Skagit County Monitoring Program

Annual Report

2004 Water Year (October 2003 – September 2004)

East Fork Nookachamps Creek

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December 2004

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Annual Report
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This report is available online at www.skagitcounty.net/SCMP

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Skagit County Monitoring Program Annual Report

2004 Water Year (October 2003-September 2004)

December 30, 2004

Introduction

The Skagit County Monitoring Program was instituted in October, 2003, as part of Skagit County's program to assess the effectiveness of Skagit County Code Chapter 14.24.120, Critical Areas Ordinance for Areas of Ongoing Agriculture. The revised ordinance was passed by the Skagit County Board of Commissioners in June, 2003 in response to a Compliance Order from the Western Washington Growth Hearings Board.

The ordinance requires farmers to "do no harm" to adjacent watercourses, and relies on specific Watercourse Protection Measures and more generalized Best Management Practices to protect the watercourses instead of requiring buffers on the streams. The associated Skagit County Resolution R20030210 committed the County to conduct water quality sampling in the agricultural areas as one method of assessing if the County's ordinance was sufficient to protect the aquatic resources in agricultural areas. The resolution was subsequently amended in June, 2004 as Resolution R20040211 in response to additional Compliance Orders from the Western Washington Growth Hearings Board. This second resolution provided details about the water quality monitoring program in addition to other topics not associated with water quality.

The monitoring program was designed to determine current conditions and long-term trends in water quality in the watercourses being monitored. It was not specifically designed to determine compliance of the watercourses with state water quality standards.

Figure 1 is a map with the sampling sites in the Skagit County Monitoring Program marked. Tables 1 and 2 list the sampling sites and site descriptions for the Skagit County Monitoring Program. Forty sites are currently included in the Program. These sites are located primarily in the agricultural zones (Agriculture-Natural Resource and Rural Resource). Other sites are located to provide context to, and comparisons with, the sites in the agricultural zones. These include sites located just upstream or downstream of agricultural areas or in streams draining suburban watersheds.

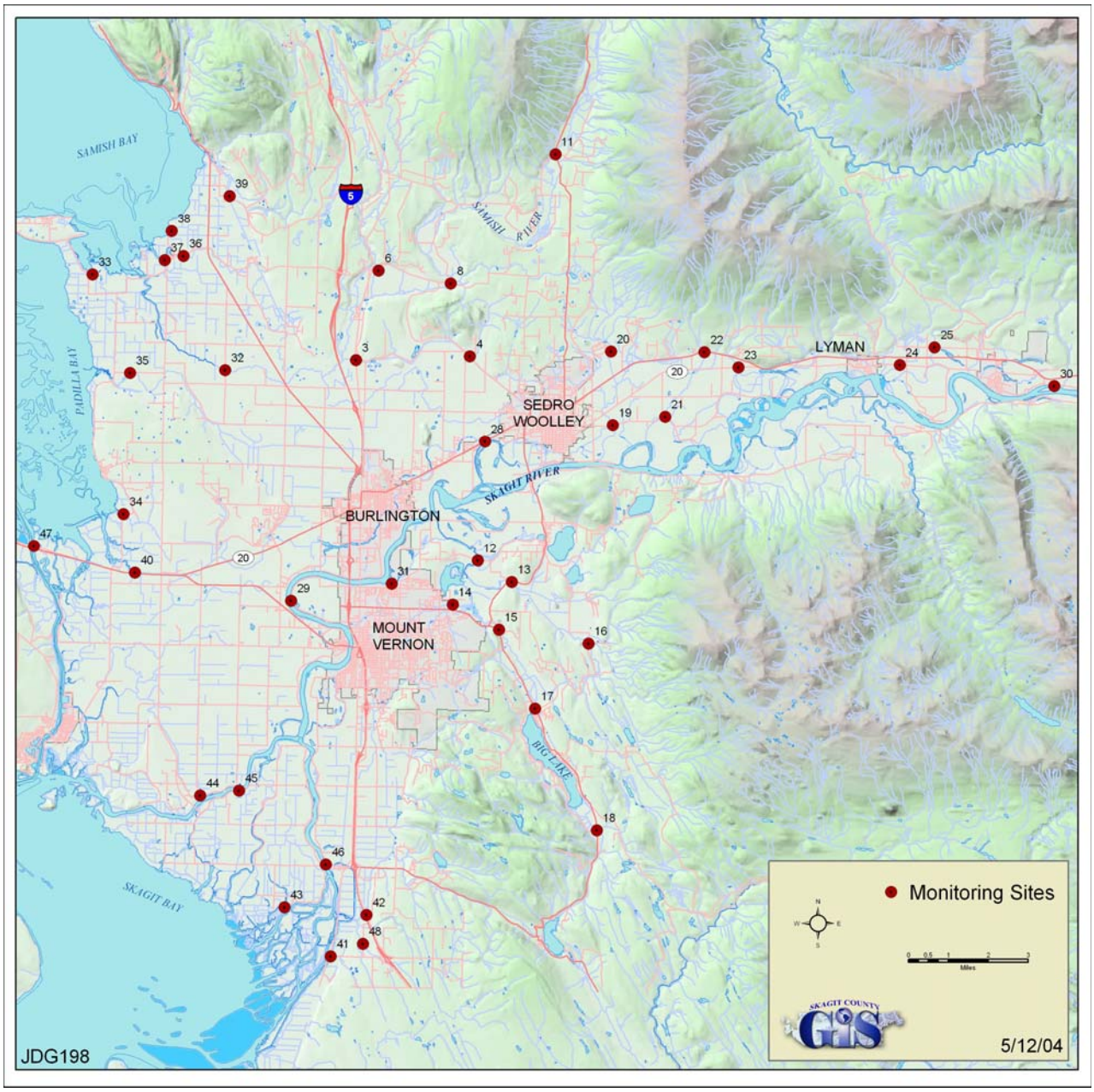


Figure 1. Sample sites in the Skagit County Monitoring Program. Refer to Tables 1 and 2 for site locations and descriptions.

Table 1. Sample sites for Skagit County Monitoring Program.

Site Number	Watercourse	Location	Latitude	Longitude	Site Type[1]
3	Thomas Ck	Old Hwy 99 N	48.526	-122.339	1
4	Thomas Ck	F&S Grade	48.528	-122.276	2
6	Friday Ck	Prairie Rd	48.559	-122.327	4
8	Swede Ck	Grip Rd	48.555	-122.287	3
11	Samish R	State Route 9	48.602	-122.231	1
12	Nookachamps Ck	Swan Rd	48.454	-122.270	3,6
13	E.F. Nookachamps Ck	State Route 9	48.446	-122.251	3,6
14	College Way Ck	College Way	48.436	-122.286	4
15	Nookachamps Ck	Knapp	48.429	-122.258	2,6
16	E.F. Nookachamps Ck	Beaver Lake Rd	48.424	-122.208	1,6
17	Nookachamps Ck	Big Lake Outlet	48.400	-122.237	1,6
18	Lake Ck	State Route 9	48.356	-122.202	1,6
19	Hansen Ck	Hoehn Rd	48.504	-122.197	3,6
20	Hansen Ck	Northern State	48.531	-122.199	1,6
21	Coal Ck	Hoehn Rd	48.507	-122.169	3
22	Coal Ck	Hwy 20	48.531	-122.149	1
23	Wiseman Ck	Minkler Rd	48.526	-122.130	2
24	Mannser Ck	Lyman Hamilton Hwy	48.528	-122.041	2
25	Red Cabin Ck	Hamilton Cem Rd	48.534	-122.023	2
28	Brickyard Ck	Hwy 20	48.497	-122.268	4
29	Skagit R	River Bend Rd	48.439	-122.372	5,6
30	Skagit R	Cape Horn Rd	48.521	-121.960	5
31	Drain Dist 20 floodgate	Francis Rd	48.445	-122.317	3
32	Samish R	Thomas Rd	48.521	-122.410	3
33	Alice Bay Pump Station	Samish Island Rd	48.555	-122.483	3
34	Noname Slough	Bayview-Edison Rd	48.468	-122.464	3
35	Joe Leary Slough	D'Arcy Rd	48.520	-122.462	3
36	Edison Slough at school	W. Bow Hill Rd	48.562	-122.435	3
37	Edison Drainage in Edison	Farm to Market Rd	48.561	-122.444	3
38	Drainage north of Edison	North Edison Rd	48.572	-122.441	3
39	Colony Ck	Colony Rd	48.581	-122.401	2
40	Big Indian Slough	Bayview-Edison Rd	48.447	-122.457	3
41	Maddox Slough/Big Ditch	Milltown Rd	48.309	-122.346	3
42	Hill Ditch	Cedardale Rd	48.324	-122.327	3
43	Wiley Slough	Wylie Rd	48.326	-122.372	3
44	Rexville Pump Station	Summers Drive	48.366	-122.419	3
45	Skagit R – North Fork	Moore Rd	48.364	-122.416	5,6
46	Skagit R – South Fork	Fir Island Rd	48.342	-122.349	5,6
47	Swinomish Channel	County Boat Launch	48.455	-122.512	7
48	Fisher Ck	Franklin Rd	48.320	-122.328	3,6

[1]See Table 2 for site type descriptions

Table 2. Sample site type descriptions for Skagit County Monitoring Program

Site Type Number	Description	Number of Sites[1]
1	Ag-upstream: Located to determine status/trends at upstream end of agricultural areas.	7
2	Ag-midstream: Located to determine status/trends in the middle of agricultural areas.	6
3	Ag-downstream: Located to determine status/trends at downstream end of a watercourse in agricultural areas.	19
4	Reference: Located to determine status/trends in a non-agricultural area, such as urban/suburban or rural reserve, for comparison with ag area results.	3
5	Skagit River: Located to determine status/trends in the mainstem Skagit River or the forks. The Skagit may show effects from a wide variety of sources.	4
6	TMDL: Located to provide information for the Department of Ecology's TMDL efforts.	12
7	Swinomish Channel: Located to provide a water quality baseline for Swinomish Channel	1

[1]Some sites have more than one designation

A secondary purpose for some of the sites included in the monitoring program is to provide data to the Department of Ecology in support of their Total Maximum Daily Load (TMDL) programs in Skagit County. The sites that provide TMDL data are also in the agricultural zones and are integral to the determination of trends and conditions in those areas.

Nineteen of the 40 (sites 3-25) sites are continued from the Skagit County Baseline Monitoring Project (Skagit County 2004a). The Baseline Project used nearly identical methods to monitor water quality at 27 sites. Five additional sites were part of the Samish Bay Watershed Water Quality Monitoring Program (Skagit County 2003). The data from the Baseline and Samish Projects will be used to help interpret trends in water quality for sites continued in the Skagit County Monitoring Program. Not all of the Baseline sites could be continued into the current program due to limited resources and the need to expand the current program into the Skagit Delta, where there were no Baseline sites. In particular, several intermediate sites on the Samish River were discontinued, leaving one upstream and one downstream site on the Samish.

A proposal was submitted in February, 2003 to the Department of Ecology for consideration in their FY 2004 Centennial Clean Water Grants program. The proposal was accepted and a grant of nearly $500,000 was awarded to support five years of the monitoring program, FY 2004 through FY 2008.

Methods

Standard water quality monitoring methods are used in the Skagit County Monitoring Program. The methods are derived from several sources, including the Department of Ecology and the U.S. Environmental Protection Agency. A brief description of monitoring procedures follows, and detailed monitoring procedures can be found in the Quality Assurance Project Plan developed for the program (Skagit County 2004b).

Each site in the monitoring program is visited every two weeks. At each visit, dissolved oxygen, temperature, pH, turbidity, conductivity, and salinity are measured and samples are obtained for fecal coliform determinations. On alternate visits (every four weeks), additional water samples are obtained for quantifying plant nutrients (total nitrogen, ammonia, nitrate, nitrite, total phosphorus and orthophospate), and total suspended solids. Stream discharge is measured at selected sites during the alternate visits.

The sample routes are designed so that each station is visited at approximately the same time of day on each visit, to minimize the effects of diurnal variation in water quality parameters on overall data variability.

Data collected is entered into a specially-designed database, and then is checked for accuracy against the original data sheets. Output from the database can be exported into Excel® spreadsheets for data summary and analysis. These spreadsheets are also published on the County's web site:

http://www.skagitcounty.net/SCMP

Activity Summary

Weekly Sampling - All weekly sampling trips were conducted on schedule, beginning on October 7, 2003. Sampling normally took place on Tuesdays except during holiday weeks (Thanksgiving and Christmas), when sampling took place on Mondays to accommodate laboratory schedules. Sampling activities are illustrated in Figures 2 and 3.

Grant Activity - Centennial Clean Water grants require a Quality Assurance Program Plan (QAPP). A draft QAPP was submitted to the Department of Ecology in September, 2003. Ecology comments were incorporated into the document and a final QAPP was submitted to Ecology in October, 2003. Ecology accepted the QAPP and a final grant agreement was signed by Ecology and the County Commissioners in January, 2004. At this point expenditures on the Skagit County Monitoring Program became grant-eligible, with reimbursement from the Centennial Clean Water Grant program at a 75% rate.

The grant requires quarterly reports and annual data submissions. Skagit County has submitted quarterly reports for the first, second, and third quarters of 2004. The annual data submission will be made in January, 2005.

Figure 2. Collecting water samples and water quality data at Alice Bay Pump Station.

Figure 3. Obtaining dissolved oxygen reading from College Way Creek.

Sample site revisions - Three sample sites were moved from the original location as delineated in the QAPP. Site 35 on Joe Leary Slough was moved approximately 3500 feet upstream from Bayview-Edison Road to D'Arcy Road to solve right-of-entry problems. Site 40 on Big Indian Slough was moved approximately 2800 feet upstream to solve right-of-entry problems and to move away from the tidegate and associated saltwater intrusion. Site 42 on Hill Ditch/Carpenter Creek was moved approximately 4300 feet upstream because the original site at Pioneer Highway was subject to backwater from the Skagit River, and in early samples it was determined that primarily Skagit River water was being sampled instead of Hill Ditch/Carpenter Creek water. These changes were approved by the Department of Ecology as revisions to the QAPP.

Data Summary

Graphs and tables on the following pages report results from the Skagit County Monitoring Program for dissolved oxygen, temperature, and fecal coliform. Full data listings for each sampling event at sample site are included in Appendix A. A summary of water quality results for each sample site is included in Appendix B.

Skagit County also conducts quarterly reviews of the data to compare current results with historical data for the site, where available. The results of those reviews for the first three quarters of 2004 are included in Appendix C.

Temperature

Water temperature governs the metabolic rate of aquatic organisms. Excessive temperature can serve as a stress on fish and other cold-water organisms, and extreme temperatures can be lethal.

Temperatures were measured with Stowaway Tidbit® dataloggers from Onset Computer Company. These devices were set to measure water temperature every half hour. They were deployed in July and retrieved in September or October.

Several of the dataloggers were missing at the end of the monitoring period. Some had apparently been lost due to channel changes associated with heavy rains in August, while others may have been vandalized. In addition, some dataloggers could not be retrieved because of the abnormally early onset of high water conditions in the fall.

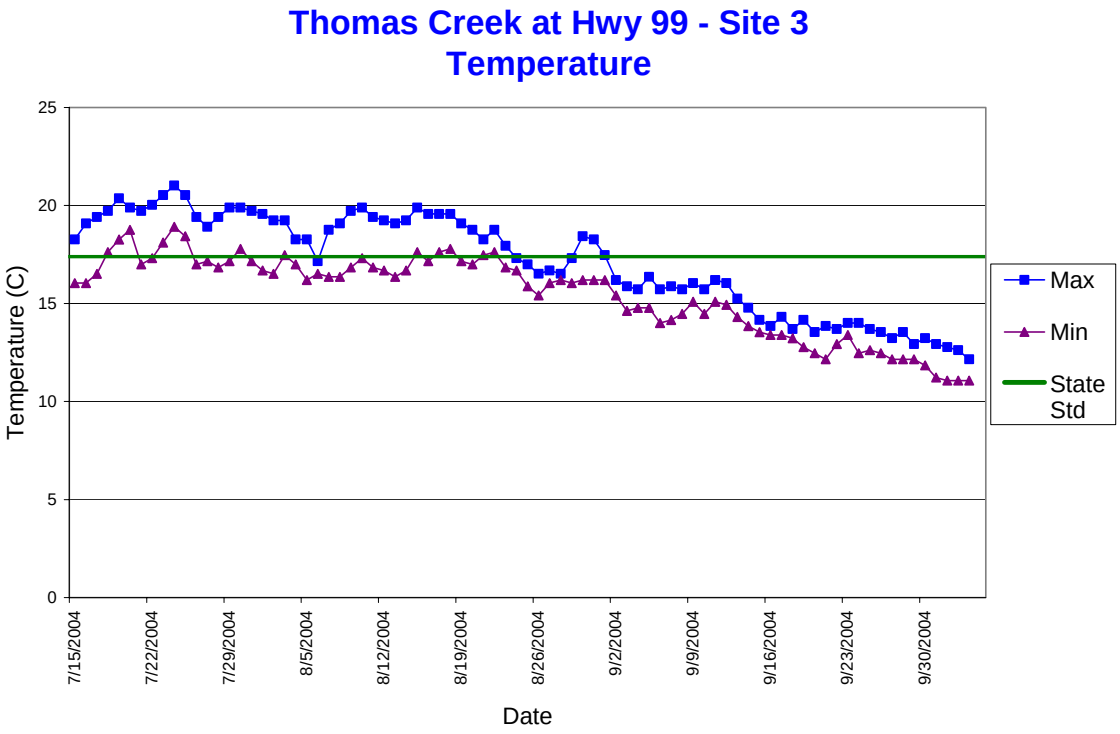
Table 3 shows the daily and 7-day average maximums (7-DAM) for those stations where temperature data was obtained, compared to the state standard for that station. The state temperature standards are based on the 7-day average maximum so that occasional abnormally hot days do not result in temperature standard violations. Most watercourses in the Skagit County Monitoring Program exceeded state temperature standards at some point during the summer.

Table 3. Maximum temperature and relationship to Department of Ecology standards for watercourses in the Skagit County Monitoring Program.

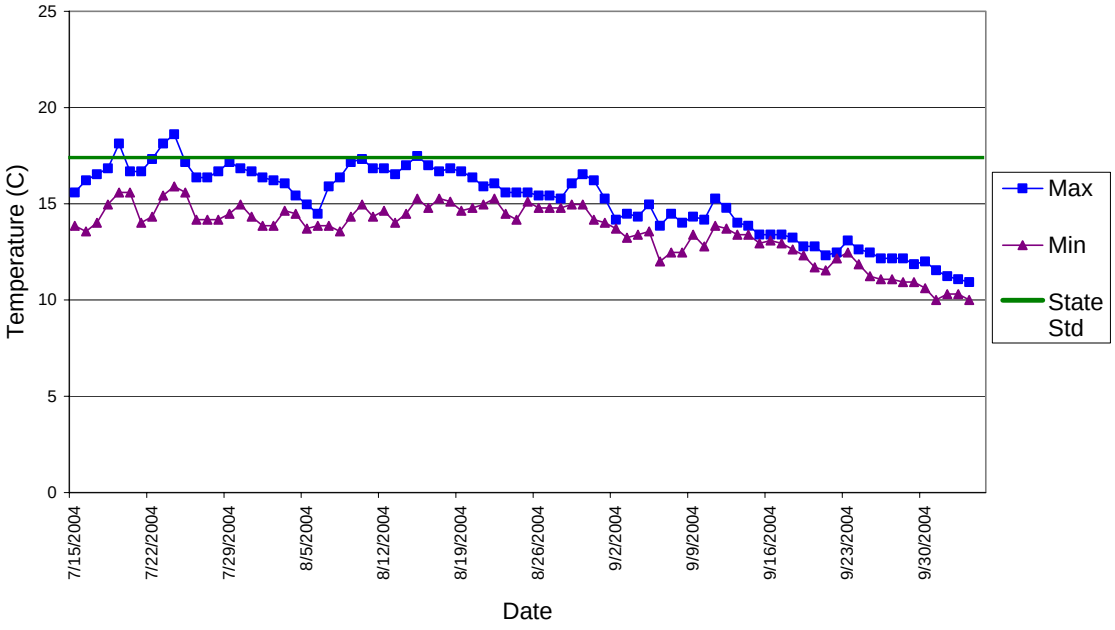
Site Number	Watercourse	Location	Daily Maximum (°C)	Maximum 7-DAM (°C)	State Std[1] (°C)
3	Thomas Ck	Old Hwy 99 N	21.0	20.3	17.5
4	Thomas Ck	F&S Grade	18.6	17.5	17.5
6	Friday Ck	Prairie Rd	22.4	21.0	17.5
8	Swede Ck	Grip Rd	20.0	19.1	17.5
11	Samish R	State Route 9	17.0	16.0	17.5
12	Nookachamps Ck	Swan Rd	25.7	24.2	17.5
13	E.F. Nookachamps Ck	State Route 9	22.5	21.5	17.5
14	College Way Ck	College Way	N/A	N/A	17.5
15	Nookachamps Ck	Knapp	23.1	22.4	17.5
16	E.F. Nookachamps Ck	Beaver Lake Rd	22.3	21.3	17.5
17	Nookachamps Ck	Big Lake Outlet	26.3	24.9	17.5
18	Lake Ck	State Route 9	19.9	18.8	17.5
19	Hansen Ck	Hoehn Rd	22.5	21.0	17.5
20	Hansen Ck	Northern State	20.6	19.6	17.5
21	Coal Ck	Hoehn Rd	19.0	18.6	16.0
22	Coal Ck	Hwy 20	N/A	N/A	16.0
23	Wiseman Ck	Minkler Rd	17.0	16.6	16.0
24	Mannser Ck	Lyman Hamilton Hwy	16.8	15.9	16.0
25	Red Cabin Ck	Hamilton Cem Rd	16.8	16.0	16.0
28	Brickyard Ck	Hwy 20	N/A	N/A	17.5
29	Skagit R	River Bend Rd	N/A	N/A	17.5
30	Skagit R	Cape Horn Rd	N/A	N/A	16.0
31	Drain Dist 20 floodgate	Francis Rd	N/A	N/A	17.5
32	Samish R	Thomas Rd	21.8	20.5	17.5
33	Alice Bay Pump Station	Samish Island Rd	22.9	21.4	17.5
34	Noname Slough	Bayview-Edison Rd	N/A	N/A	17.5
35	Joe Leary Slough	D'Arcy Rd	25.2	22.8	17.5
36	Edison Slough at school	W. Bow Hill Rd	32.2	30.1	17.5
37	Edison Drain. in Edison	Farm to Market Rd	28.8	27.4	17.5
38	Drainage north of Edison	North Edison Rd	17.8	15.9	17.5
39	Colony Ck	Colony Rd	21.4	20.4	17.5
40	Big Indian Slough	Bayview-Edison Rd	N/A	N/A	17.5
41	Maddox Slough/Big Ditch	Milltown Rd	29.0	25.7	17.5
42	Hill Ditch	Cedardale Rd	N/A	N/A	17.5
43	Wiley Slough	Wylie Rd	23.6	22.6	17.5
44	Rexville Pump Station	Summers Drive	26.6	25.4	17.5
45	Skagit R – North Fork	Moore Rd	18.0	17.5	17.5
46	Skagit R – South Fork	Fir Island Rd	20.9	19.1	17.5
47	Swinomish Channel	County Boat Launch	N/A	N/A	16.0
48	Fisher Ck	Franklin Rd	16.5	15.7	17.5

[1]Washington State Water Quality Standard per WAC 173-201A

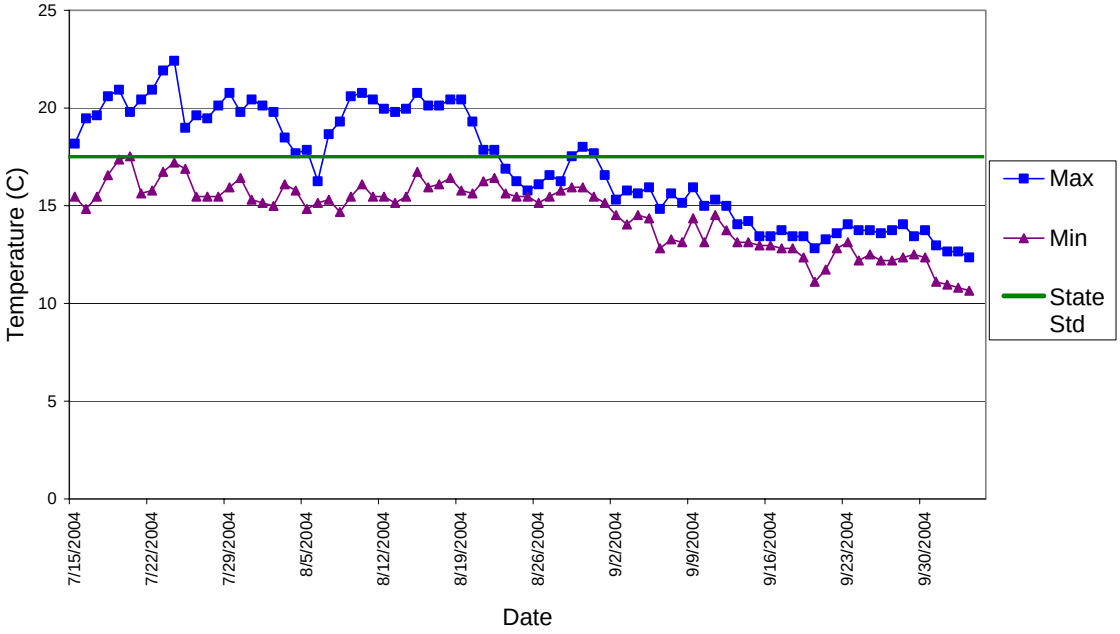
Graphs on the following pages illustrate daily temperature maximums and minimums for the sample sites with temperature data in the Skagit County Monitoring Program. Each graph shows daily high and low temperatures and a line representing the state water quality standard for that water body. The state standard is actually based on the 7-day average maximum temperature, so individual readings over the standard may not constitute a water quality standards violation.



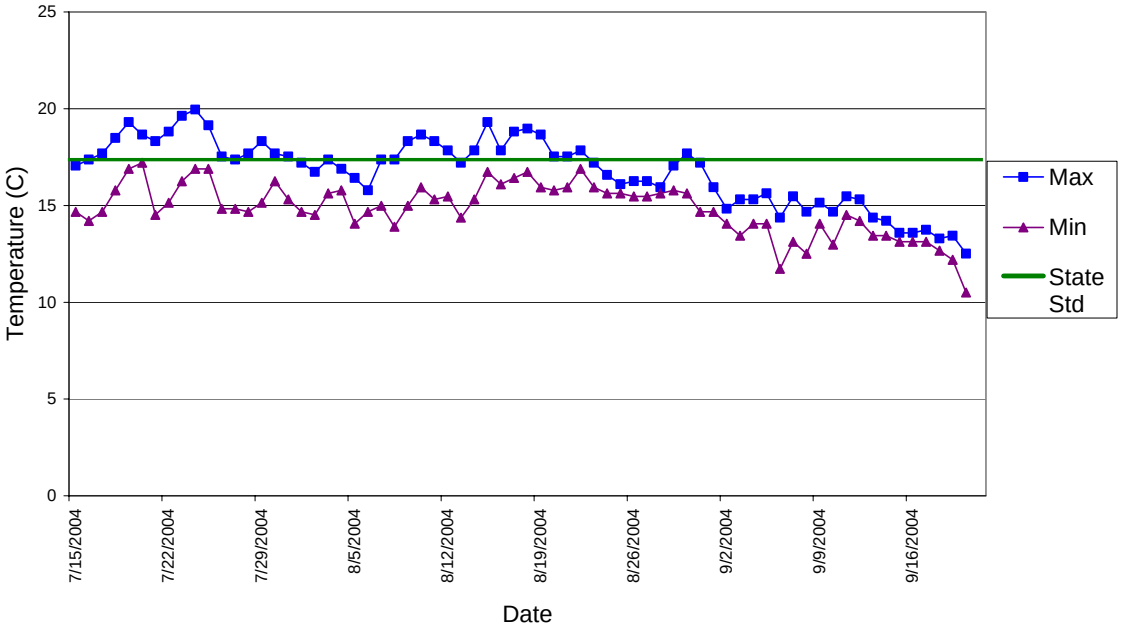
Thomas Creek at F&S Grade Rd - Site 4
Temperature



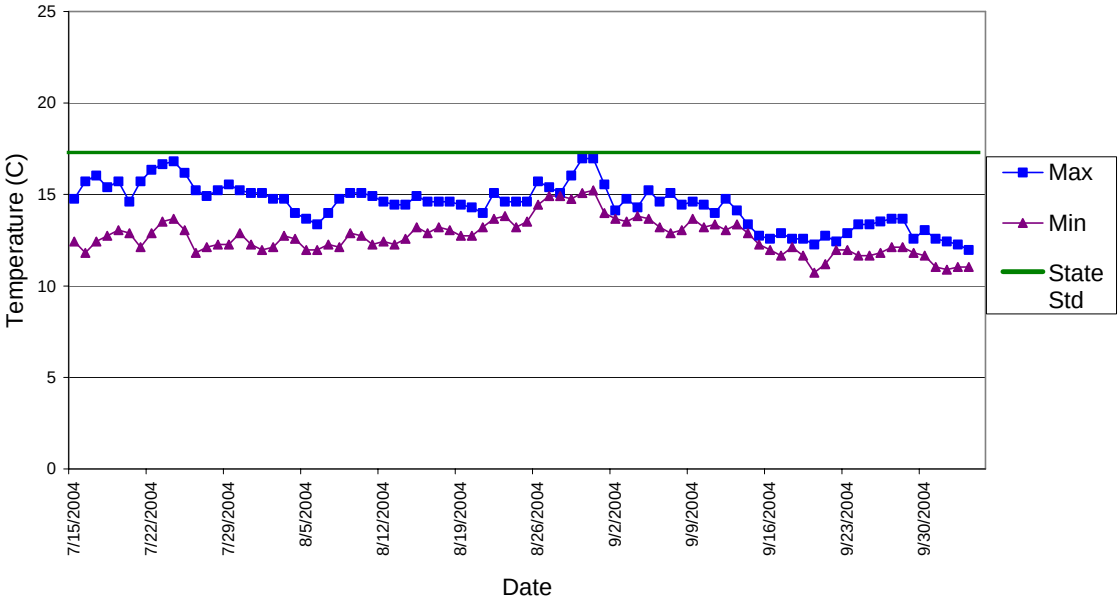
Friday Creek at Prairie Rd - Site 6
Temperature



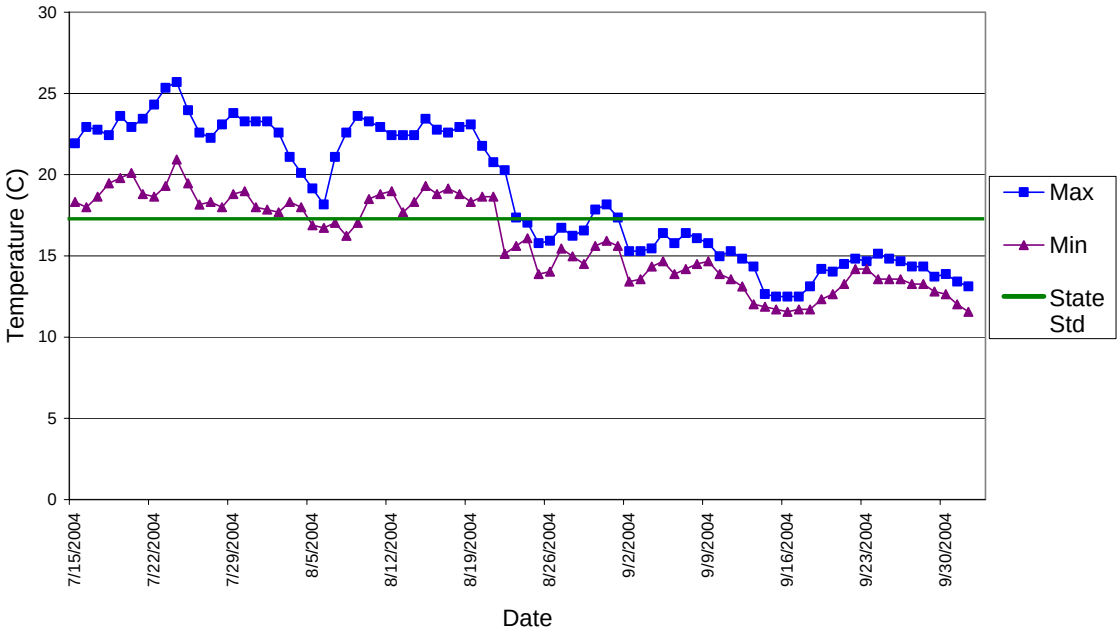
Swede Creek at Grip Rd - Site 8
Temperature



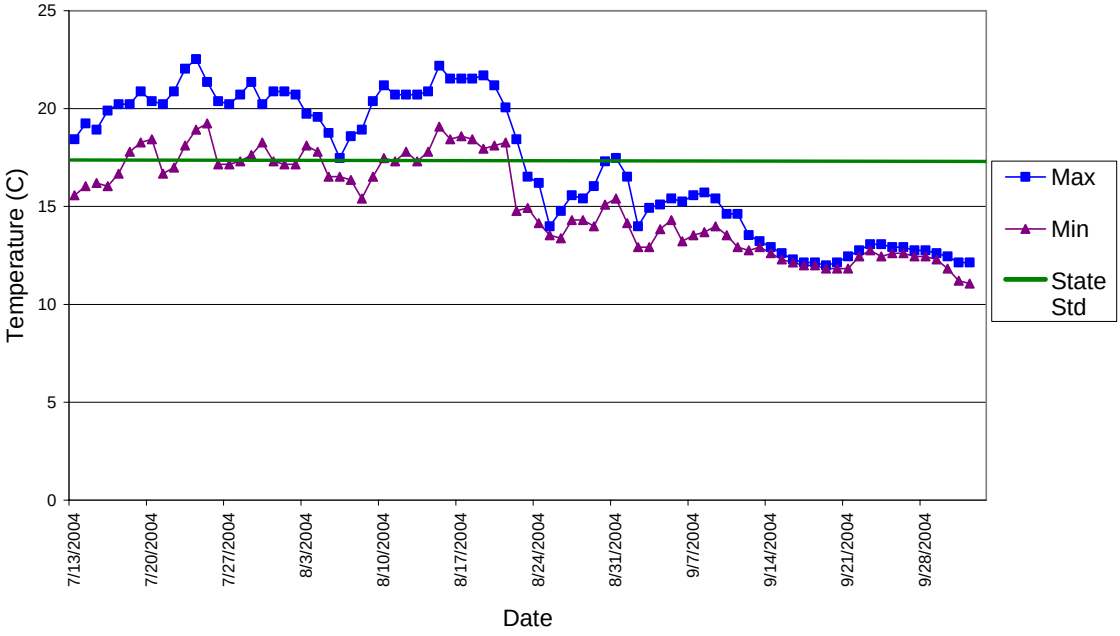
Samish River at Highway 9 - Site 11
Temperature



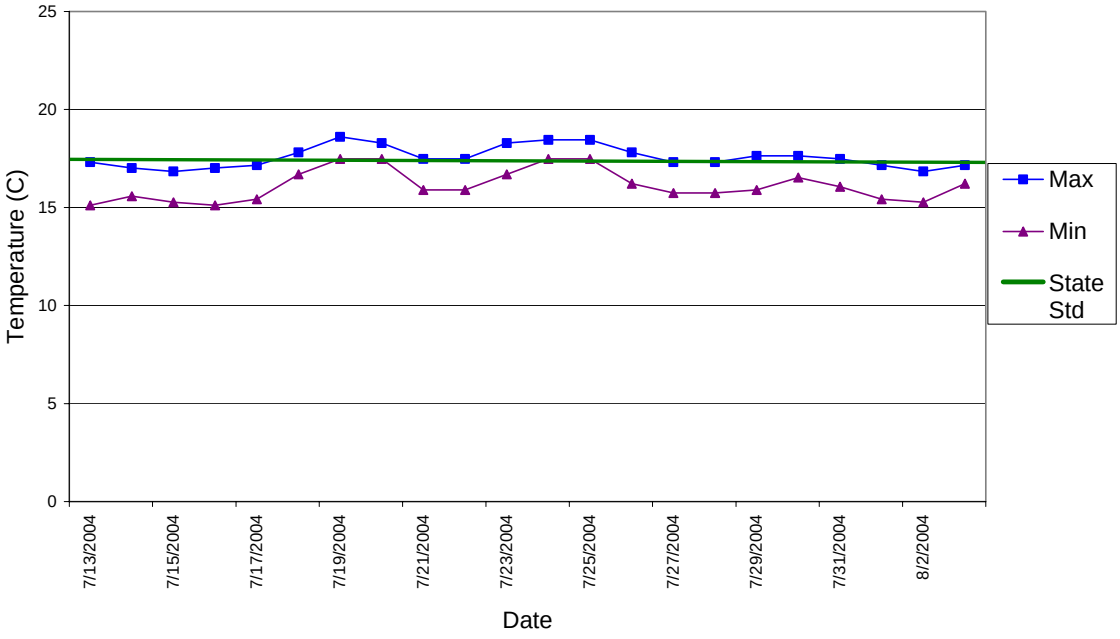
Nookachamps Creek At Swan Road - Site 12
Temperature



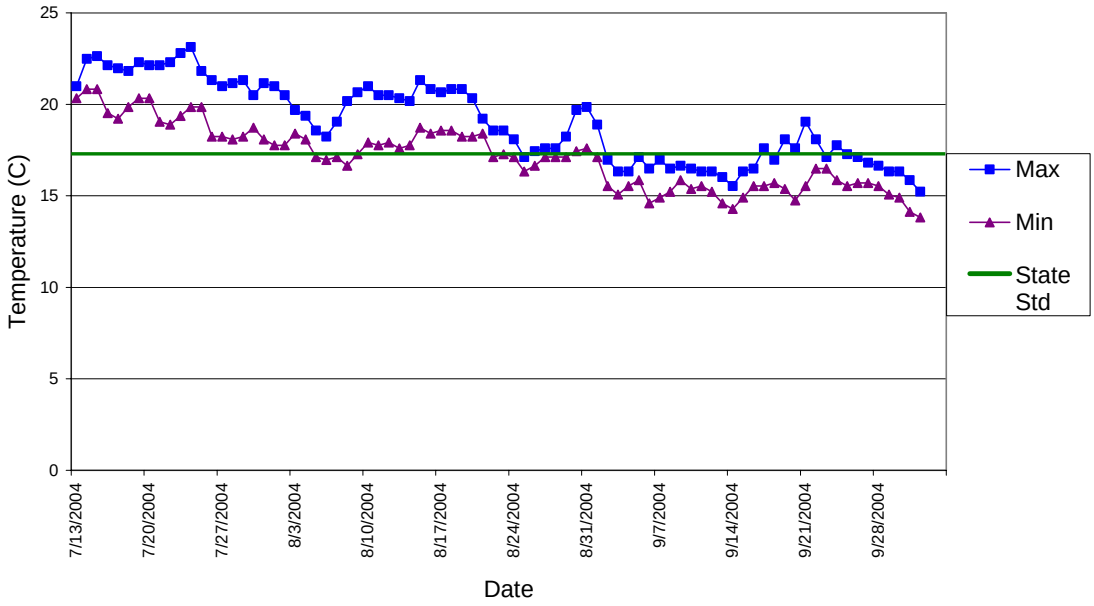
E.F. Nookachamps Creek at Highway 9 - Site 13
Temperature



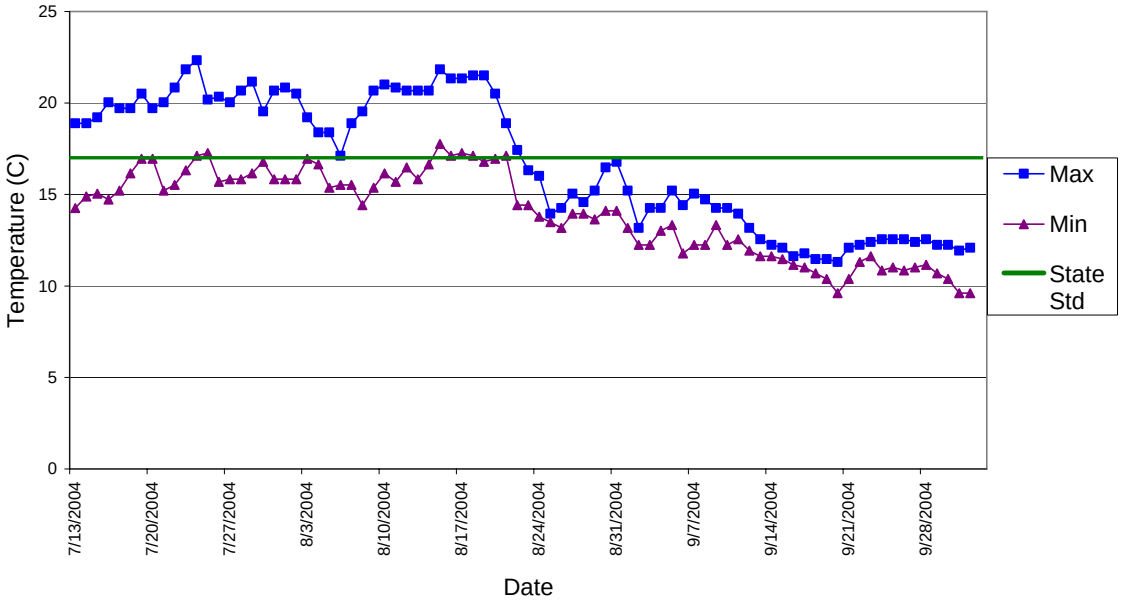
College Way Creek at College Way - Site 14
Temperature



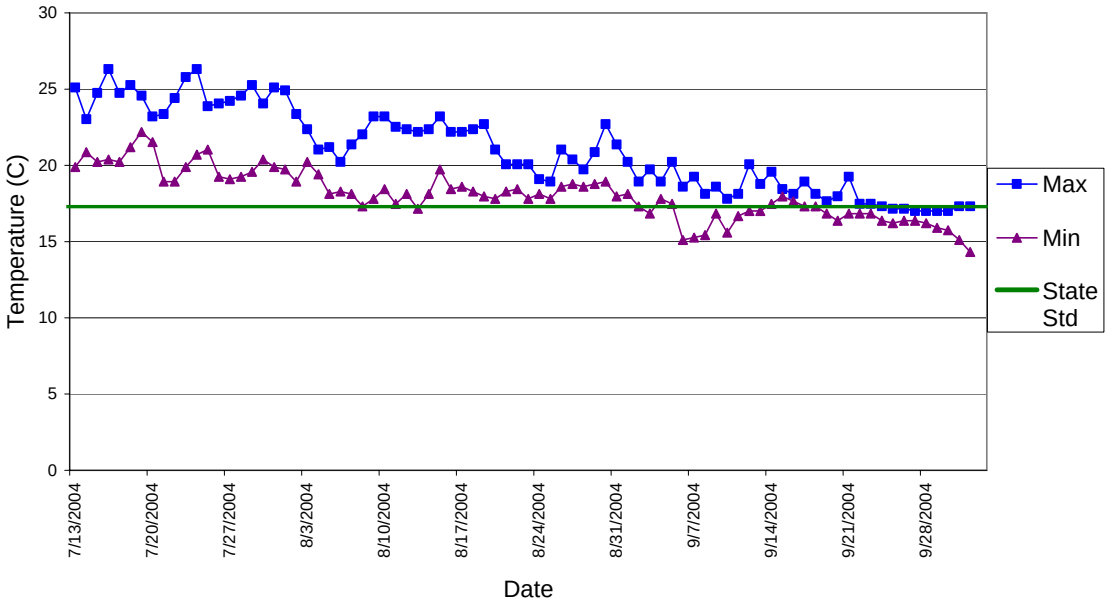
Nookachamps Creek at Knapp Road - Site 15
Temperature



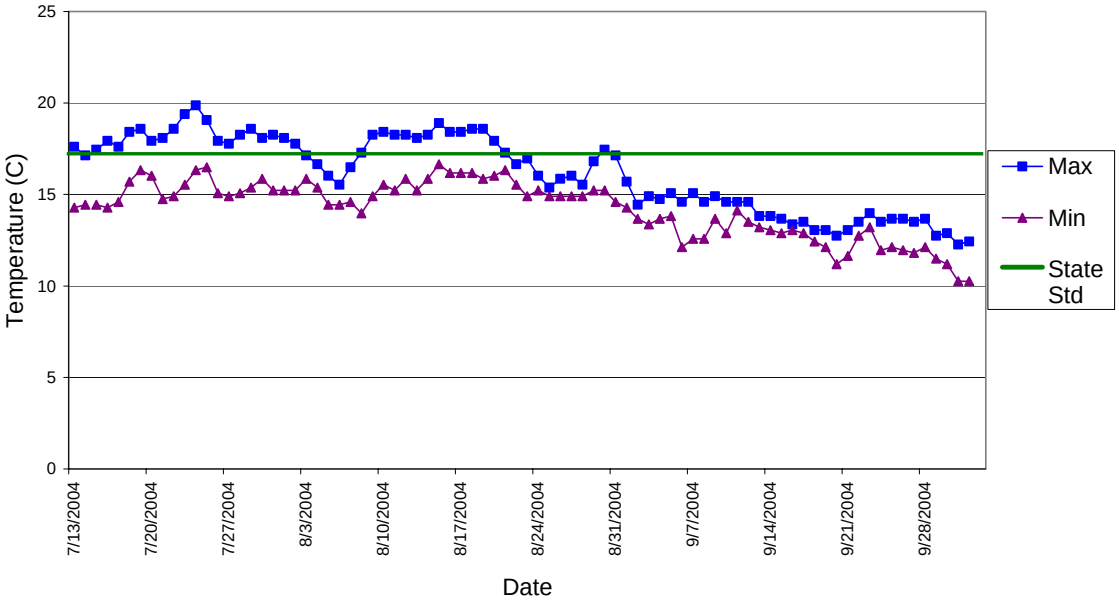
E.F. Nookachamps Creek at Beaver Lk Rd - Site 16
Temperature



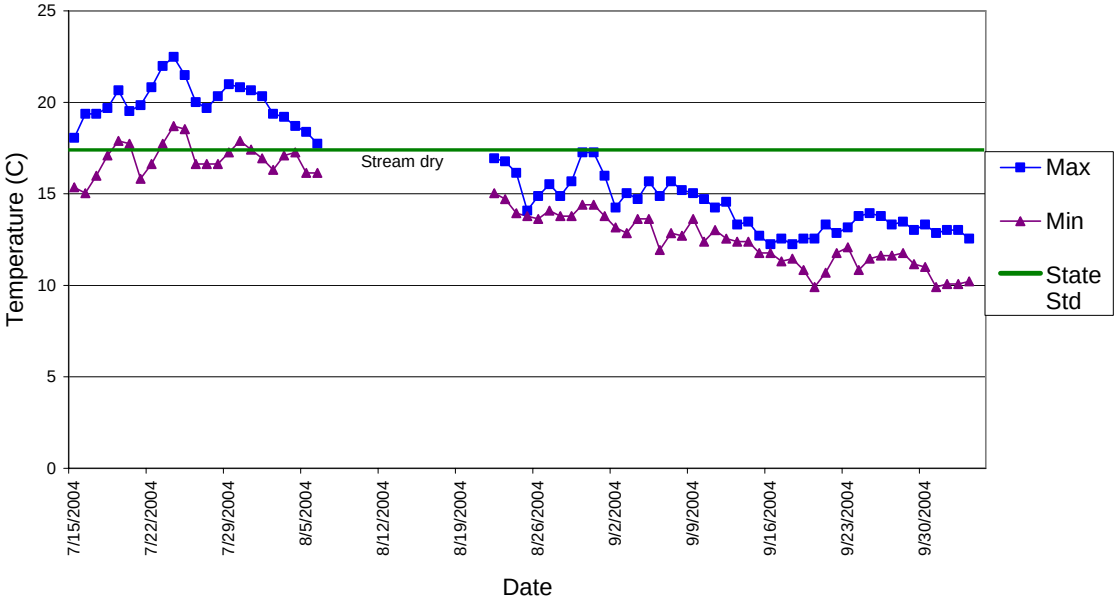
Nookachamps Creek At Big Lake Outlet - Site 17
Temperature



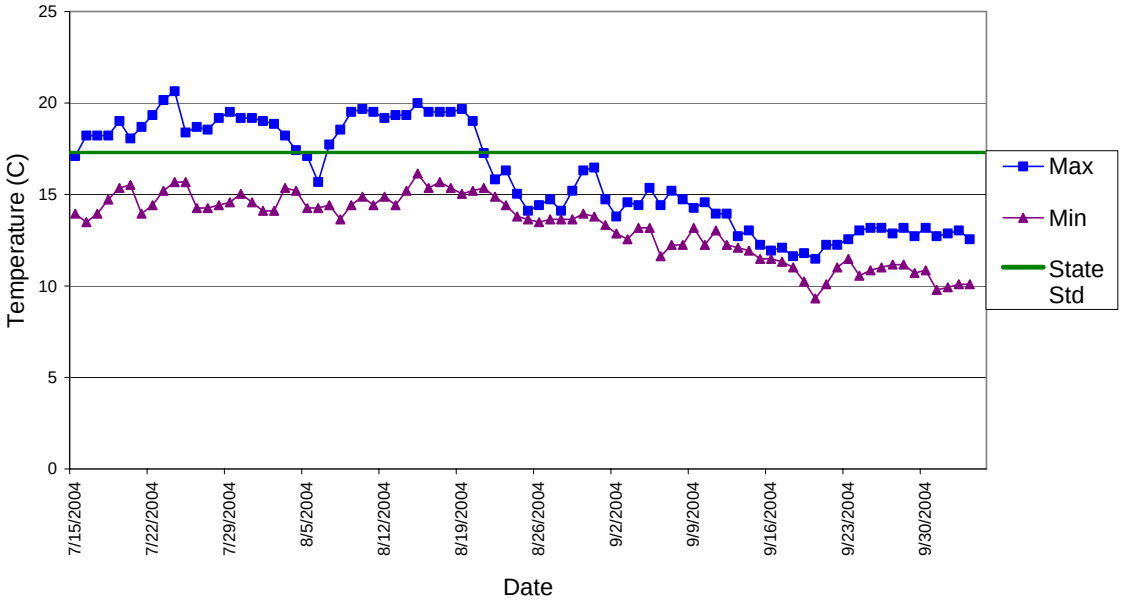
Lake Creek at Highway 9 - Site 18
Temperature



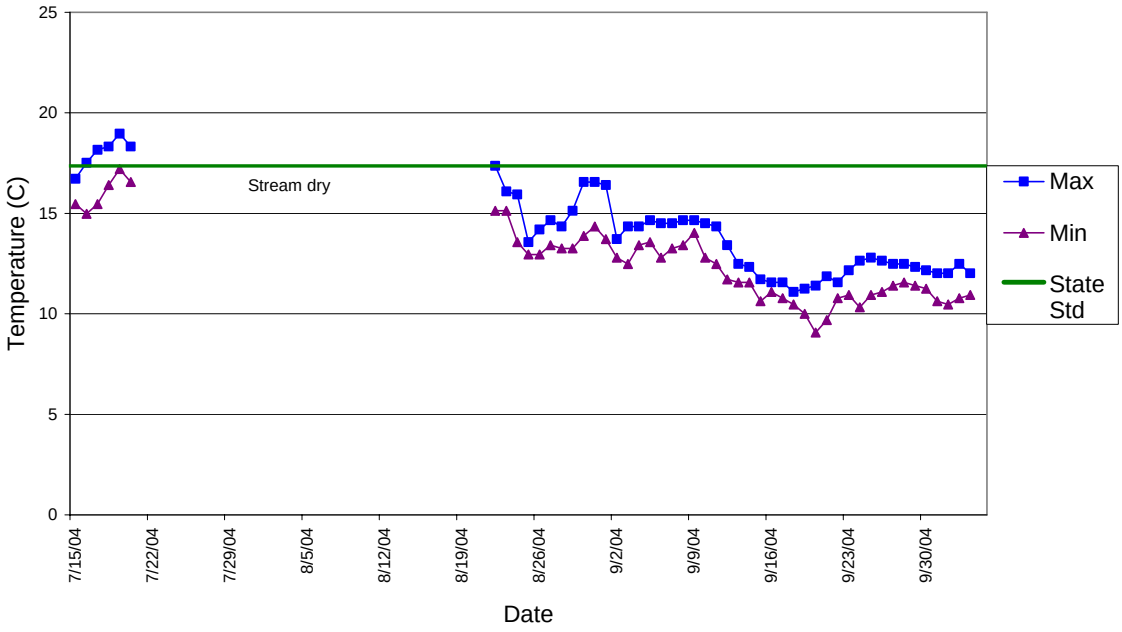
Hansen Creek at Hoehn Road - Site 19
Temperature



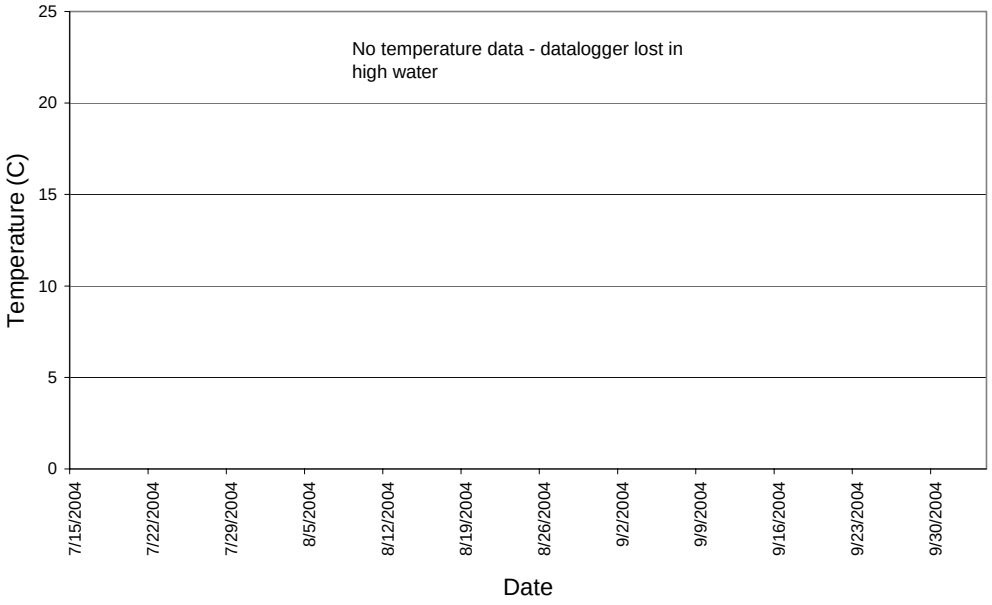
Hansen Creek at Northern State Hospital - Site 20
Temperature



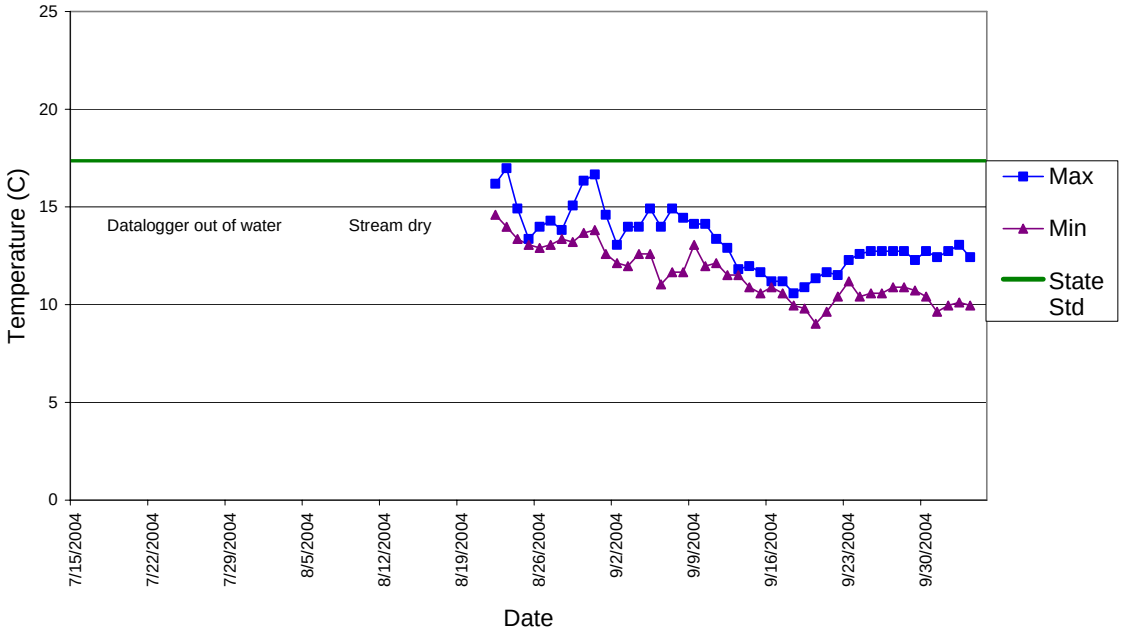
Coal Creek at Hoehn Road - Site 21
Temperature



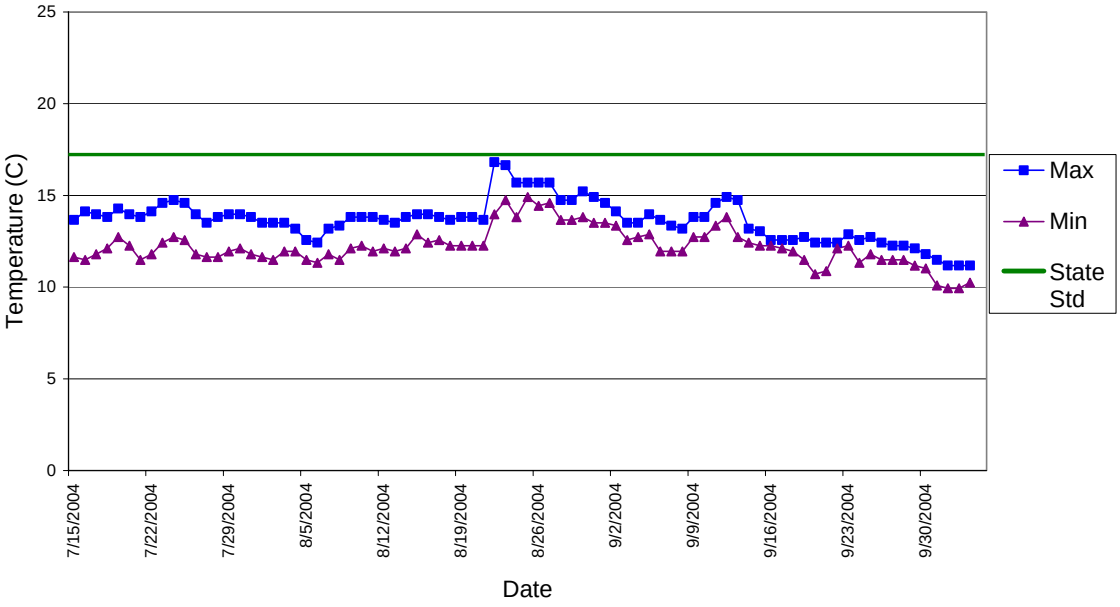
Coal Creek at Highway 20 - Site 22
Temperature



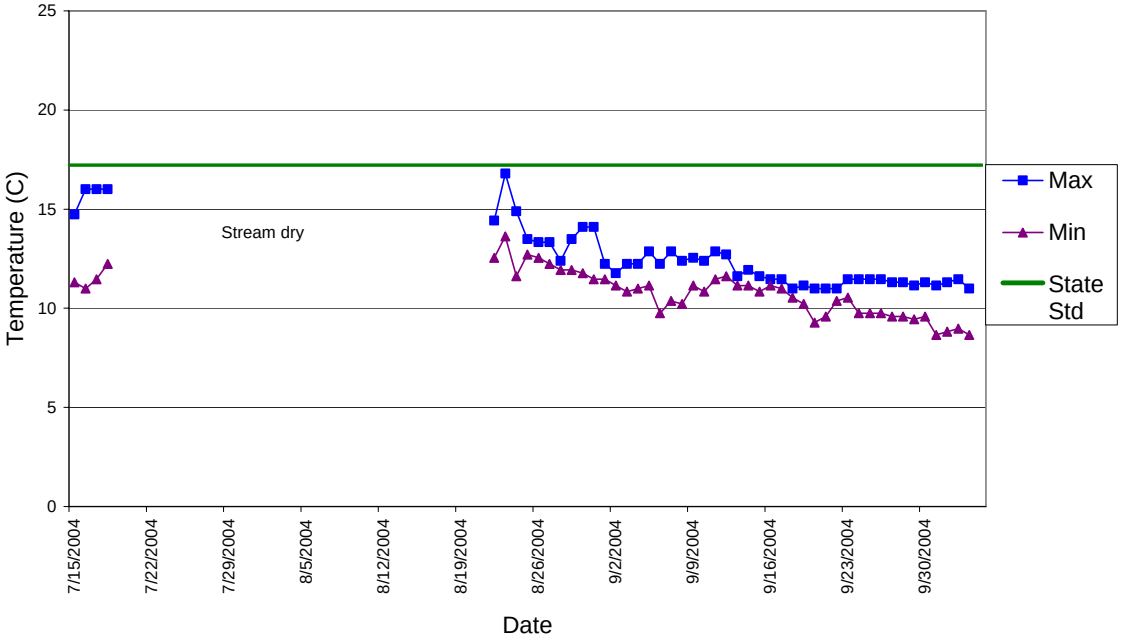
Wiseman Creek at Minkler Road - Site 23
Temperature



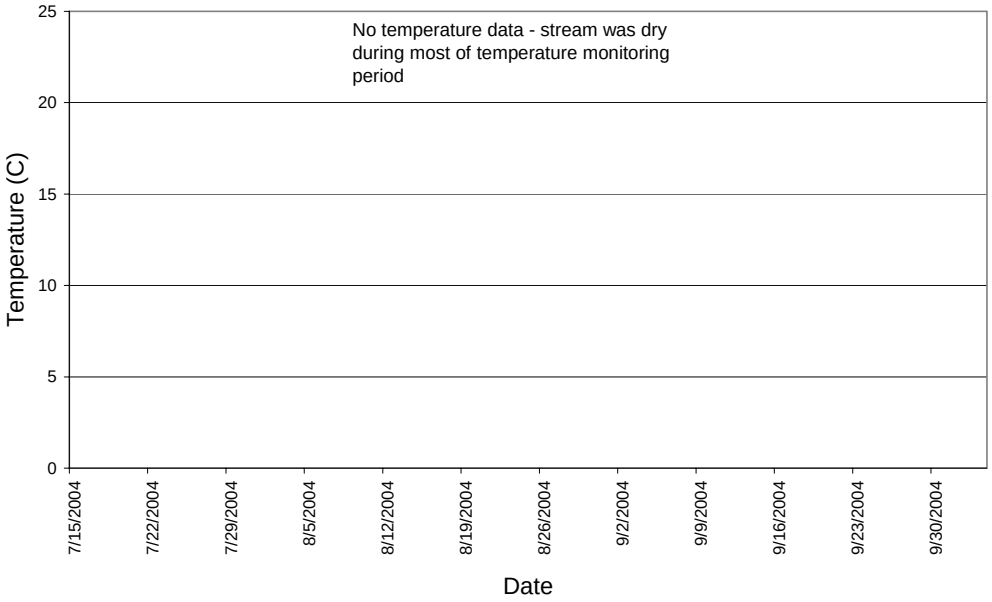
Mannser Creek at Lyman-Hamilton Highway - Site 24
Temperature



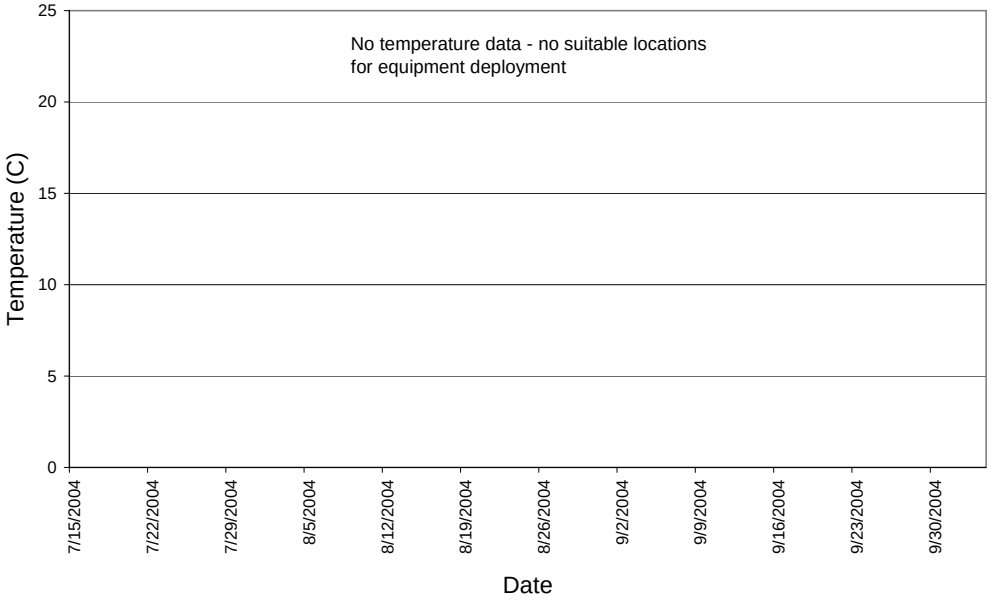
Red Cabin Creek at Lyman-Hamilton- Site 25
Temperature



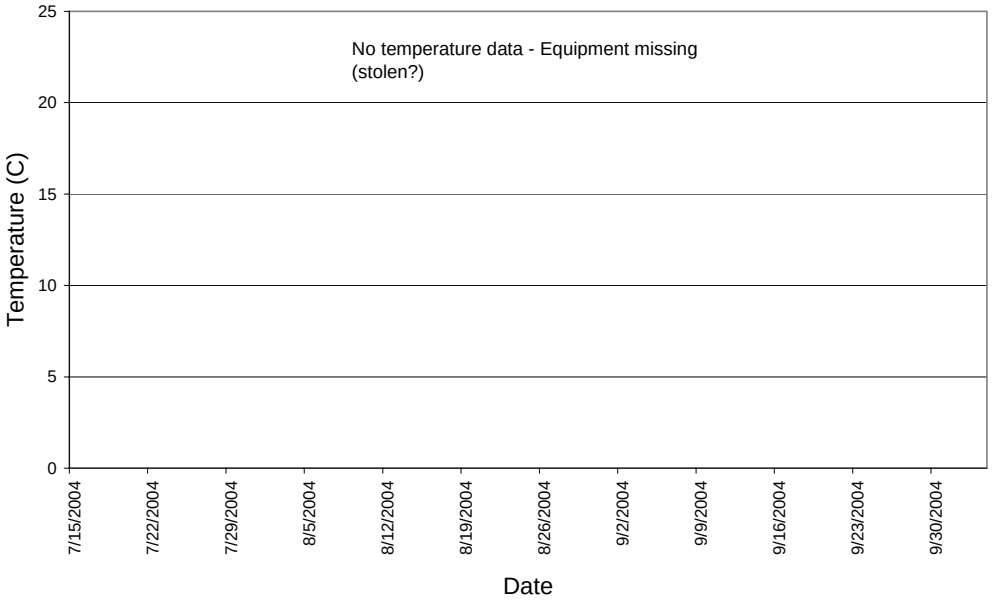
Brickyard Creek at Highway 20 - Site 28
Temperature



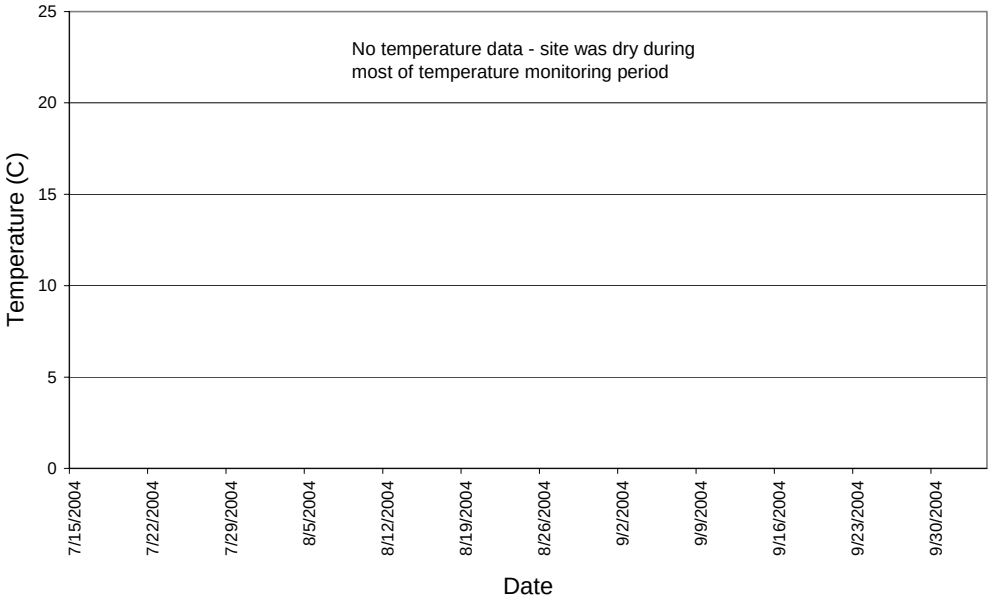
Skagit River at River Bend - Site 29
Temperature



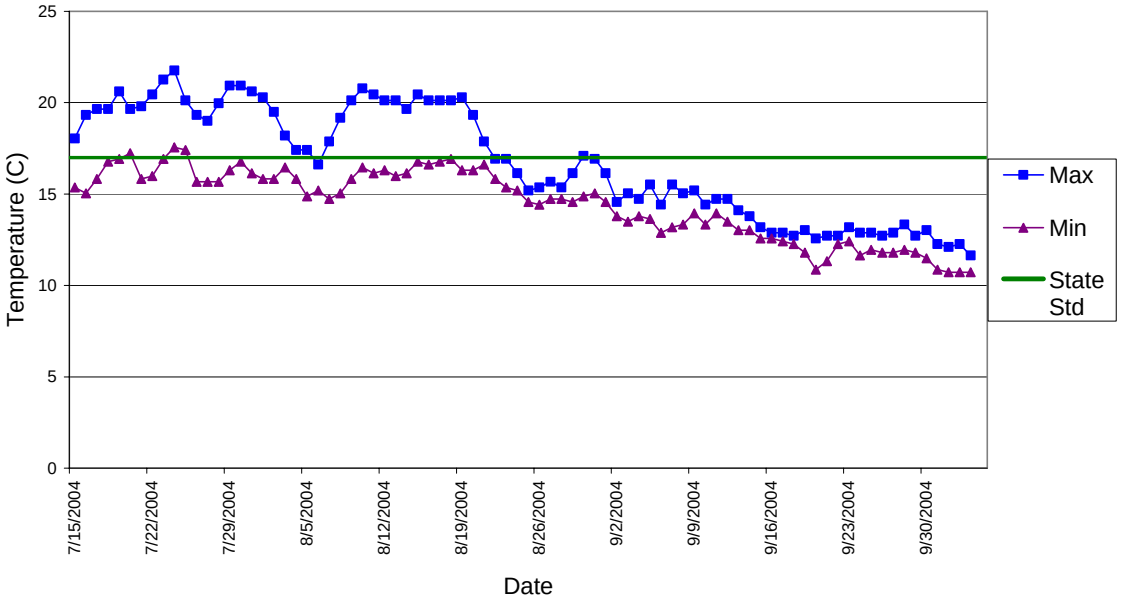
Skagit River at Cape Horn Road - Site 30
Temperature



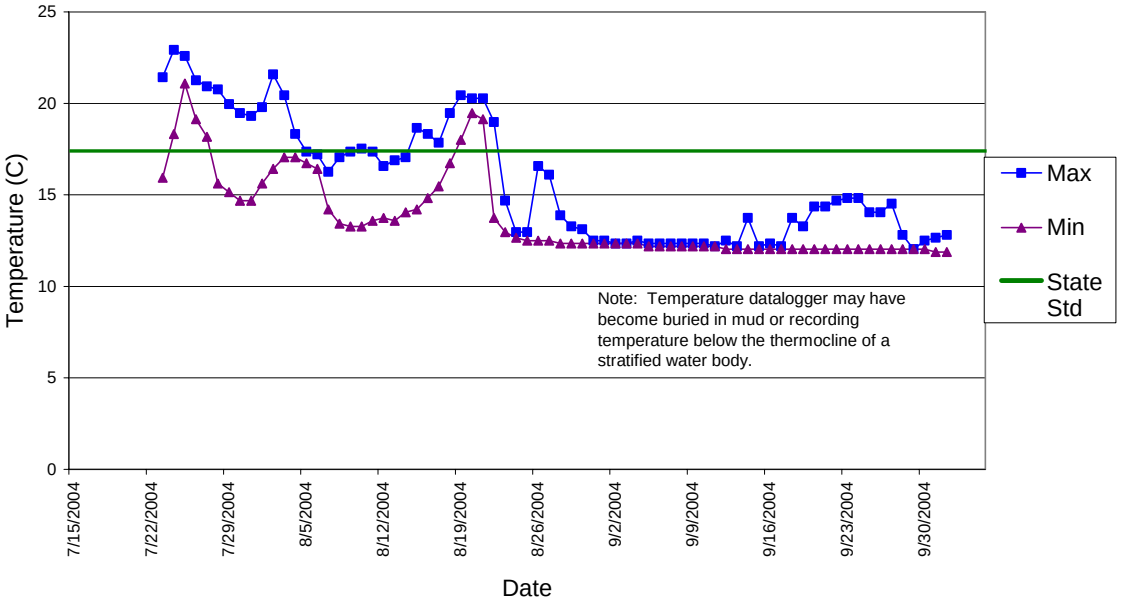
Drainage District 20 at floodgate - Site 31
Temperature



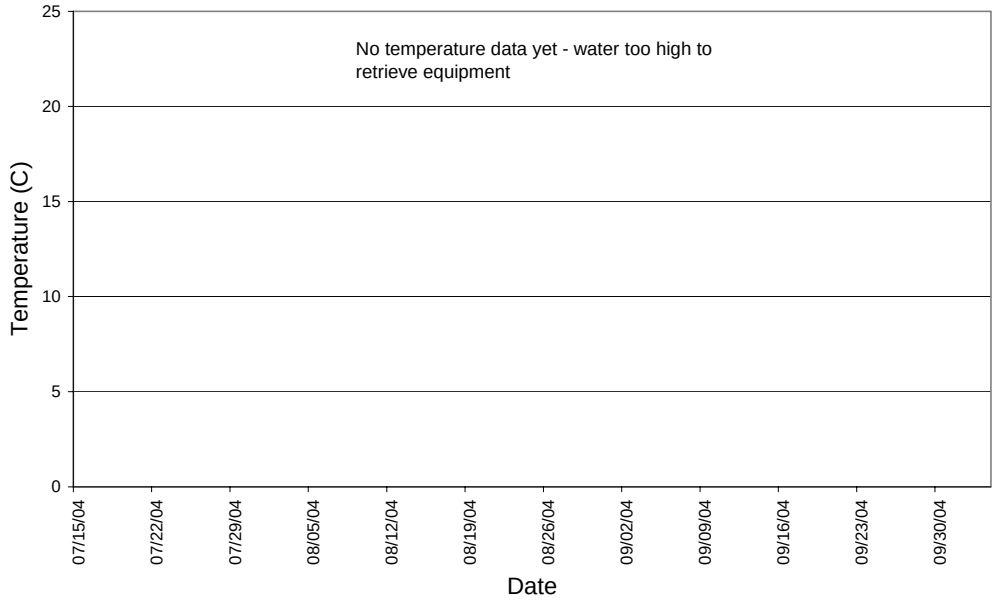
Samish River at Thomas Road - Site 32
Temperature



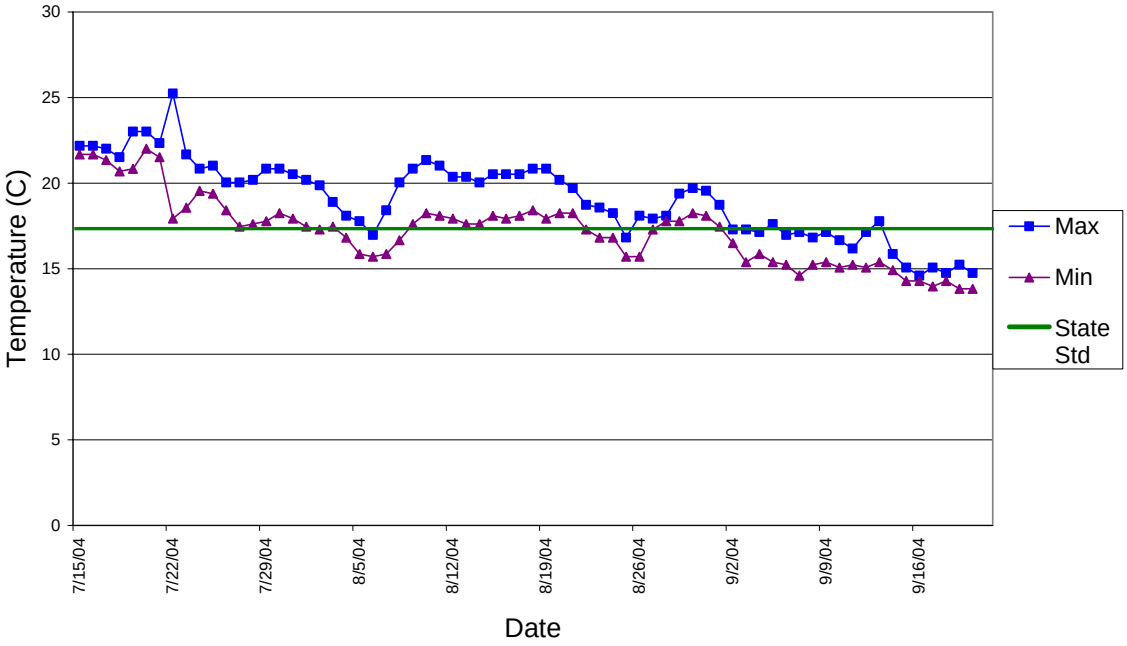
Alice Bay Pump Station - Site 33
Temperature



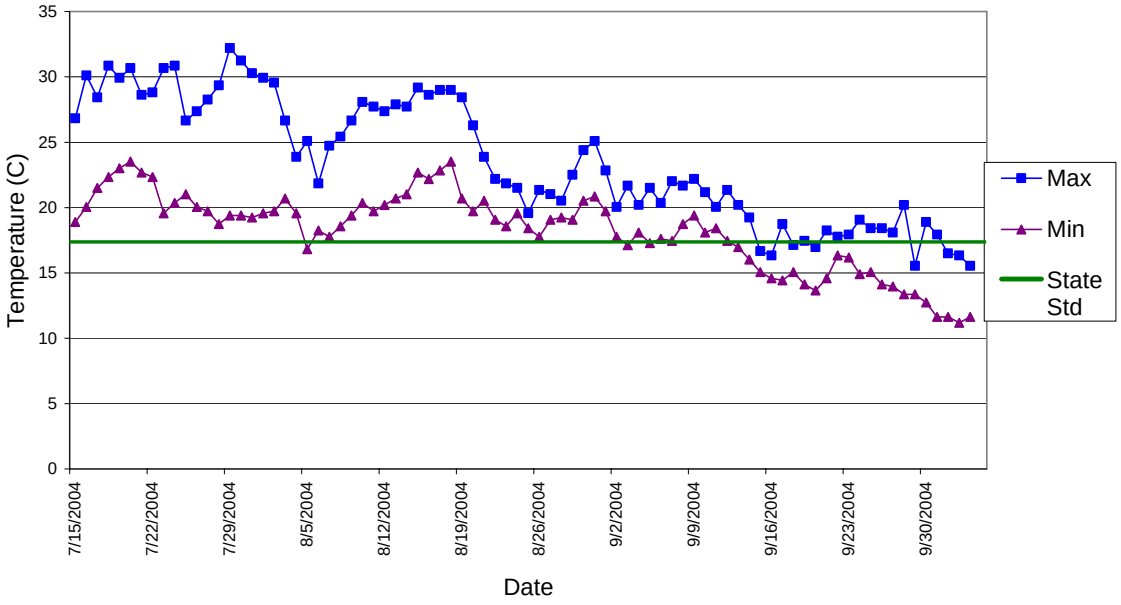
No Name Slough at Bayview-Edison Rd - Site 34
Temperature



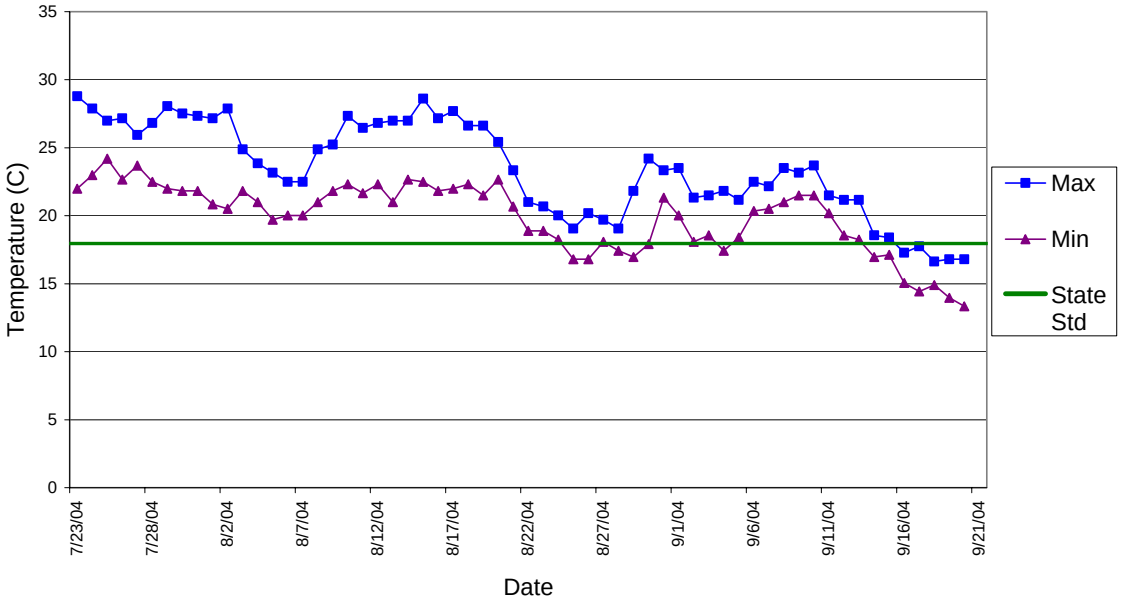
Joe Leary Slough at D'Arcy Road - Site 35
Temperature



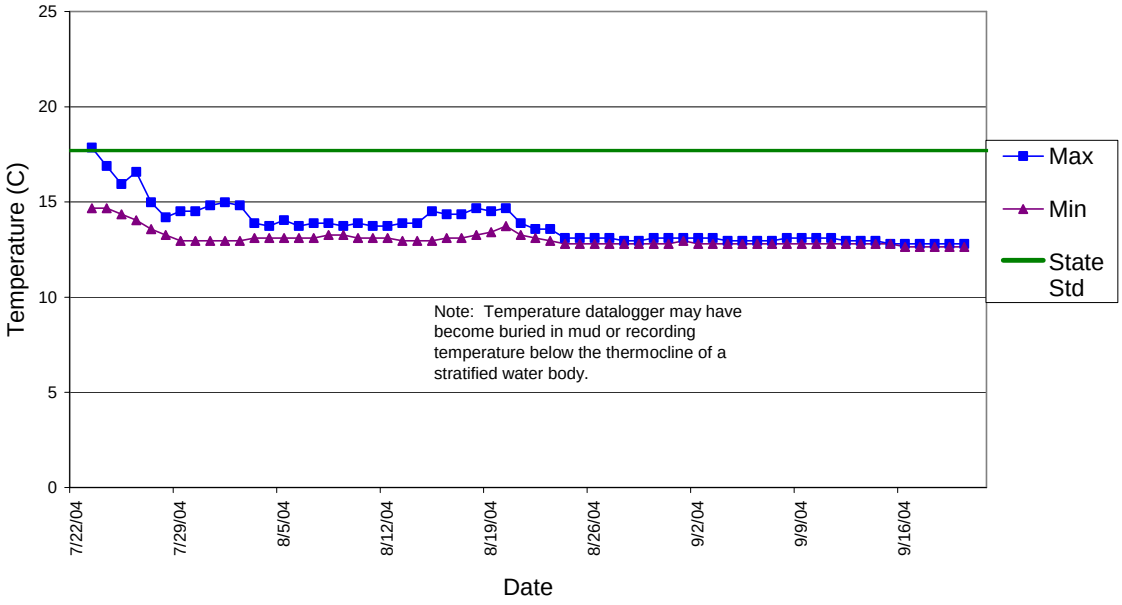
Edison Slough at school - Site 36
Temperature



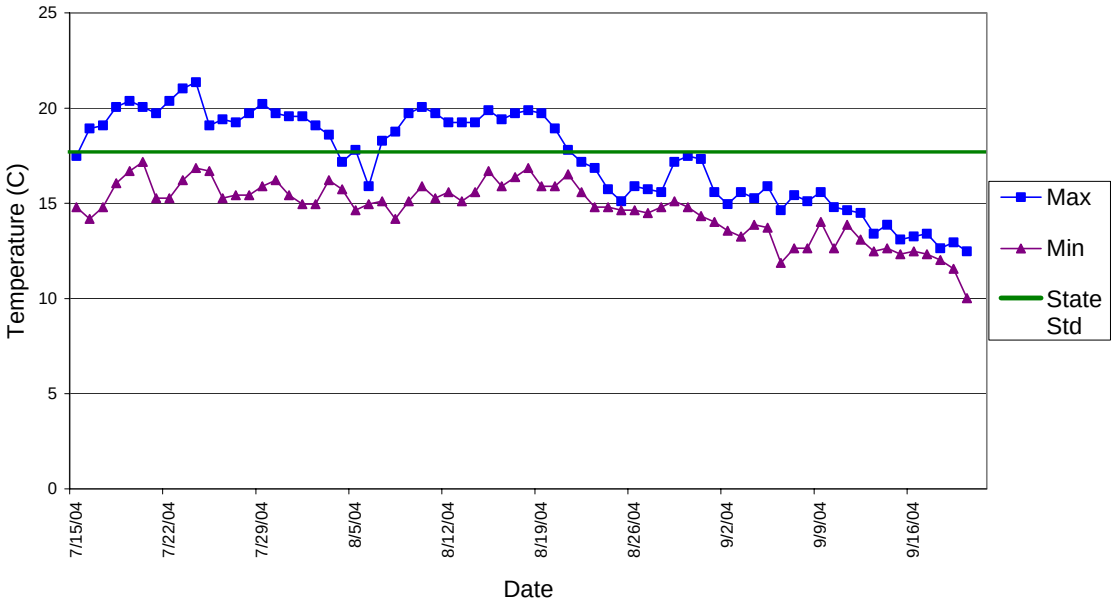
Edison Pump Station - Site 37
Temperature



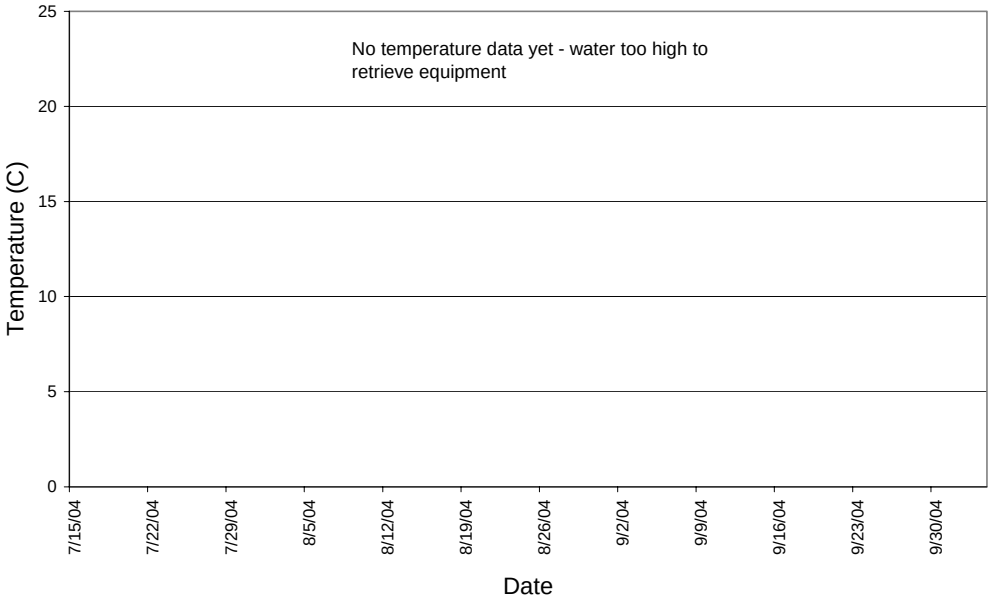
North Edison Drainage - Site 38
Temperature



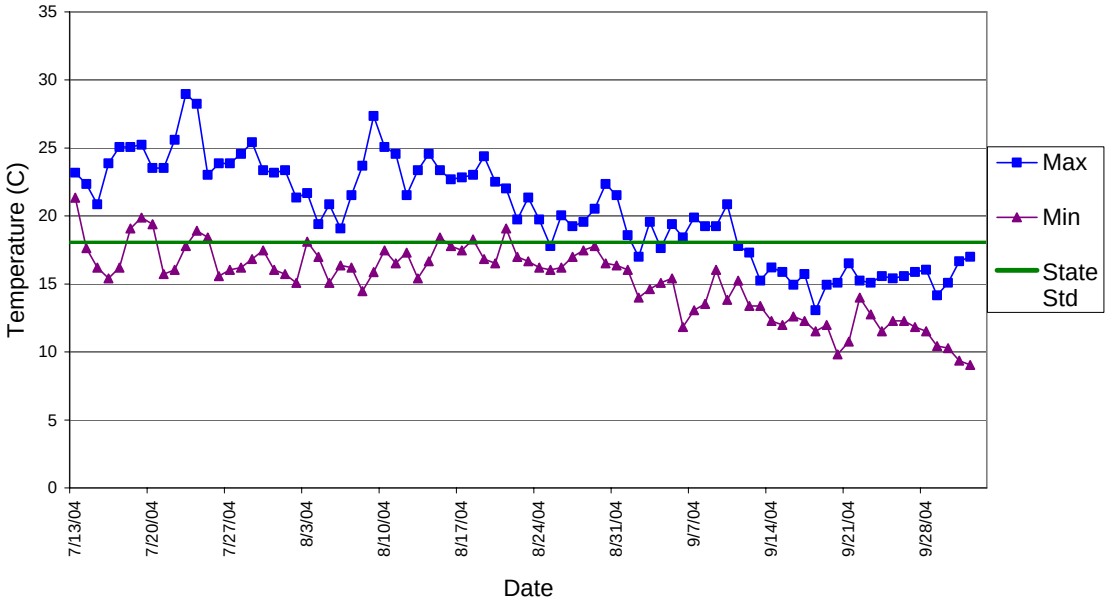
Colony Creek - Site 39
Temperature



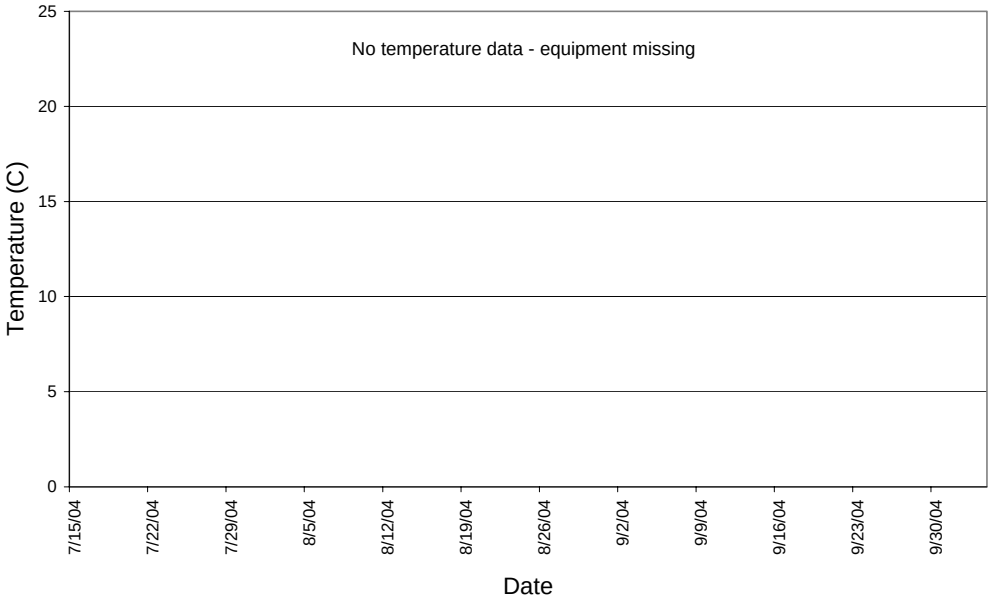
Big Indian Slough at Hwy 20 - Site 40
Temperature



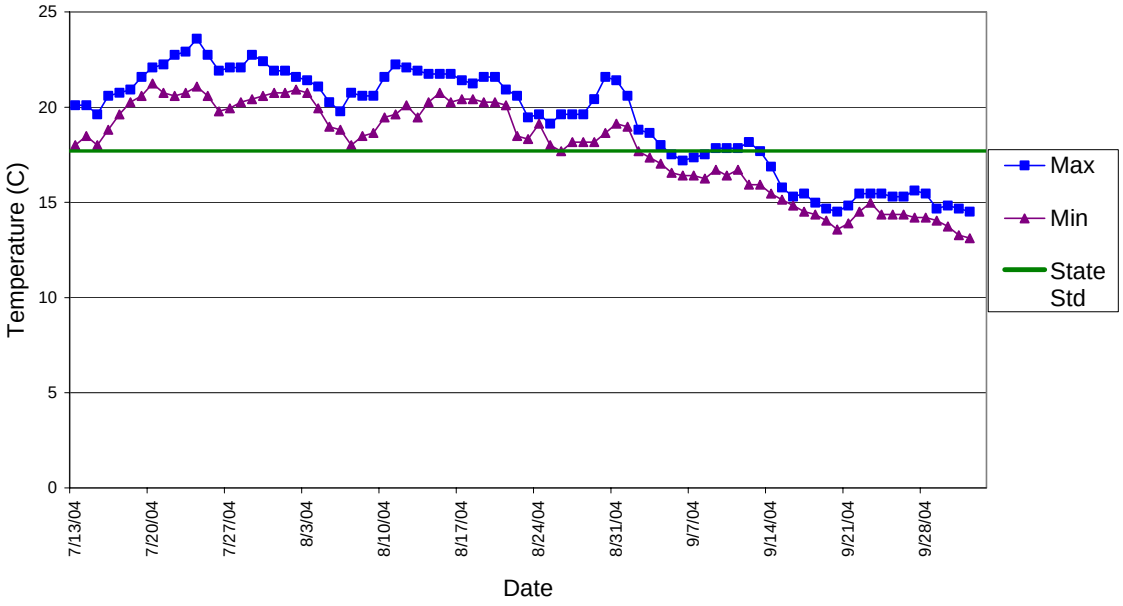
Maddox Creek/Big Ditch - Site 41
Temperature



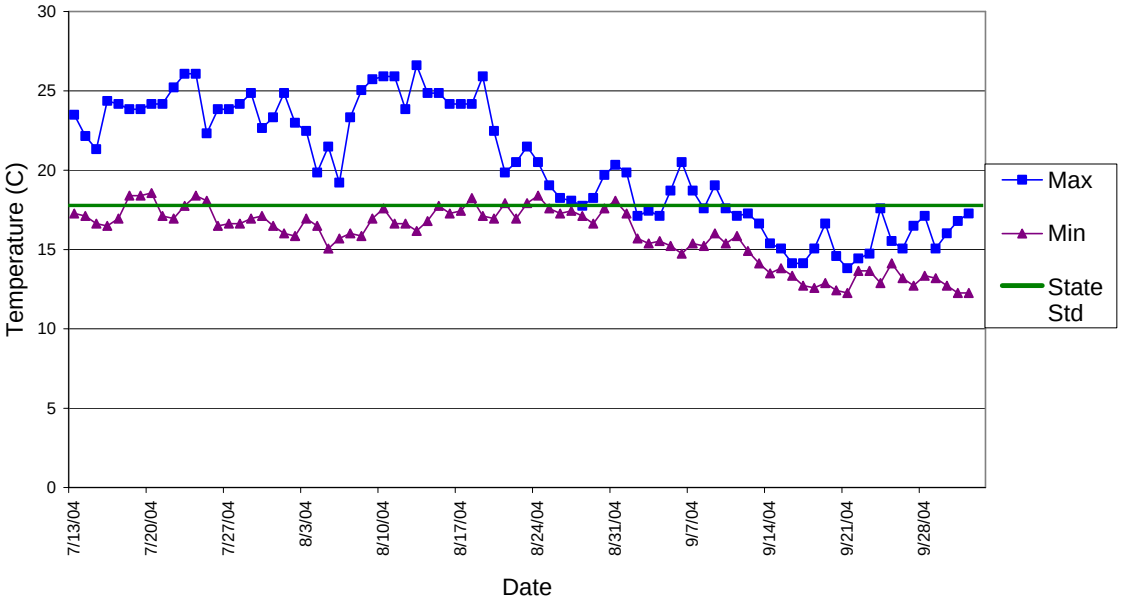
Carpenter Creek/Hill Ditch at Cedardale Rd - Site 42
Temperature



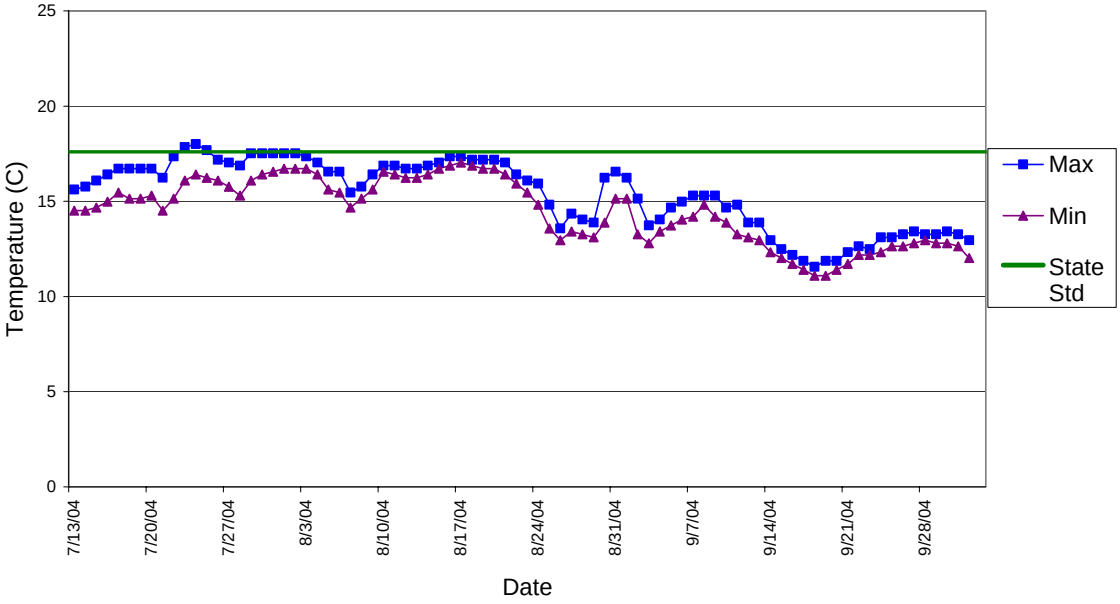
Wiley Slough - Site 43
Temperature



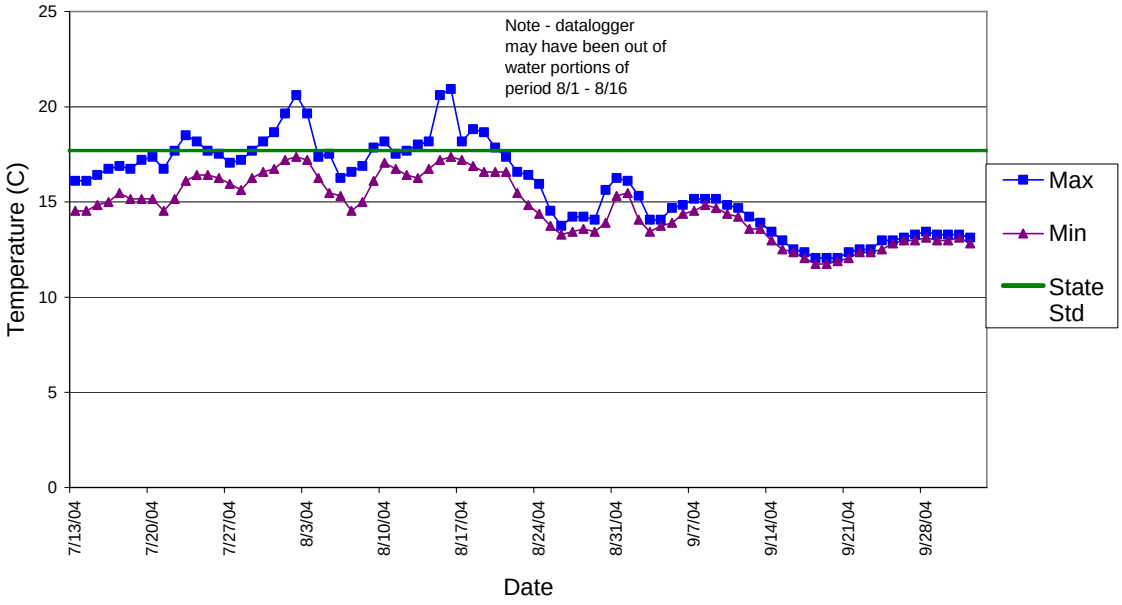
Rexville Pump Station - Site 44
Temperature



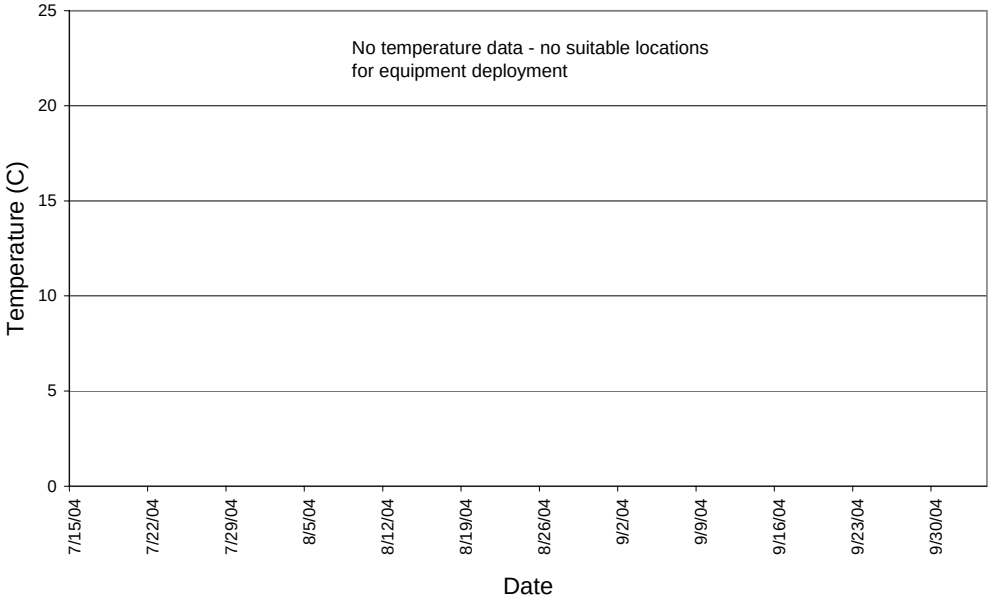
North Fork Skagit River near Moore Road - Site 45
Temperature

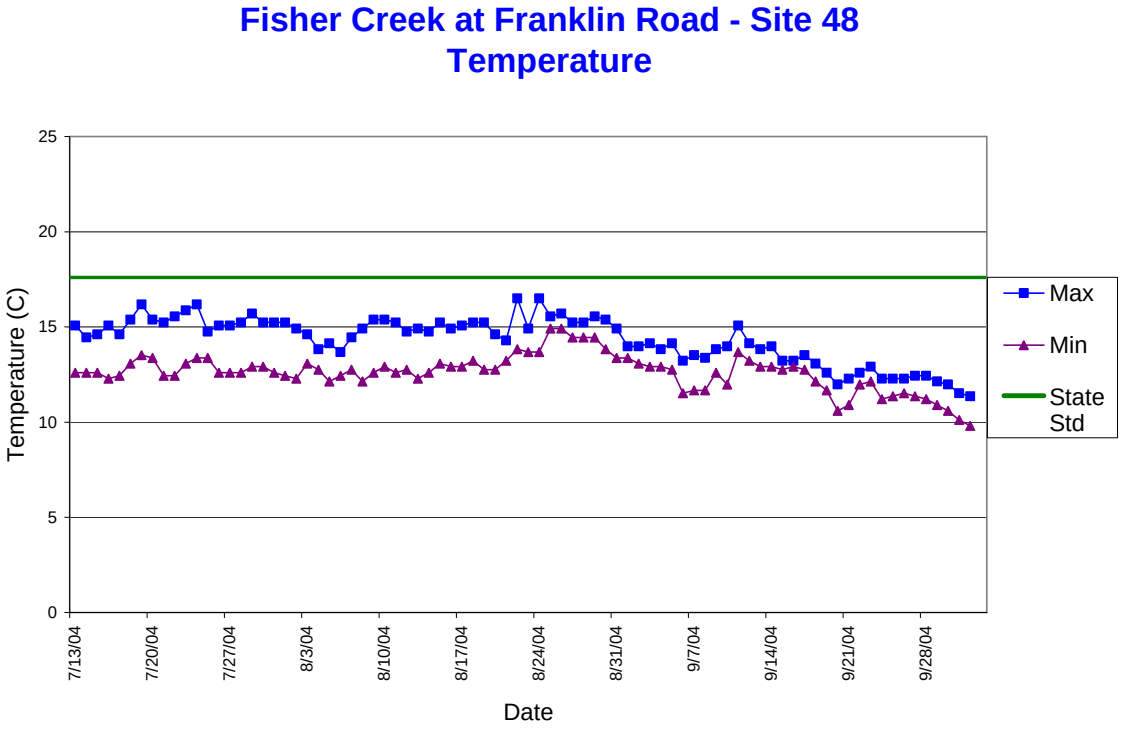


South Fork Skagit River at Conway - Site 46
Temperature



Swinomish Channel at County Boat Ramp - Site 47
Temperature





Dissolved Oxygen

Dissolved oxygen (DO) measurements determine how much oxygen is available in the water for fish and other organisms. DO measurements were taken at each site during each visit. A summary of DO readings (in mg/L) obtained during the first year of the Skagit County Monitoring Program is provided in Table 4.

The state water quality standards for dissolved oxygen are based on single-day minimum measurements. For most watercourses in the Skagit County Monitoring Program (sites 3-20, 28-29, 31-46, 48), the minimum standard is 8.0 mg/L. For the upriver sites (sites 21-25, 30), the standard is 9.5 mg/L. For the marine site (site 47), the standard is 6.0 mg/L. The solubility of oxygen in water is inversely related to temperature, so that higher temperatures frequently result in lower dissolved oxygen values.

Many streams in the Skagit County Monitoring Program meet oxygen standards all or most of the year. In a few streams, oxygen levels show steep declines in summer. These declines are usually associated with very low flows.

In the drainage infrastructure and lower sloughs, dissolved oxygen levels can be greatly influenced by algal activity. During large algae blooms, the oxygen produced during photosynthesis can lead to very high oxygen levels during the day. However, at those same times, nighttime oxygen levels can be very low as the large populations of algae turn from producing oxygen to consuming it. Because our oxygen readings are taken during the day, the monitoring program does not account for these nighttime oxygen

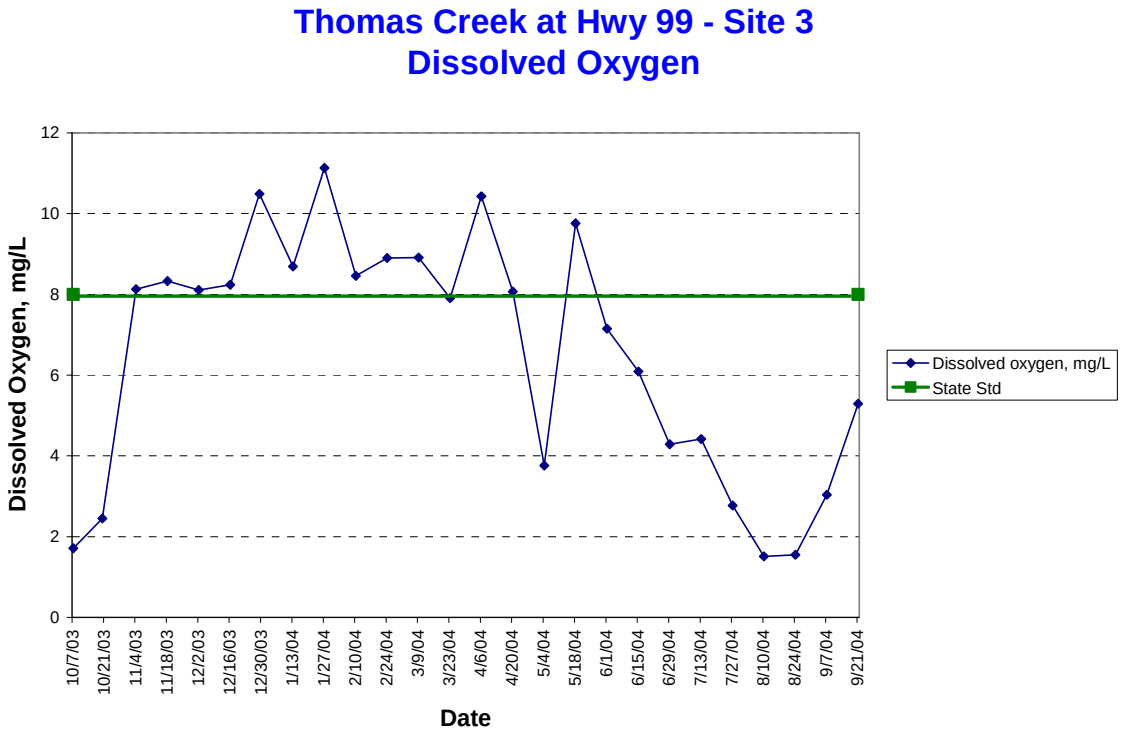
reductions. During times when algae blooms are dying off, the decomposition of the dying algae can lead to very low oxygen levels both day and night.

Table 4. Dissolved oxygen (DO) measurements and relationship to State standards for watercourses in the Skagit County Monitoring Program.

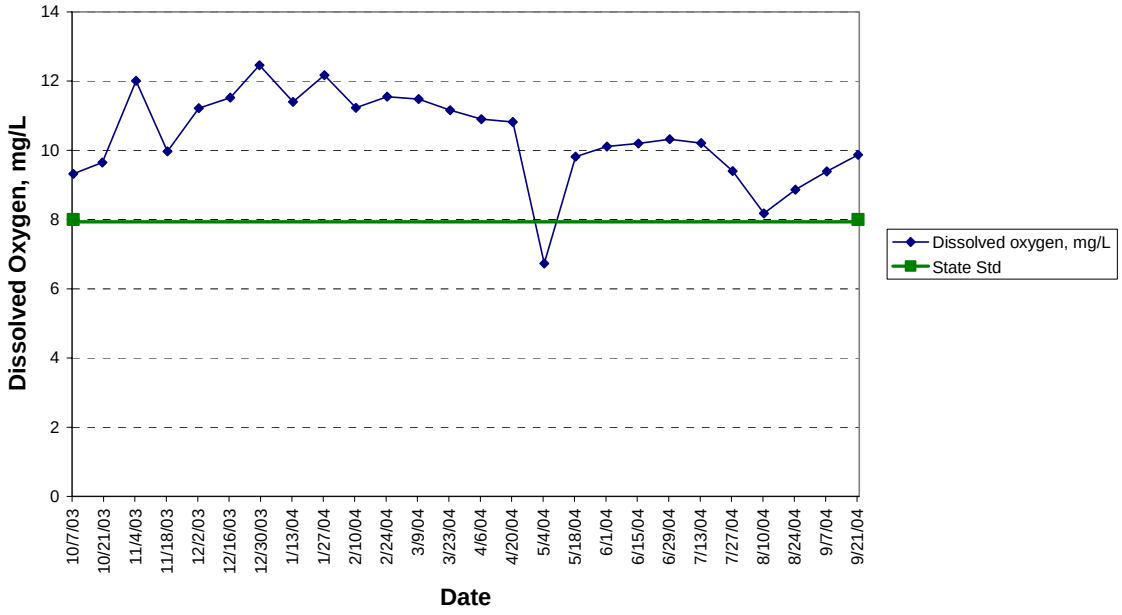
Site Number	Watercourse	Location	Mean DO (mg/L)	Minimum DO (mg/L)	St. Std[1]
3	Thomas Ck	Old Hwy 99 N	6.52	1.51	8.0
4	Thomas Ck	F&S Grade	10.38	6.73	8.0
6	Friday Ck	Prairie Rd	10.54	6.95	8.0
8	Swede Ck	Grip Rd	10.43	6.61	8.0
11	Samish R	State Route 9	8.17	4.70	8.0
12	Nookachamps Ck	Swan Rd	9.01	3.30	8.0
13	E.F. Nookachamps Ck	State Route 9	9.30	4.21	8.0
14	College Way Ck	College Way	8.99	5.15	8.0
15	Nookachamps Ck	Knapp	7.78	1.80	8.0
16	E.F. Nookachamps Ck	Beaver Lake Rd	11.15	8.22	8.0
17	Nookachamps Ck	Big Lake Outlet	9.71	5.95	8.0
18	Lake Ck	State Route 9	10.74	8.45	8.0
19	Hansen Ck	Hoehn Rd	10.04	5.73	8.0
20	Hansen Ck	Northern State	10.54	7.34	8.0
21	Coal Ck	Hoehn Rd	10.67	7.38	9.5
22	Coal Ck	Hwy 20	11.66	9.42	9.5
23	Wiseman Ck	Minkler Rd	11.62	8.87	9.5
24	Mannser Ck	Lyman Hamilton Hwy	6.11	1.97	9.5
25	Red Cabin Ck	Hamilton Cem Rd	11.57	10.22	9.5
28	Brickyard Ck	Hwy 20	8.61	4.34	8.0
29	Skagit R	River Bend Rd	11.20	9.57	8.0
30	Skagit R	Cape Horn Rd	11.03	8.35	9.5
31	Drain Dist 20 floodgate	Francis Rd	8.68	5.26	8.0
32	Samish R	Thomas Rd	10.30	6.86	8.0
33	Alice Bay Pump Station	Samish Island Rd	10.37	3.88	8.0
34	Noname Slough	Bayview-Edison Rd	5.86	0.98	8.0
35	Joe Leary Slough	D'Arcy Rd	5.15	2.74	8.0
36	Edison Slough at school	W. Bow Hill Rd	9.31	4.70	8.0
37	Edison Drain. in Edison	Farm to Market Rd	7.58	1.54	8.0
38	Drainage north of Edison	North Edison Rd	6.53	2.33	8.0
39	Colony Ck	Colony Rd	10.11	6.11	8.0
40	Big Indian Slough	Bayview-Edison Rd	3.98	1.46	8.0
41	Maddox Slough/Big Ditch	Milltown Rd	5.16	0.75	8.0
42	Hill Ditch	Cedardale Rd	6.73	2.05	8.0
43	Wiley Slough	Wylie Rd	4.88	0.14	8.0
44	Rexville Pump Station	Summers Drive	4.23	0.09	8.0
45	Skagit R – North Fork	Moore Rd	11.15	9.11	8.0
46	Skagit R – South Fork	Fir Island Rd	11.03	9.30	8.0
47	Swinomish Channel	County Boat Launch	8.39	6.57	6.0
48	Fisher Ck	Franklin Rd	10.81	8.91	8.0

[1]Washington State Water Quality Standard per WAC 173-201A

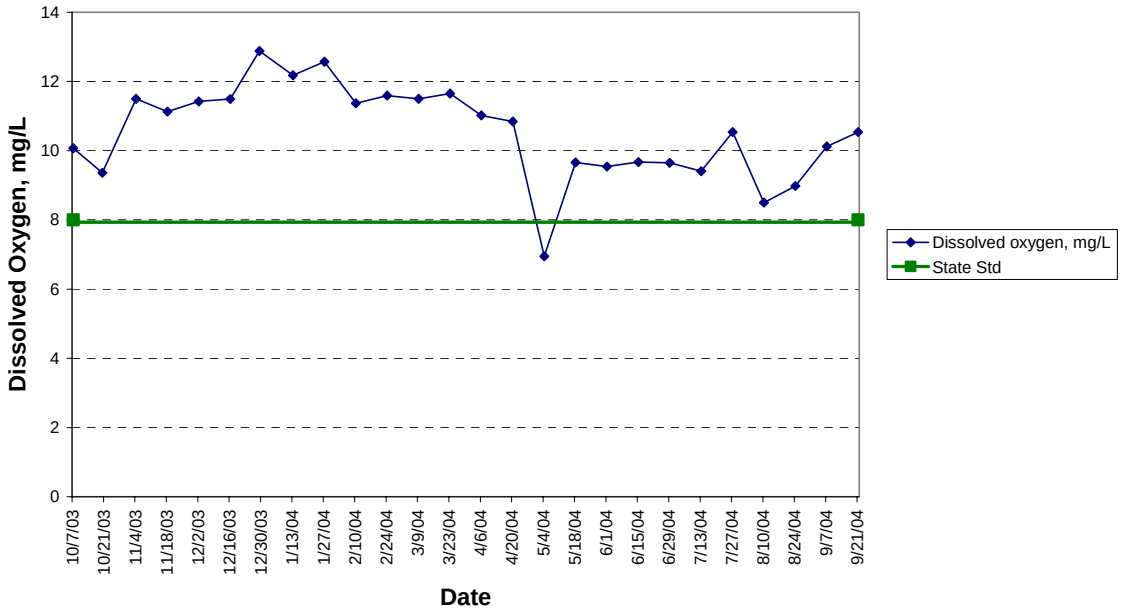
Graphs on the following pages illustrate dissolved oxygen measurements over time for each sampling station.



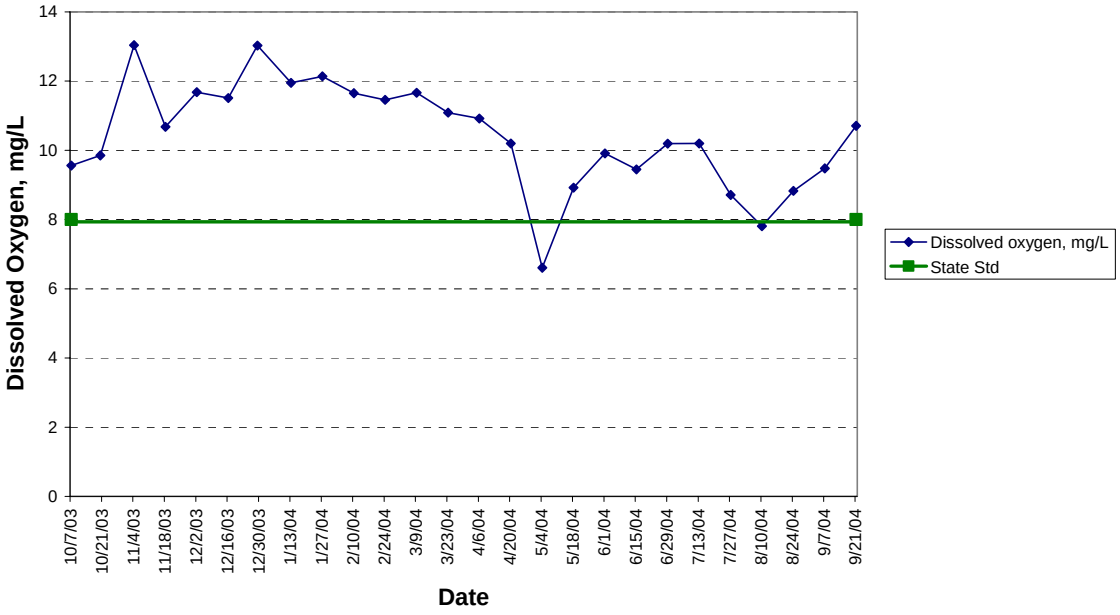
Thomas Creek at F&S Grade Rd - Site 4
Dissolved Oxygen



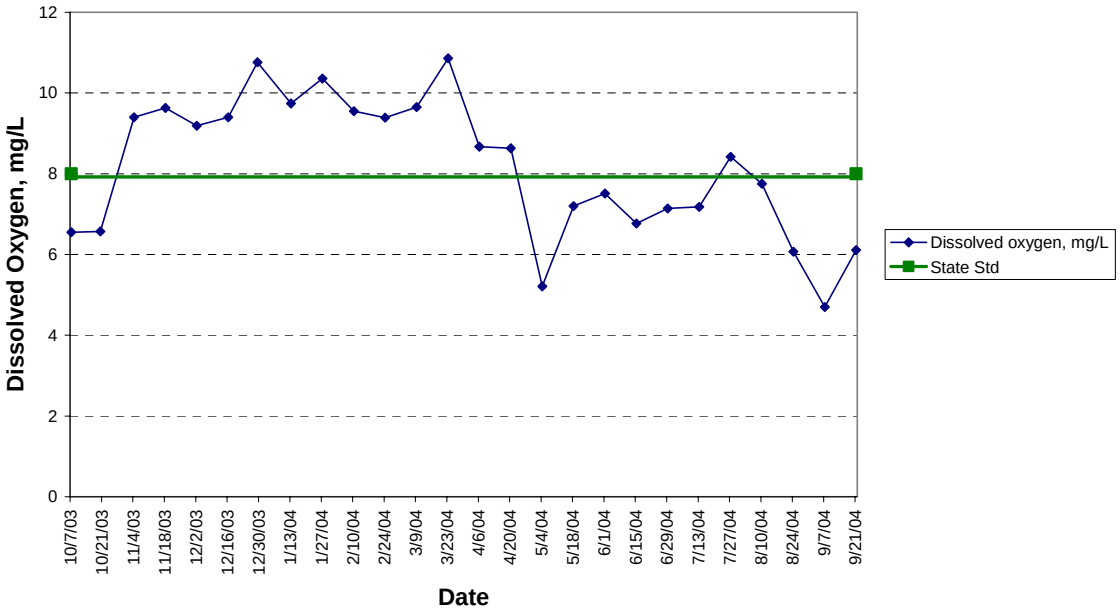
Friday Creek at Prairie Rd - Site 6
Dissolved Oxygen



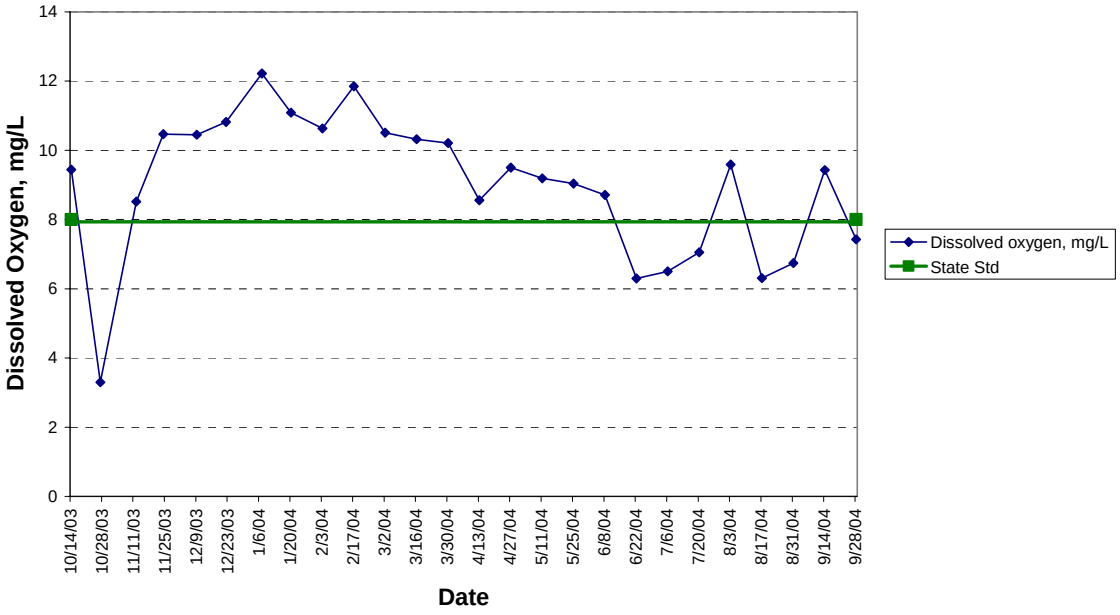
Swede Creek at Grip Rd - Site 8
Dissolved Oxygen



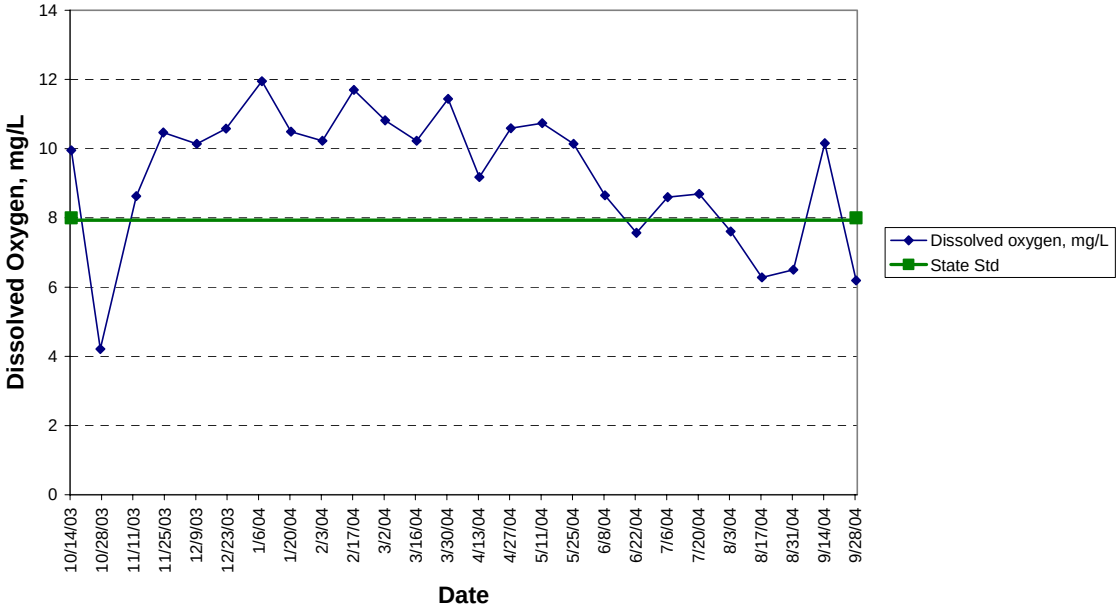
Samish River at Hwy 9 - Site 11
Dissolved Oxygen



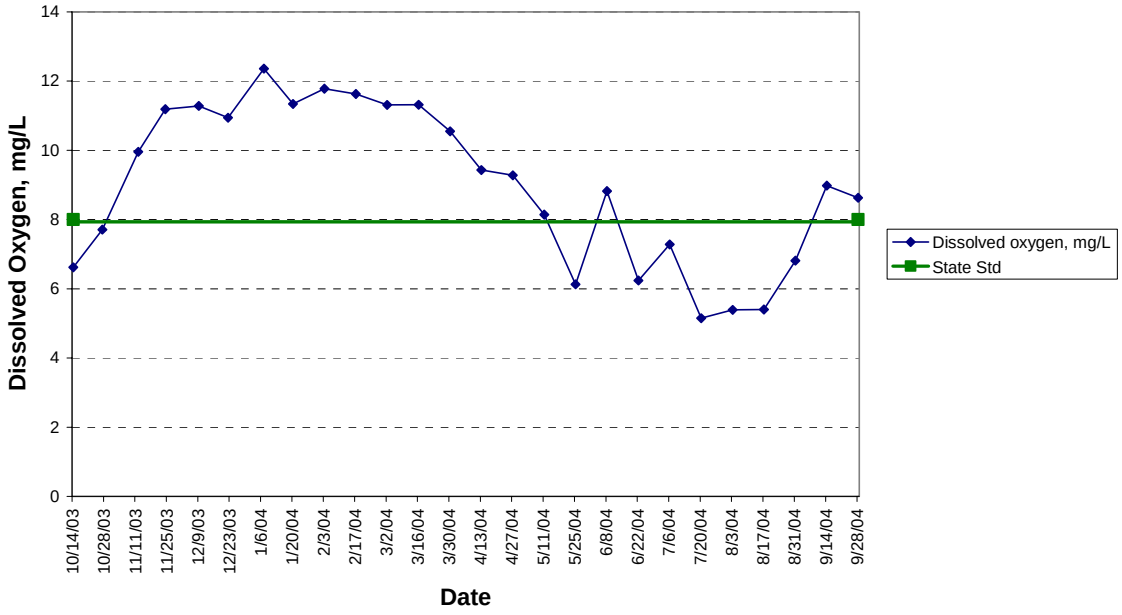
Nookachamps Creek at Swan Rd - Site 12
Dissolved Oxygen



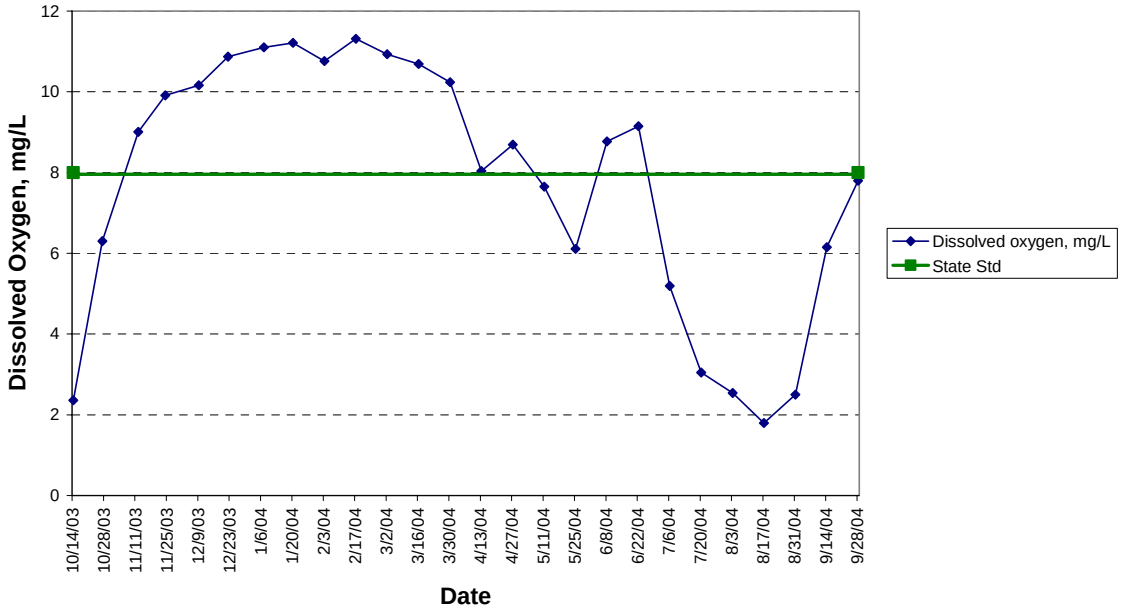
E.F. Nookachamps Creek at Hwy 9 - Site 13
Dissolved Oxygen



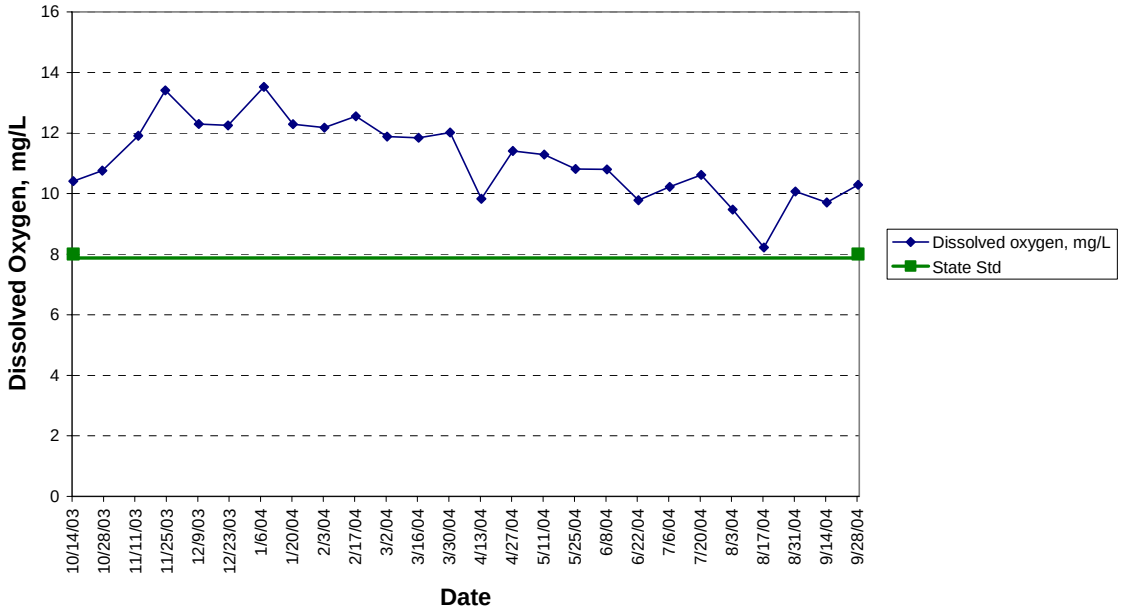
College Way Creek at College Way - Site 14
Dissolved Oxygen



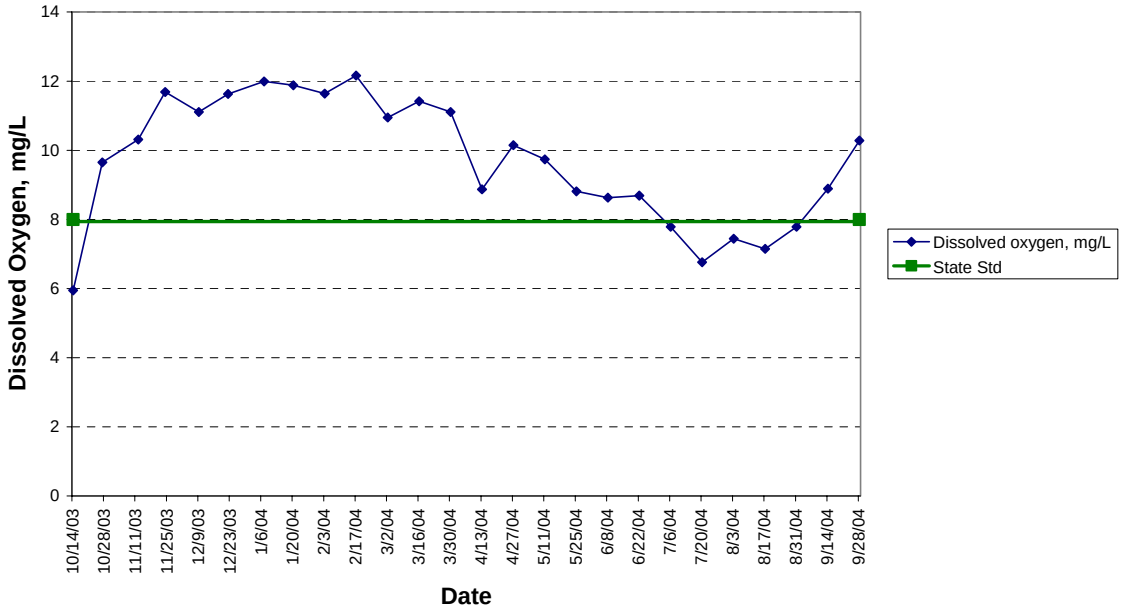
Nookachamps Creek at Knapp Rd - Site 15
Dissolved Oxygen



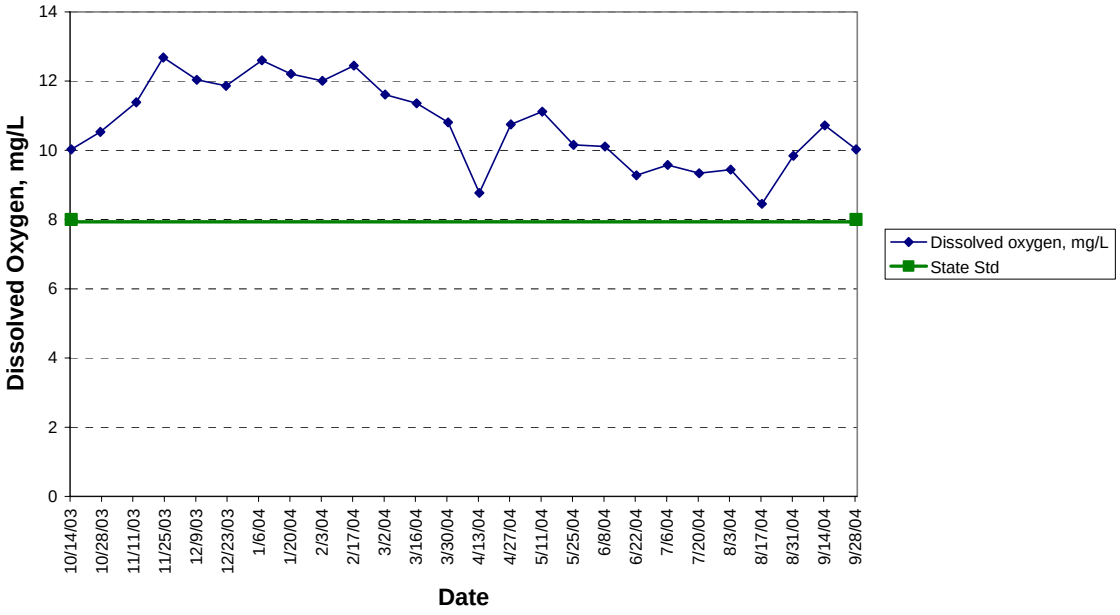
E.F. Nookachamps Creek at Beaver Lk Rd - Site 16
Dissolved Oxygen



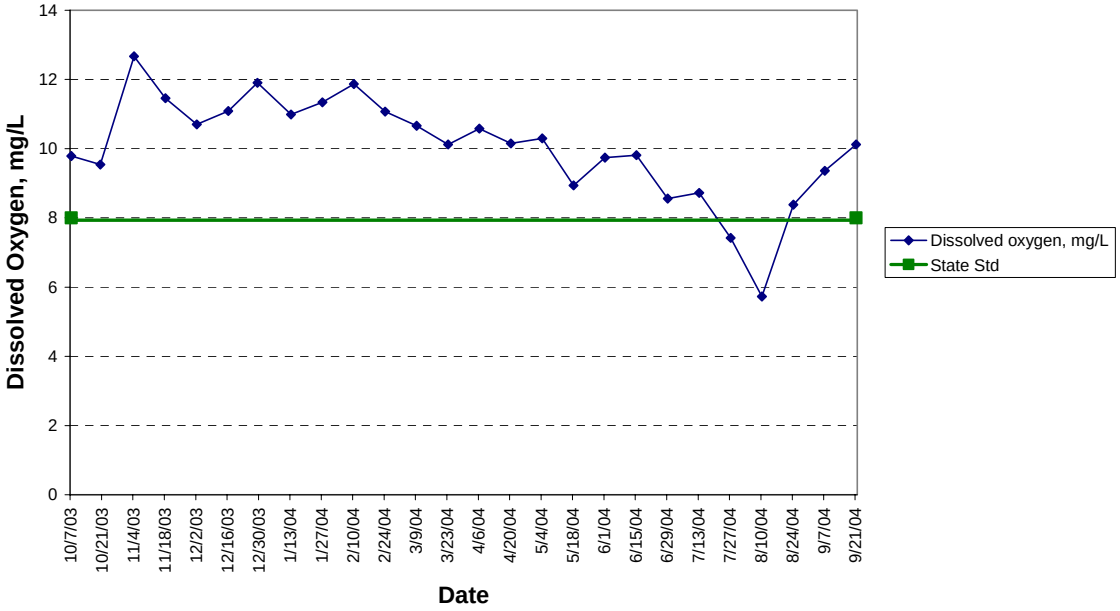
Nookachamps Creek at Big Lake Outlet - Site 17
Dissolved Oxygen



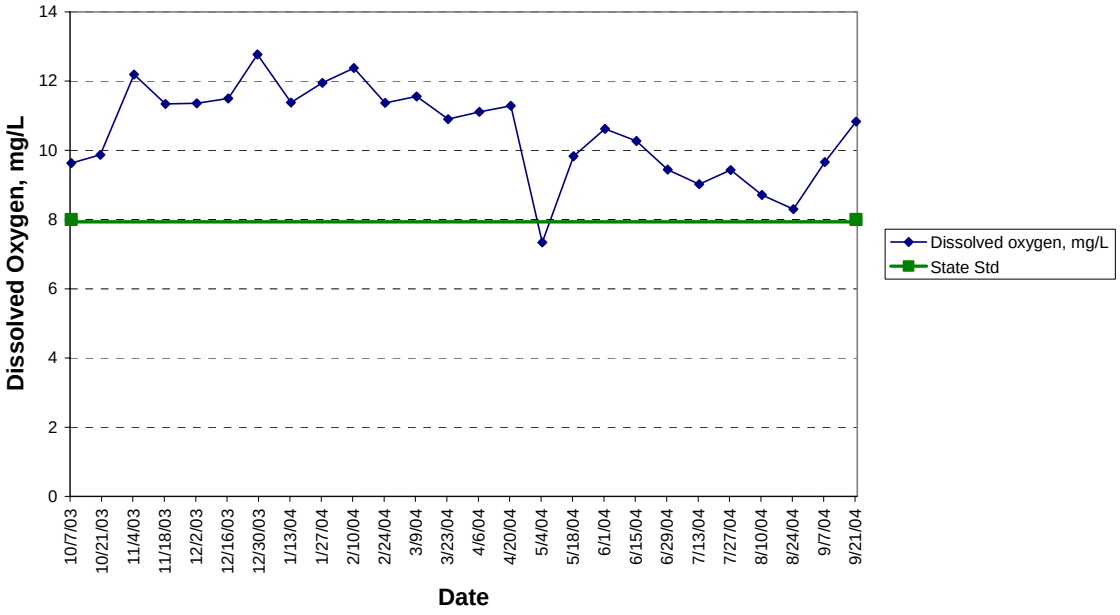
Lake Creek at Hwy 9 - Site 18
Dissolved Oxygen



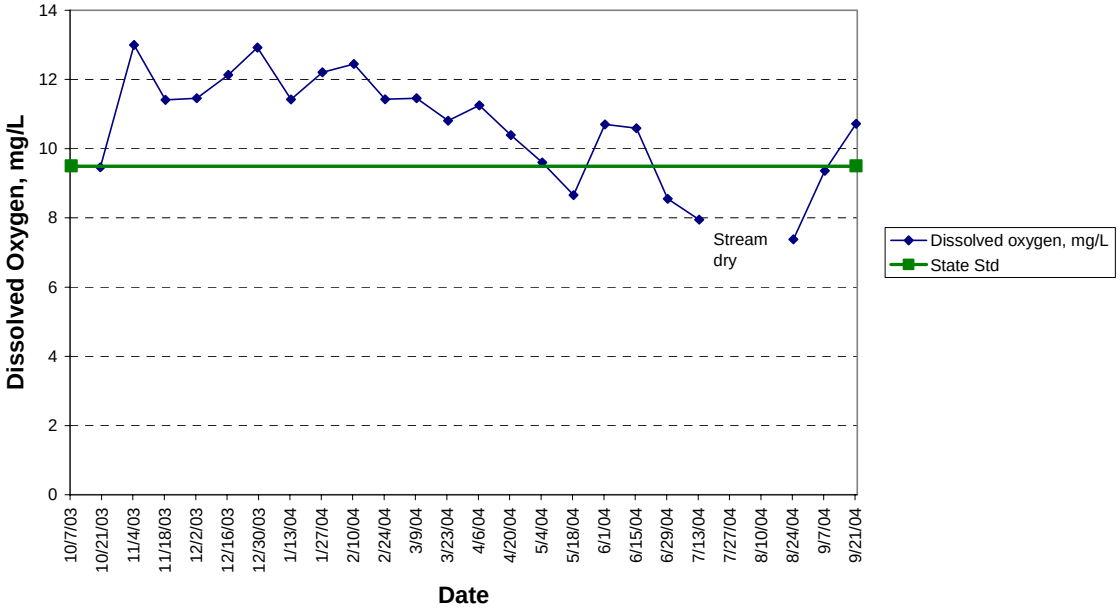
Hansen Creek at Hoehn Rd - Site 19
Dissolved Oxygen



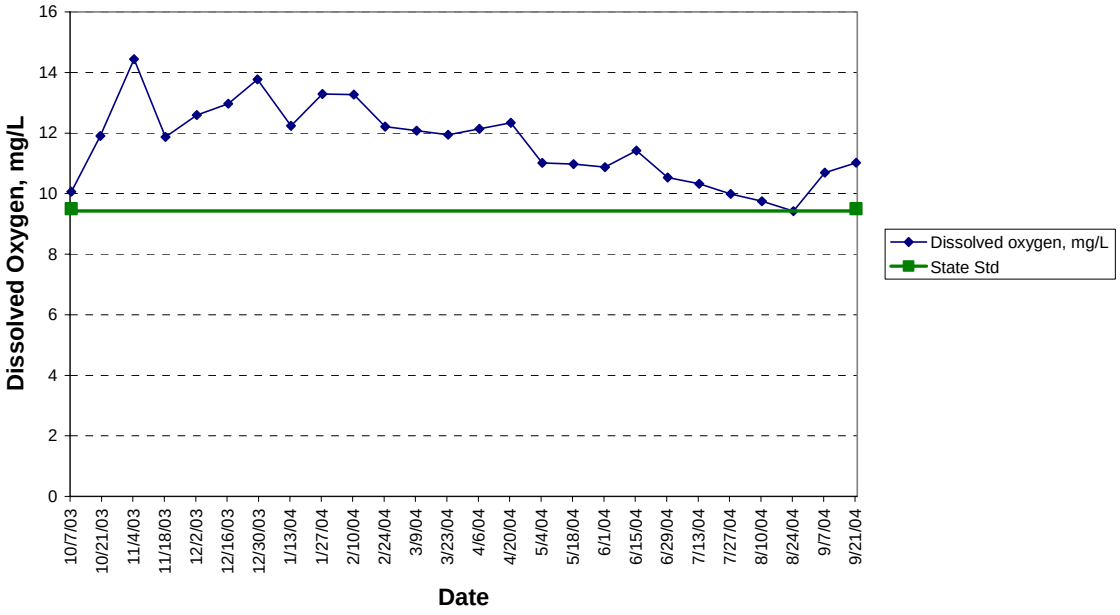
Hansen Creek at Northern State Hospital - Site 20
Dissolved Oxygen



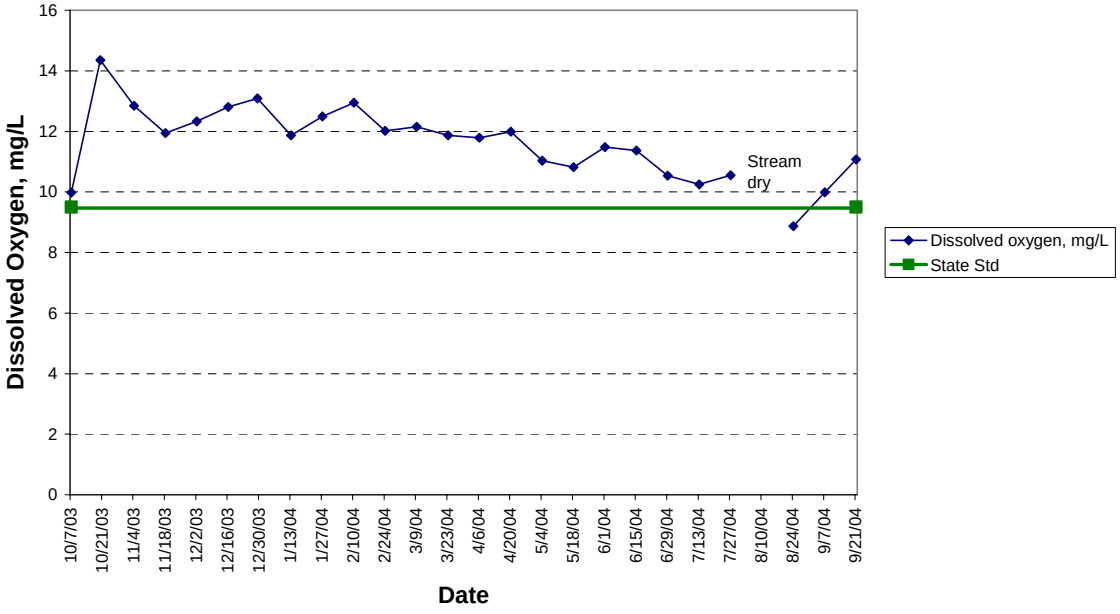
Coal Creek at Hoehn Rd - Site 21
Dissolved Oxygen



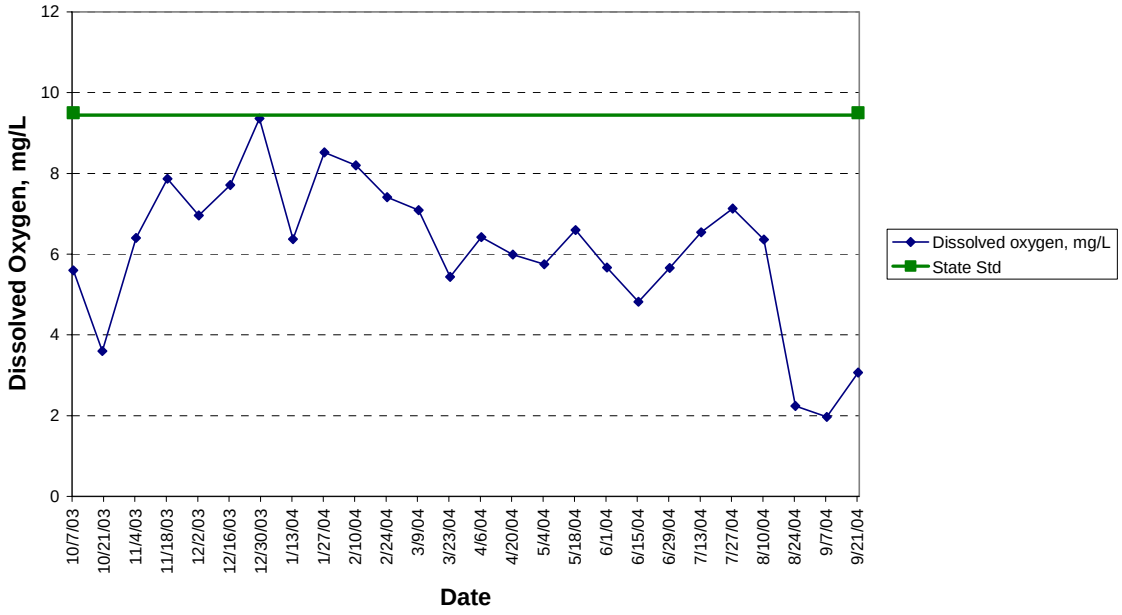
Coal Creek at Hwy 20 - Site 22
Dissolved Oxygen



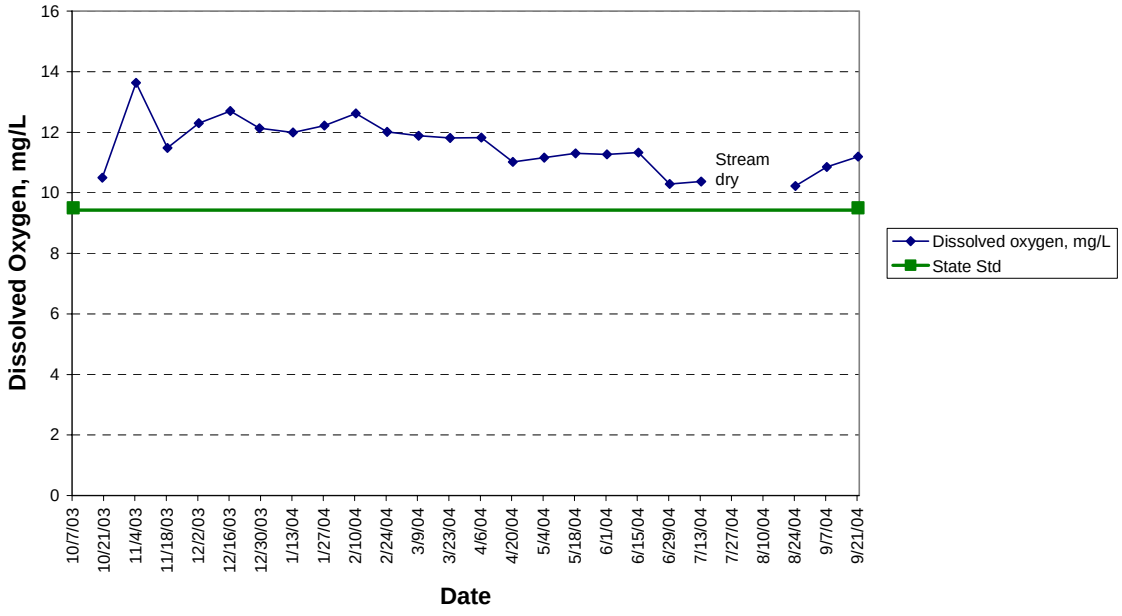
Wiseman Creek at Minkler Rd - Site 23
Dissolved Oxygen



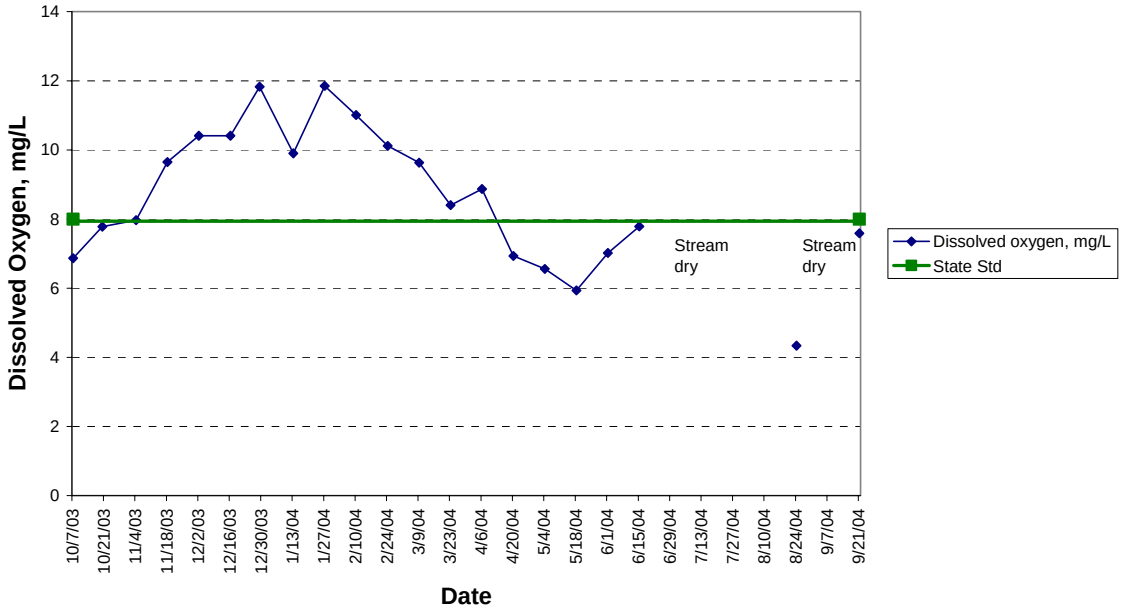
Mannser Creek at Lyman-Hamilton Hwy - Site 24
Dissolved Oxygen



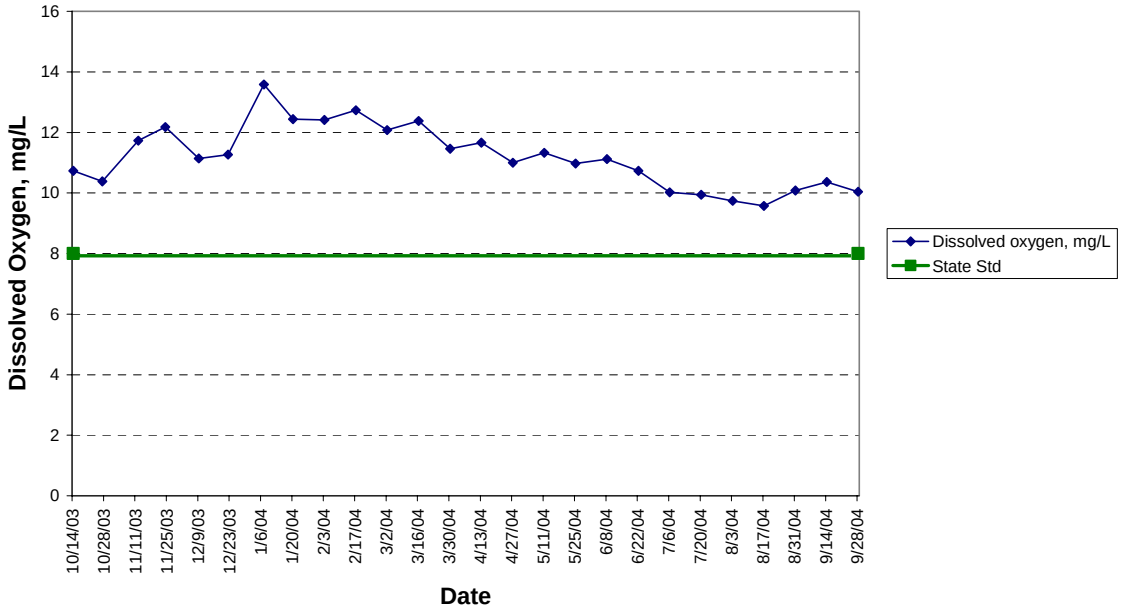
Red Cabin Creek at Hamilton Cemetery Rd - Site 25
Dissolved Oxygen



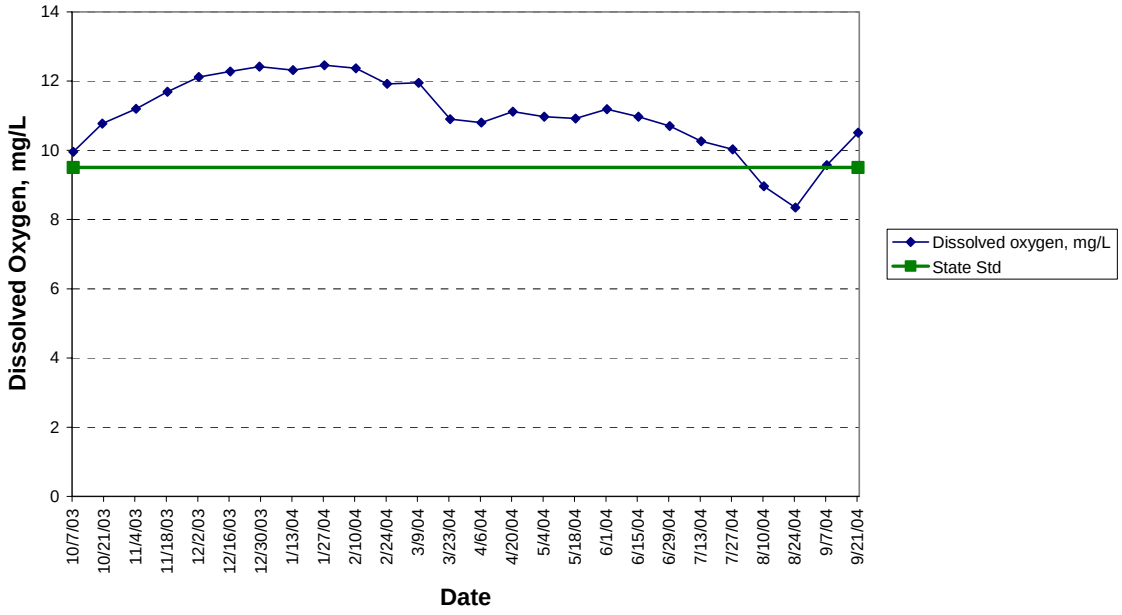
Brickyard Creek at Hwy 20 - Site 28
Dissolved Oxygen



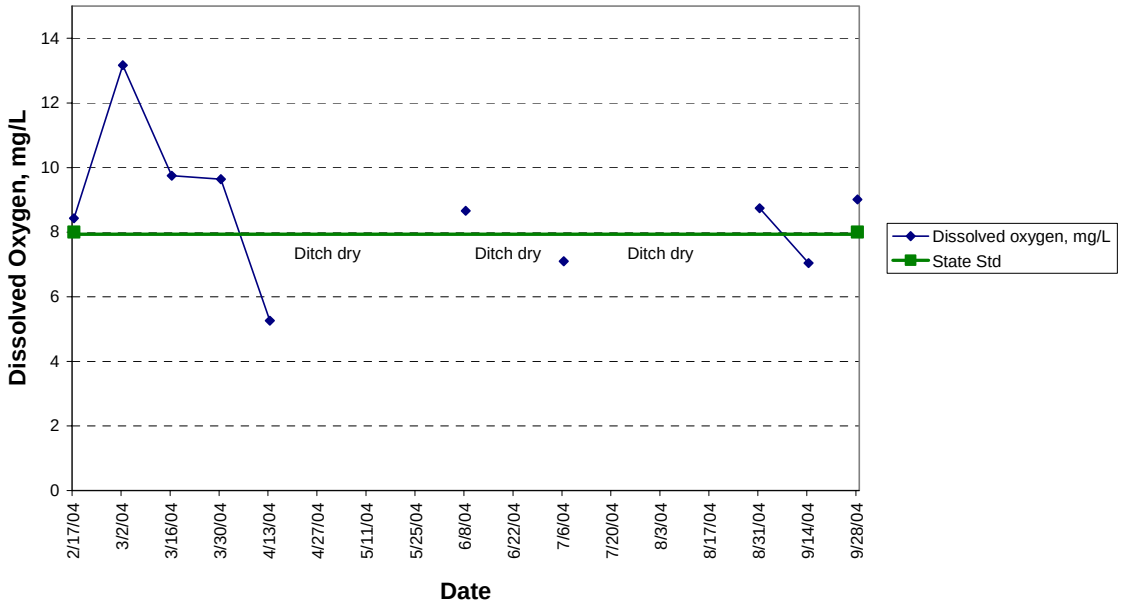
Skagit River at River Bend - Site 29
Dissolved Oxygen



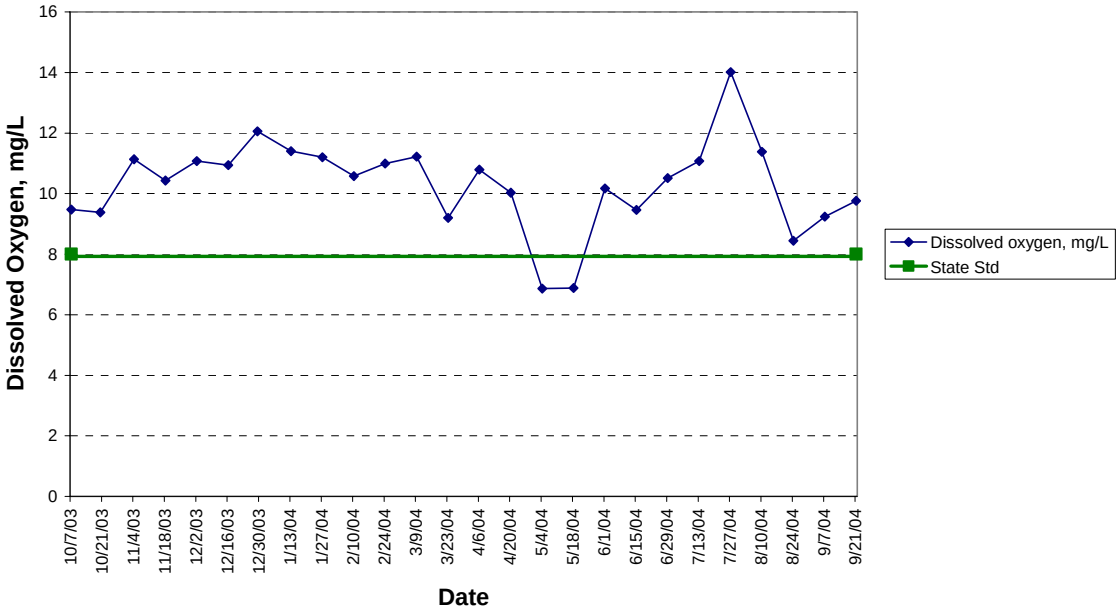
Skagit River at Cape Horn Rd - Site 30
Dissolved Oxygen



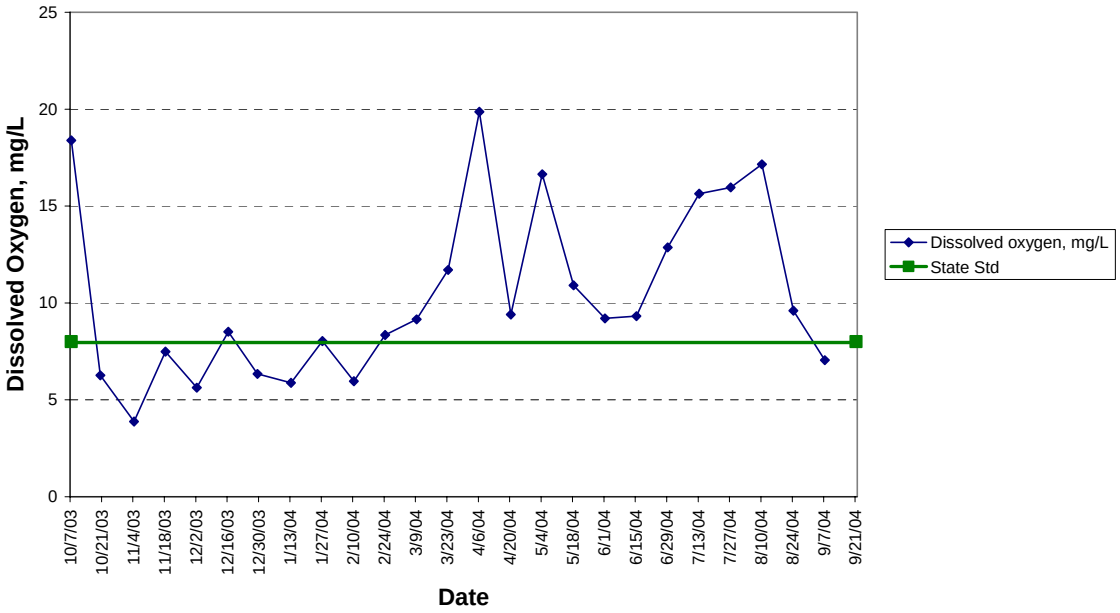
Drainage District 20 Ditch at Floodgate - Site 31
Dissolved Oxygen



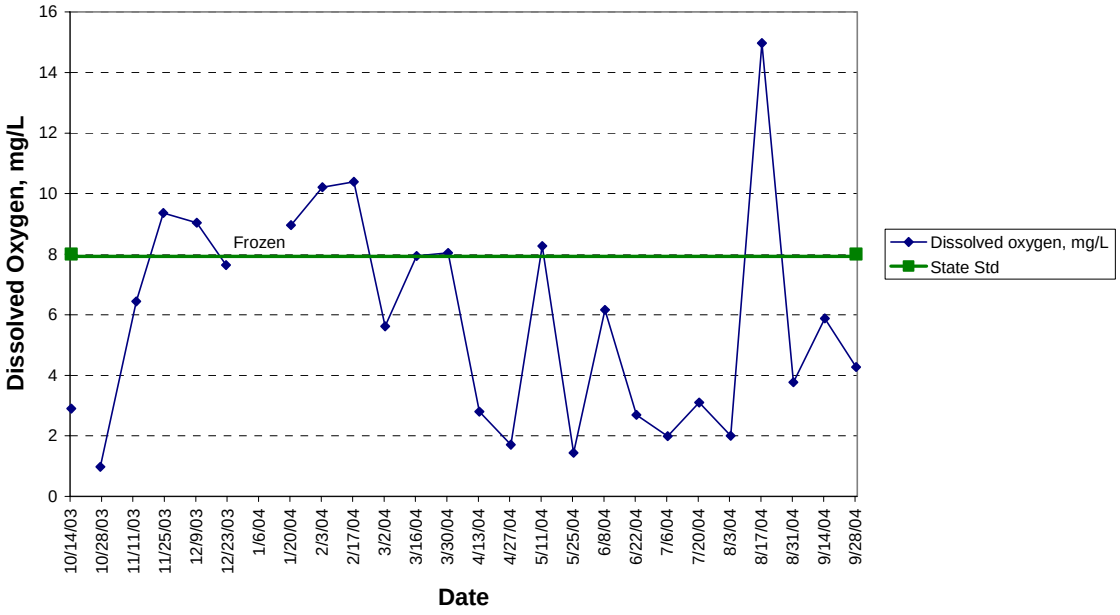
Samish River at Thomas Rd - Site 32
Dissolved Oxygen



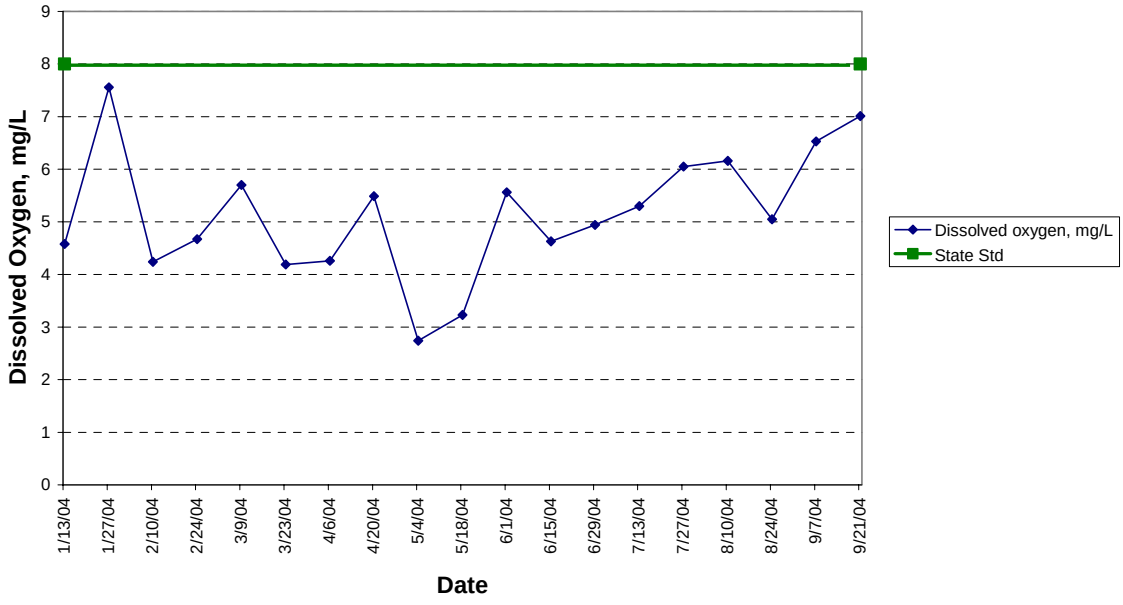
Alice Bay Pump Station - Site 33
Dissolved Oxygen



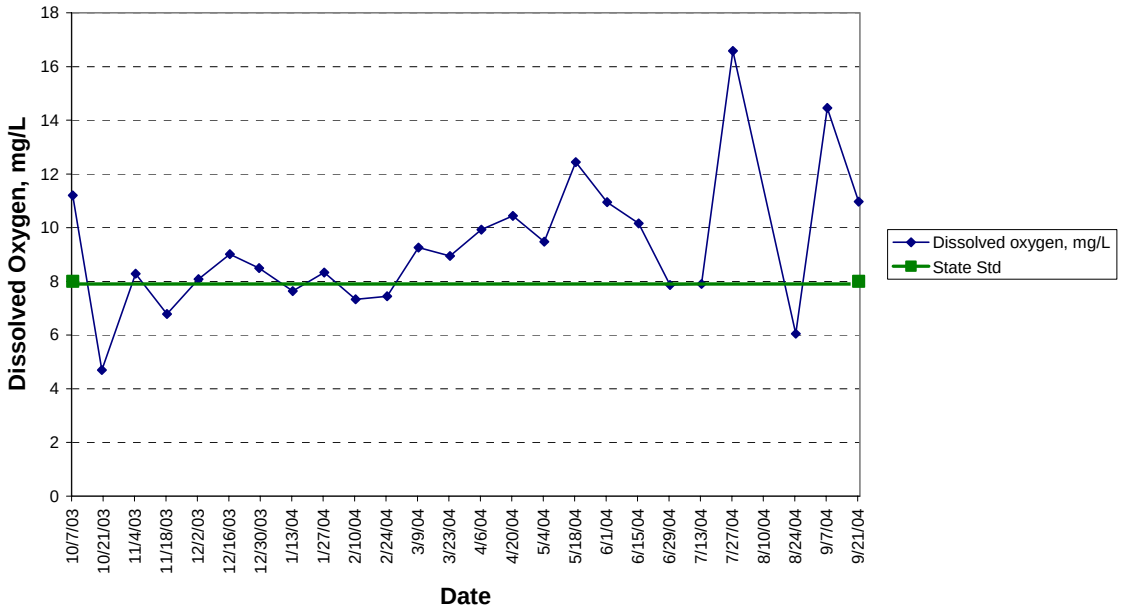
No Name Slough at Bayview-Edison Rd - Site 34
Dissolved Oxygen



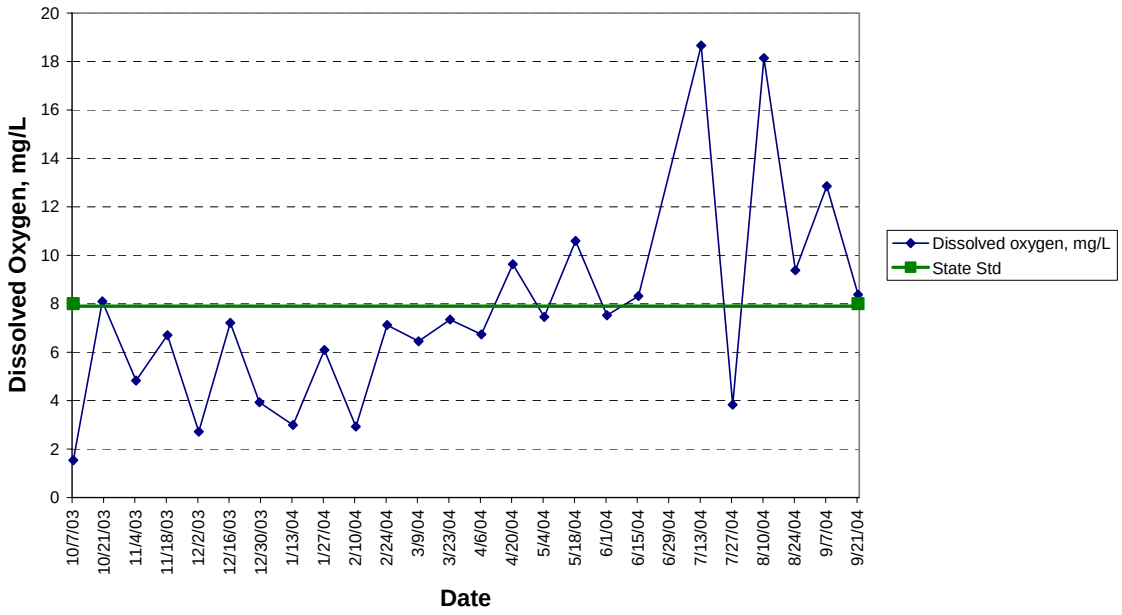
Joe Leary Slough at D'Arcy Rd - Site 35
Dissolved Oxygen



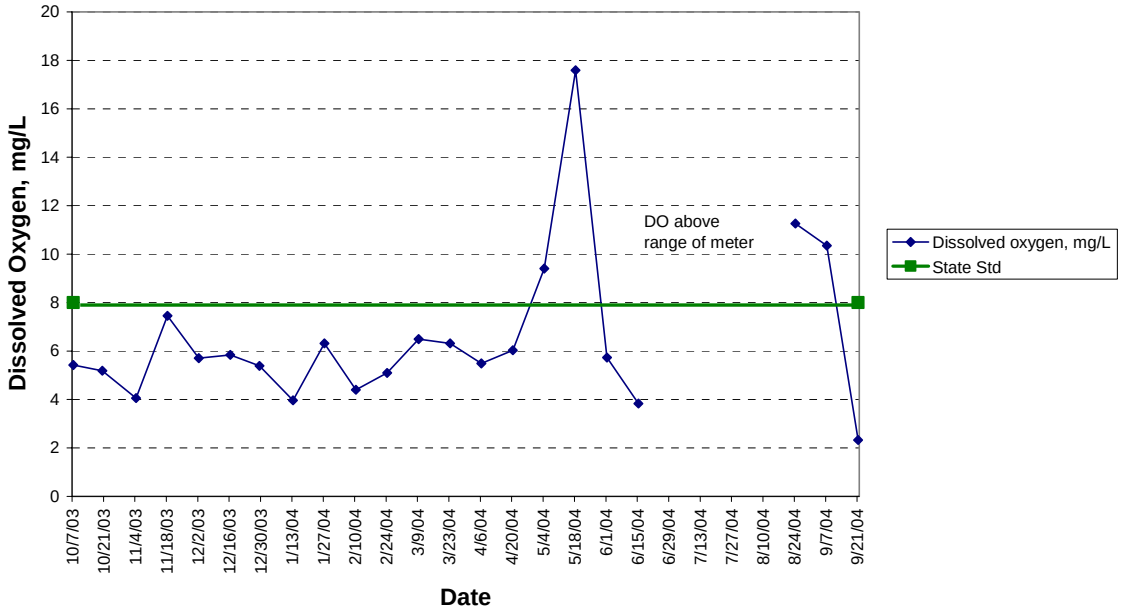
Edison Slough at Edison School - Site 36
Dissolved Oxygen



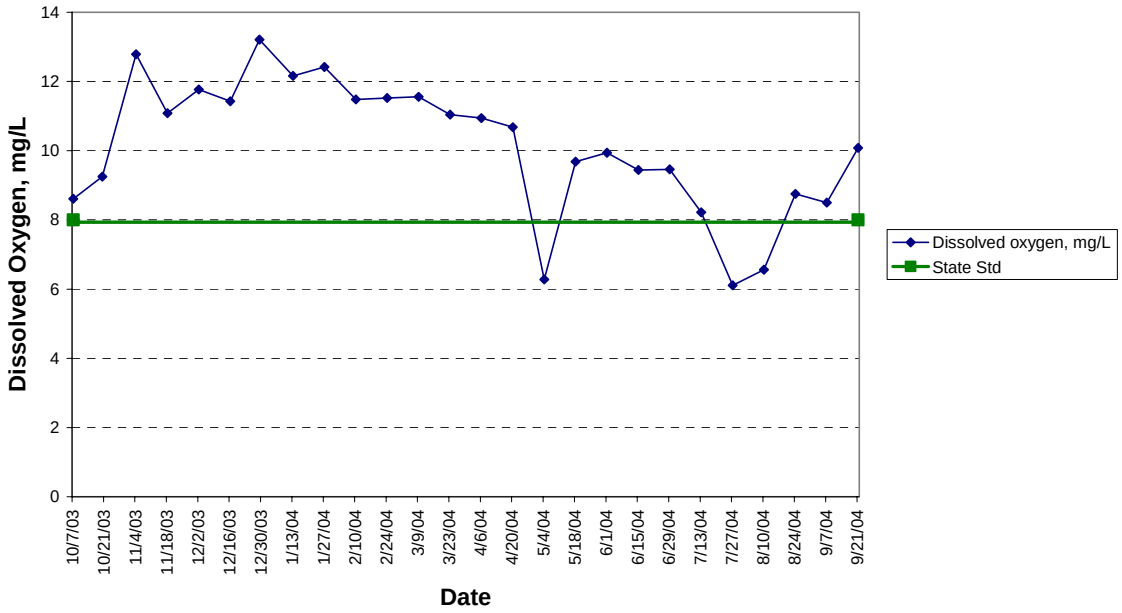
Edison Pump Station - Site 37
Dissolved Oxygen



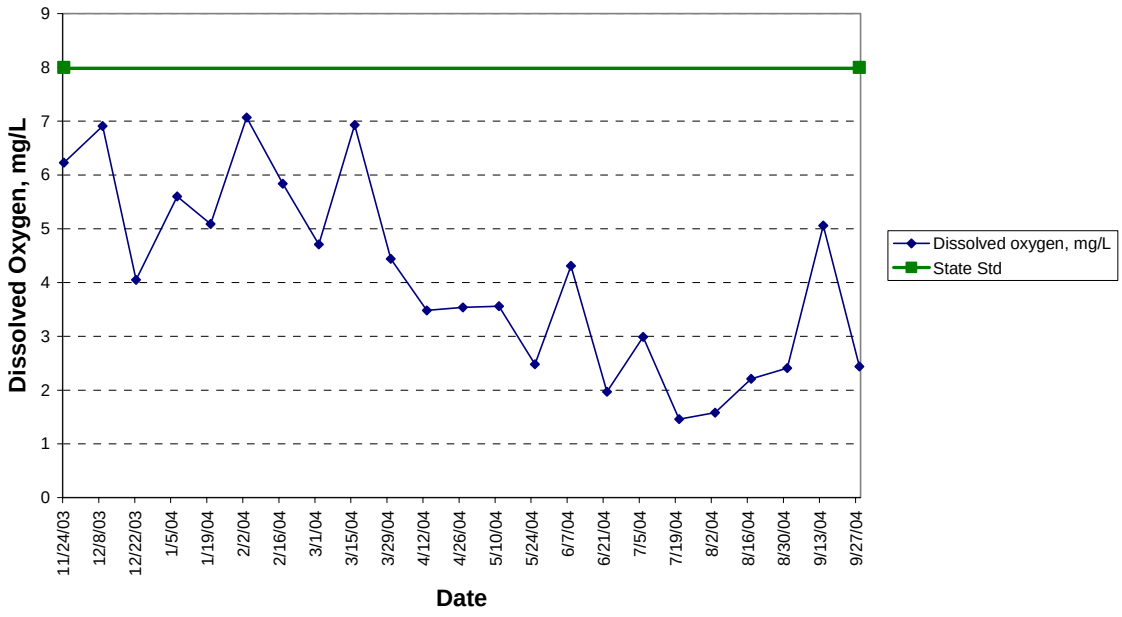
North Edison Pump Station - Site 38
Dissolved Oxygen



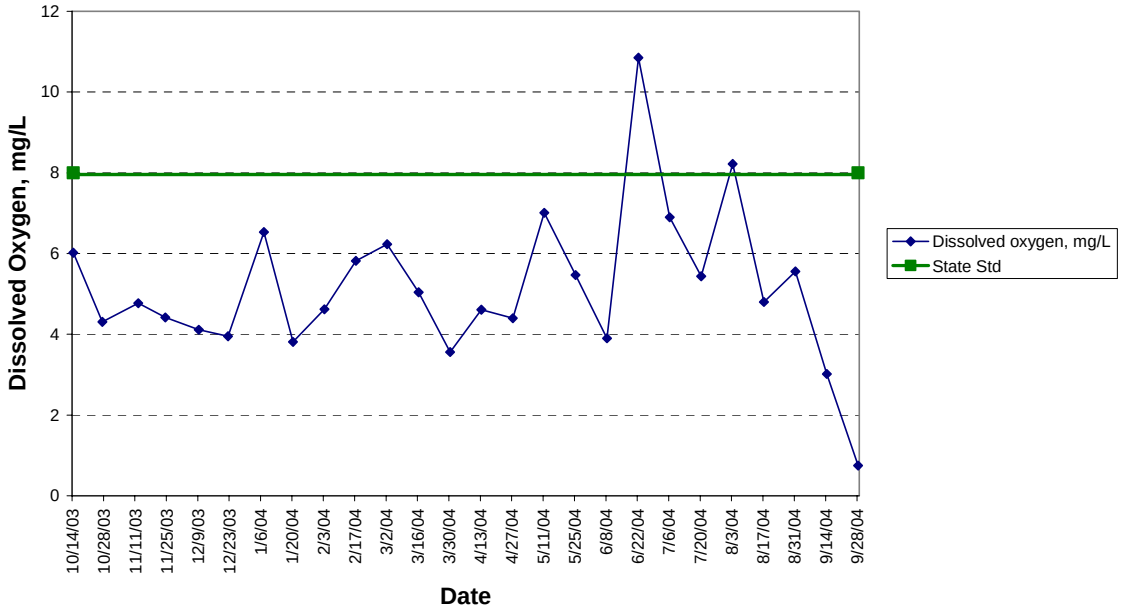
Colony Creek at Colony Rd - Site 39
Dissolved Oxygen



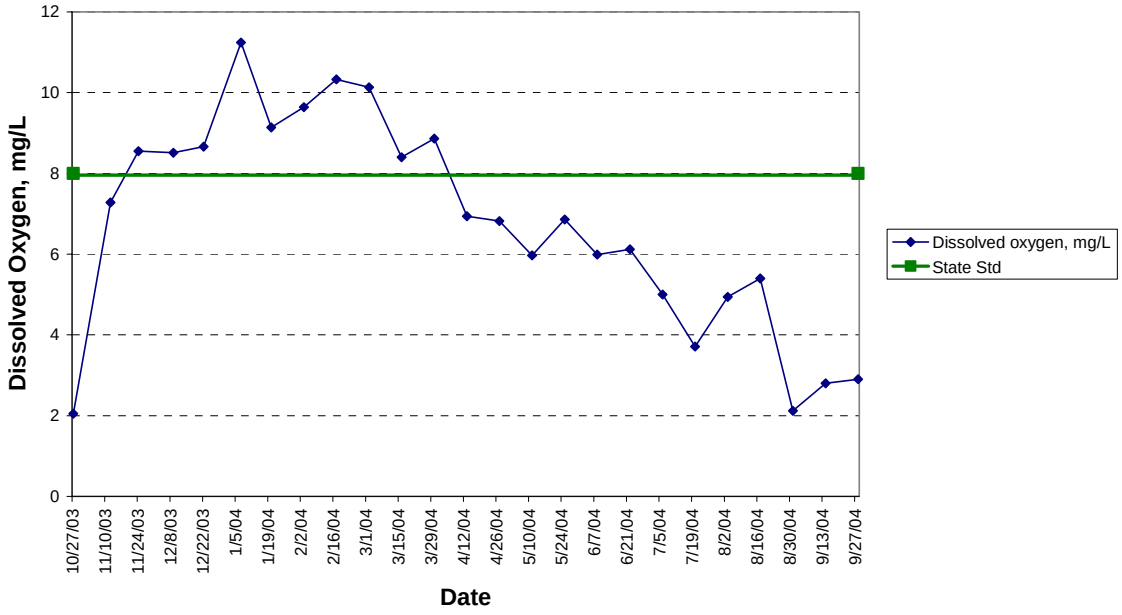
Big Indian Slough at Hwy 20 Truck Scales - Site 40
Dissolved Oxygen



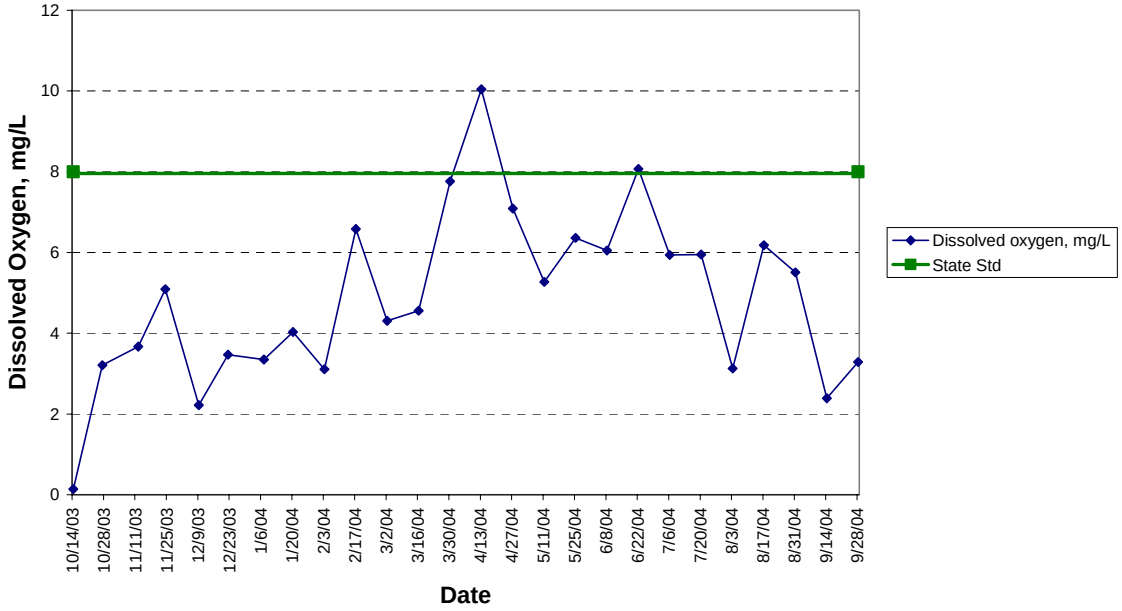
Maddox Creek/Big Ditch at Milltown Rd - Site 41
Dissolved Oxygen



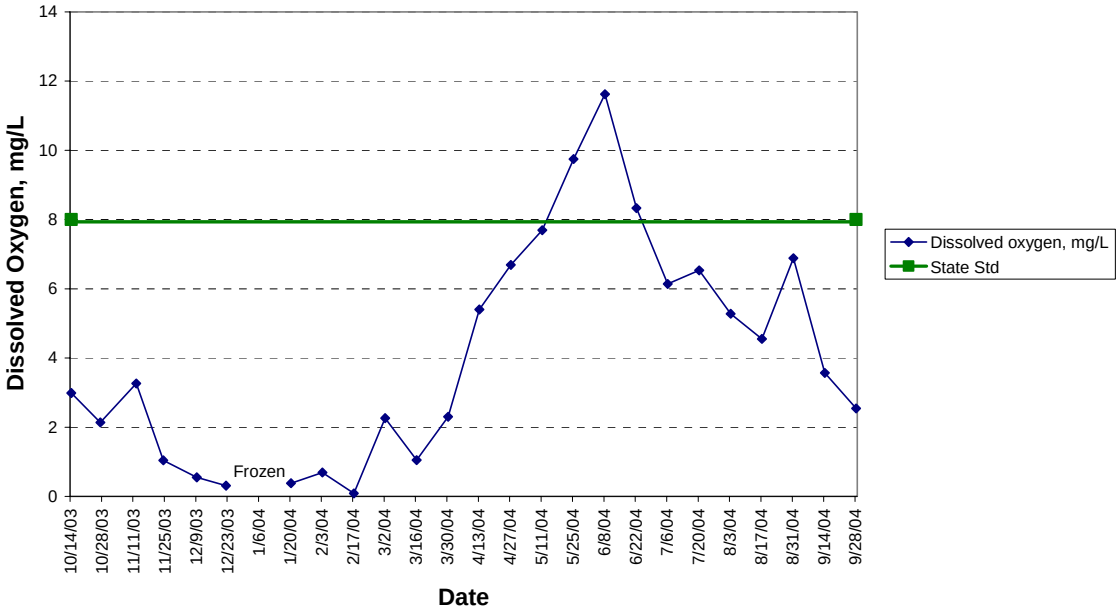
Carpenter Creek/Hill Ditch at Cedardale Rd - Site 42
Dissolved Oxygen



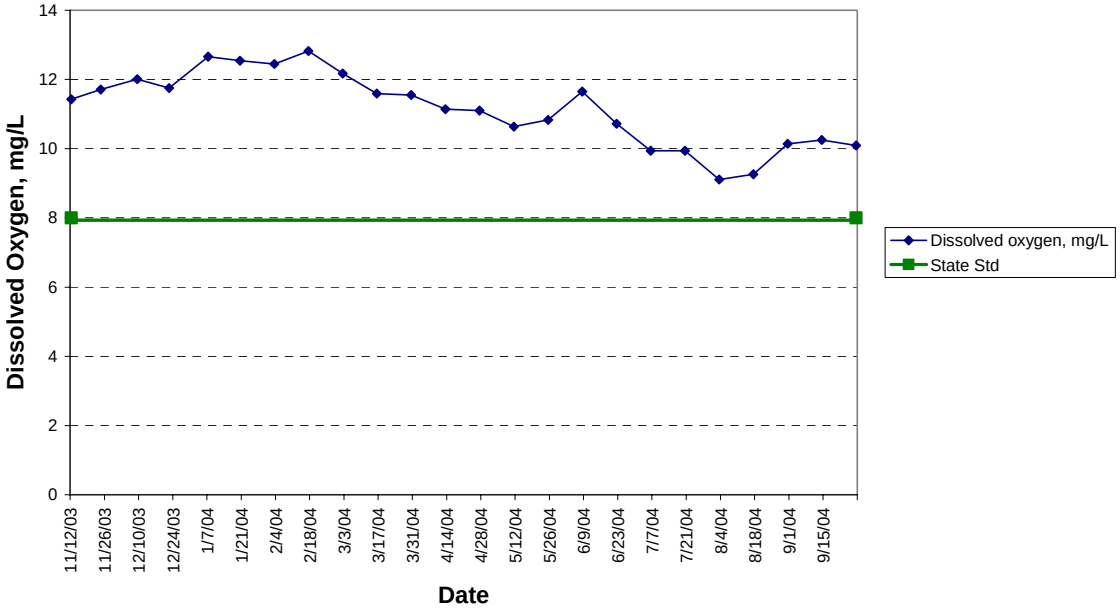
Wiley Slough at Wylie Rd - Site 43
Dissolved Oxygen



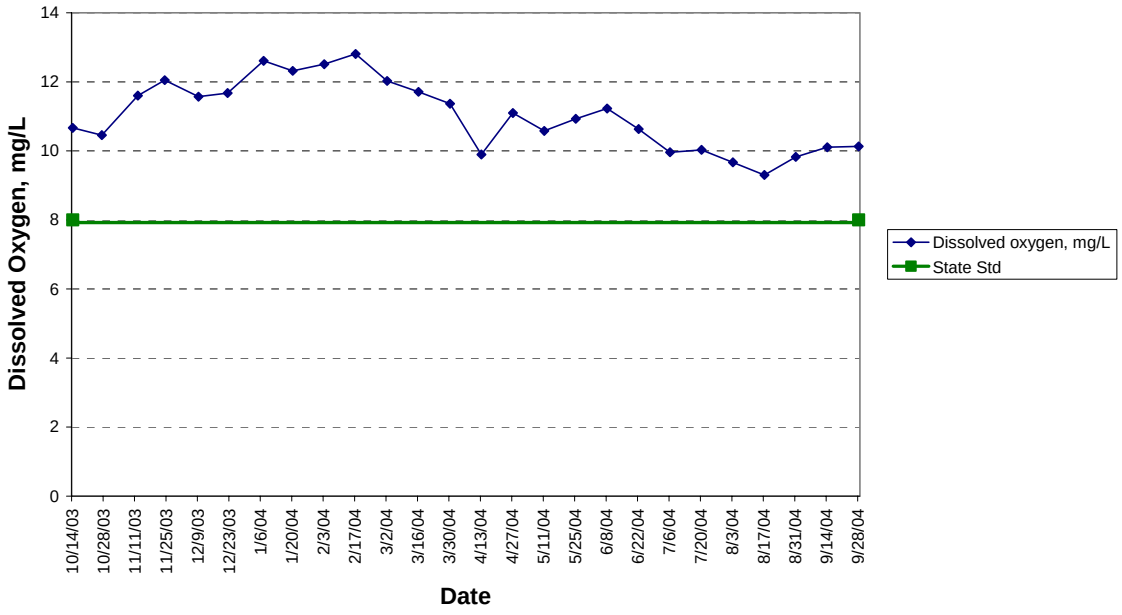
Rexville Pump Station - Site 44
Dissolved Oxygen



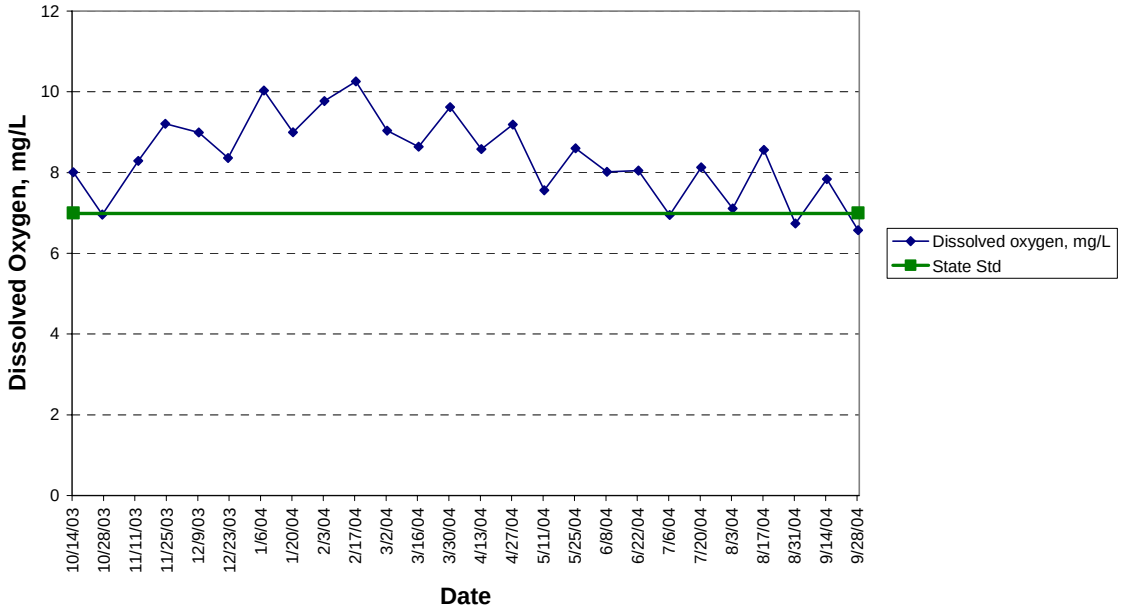
N.F. Skagit River near Moore Rd - Site 45
Dissolved Oxygen

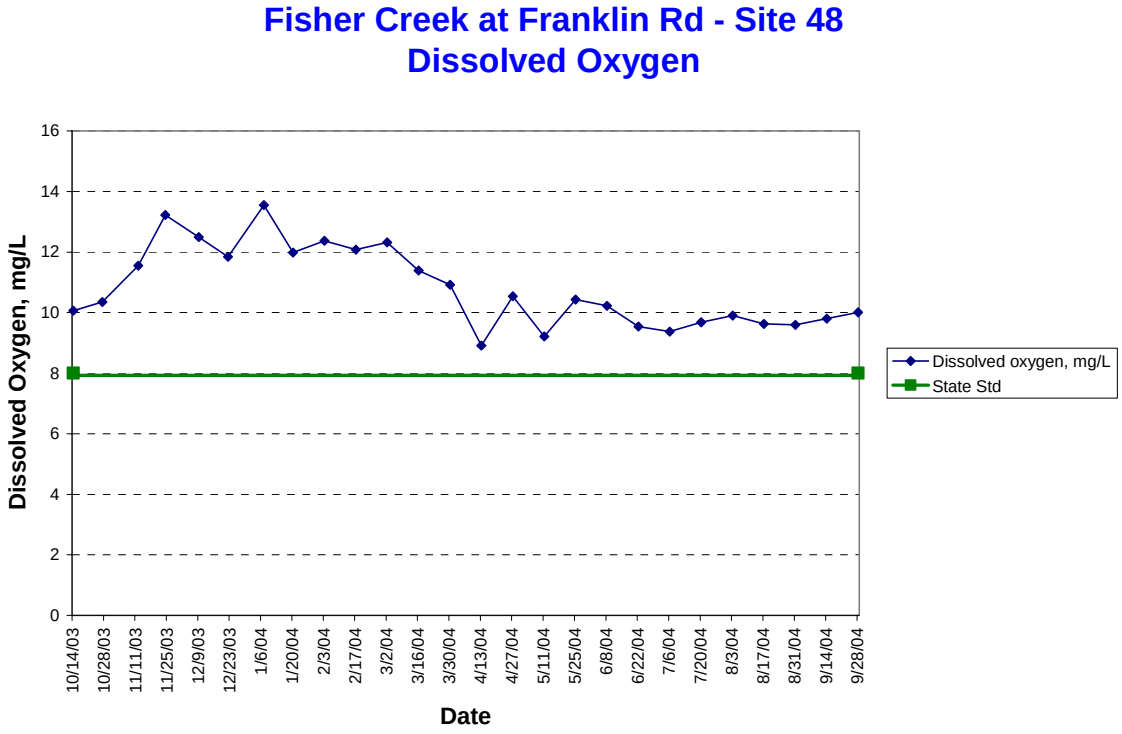


S.F. Skagit River at Conway Boat Ramp - Site 46
Dissolved Oxygen



Swinomish Channel at County Boat Ramp - Site 47
Dissolved Oxygen





Fecal Coliform

Fecal coliform is a measurement of the amount of enteric bacteria from warm-blooded animals present in a watercourse. Although fecal coliform measurements do not directly quantify disease-causing organisms, they serve as an indicator of the possible presence of such bacteria. Samples for fecal coliform measurements are taken at each site during each visit.

Fecal coliform measurements, in colony-forming units per 100 ml (cfu), are summarized in Table 5. State standards for fecal coliform are based on the geometric mean of the samples as well as the percent of the samples that exceed given criteria. For most of the watercourses in the Skagit County Monitoring Program (sites 3-20, 28-29, 31-46, 48), fecal coliform is not to exceed a geometric mean of 100 cfu, with no more than 10% of the measurements exceeding 200 cfu. For the upriver sites (sites 21-25, 30), the standard is a geometric mean of 50 cfu, with no more than 10% of the measurements exceeding 100 cfu. For the marine site (site 47), a more stringent standard of 14 cfu with no more than 10% exceeding 41 cfu is enforced to protect shellfish beds.

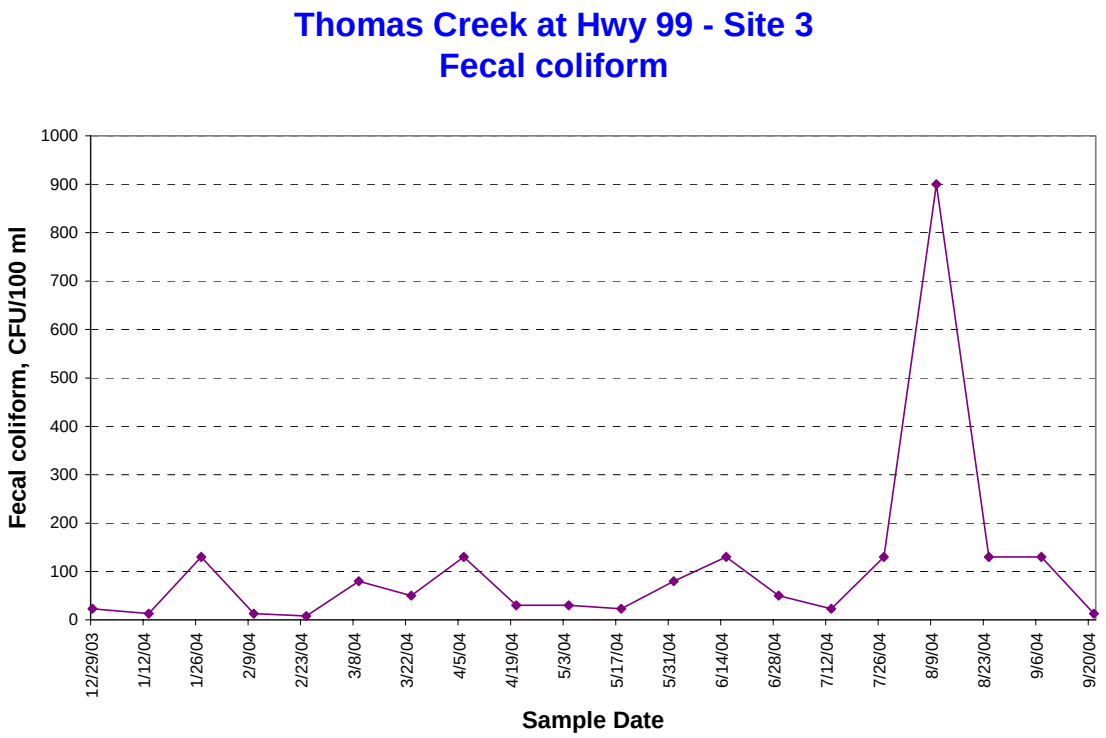
All Skagit River sites (sites 29, 30, 45, and 46) met the state standard for fecal coliform during this reporting period. Most other watercourses in the Skagit County Monitoring Program did not meet the standard.

Table 5. Summary of fecal coliform readings in Skagit County Monitoring Program, Oct 2003 – Sept 2004

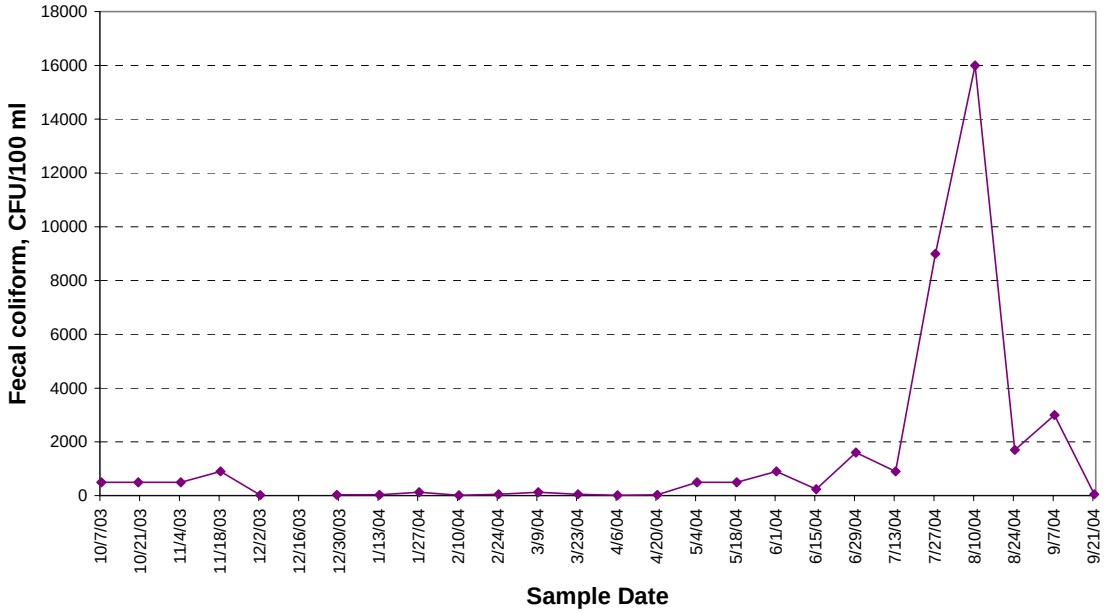
Site Number	Watercourse	Location	N	Geometric mean (cfu)[1]	% > 100 or 200[1]
3	Thomas Ck	Old Hwy 99 North	26	57.4	11.5
4	Thomas Ck	F&S Grade	25	254.8	56.0
6	Friday Ck	Prairie Rd	26	42.6	23.1
8	Swede Ck	Grip Rd	26	94.9	34.6
11	Samish R	State Route 9	26	22.0	7.7
12	Nookachamps Ck	Swan Rd	26	90.0	30.8
13	E.F. Nookachamps Ck	State Route 9	26	44.0	19.2
14	College Way Ck	College Way	26	171.2	42.3
15	Nookachamps Ck	Knapp	26	78.1	23.1
16	E.F. Nookachamps Ck	Beaver Lake Rd	26	54.2	23.1
17	Nookachamps Ck	Big Lake Outlet	26	15.3	11.5
18	Lake Ck	State Route 9	26	68.2	34.6
19	Hansen Ck	Hoehn Rd	26	75.4	34.6
20	Hansen Ck	Northern State	26	37.1	15.4
21	Coal Ck	Hoehn Rd	23	109.9	52.2
22	Coal Ck	Hwy 20	25	14.5	16.0
23	Wiseman Ck	Minkler Rd	25	13.8	12.0
24	Mannser Ck	Lyman Hamilton Hwy	24	42.5	25.0
25	Red Cabin Ck	Hamilton Cem Rd	22	13.5	4.5
28	Brickyard Ck	Hwy 20	20	53.0	20.0
29	Skagit R	R Bend Rd	26	13.6	3.8
30	Skagit R	Cape Horn Rd	24	3.2	0.0
31	Drain Dist 20 near floodgate	Francis Rd	9	88.0	44.4
32	Samish R	Thomas Rd	26	63.5	23.1
33	Alice Bay Pump Station	Samish Island Rd	26	96.3	42.3
34	Noname Slough	Bayview-Edison Rd	23	78.7	34.8
35	Joe Leary Slough	D'Arcy Rd	19	115.4	42.1
36	Edison Slough at school	W. Bow Hill Rd	26	82.6	38.5
37	Edison Drain ditch in Edison	Farm to Market Rd	26	102.0	42.3
38	Drainage north of Edison	North Edison Rd	25	179.9	36.0
39	Colony Ck	Colony Rd	26	94.8	42.3
40	Big Indian Slough	Bayview-Edison Rd	22	48.0	27.3
41	Maddox Slough/Big Ditch	Milltown Rd	26	24.8	11.5
42	Hill Ditch	Cedardale Rd	25	22.0	8.0
43	Wiley Slough	Wylie Rd	26	55.1	7.7
44	Rexville Pump Station	Summers Drive	24	13.5	20.8
45	Skagit R – North Fork	Moore Rd	23	6.0	0.0
46	Skagit R – South Fork	Fir Island Rd	26	13.4	3.8
47	Swinomish Channel	County Boat Launch	26	5.5	7.7
48	Fisher Ck	Franklin Rd	26	77.2	26.9

[1]State water quality standard for fecal coliform requires water bodies to have a geometric mean of less than 50 (sites 21-25, 30) or 100 (sites 3-20, 28-29, 31-46, 48) colony forming units (cfu) per 100 ml and less than 10% of the samples > 100 (sites 21-25, 30) or > 200 cfu (sites 3-20, 28-29, 31-46, 48). Marine locations (site 47) are required to be < 14 cfu with no more than 10% > 41 cfu.

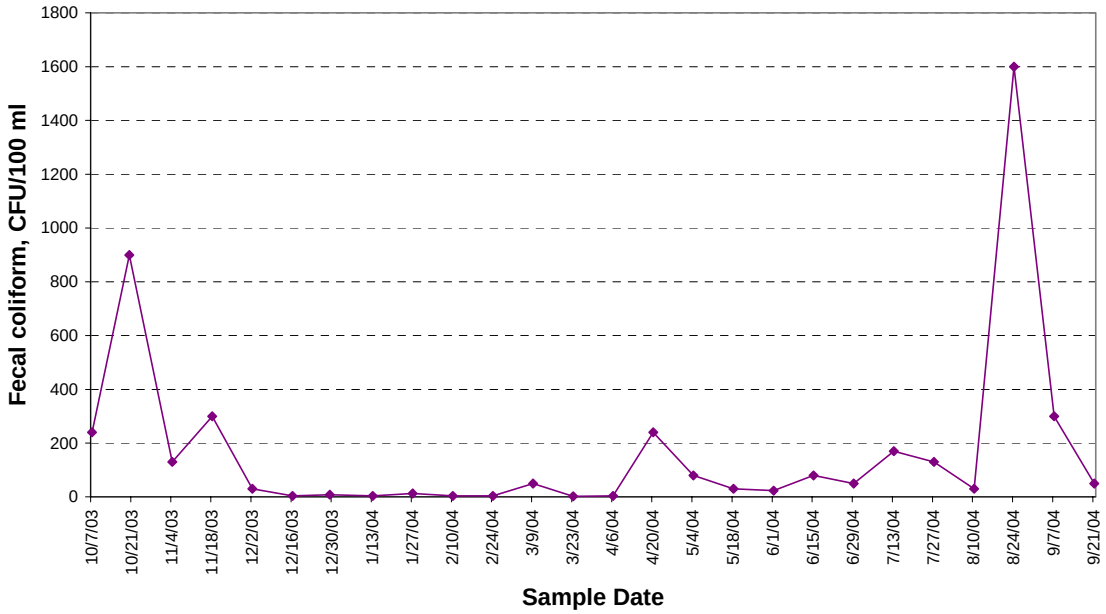
Graphs on the following pages illustrate fecal coliform measurements over time for each station. In order to adequately display the variability of readings at each station, the scales for each graph are tailored to the data for that station and may be very different from preceding or succeeding graphs. State standards for fecal coliform are based on both the geometric mean and the percentage of instances over a given value. These standards cannot be simply represented on the graphs, so no state standard designations are included on the fecal coliform graphs.



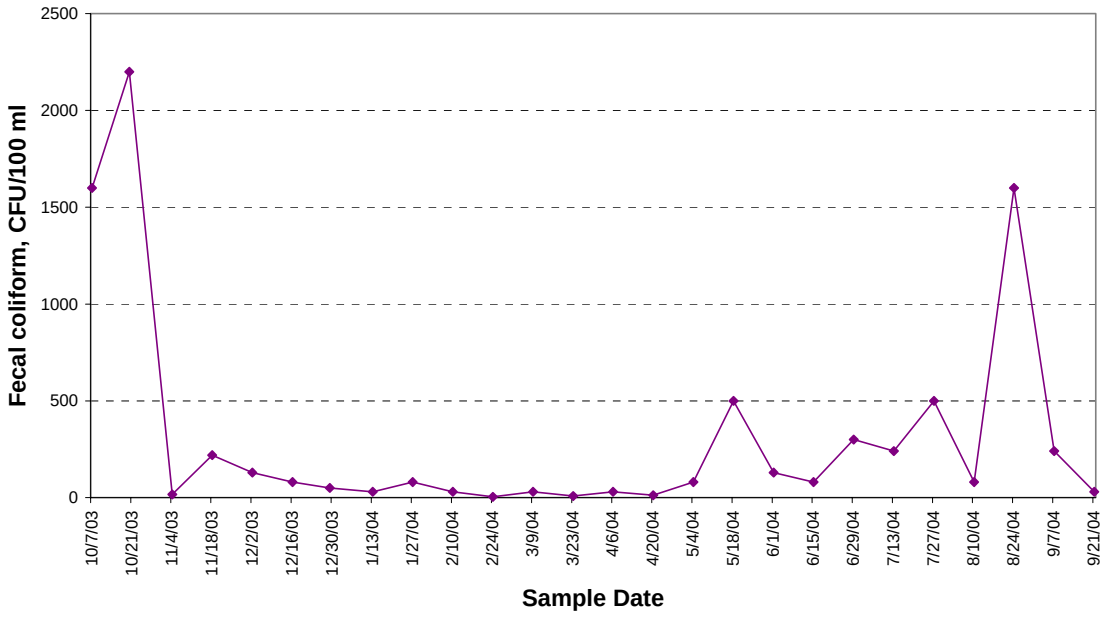
Thomas Creek at F&S Grade Rd - Site 4
Fecal coliform



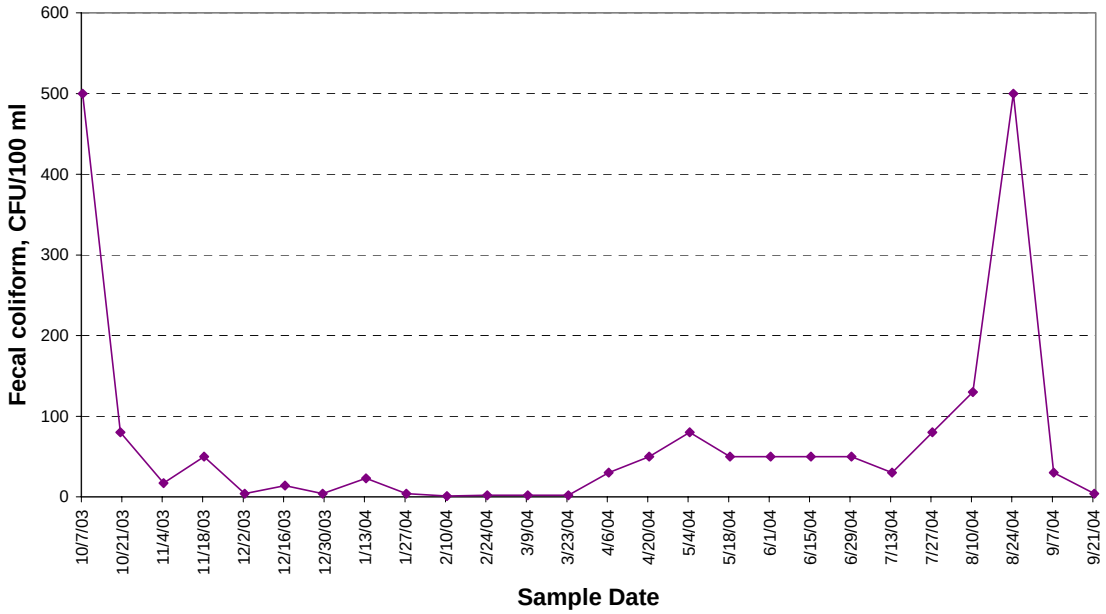
Friday Creek at Prairie Rd - Site 6
Fecal coliform



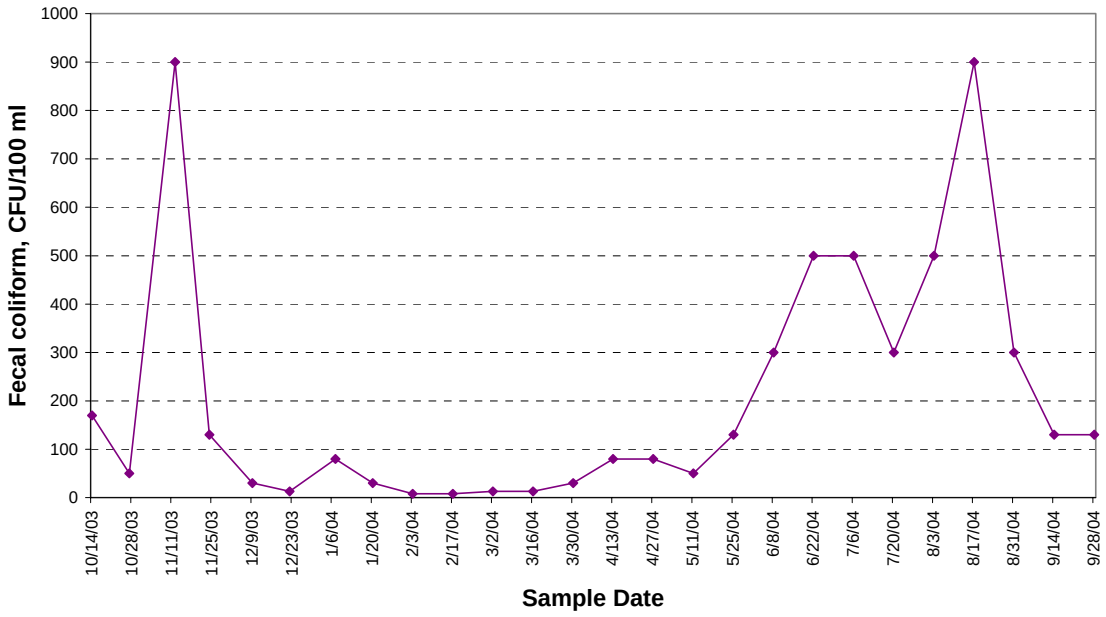
Swede Creek at Grip Rd - Site 8
Fecal coliform



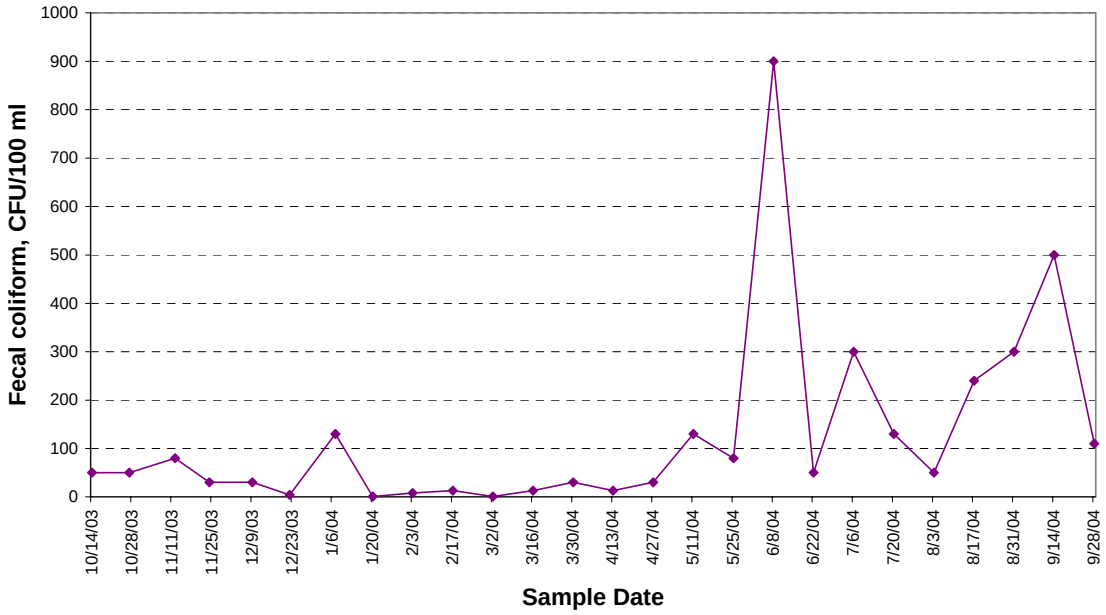
Samish River at Hwy 9 - Site 11
Fecal coliform



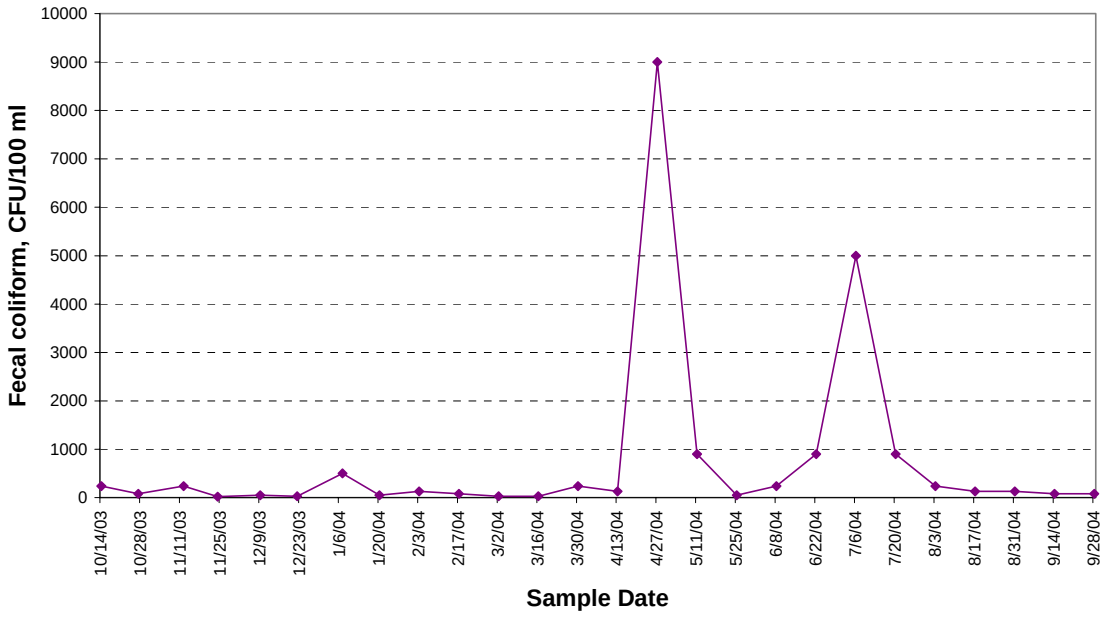
Nookachamps Creek at Swan Rd - Site 12
Fecal coliform



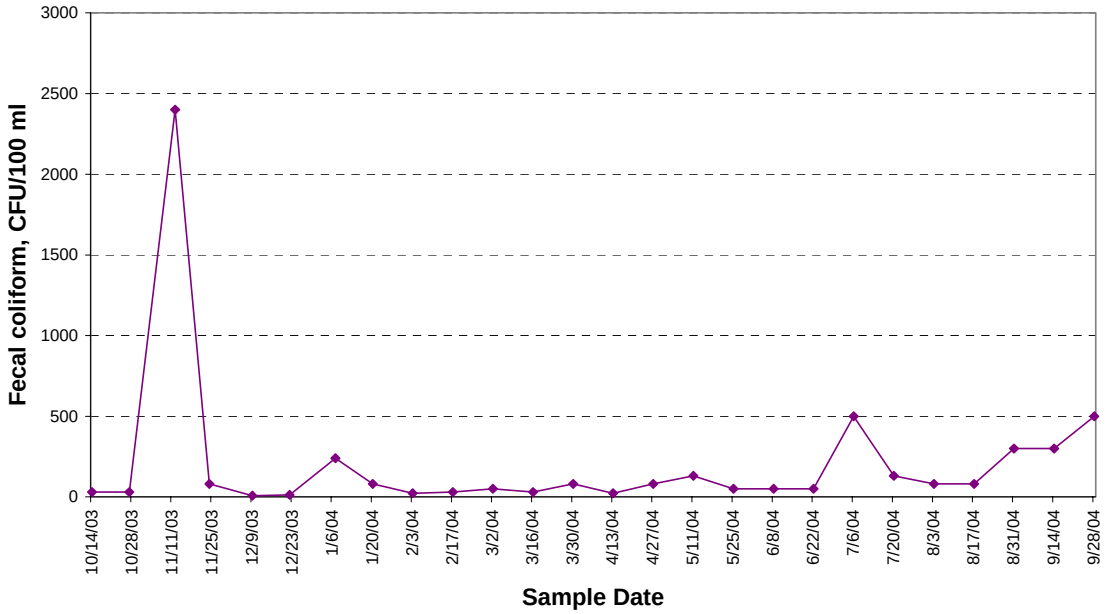
E.F. Nookachamps Creek at Hwy 9 - Site 13
Fecal coliform



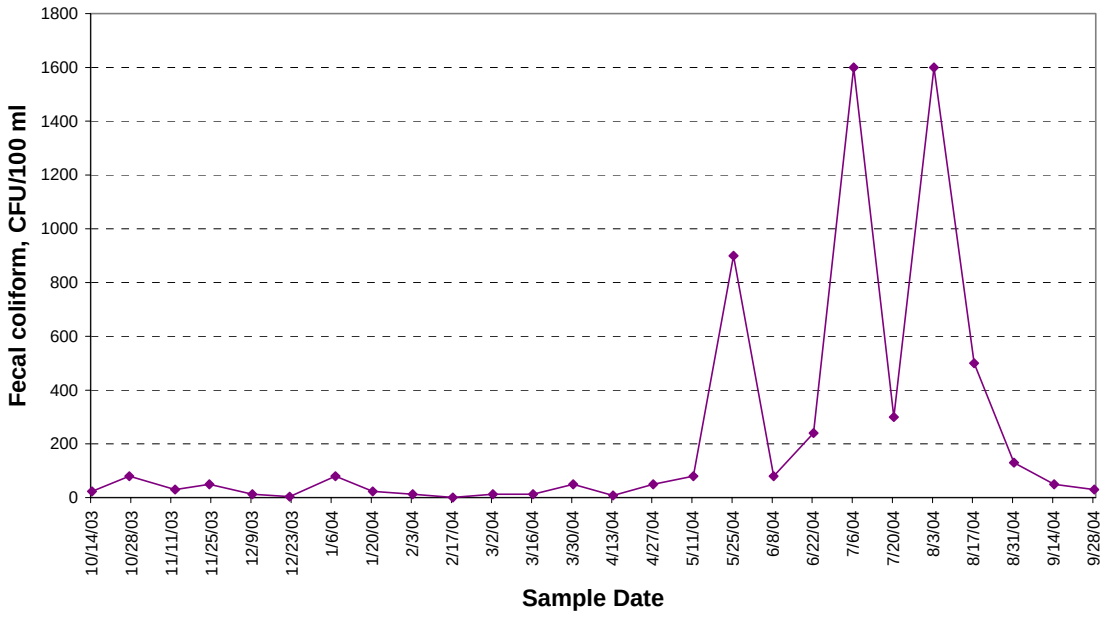
College Way Creek at College Way - Site 14
Fecal coliform



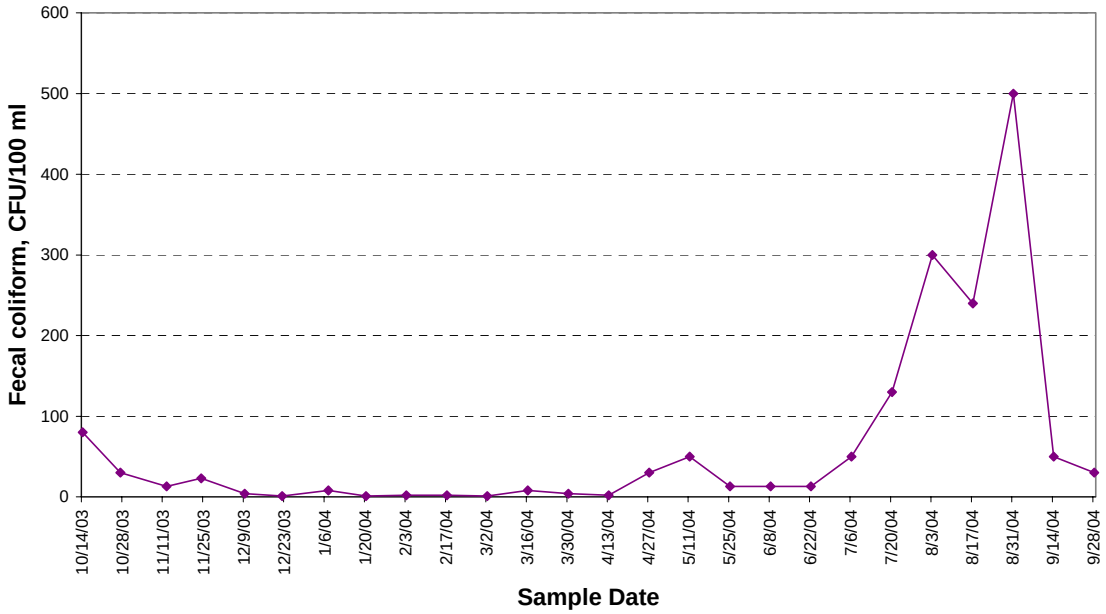
Nookachamps Creek at Knapp Rd - Site 15
Fecal coliform



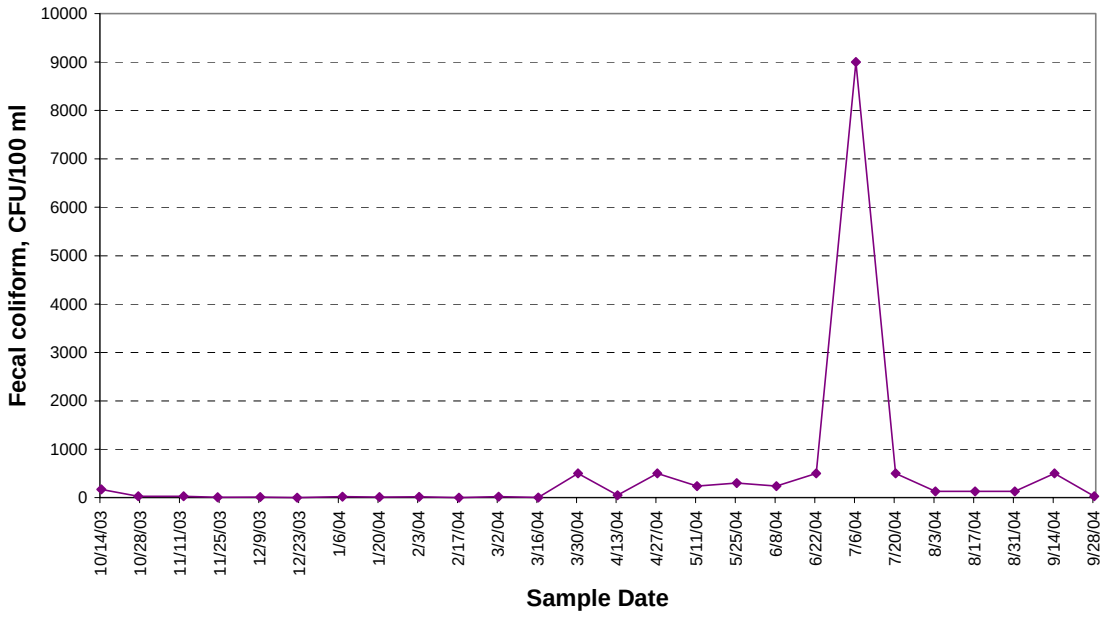
E.F. Nookachamps Cr at Beaver Lk Rd - Site 16
Fecal coliform



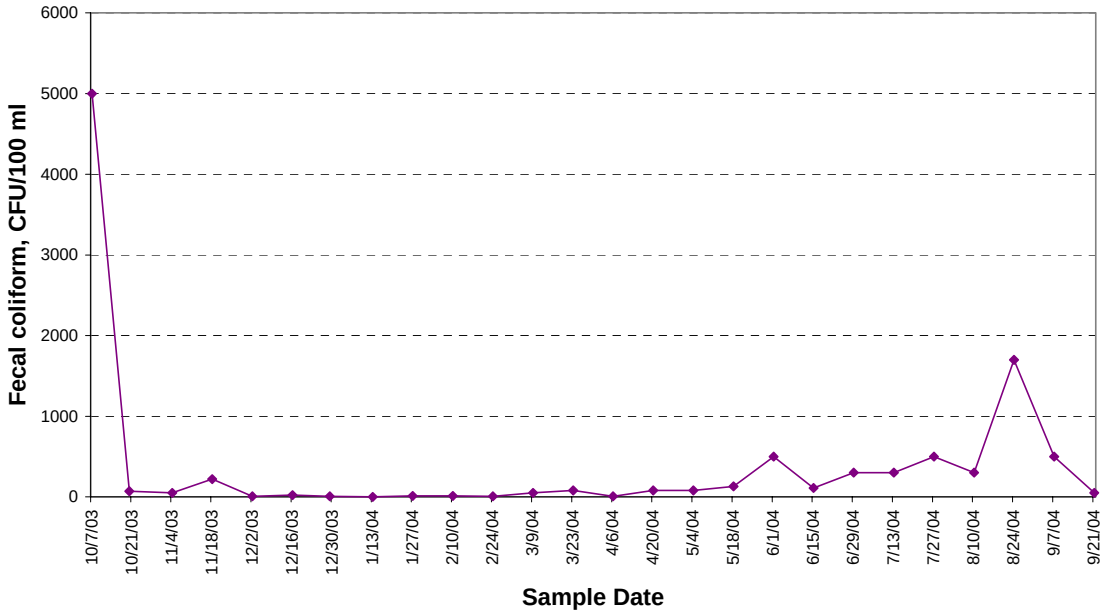
Nookachamps Creek at Big Lk Outlet - Site 17
Fecal coliform



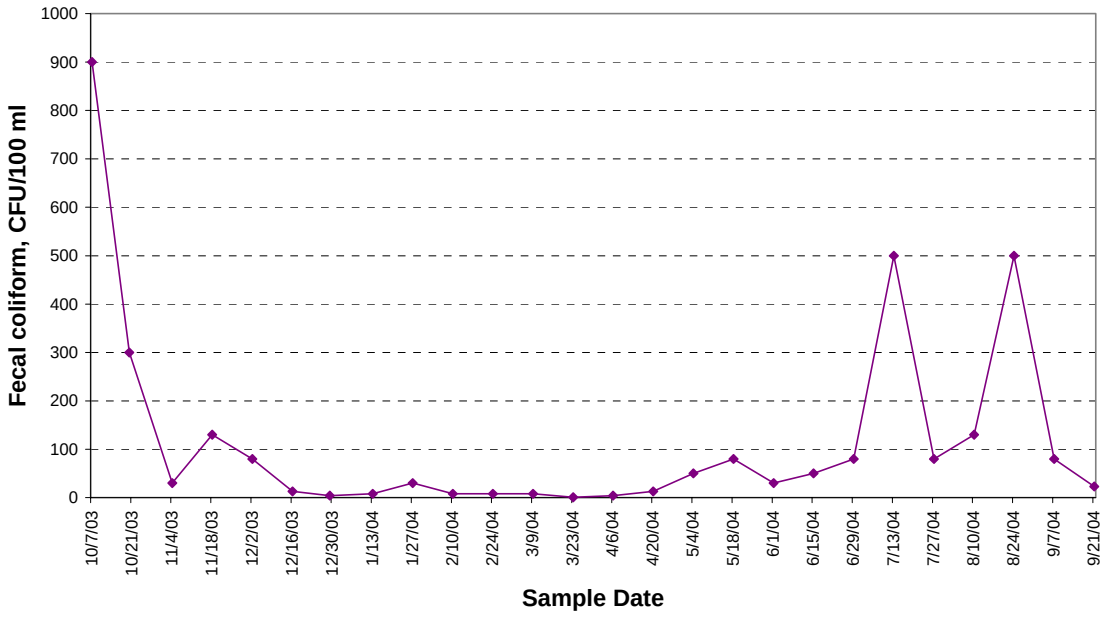
Lake Creek at Hwy 9 - Site 18
Fecal coliform



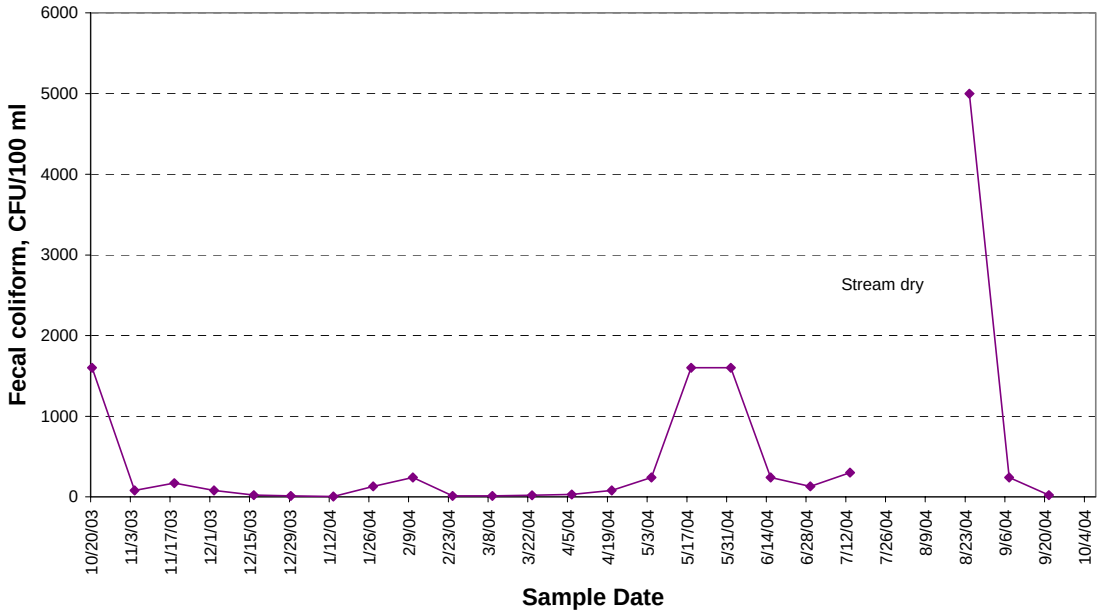
Hansen Creek at Hoehn Rd - Site 19
Fecal coliform



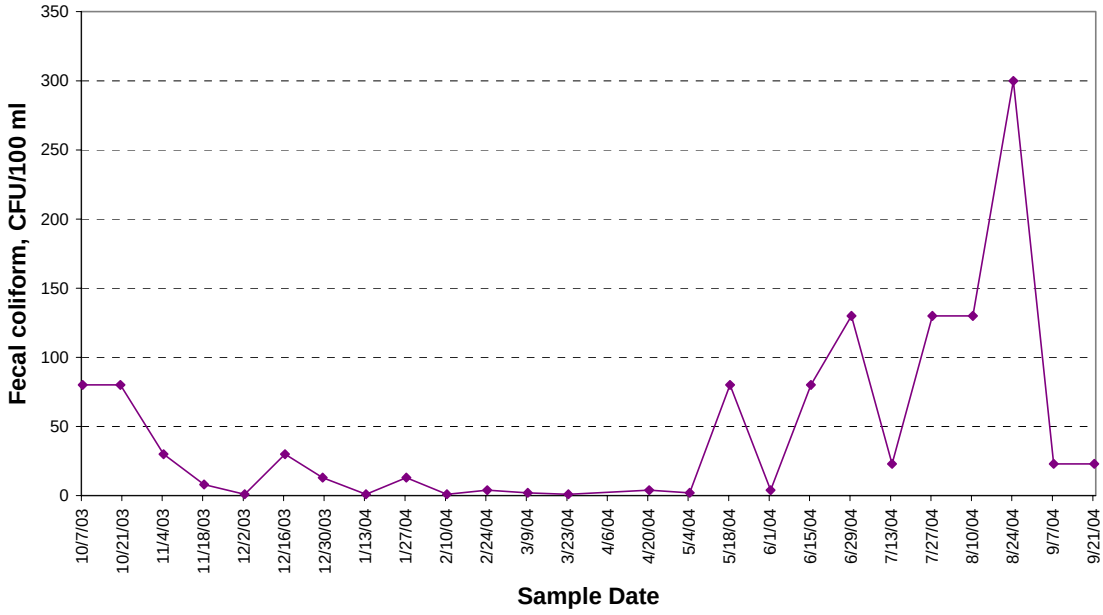
Hansen Creek at Northern State Hospital - Site 20
Fecal coliform



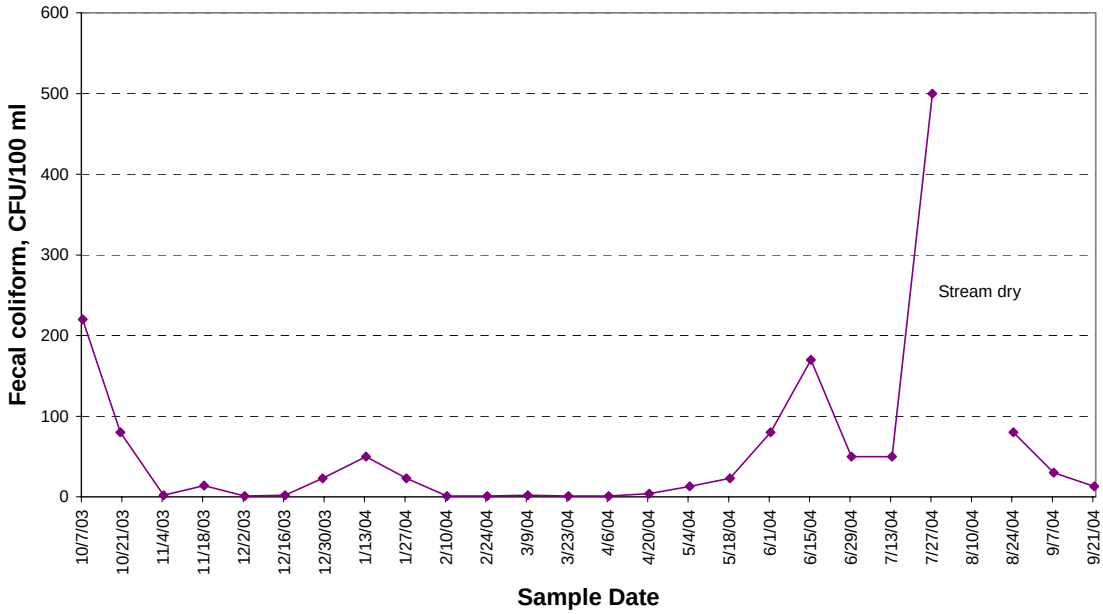
Coal Creek at Hoehn Road - Site 21
Fecal coliform



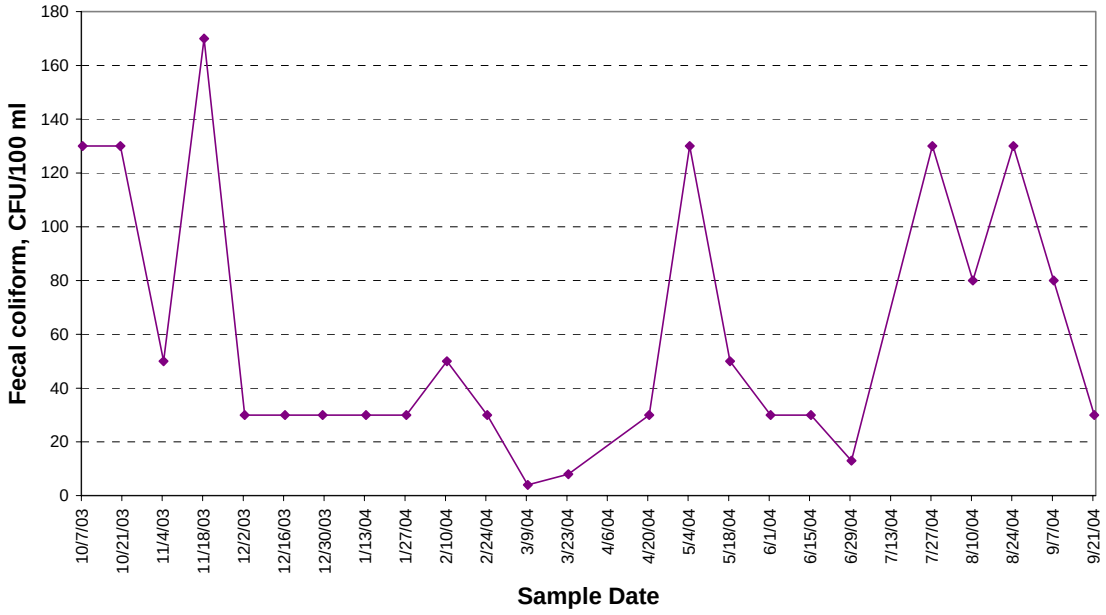
Coal Creek at Hwy 20 - Site 22
Fecal coliform



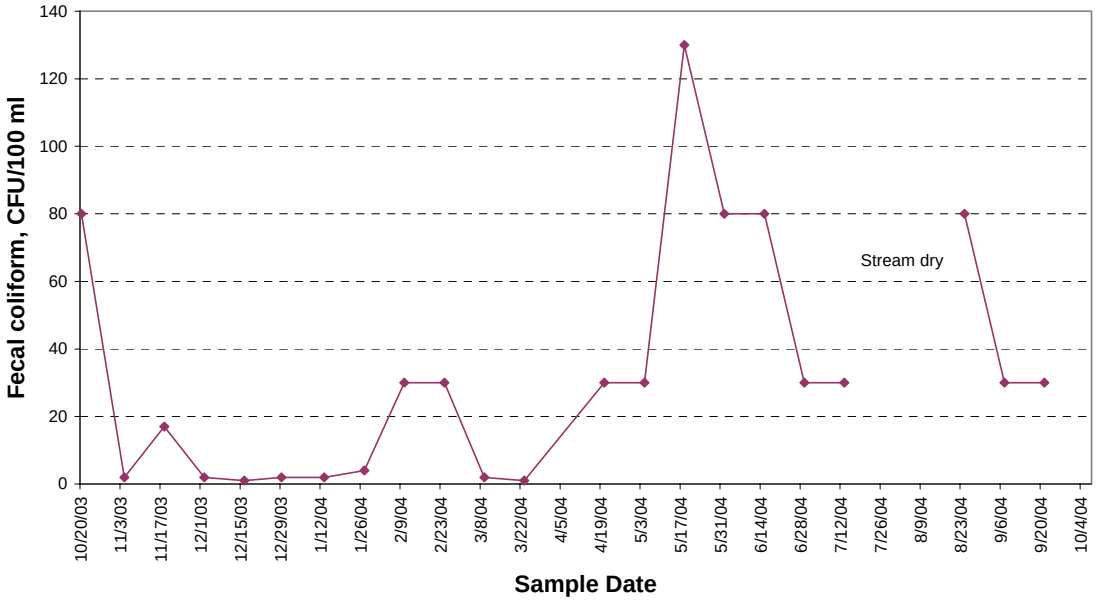
Wiseman Creek at Minkler Rd - Site 23
Fecal coliform



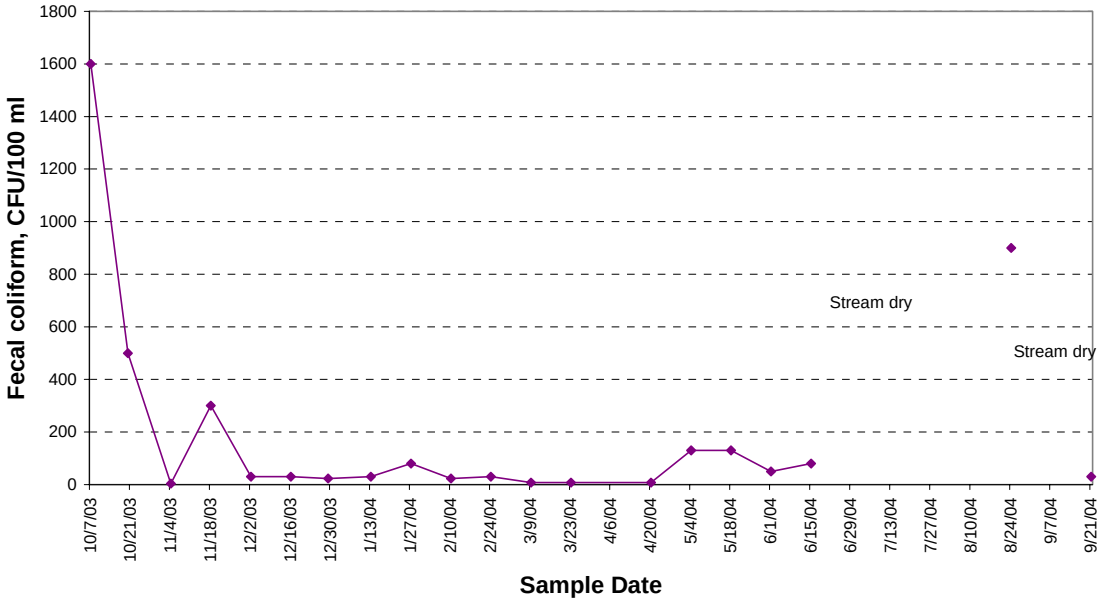
Mannser Creek at Lyman-Hamilton Hwy - Site 24
Fecal coliform



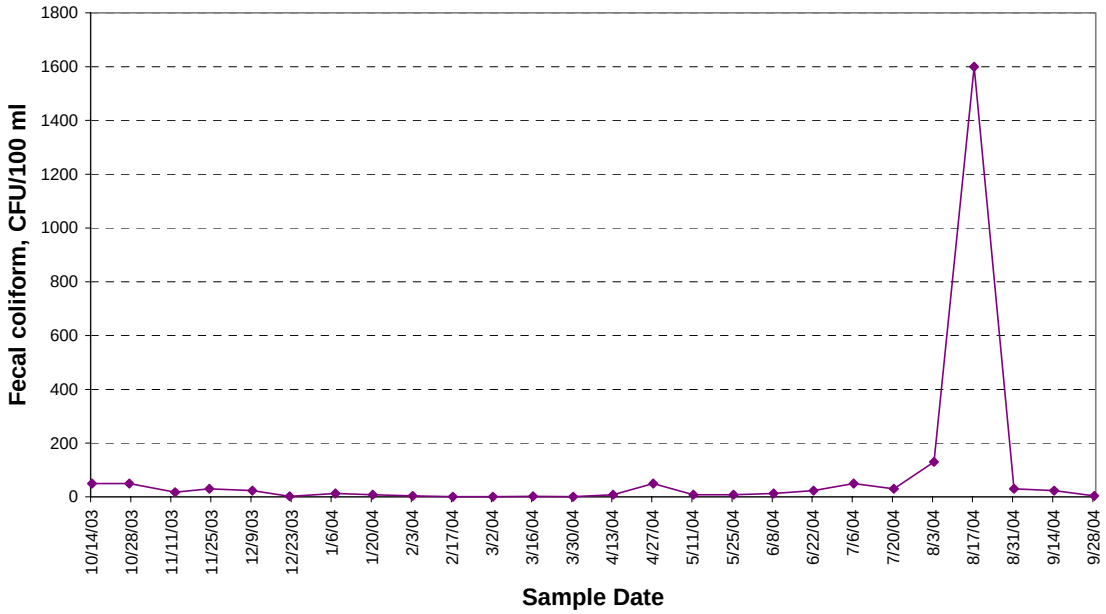
Red Cabin Creek at Hamilton Cemetery Rd - Site 25
Fecal coliform



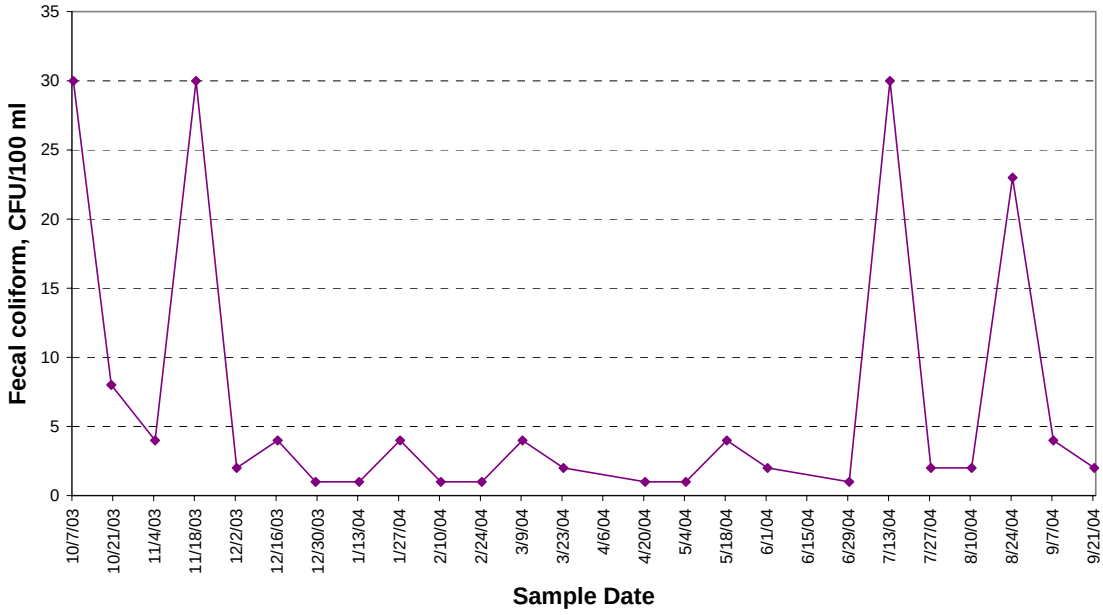
Brickyard Creek at Hwy 20 - Site 28
Fecal coliform



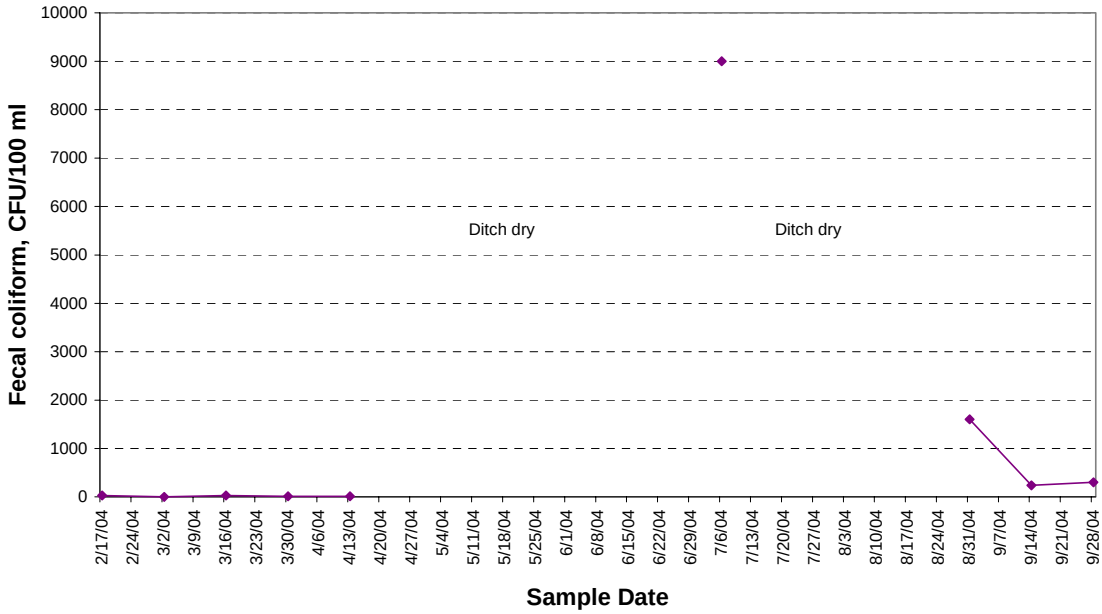
Skagit River at River Bend - Site 29
Fecal coliform



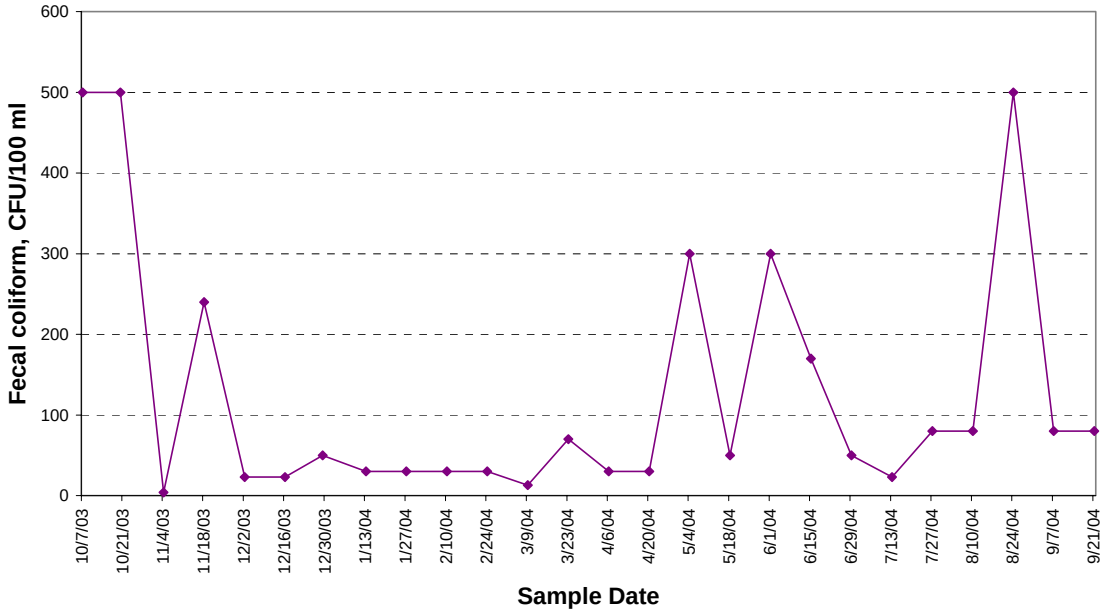
Skagit River at Cape Horn Rd - Site 30
Fecal coliform



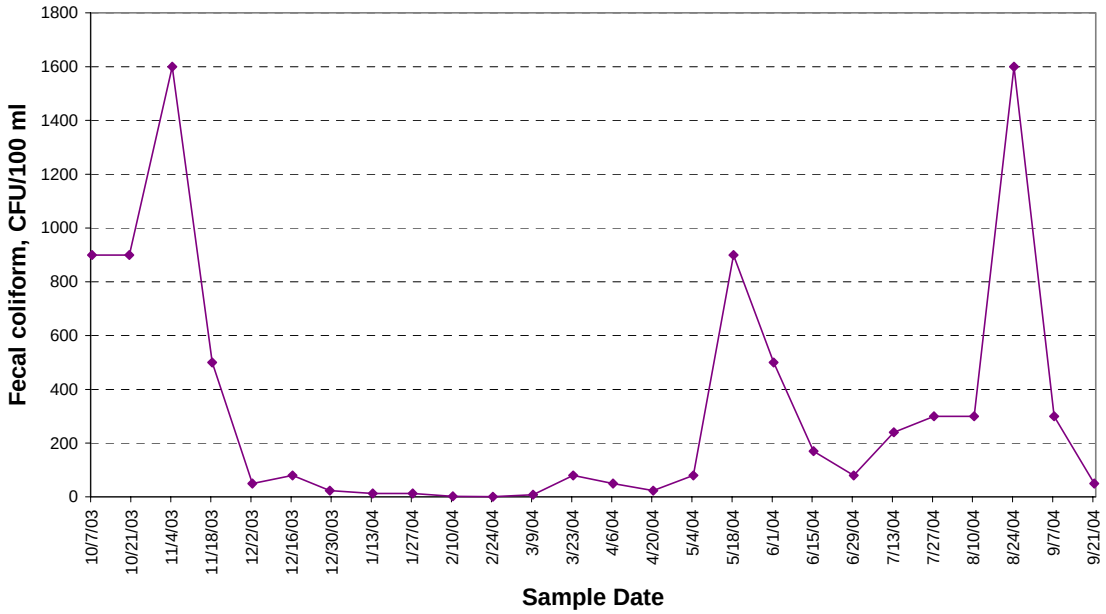
Drainage District 20 Ditch at Floodgate - Site 31
Fecal coliform



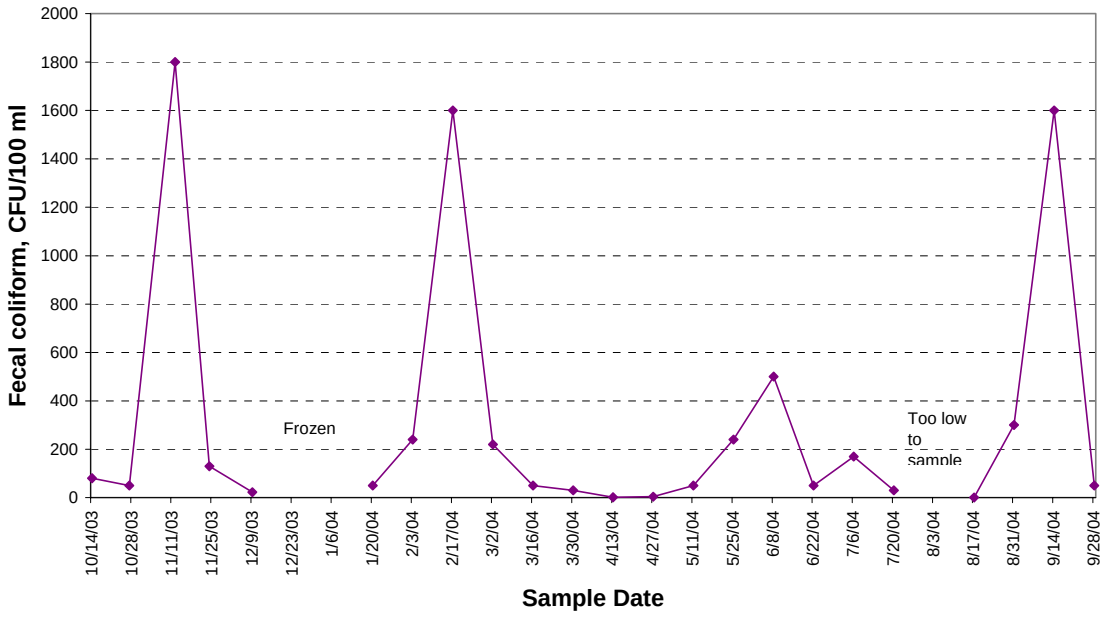
Samish River at Thomas Rd - Site 32
Fecal coliform



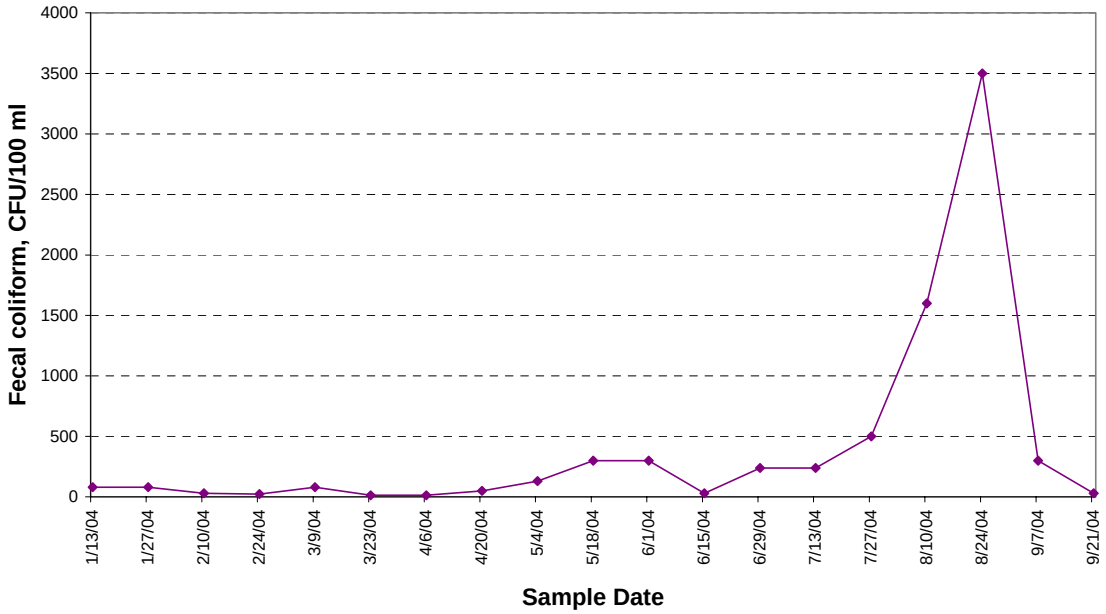
Alice Bay Pump Station - Site 33
Fecal coliform



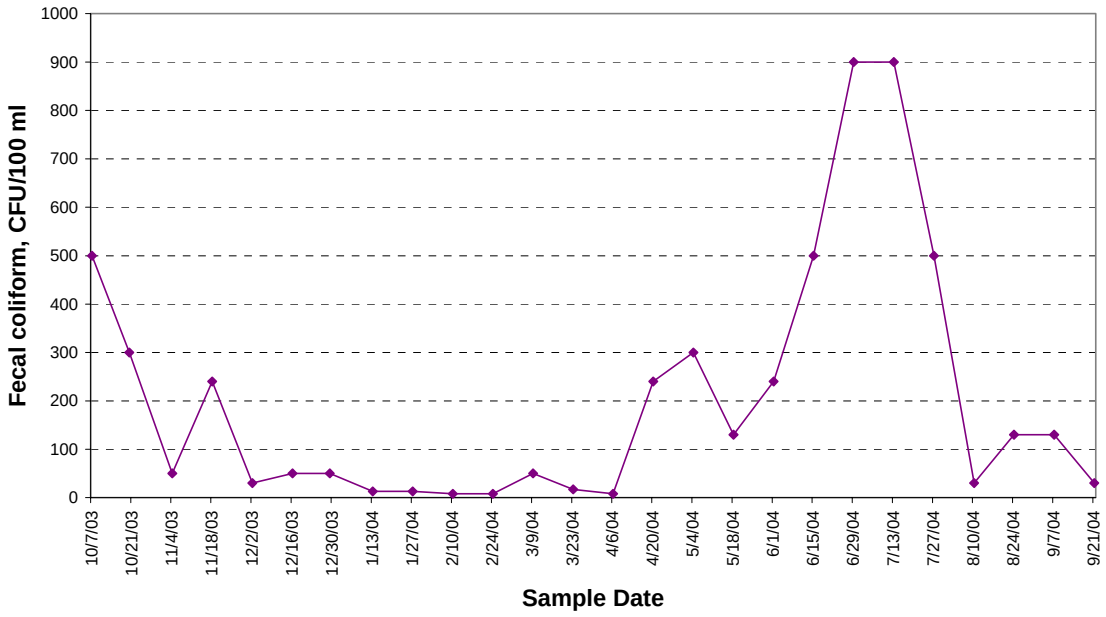
No Name Slough at Bayview-Edison Rd - Site 34
Fecal coliform



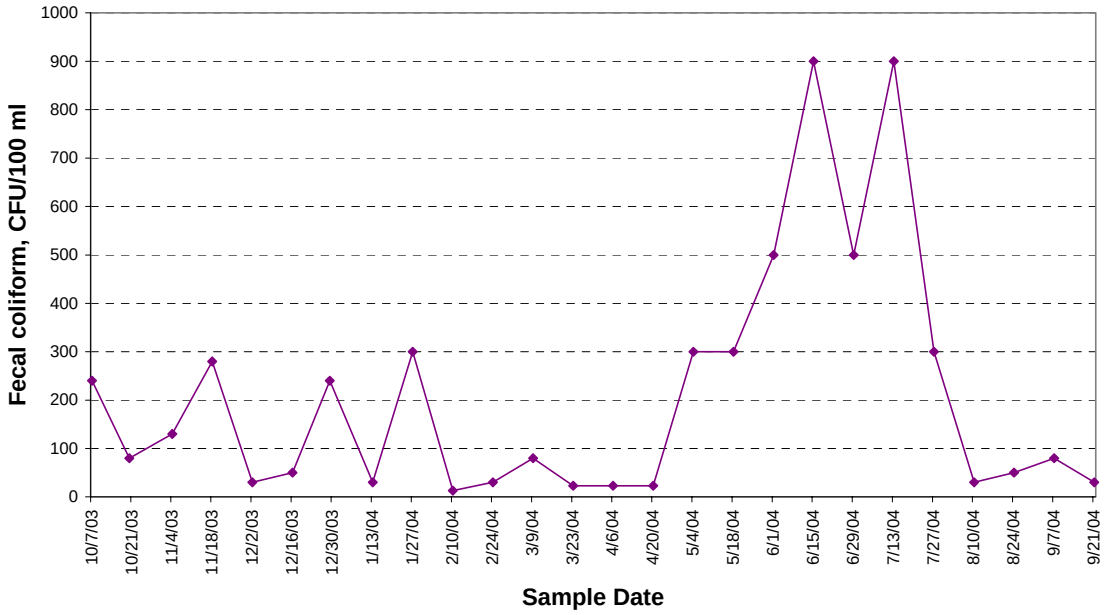
Joe Leary Slough at D'Arcy Rd - Site 35
Fecal coliform



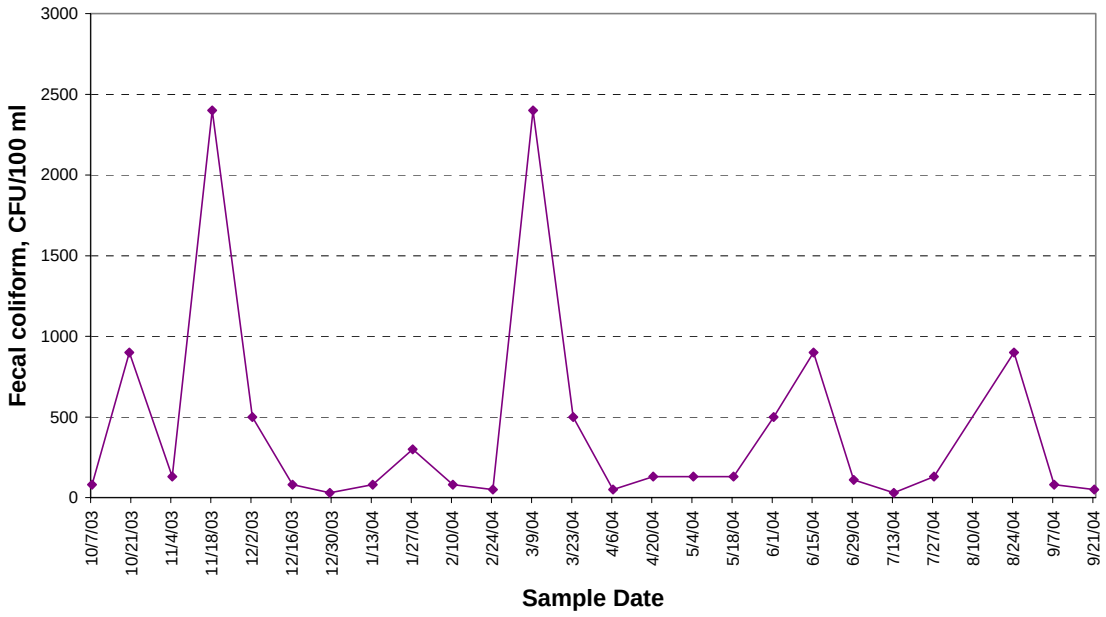
Edison Slough at Edison School - Site 36
Fecal coliform



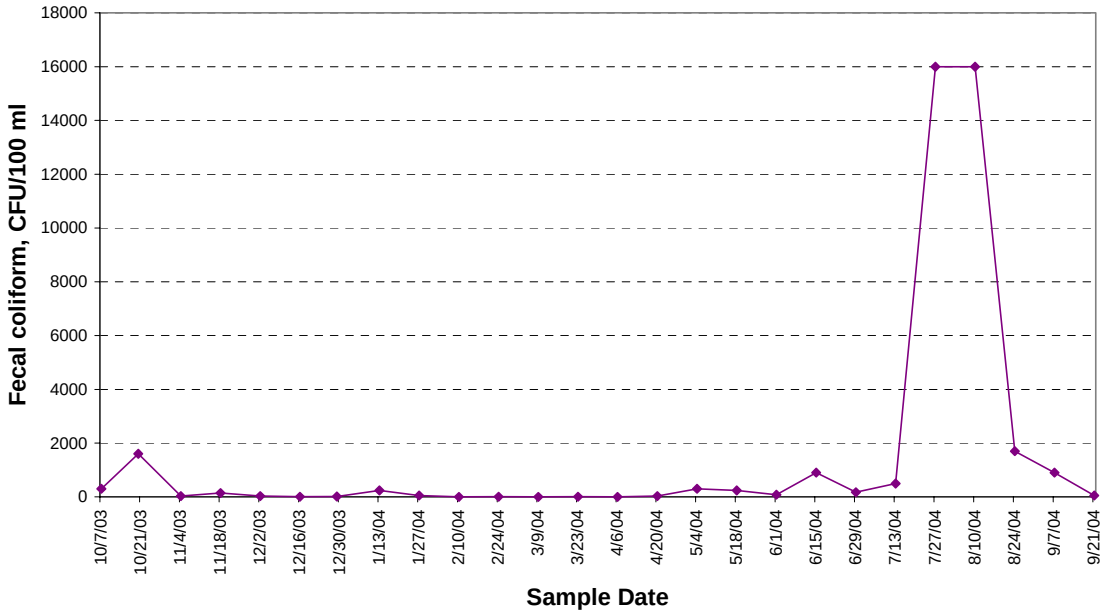
Edison Pump Station - Site 37
Fecal coliform



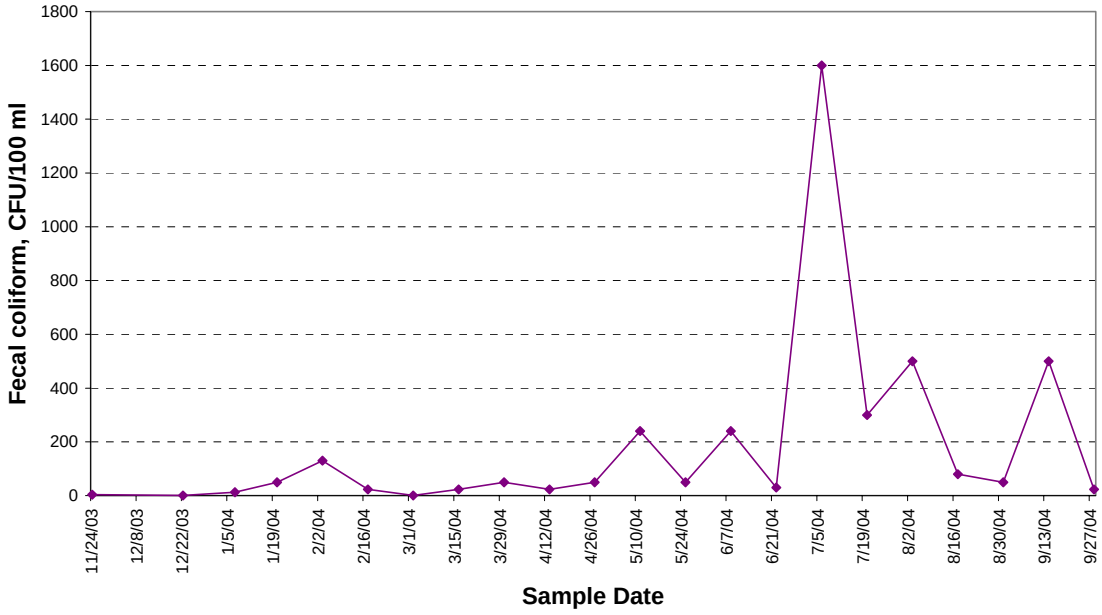
North Edison Pump Station - Site 38
Fecal coliform



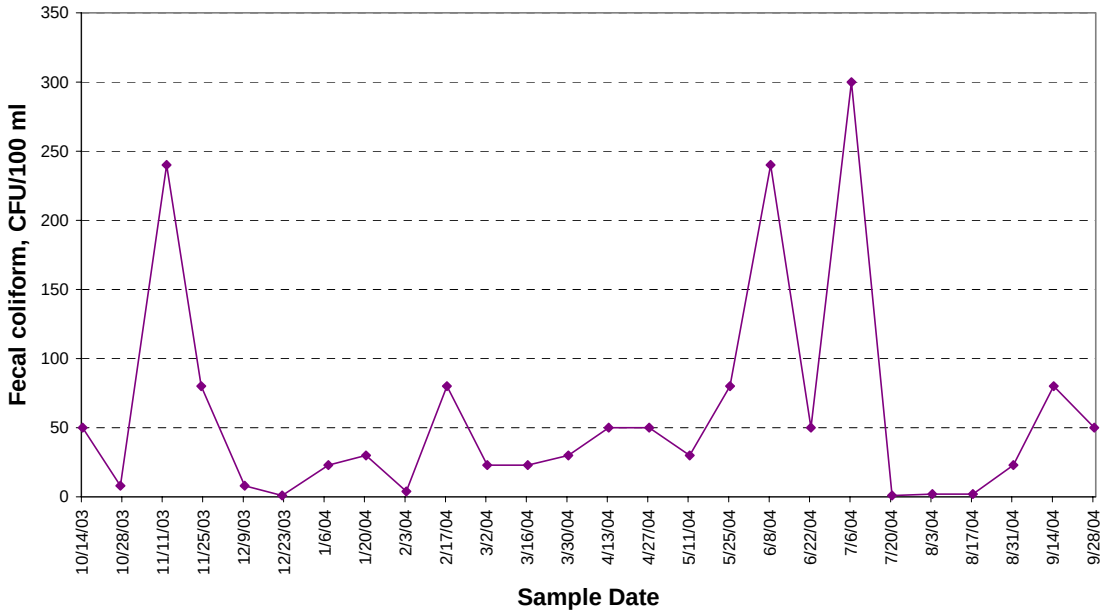
Colony Creek at Colony Rd - Site 39
Fecal coliform



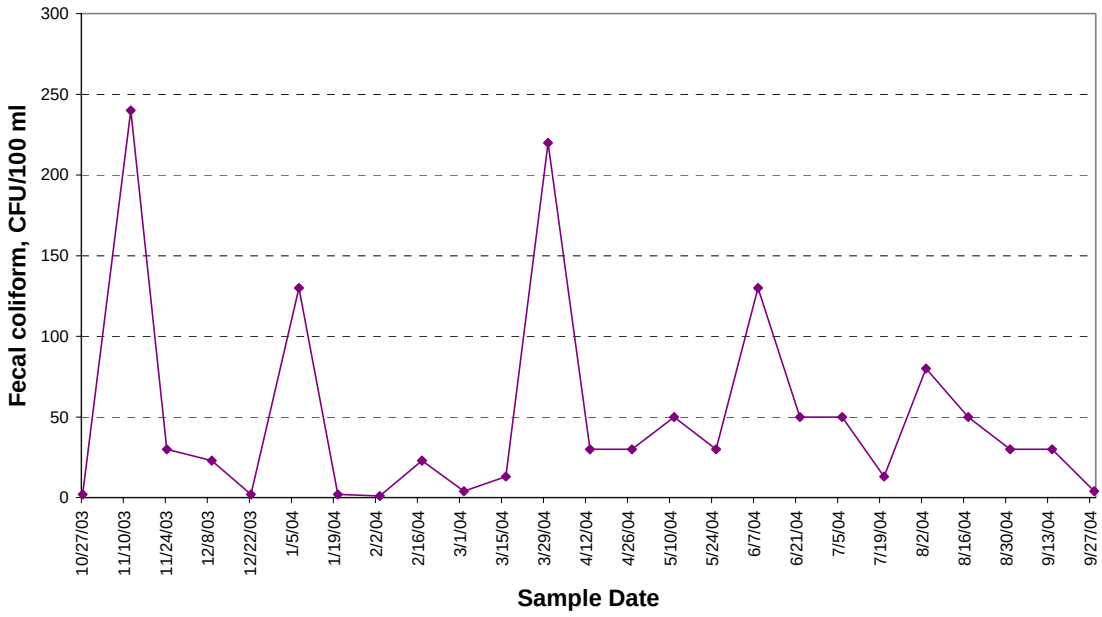
Big Indian Slough at Hwy 20 Truck Scales - Site 40
Fecal coliform



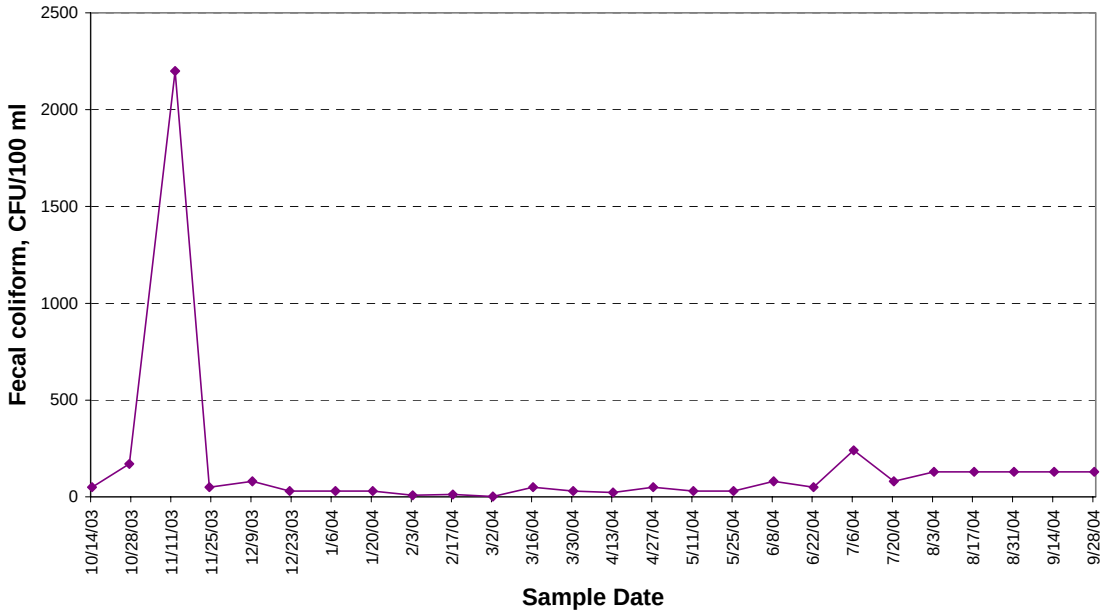
Maddox Creek/Big Ditch at Milltown Rd - Site 41
Fecal coliform



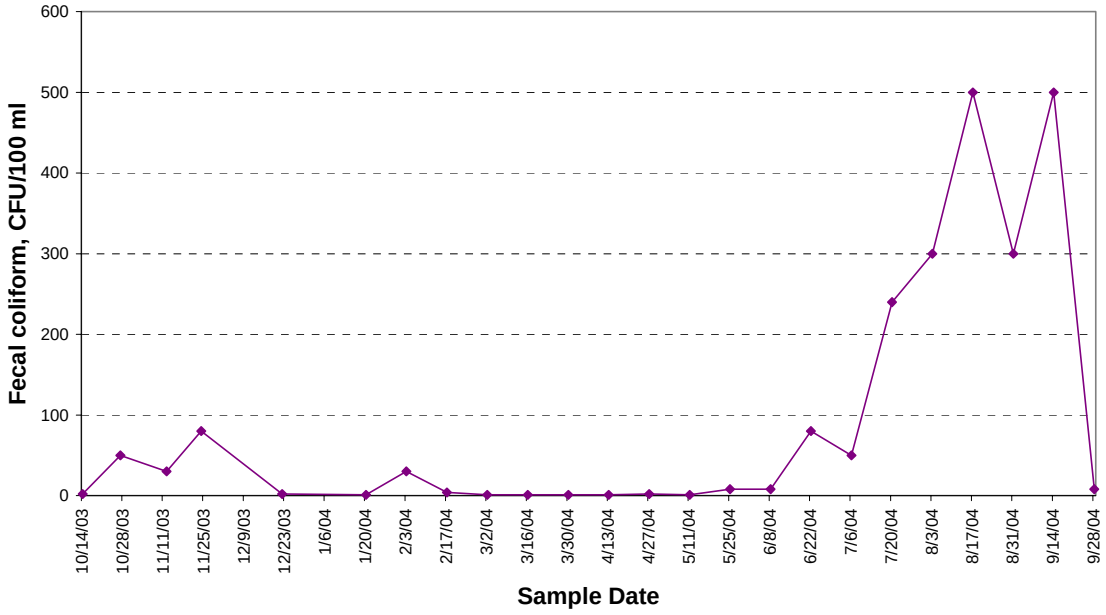
Carpenter Creek/Hill Ditch - Site 42
Fecal coliform



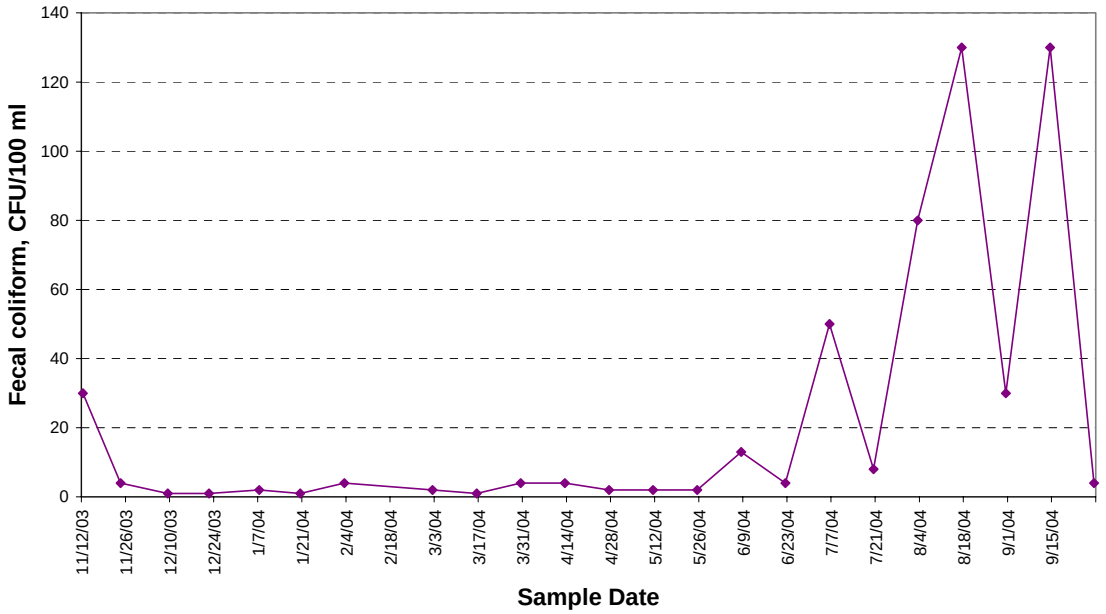
Wiley Slough at Wylie Rd - Site 43
Fecal coliform



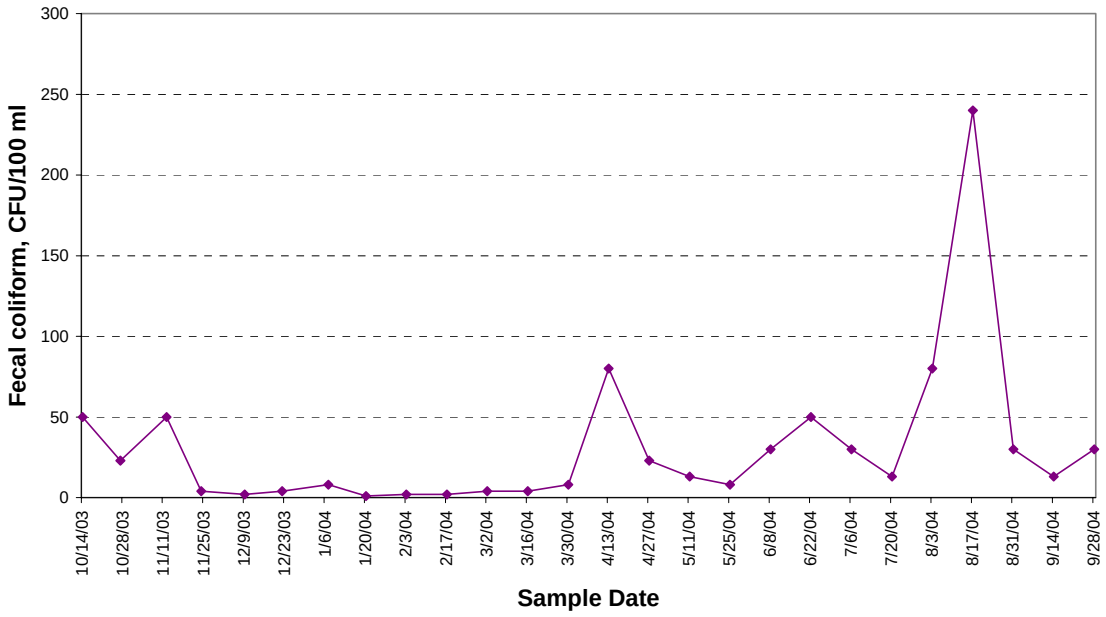
Rexville Pump Station - Site 44
Fecal coliform



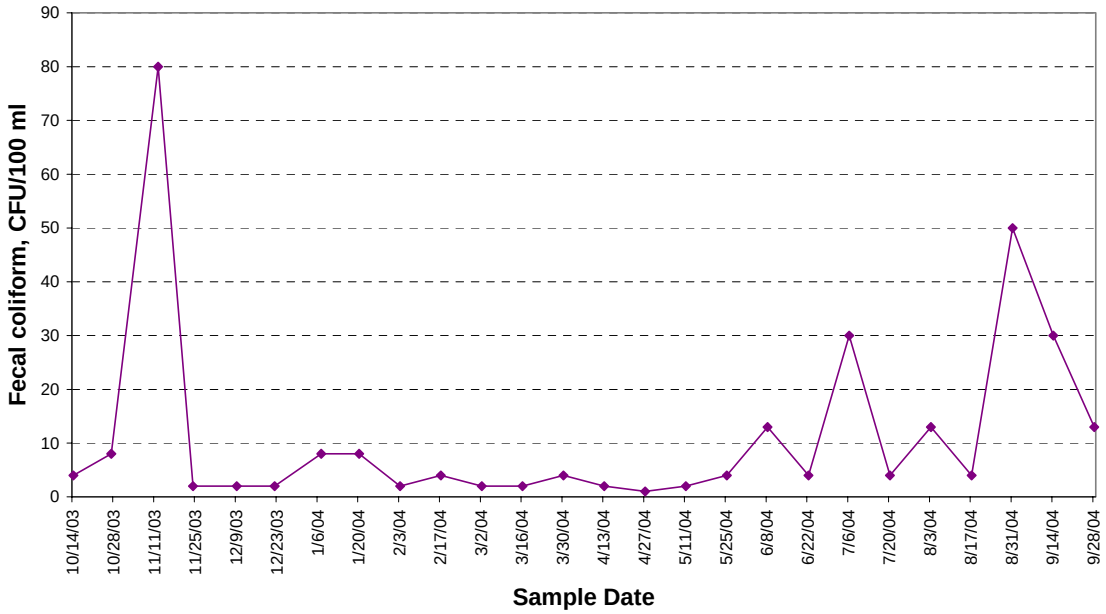
N.F. Skagit River near Moore Rd - Site 45
Fecal coliform

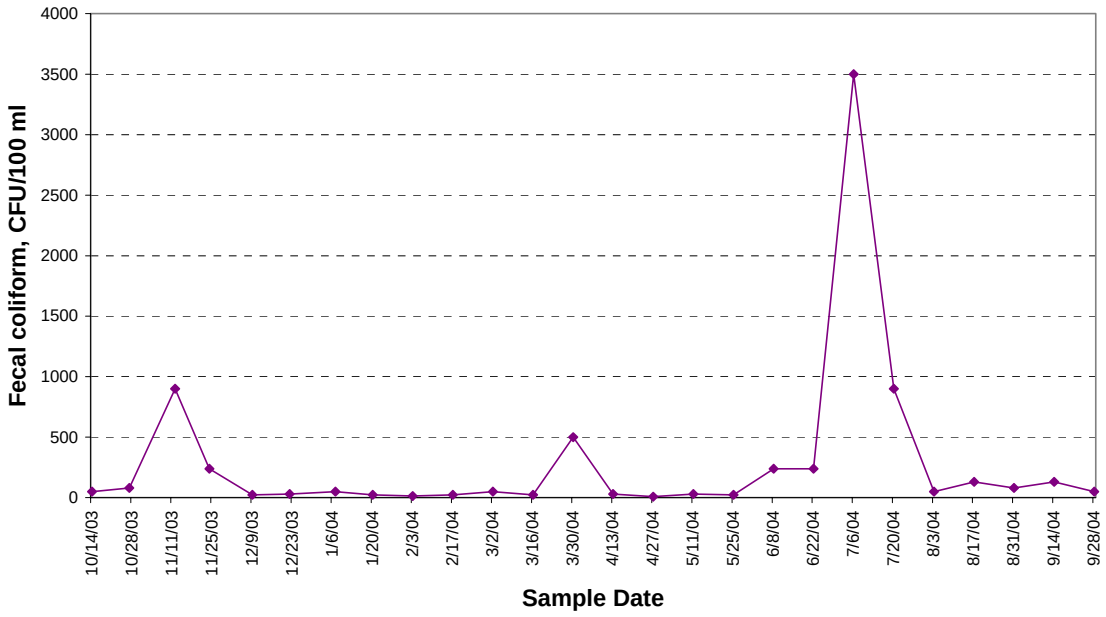


S.F. Skagit River at Conway - Site 46
Fecal coliform



Swinomish Channel at County Boat Ramp - Site 47
Fecal coliform





Nutrients

Water samples for measurement of plant nutrients were taken at each station on every other sampling trip, or once every four weeks. Samples were analyzed by Edge Analytical of Burlington, WA. Table 6 gives mean nutrient values for the sampling stations.

Nutrient levels in watercourses determine the potential for algal activity. Excessive nutrient levels can lead to large blooms of algae, which can increase dissolved oxygen levels during the day but lead to large decreases in dissolved oxygen at night when the algae are respiring, and also when the algae die and decompose.

Most of the streams in the program showed moderate total nitrogen and ammonia values and moderate levels of total phosphorus. The drainage infrastructure sampling sites generally had similar total phosphorus values and higher levels of total nitrogen and ammonia compared to the stream stations.

There are no numeric state standards for nutrients as factors in algal blooms. However, the state has both acute and chronic water quality standards for ammonia toxicity that are calculated from the ammonia level combined with the water temperature and pH for each individual ammonia measurement. Calculation of ammonia standards for a few

individual readings suggests that many Skagit County watercourses would exceed the state standards on many occasions.

Table 6. Mean nutrient values (mg/L) for watercourses in the Skagit County Monitoring Program.

Site Number	Watercourse	Location	Total Nitrogen[1]	Total Phosphorus	Ammonia
3	Thomas Ck	Old Hwy 99 N	0.68	0.44	0.16
4	Thomas Ck	F&S Grade	0.50	0.45	0.05
6	Friday Ck	Prairie Rd	0.45	0.43	0.05
8	Swede Ck	Grip Rd	0.54	0.44	0.06
11	Samish R	State Route 9	0.33	0.48	0.04
12	Nookachamps Ck	Swan Rd	0.53	0.48	0.08
13	E.F. Nookachamps Ck	State Route 9	0.43	0.44	0.06
14	College Way Ck	College Way	0.54	0.43	0.09
15	Nookachamps Ck	Knapp	0.63	0.47	0.10
16	E.F. Nookachamps Ck	Beaver Lake Rd	0.32	0.50	0.04
17	Nookachamps Ck	Big Lake Outlet	0.41	0.50	0.05
18	Lake Ck	State Route 9	0.35	0.47	0.05
19	Hansen Ck	Hoehn Rd	0.47	0.51	0.04
20	Hansen Ck	Northern State	0.62	0.58	0.05
21	Coal Ck	Hoehn Rd	0.42	0.48	0.03
22	Coal Ck	Hwy 20	0.39	0.51	0.03
23	Wiseman Ck	Minkler Rd	0.39	0.46	0.03
24	Mannser Ck	Lyman Hamilton Hwy	0.76	0.50	0.03
25	Red Cabin Ck	Hamilton Cem Rd	0.35	0.50	0.03
28	Brickyard Ck	Hwy 20	0.47	0.50	0.06
29	Skagit R	River Bend Rd	0.43	0.44	0.03
30	Skagit R	Cape Horn Rd	0.27	0.47	0.03
31	Drain Dist 20 floodgate	Francis Rd	1.41	0.40	0.21
32	Samish R	Thomas Rd	0.41	0.48	0.06
33	Alice Bay Pump Station	Samish Island Rd	3.25	0.54	1.25
34	Noname Slough	Bayview-Edison Rd	1.17	0.40	0.42
35	Joe Leary Slough	D'Arcy Rd	1.06	0.34	0.48
36	Edison Slough at school	W. Bow Hill Rd	1.44	0.56	0.43
37	Edison Drain. in Edison	Farm to Market Rd	2.37	0.78	1.05
38	Drainage north of Edison	North Edison Rd	2.68	0.71	1.22
39	Colony Ck	Colony Rd	1.27	0.54	0.09
40	Big Indian Slough	Bayview-Edison Rd	0.93	0.33	0.43
41	Maddox Slough/Big Ditch	Milltown Rd	1.12	0.35	0.39
42	Hill Ditch	Cedardale Rd	0.53	0.47	0.08
43	Wiley Slough	Wylie Rd	1.41	0.50	0.41
44	Rexville Pump Station	Summers Drive	1.06	0.78	0.31
45	Skagit R – North Fork	Moore Rd	0.28	0.41	0.03
46	Skagit R – South Fork	Fir Island Rd	0.27	0.45	0.03
47	Swinomish Channel	County Boat Launch	0.30	0.46	0.06
48	Fisher Ck	Franklin Rd	0.68	0.36	0.10

[1]Total Kjeldahl nitrogen

Other Parameters

The Skagit County Monitoring Program also measures pH, conductivity, and salinity during each visit to each site. Conductivity and salinity are measured to help interpret other water quality parameters. Measurement of pH shows whether a watercourse is within the range that supports aquatic life. In general, pHs in the Skagit program have been within state standards.

Discharge measurements are made in selected locations, usually on a four-week basis. Discharge measurements are intended to provide a general indication of the flow regime for that watercourse and as an aid in interpreting other water quality parameters.

Although results for these parameters are not discussed in detail in the main report, all measurements are available in Appendix A and are summarized in Appendix B.

Data Analysis

Summary statistics for all measured parameters at each sampling site can be found in Appendix B. Quarterly reports comparing each quarter's water quality results with historical data, when available, are found in Appendix C.

A primary goal of the Skagit County Monitoring Program is to detect trends in water quality over time. The purpose of the trends analysis is to provide indications of whether water quality in agricultural areas is improving, staying the same, or deteriorating. Once trends are detected, we will try to determine if the trends are caused by local activities or by regional conditions such as changes in climate. By comparing trends at stations inside and outside of the agricultural areas and monitoring climate conditions, we should be able to focus on those conditions that seem to be caused by local activities.

One important statistical tool in trends monitoring is the Seasonal Kendall's Test. This test is designed to determine overall trends in water quality for parameters that vary seasonally, such as temperature and dissolved oxygen. In fact, most parameters measured in the Skagit County Monitoring Program have seasonal variation, caused by our local climate which produces comparatively high water flows in the winter and spring and lower flows in the summer and early fall.

Skagit County intends to conduct a comprehensive trends analysis program once two or more years of data is collected. However, many of the watercourses in the Skagit County Monitoring Program were monitored in earlier studies such as the Skagit County Baseline Monitoring Program and the Samish Bay Watershed Water Quality Monitoring Program. Because the methods employed in these efforts were very similar to the current methods, we can begin to examine trends in some of our watercourses. An example of the results of trends analysis using the Seasonal Kendall's Test is included in Appendix D.

Other statistical methods may also be appropriate for the detection of trends in water quality data. Analysis of Variance techniques have been used in some studies, and an example of the possible uses of that tool is also included in Appendix D. Skagit County continues to examine the available tools for determining trends.

Summary

The Skagit County Monitoring Program collected water quality data biweekly at 40 sites in Skagit County from October, 2003 through September, 2004. Dissolved oxygen, temperature, pH, conductivity, salinity, and turbidity measurements were made and fecal coliform samples obtained at each site visit. On alternate visits, every four weeks, samples were also obtained for nutrient analysis.

The sampling revealed considerable variability in the water quality data, both between different sites and also over time at the same sites. Many of the parameters measured in the Skagit County Monitoring Program have seasonal variability, which must be taken into account when interpreting the results and analyzing the data.

Most watercourses did not meet state water quality standards at some point during the water year. Temperature exceedances in streams were often associated with low water flows. Dissolved oxygen minimums also mostly occurred in the summer. Fecal coliform standards exceedances occurred sporadically throughout the year. Failure to meet state water quality standards could be due to a wide variety of reasons, including local land use practices, upstream activities, and regional climate conditions.

References

Skagit County. 2003. Samish Bay Watershed Water Quality Monitoring Project Final Report. Skagit County Public Works, Mount Vernon, WA.

Skagit County. 2004a. Baseline Water Quality Monitoring Project Final Report. Skagit County Public Works, Mount Vernon, WA.

Skagit County. 2004b. Skagit County Water Quality Monitoring Program Quality Assurance Program Project Plan, Update 5-13-04. Skagit County Public Works, Mount Vernon, WA.