2014 Stream Health Assessment for City of Bothell Streams

Version 2014-01

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City of Bothell™

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Introduction

The City of Bothell's Comprehensive Plan, *Imagine Bothell*…, calls for actions to "protect, preserve, and enhance those features of the natural environment which are most sensitive to human activities." Collection of data and observations (i.e. monitoring) is one means to determine attainment of that goal.

The City of Bothell has adopted ordinances and Department goals to protect, maintain, and restore its waters through knowledge of past, current, and future trends and conditions. The City of Bothell's Municipal code 18.01.010 (18) defines Storm and Surface Water Management Services in part as "…water quality and environmental monitoring…." Ordinance 1968 (2006) effective in 2007 stipulates the expenditure of Surface Water Management fees be used to conduct Storm and Surface Water Management Services.

The monitoring effort will facilitate the City's commitment to wise management of land and water for the benefit of current and future generations. A primary measure of success will be attainment of state water quality standards and beneficial uses as designated by city, state, and federal water quality standards.

Goal

Create a means by which the City of Bothell can measure and describe in a quantitative and qualitative manner, whether it has achieved its objective to protect and restore the chemical, physical, and biological integrity of the City's surface waters.

Objective

Annually monitor surface waters along select water quality measures to develop baseline data for trend identification. Assess data for occurrences of degraded conditions and quantify levels observed, and document in-stream water quality and other opportunistic observations. Use information to facilitate City policy and land use rules, prioritize restorative actions, and direct future program monitoring efforts. Use the assessment to measure compliance with the Federal National Pollutant Discharge Elimination System (NPDES) Phase II permit, Endangered Species Act, and Clean Water Act.

Methods

Methods have been extensively described in previous annual monitoring reports (Loch 2009 and 2010). The following is a brief summary of methods.

Sample Station Selection

Selection of sites was determined through in-office review of maps and follow-up field surveys. Sites were selected based on their representativeness of the stream and upstream land use patterns. Sites were located as far downstream as was practical.

Chemical

At each site, monthly water quality measures were taken of dissolved oxygen, temperature, turbidity, conductivity, specific conductivity, and salinity.

Temperature

Stream temperatures were taken using two methods. One method was an instantaneous measure collected at the time of general water quality sample with YSI 85 meter. The second method involved use of a continuous instream temperature data logger. The data loggers were installed in a stream and were set to record continuous temperature reading every 15 minutes.

Physical

Hydrology Flows

Visual estimates of flow were made during monthly water quality sampling events. Flows were estimated and recorded in cubic feet per second (CFS) or, if flows were slight, estimates were made in gallons per minute (gpms).

QA/QC

To ensure accurate and precise data, all meters are calibrated at a minimum of once per month or per manufacturer's recommendations. Calibration records were kept of water quality meters. Meters were checked for accuracy prior to each monthly sampling event.

Field data collection was supervised by a professional aquatic ecologist. Field data was entered into digital tables and checked for accuracy. Anomalies were investigated for possible errors in transferring data and accompanying field comments.

Data Analysis

The data for annual summary report is limited to simple graphs. Graphs are assessed for general characteristic purposes and as early indicators of trends. Future efforts should include stronger statistical review to provide insight to problematic or poorly understood observations.

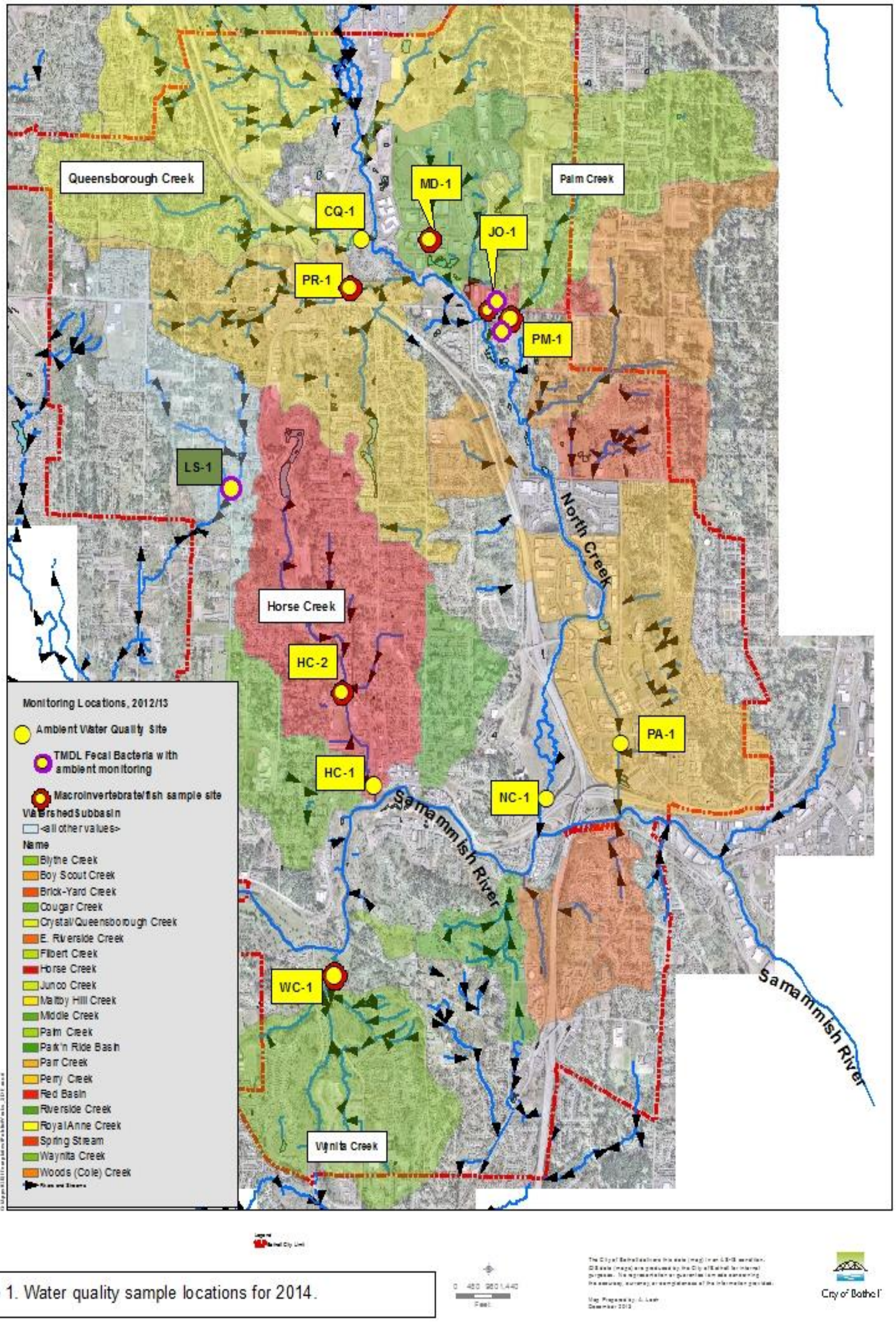

Figure 1. Water quality sample locations for 2014.

Results

Sample Station Selection

A total of 11 sites (Figure 1) were selected for sampling in 2014. This represents a reduction from 17 sites in previous years. The reduction was needed to conserve time and cost over the value offered from each eliminated site. Sites were discontinued due to their previous inability to add much information to our understanding of the general water quality conditions throughout the City. The sites were sampled for water quality parameters and six sites received deployment of temperature loggers. Three of the sites are part of the City's long-term fecal coliform bacteria sampling efforts. Fecal coliform test results are presented in a separate annual report (Loch 2015).

Basin Descriptions:

Ten watersheds were sampled among the eleven sample sites (Figure 1). Their basins' general characteristics are summarized in previous reports (Loch 2014). One watershed, Horse Creek, had two sample sites. These two locations were selected to detect any significant difference in their stream water quality conditions given the disparity of land use occurring within each area. The complete ambient monitoring data set for all sample locations may be found in Appendix A.

Chemical

Monthly measurements included dissolved oxygen, specific conductivity, salinity, pH and NTUs (nephelometric turbidity units). No noted events occurred during the sampling period. The meters would stop working occasionally due to expired batteries. Sampling was suspended until the batteries were replaced.

Dissolved Oxygen (DO)

Dissolved oxygen levels for all but one stream (Palm Creek) recorded readings below Washington State Department of Ecology's water quality standard of $\geq$ 9.5 mg/l (Figure 2). The annual 12-month average was below state standards at eight streams. Lower Parr Creek (PA-1) had DO lethal levels for salmonids from July through October (critical times for juvenile rearing and adult spawner migration). Middle Creek had lethal levels during August. (Lethal level to salmonids is: < 3.3 mg/l, Spence et. al. 1996.)

The five-year trend analysis (Figure 3) shows a decrease in dissolved oxygen at nearly all stream sites between 2010 and 2014.

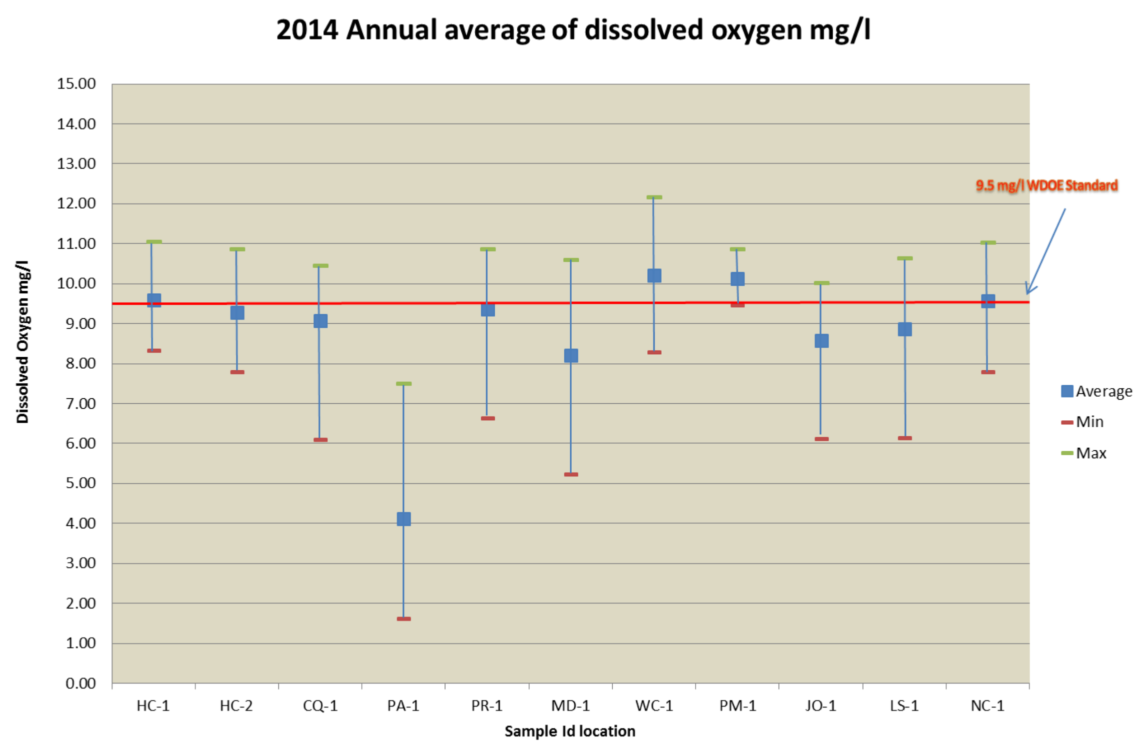

Figure 2. 2014 Annual average of dissolved oxygen mg/l.

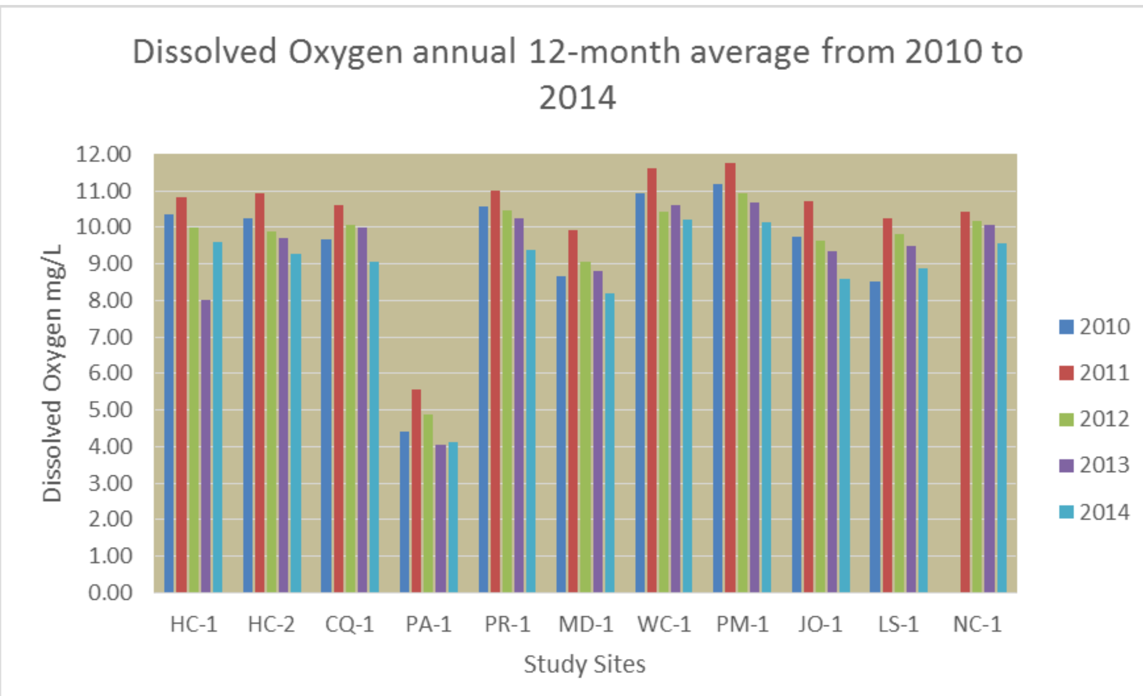

Figure 3. Dissolved oxygen annual 12-month average from 2010 to 2014.

Conductivity

Specific conductivity throughout the City was seasonally influenced. Highest readings occurred in the summer and lowest readings in late spring. The highest readings for specific conductivity occurred on Parr Creek (PA-1) and at Waynita Creek (WC-1). The five-year trend was for an overall decrease in conductivity levels. The exceptions were at Junco Creek which remained relatively unchanged, and Waynita Creek (WC-1) which is experiencing a slight increase since 2011.

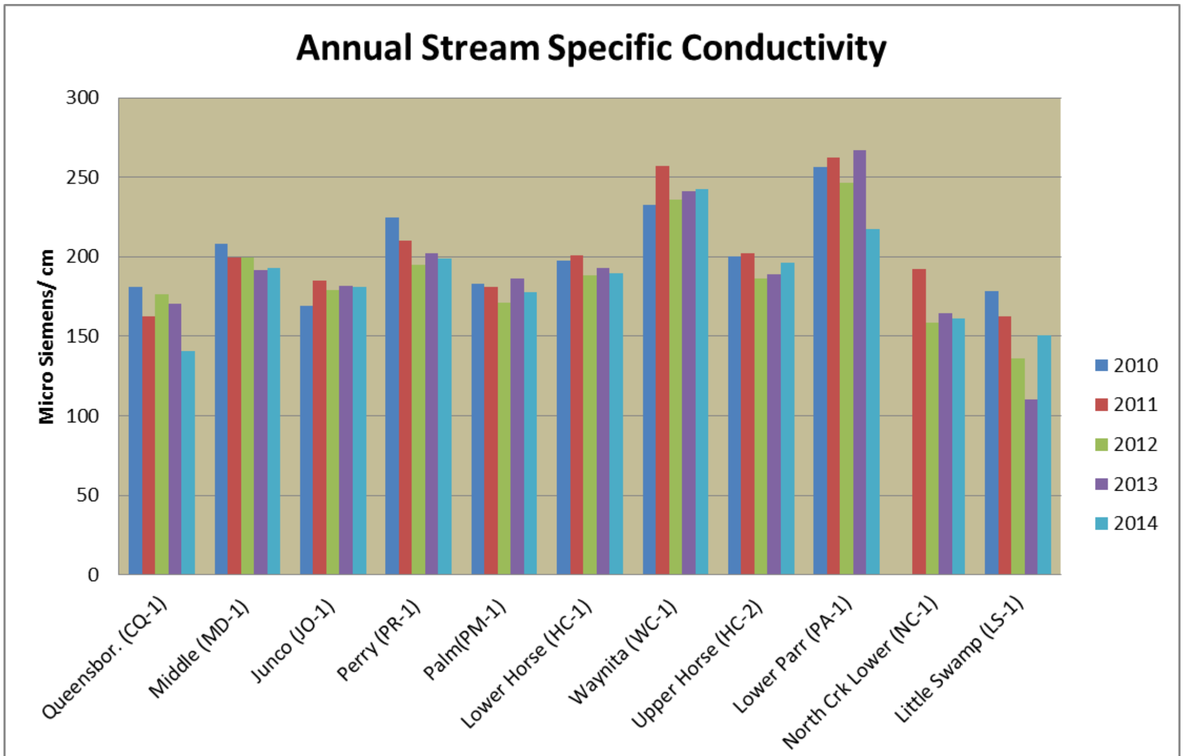

Figure 4. Annual Stream Conductivity

pH

Values of pH followed the same seasonal trend as conductivity. No site had recorded measures below or above state water quality standards. The five-year trend in pH has been for a slight increase at most streams beginning in 2012 (Figure 5).

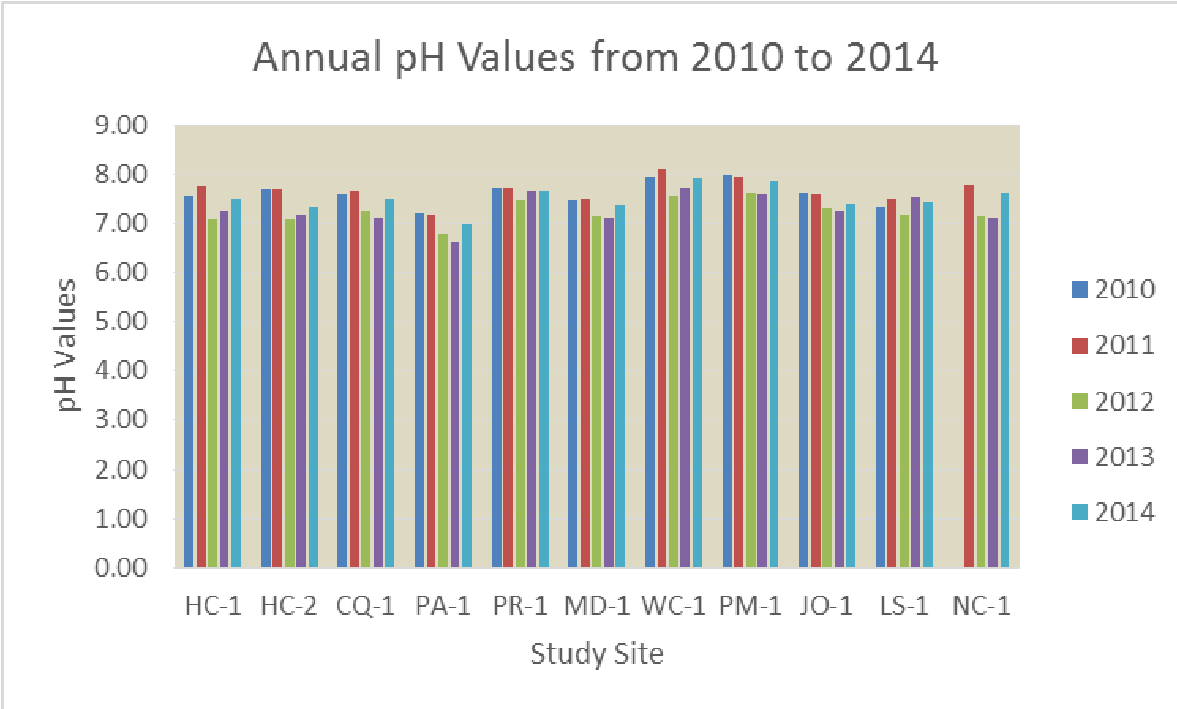

Figure 5. Annual pH values for study sites from 2010 to 2014.

NTUs (Nephelometric Turbidity Units)

Turbidity levels were typically positively correlated to rain events. Parr Creek tended to have highest turbidity readings throughout the year due to algae diatom blooms from an upstream wetland pond. Two streams, Horse Creek and Waynita Creek, with active construction or demolition work upstream of the sample locations at times had elevated levels of turbidity that were unrelated to rain events (see Appendix A for data set).

Temperature

Temperature loggers were deployed at six sites in 2013 and retrieved in late April 2014. The loggers measured stream temperature at 15-minute intervals. One deployed logger was lost in the stream at Perry Creek. Data was cropped pre-retrieval and post-deployment to allow for near same start and finish time for all streams. This allows direct comparison of logger data for all streams.

To see overall general trend for stream temperatures, Figure 6 represents annual maximum monthly stream temperature collected at the time of ambient monitoring. There has been an overall trend of warming stream temperatures since 2010. In 2014 local ambient air temperatures were the warmest recorded since 1945 when monitoring began at SeaTac Airport (Komo, 2015).

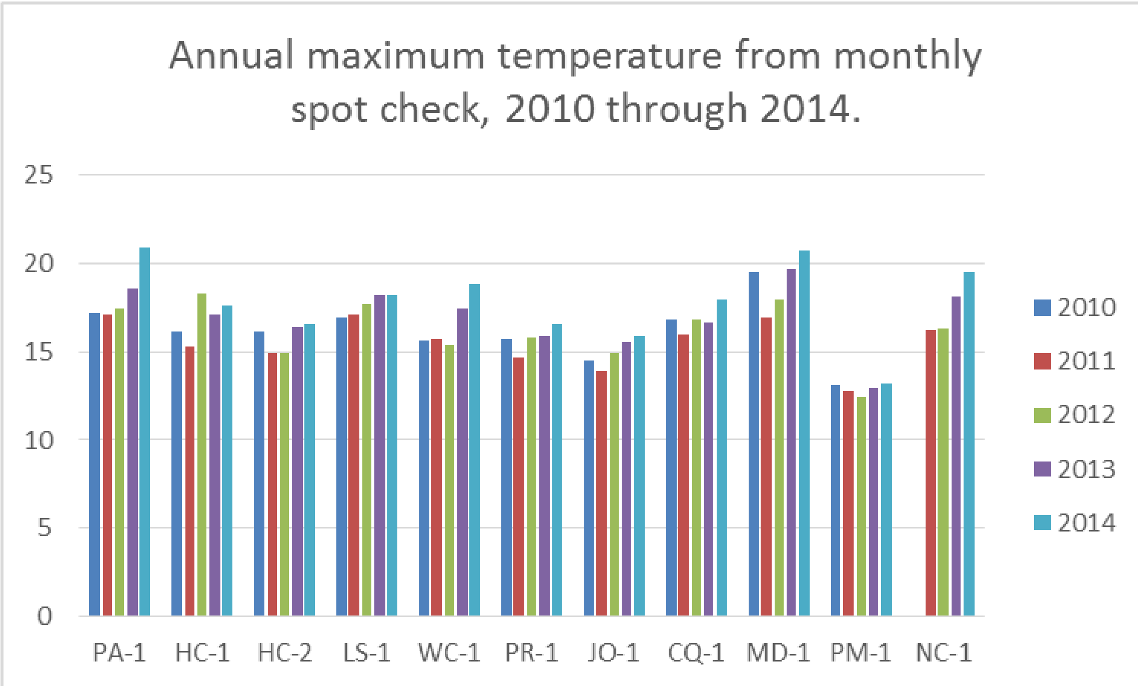

Figure 6. Annual maximum stream temperature from monthly spot checks for 2010 through 2014.

Temperature logger data found all streams to exceed state standards. Figure 7 depicts the number of days a site exceeded Washington State Department of Ecology (WDOE) water quality standards, 7DADMax. The 7DADMax is a running average of maximum daily temperature over a 7-day period. The state standards for streams vary depending on time of year and use designation. For all streams in Bothell, the aquatic life temperature criteria is salmon and trout spawning not to exceed 7DADMax of 13 C from September 15^{th} to May 15^{th}, and core summer salmonid habitat not to exceed 7DADMax of 16 C any time of year.

All five streams exceeded WDOE standards at some point throughout the year, typically May through September in 2013, except for Palm Creek (PM-1) which only exceeded 13 C WDOE standards in September.

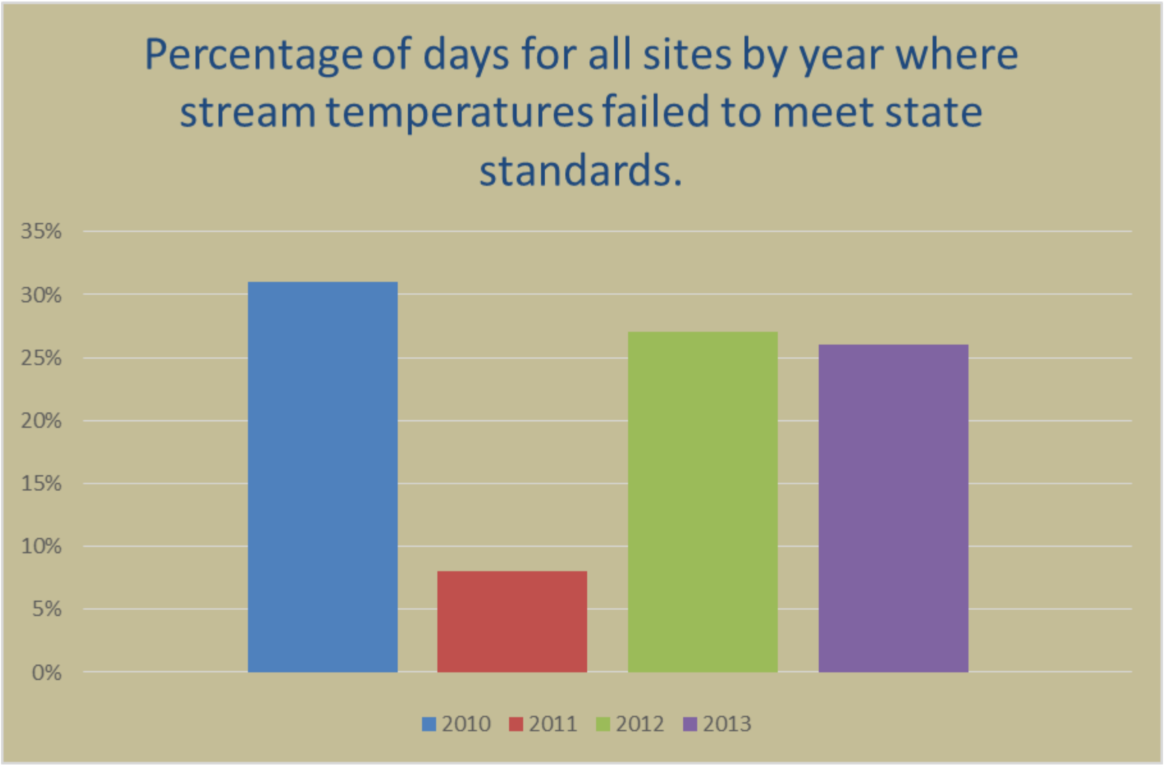

Figure 7. Percentage of days for all sites by year where stream temperatures exceeded state standards.

Summary

Results for ambient water quality monitoring for 2014 found degraded conditions throughout the City. Best available science has frequently found such levels of degradation to be related to common and pervasive urban development. Urban development is often characterized as having a dense road network, high levels of impervious surfaces, loss of riparian corridor (treed stream sides), increases in peak storm flows, inadequate storm runoff controls, reduced wetland acreage, modified stream channel networks, and degraded water quality. It may also include an increase in heavy metals concentrations, nutrients, pesticides and herbicides, and a loss of instream and terrestrial habitat, as well as a decrease (and in some cases extirpation) of native species.

Future

To address the impairments noted in this study, the following are recommended actions:

- ✓ Reduce peak flows, discharge of fine sediment, and polluted stormwater to streams.
- ✓ Identify means to retrofit direct discharge of stormwater that has been inadequately treated for pollutants and flow volumes.
- ✓ Encourage landowners to enhance and increase riparian zones along streams and wetlands, while limiting future encroachment.

- ✓ Develop and prioritize watershed-based restoration schedule to address instream deficiencies.
- ✓ Allow for and protect stream channel migration zones within floodplains.
- ✓ Educate landowners on improved vegetation management techniques that reduce applications of fertilizers, herbicides, and pesticides.
- ✓ Develop City plans to reduce road-generated pollutants from reaching streams.
- ✓ Continue to monitor the condition of streams for future trend and effectiveness analysis.
- ✓ Increase forested canopy throughout the City that promotes hydrologic maturity runoff conditions.
- ✓ The City's National Pollution Discharge Elimination System Phase II permit should be closely structured around the identified sources of degradation identified in this report.

The City is currently carrying out actions to address the problem of degraded stream conditions. Some of these actions have been ongoing for years, such as the Shoreline Management Plan and Critical Areas Ordinance and the stormwater design controls. In 2007, the National Pollution Discharge Elimination System (NPDES) permit issued by Washington State Department of Ecology mandated that the City begin implementation of measures and programs to address stormwater impacts on streams. The results here provide a means to measure over time whether the new stormwater programs are effective towards meeting the goal to protect and restore the chemical, physical, and biological integrity of the City's surface waters.

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APPENDIX A

2014 Stream Ambient Monitoring Data

Annual Summary of ambient water quality monitoring for 2014

Parameter	HC-1	HC-2	CQ-1	PA-1	PA-2	PR-1	MD-1	PR-2	MH-1	WC-1	PM-1	WD-1	JO-1	BY-1	LS-1	NC-1	NC-2
Dissolved Oxygen (mg/l)					N			N	N			N		N			N
Average	9.58	9.28	9.07	4.12	O	9.37	8.20	O	O	10.20	10.14	O	8.59	O	8.87	9.57	O
Deviation	0.70	0.88	1.20	1.91		1.28	1.58			1.20	0.52		1.15		1.62	1.13	
Min	8.34	7.79	6.11	1.63	D	6.64	5.24	D	D	8.30	9.46	D	6.13	D	6.14	7.79	D
Max	11.03	10.86	10.43	7.49	A	10.85	10.59	A	A	12.15	10.84	A	10.01	A	10.62	11.01	A
Count	12	12	12	12	T	12	12	T	T	11	12	T	12	T	12	12	T
Specific Conductivity (*us/* cm)					A			A	A			A		A			A
Average	196.48	189.35	140.37	217.57		198.87	193.06			242.53	177.80		180.96		150.61	161.22	
Deviation	30.73	28.45	33.79	84.95	C	32.63	30.21	C	C	45.13	28.71	C	13.47	C	40.68	35.19	C
Min	130.2	129.70	73.70	18.20	O	115.30	101.20	O	O	147.10	113.70	O	147.80	O	83.70	91.80	O
Max	236	229.20	170.00	282.80	L	225.40	211.20	L	L	313.3	198.60	L	195.80	L	203.30	203.60	L
Count	12	12	12	12	L	12	12	L	L	11	12	L	12	L	12	12	L
pH					E			E	E			E		E			E
Average	7.50	7.34	7.50	6.98	C	7.66	7.38	C	C	7.91	7.84	C	7.40	C	7.44	7.64	C
Deviation	0.23	0.24	0.20	0.20	T	0.23	0.30	T	T	0.21	0.17	T	0.20	T	0.27	0.27	T
Min	7.18	7.10	7.18	6.67	E	7.35	6.96	E	E	7.63	7.54	E	7.06	E	7.01	7.15	E
Max	8.08	7.90	7.81	7.32	D	8.06	7.89	D	D	8.41	8.04	D	7.68	D	7.97	8.05	D
Count	12	12	12	12		12	12			11	12		12		12	12	
NTUs																	
Average	2.86	3.39	1.79	6.28		3.31	2.41			8.50	0.60		0.94		4.48	3.62	
Deviation	3.23	3.25	2.36	1.44		3.65	1.54			13.88	1.42		0.90		3.88	4.47	
Min	0.14	0.80	0.15	3.40		0.09	0.18			0.90	3.02		0.18		0.46	0.23	
Max	11.50	12.80	9.04	8.14		12.20	6.00			48.70	2.89		3.35		11.80	16.20	
Count	12	12	12	12		12	12			11	12		12		12	12	
Flow (cfs)																	
Average	1.55	1.31	0.93	2.35		1.62	0.60			1.42	2.29		1.27		0.45	59.92	
Deviation	0.96	0.70	0.78	2.53		0.90	0.58			1.22	0.83		0.52		0.62	38.78	
Min	0.50	0.50	0.13	0.50		0.75	0.03			0.04	1.25		0.75		0.02	18.00	
Max	4.00	3.00	3.00	10.00		4.00	2.00			4.00	4.00		2.00		2.00	160.00	
Count	12	12	12	12		12	12			11	12		12		12	12	