevation for a portion of the year. Well 616494 lacked in readings due to this well drying up from April through September.

Well #	Dates Monitored	# Readings	Monitoring Point Elevation (ft)	Lowest Reading (ft) Date	Highest Reading (ft) Date	Range (ft)	Average Elevation (ft)
545602	1-6-05 to 12-21-05	11	889.25	817.61 10-26-05	820.73 1-6-05	3.12	818.90
545603	1-6-05 to 12-21-05	11	909.15	846.90 9-20-05	862.12 11-30-05	15.22	852.26
545604	1-6-05 to 12-21-05	11	906.70	860.99 9-20-05	873.17 10-26-05	12.18	865.57
616493	1-6-05 to 12-21-05	4	916.75	836.23 9-20-05	840.40 1-6-05	4.17	837.74
616494	1-6-05 to 12-21-05	6	916.95	839.86 3-9-05	849.99 10-26-05	10.13	844.16
616497	1-6-05 to 12-21-05	11	913.53	862.11 6-30-05	883.46 10-26-05	21.35	864.44
616498	1/6/2005	1	920.24	NA	NA	NA	NA

Table 21. SWWD 2005 Observation Well Elevations

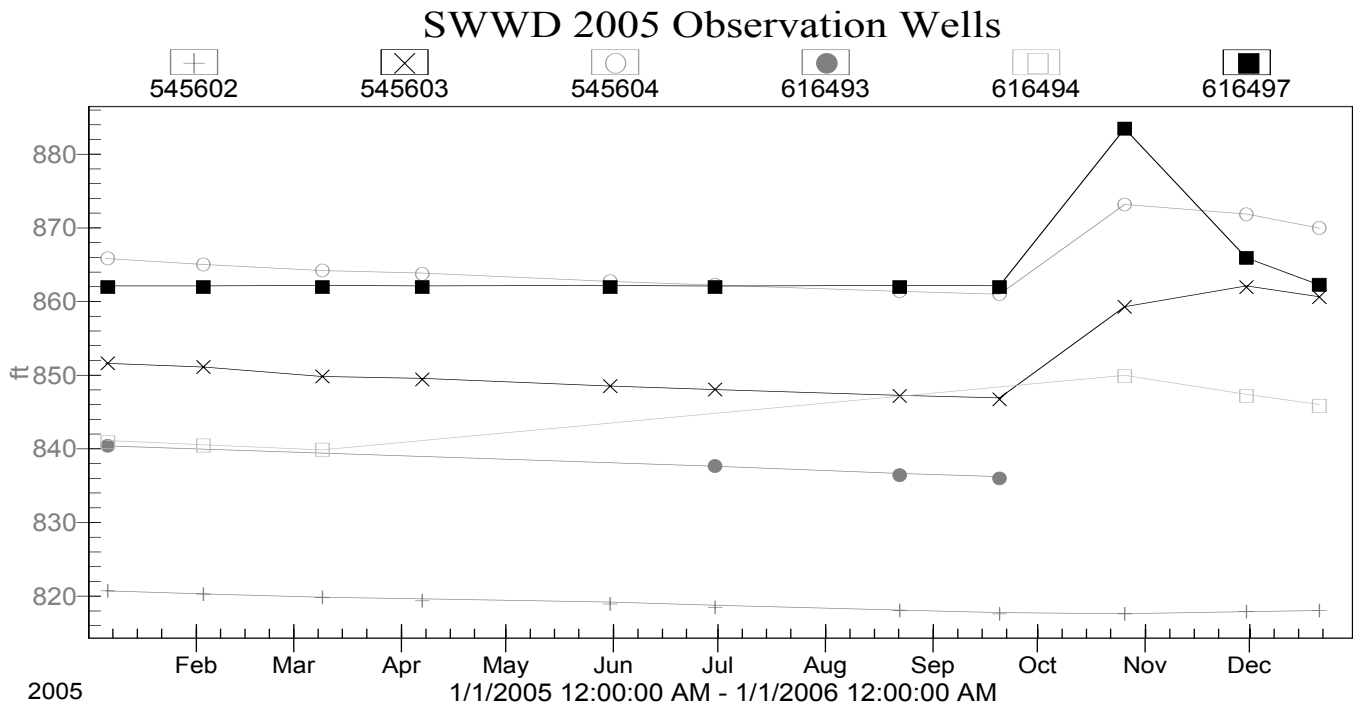


Figure 27. SWWD 2005 Observation Well Elevations