CreekWatch
Urban Stormwater Monitoring

Alberta CreekWatch
A Report Card on Urban Creek Water Quality
2015


Calgary's Fish Creek was ranked first for best water quality

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Executive Summary

CreekWatch Report Cards function to annually review the water quality of urban creeks in Alberta, Canada. These creeks function as conduits for stormwater runoff, and higher rankings denote greater overall water quality, while lower rankings signify lesser overall water quality. See Table 1.

A Report Card on Urban Creek Water Quality, 2015			
Rank	**Creek**	**Score/49**	**Location**
1	Fish Creek	47	Calgary, AB
2	Pine Creek	39	Calgary, AB
3	Blackmud Creek	38	Edmonton, AB
4	Whitemud Creek	37	Edmonton, AB
4	West Nose Creek	37	Calgary, AB
5	Mill Creek	36	Edmonton, AB
6	Nose Creek	28	Calgary, AB

Table 1: Overall Urban Creek Rankings

The first-ever 2015 CreekWatch Report Card examines the state of urban creeks in Alberta based on the water quality data collected through the use of citizen science, water quality technicians and lab analysis. We are sharing our findings with the public and government water quality professionals to collaboratively work towards the consistent monitoring and improvement of our urban creeks in Alberta.

In 2015, between the months of June and October, there were 24 active volunteers and two science technicians in Edmonton and Calgary who combined for 178 site visits, over 1,500 collected water samples, and an estimated 130 hours total time spent on seven urban creeks.

CreekWatch data is uploaded to an online database www.riverwatch.ab.ca/science/creekwatch that allows for immediate, real-time data viewing through a custom-designed interactive graphing tool. Data and graphing is publicly available. The data collected in 2015 was used to generate a comparative report card on urban creek water quality.

Rankings were obtained by awarding points for eight parameters – dissolved oxygen, ammonia nitrogen, nitrate-nitrogen, phosphorus, temperature, conductivity, turbidity and macroinvertebrates. Higher points were awarded for the best values in each of the eight parameters. A top score of 7 for all 8 parameters would result in a total possible score of 56. See Appendix 1 and 2 for calculations.

The CreekWatch 2015 monitoring program suggests that both Edmonton and Calgary have a range of water quality exemplified in their stormwater creeks, with Calgary creeks ranked the best and the lowest water quality. It would be important to investigate the best management practices employed in the top ranked creeks for potential emulation into the management practices of the lower ranked creeks.

The collection of reputable baseline water quality data using citizen science is an emergent tool to engage Albertans as stewards of their local waters. Cost-effective and publicly available data can help municipalities make important decisions aimed at the protection and management of water quality and aquatic environments.

Acknowledgements

CreekWatch was made possible through HSBC Water Programme funding and HSBC volunteers in a collaborative effort with the RiverWatch Institute of Alberta. In particular, assistance was appreciated from Kim Hallwood, Head of Sustainability; Ruth Legg, Manager, Sustainability; and Aurora Bonin, Senior Media Relations Manager.

The enthusiasm and time donated by citizen science volunteers was amazing. Twenty-four active and trained volunteers used a loan-pool of monitoring equipment to collect data from their local creeks in Edmonton and Calgary. Volunteers were recruited from the following organizations:

HSBC Bank Canada
Keepers of Mill Creek
GE Water

Advice and support was received from organizations and professionals across Alberta to help plan, develop, manage and analyze CreekWatch data collection, and include the following:

Alberta Environment & Parks
City of Calgary
City of Edmonton
Bow River Basin Council
North Saskatchewan Watershed Alliance
EPCOR
Web3 Marketing
Exova
Miistakis Institute
Salmo Consulting
Kevin Weimer
Friends of Fish Creek

Thank you everyone.

Introduction

CreekWatch Year One set out to develop and evaluate a citizen science network for the collection of useable, cost-effective and publicly available data on urban creek stormwater quality. The primary goal of CreekWatch was to collect baseline water quality data on urban stormwater creeks in Alberta. Urban stormwater tributaries face unique stressors that already make them some of the most highly impacted local waterways, and consequently, they are of interest and importance to communities and watershed managers.

With increasing residential and industrial development, many urban surfaces are now impermeable, allowing snowmelt and rainwater to move much more quickly over these areas rather than soaking into the soil. Along this surface run-off journey, stormwater collects various contaminants from vehicles, roadway maintenance, industries, pet waste and neighborhood yards that ultimately discharges into creeks that impact river ecology and urban sustainability. See Table 2 for total stormwater outfalls per creek.

Urban Stormwater Outfalls per Creek							
	Fish Creek	**Nose Creek**	**West Nose Creek**	**Pine Creek**	**Whitemud Creek**	**Blackmud Creek**	**Mill Creek**
City	Calgary	Calgary	Calgary	Calgary	Edmonton	Edmonton	Edmonton
Total Outfalls	14	53	14	2	16	11	46

Table 2: Total number of urban stormwater outfalls per monitored creek.
Source: City of Calgary Water Resources, 2016; City of Edmonton Drainage Services, 2016

Justification

The one-year CreekWatch pilot project June 2015-May 2016 aimed to establish a framework and tools for incorporating public participation in science research (citizen science) to address existing issues and research gaps in stormwater monitoring. Contributions were made to address issues and research gaps including:

- the number and frequency of stormwater creeks being monitored
- baseline data for stormwater quality
- reliability of volunteer citizen science data
- the cost-efficiency of monitoring programs
- the public availability of online data
- and the engagement of a public able to understand and contribute to the management of rivers and streams.

Site Information

Sampling sites were identified on urban tributaries of the North Saskatchewan River in Edmonton and the Bow River in Calgary. Sites were selected based on the consideration of accessibility, perceived value of tributary importance, the extent of our resources to collect data, and the advice and suggestions from other water quality professionals. Samples were collected at the mouth of each selected tributary. See Appendices 7 - 13 for individual creek descriptions.

Study Design

Three levels of data collection were undertaken in 2015 as means to involve citizen science volunteers, increase the number of sampling events and to provide quality assurance.

Level One data was obtained through trained citizen science volunteers using manual equipment, as seen in Photo 1. This involved the use of Hach testing kits housed in wheeled coolers for ease of transport and access (See Photo 2). Expectations were that each volunteer would collect data on their own free time at least 2-4 times through the open-water season. We had 10 volunteers in Edmonton, and 14 volunteers in Calgary. Citizen science volunteers were trained in May 2015 in both Edmonton and Calgary. Water sampling occurred between the months of June and October 2015.

Photo 1 - Volunteers streamside performing water quality tests.

Photo 2 - Level One Hach Monitoring Kit.

Level Two data was collected by CreekWatch Technicians on a weekly basis between June-October (See Photo 3). This involved the use of a YSI Professional Plus instrument capable of measuring a wide range of parameters. Also included in the equipment were two separate LaMotte 1200 Colorimeters, one for nitrate-nitrogen and one for phosphorus. See Photo 4.

Photo 3 - CreekWatch Technician using Level Two Equipment.

Photo 4 - Level Two Electronic Monitoring Equipment.

The collection of **Level Three** data happened once in 2015, and this involved the submission of water samples to Exova for laboratory-based testing. All three levels of data were collected at the same time, allowing for a unique comparison between the three different data levels to verify accuracy and consistency. See Appendix 3 for detailed explanations on equipment and levels of monitoring, and see Appendix 4 for a comparison of data across three levels of data.

Table 3 below lists the number of sampling events in 2015.

Sampling Events per Creek								
City	Calgary				Edmonton			
	Fish Creek	Nose Creek	West Nose Creek	Pine Creek	Whitemud Creek	Blackmud Creek	Mill Creek	Total Events
Level One	8	6	4	3	10	5	7	43
Level Two	19	33	19	17	11	14	13	126
Level Three	1	2	1	1	2	1	1	9
Total Events	28	41	24	21	23	20	21	178

Table 3: Total sampling events in 2015

All volunteers and technicians were provided a unique PIN to access the data entry portion of the CreekWatch website. This information could be entered on a computer or mobile device, and once submitted, it was available for public viewing in real-time. Please see Appendix 5 for a description of the data viewing and entry platform.

General Observations

All seven monitored creeks contained flowing water throughout the open-water season, despite the Alberta drought conditions of 2015.

- Globally, 2015 was declared the hottest year on record.
- Record-breaking temperatures and extremely low rainfall resulted in drought conditions across much of Alberta.
- Several counties declared states of agricultural disaster;
- province-wide fire bans were set in place;
- early snowpack melting lead to low flows in rivers, some of which were even closed to recreational angling due to high water temperatures.

The comparability of our three levels of data was shown to be an effective way to determine the accuracy of each method of data collection. By means of these comparisons, we can speak to the accuracy of the data we are collecting. With the data collected in Level One and Two being relatively close, there is definitely a trade-off for the cost effectiveness of using volunteer water quality monitoring equipment as a valuable means to collect data.

Graphing the individual water quality parameters showed that there is a general pattern in the life of creeks and there are many direct correlations between the parameters that we are monitoring. See the box-and-whisker plots in Appendix 6. For instance, temperature had a direct correlation with dissolved oxygen levels. As temperature increased, dissolved oxygen levels decreased. Another interesting pattern was the pH levels that were noticeably similar within each city's creeks, although widely different between Edmonton and Calgary.

In creating a report card summary of stormwater creek water quality, it became apparent that there is a range of creek water quality in Edmonton and Calgary. This report functions as baseline water quality data for the 2015 open-water season and will be used going forward to compare differences in water quality over the years.

Stewardship Action

In September 2015, a pilot stewardship project was coordinated along a section of the Bow River in Calgary. This was coordinated with the help of the City of Calgary and volunteers spent a Saturday removing invasive plants from selected areas. The target plant for the day was Common tansy (*Tanacetum vulgare*), which has taken up residence along much of the Bow and its tributaries in Calgary. Listed as a noxious weed in Alberta, this plant grows in dense 1.5m tall stands with yellow button-like flowers. As seen in the photos below, our volunteers had a great time removing this plant and look forward to more events in 2016. In addition to invasive weed pulls, events will be coordinated to collect shoreline litter and plant native trees and shrubs in riparian areas.

Photo 5 - Common Tansy (Tanacetum vulgare)

Photo 6 – Volunteers were well equipped by the City of Calgary to properly remove the entire plant

Analysis

While each study creek had a different source area, the data might be best compared for changes along the length of a particular creek. Ranking creeks with each other was the chosen comparison method in this first year of establishing a volunteer network. Other comparison methods such as the Canadian Council for Ministers of the Environment (CCME) Water Quality Index were considered and will be considered again. It is of interest to note that the highest ranked creek (Fish Creek, Calgary) is known for its constructed stormwater treatment wetlands while the lowest ranked creek (Nose Creek, Calgary) receives discharges from the Town of Crossfield and City of Airdrie before even entering the City of Calgary.

In 2015, between the months of June and October:

- there were 24 active volunteers and two science technicians in Edmonton and Calgary
- a combined 178 total site visits
- over 1,500 collected water sample data points
- an estimated 130 hours total time spent on seven urban creeks
- ten portable water monitoring kits were distributed
- 10 sampling locations were monitored across urban creeks in Edmonton and Calgary.

Conclusion

The one-year CreekWatch pilot project June 2015 - May 2016 aimed to establish a framework and tools for incorporating public participation in science research (citizen science) to address existing issues and research gaps in stormwater monitoring.

The key CreekWatch objective is to provide sound data to support informed decisions on basin-wide watershed management, and to make this data readily available in a timely manner to watershed managers and the public. An annual report card on the water quality of urban stormwater creeks is one method to accomplish this objective. See Table 1 for the 2015 CreekWatch Report Card.

Many lessons were learned from different challenges during CreekWatch Year One. Sourcing equipment required constant kit maintenance, upkeep, and the replacing of consumables throughout the season for both Level One and Level Two equipment. Data accuracy was also a concern, and to address these concerns we collected three levels of data on the same day to compare accuracy of our equipment against lab results. The engagement of volunteers was ongoing throughout the season with frequent program updates, friendly reminders, and technical support for equipment and online data entry. Engagement incentives are currently being explored to further increase volunteer participation for 2016. Addressing these challenges will help to improve CreekWatch for 2016.

Next Steps

Looking ahead to the 2016 sampling season, there are changes that will be implemented to further add to the current data collected. CreekWatch hopes to expand the project scope to allow:

- The inclusion of additional urban creeks and additional sampling sites on currently monitored creeks.
- The addition of more volunteers to complement the current volunteer base established in 2015. This will be accomplished through collaboration with other similar interest groups.
- A protocol for replicate sampling in the case of outlier data points.
- Data on the total area of all combined outfalls for each creek
- The purchasing of additional equipment that will be provided for additional groups of volunteers.
- Additional parameters will also be added for 2016 that include monitoring water flow/discharge rates and *E. coli* and coliform bacteria levels in each creek.

APPENDICES

Appendix 1. Stream Ranking Calculations Based on Median Values for Eight Parameters

Recent approaches to river health assessment recognize the importance of examining physical, chemical and biological interactions. The comparison ranking of study creeks was based on a point system for eight parameters using median values for dissolved oxygen, ammonia nitrogen, nitrate-nitrogen, phosphorus, temperature, conductivity and turbidity. A benthic macroinvertebrate index was also used as a metric, explained in Appendix 2.

Ranking the seven study creeks meant that there were 1-7 points available for each parameter. The highest point (seven) was awarded for the lowest value in each parameter except for dissolved oxygen and benthic macroinvertebrates, where the seven was given for the highest value.

Points (possible 56) were totaled for each individual creek to achieve the rankings (1-7). Rankings were interpreted as an indication of overall water quality compared between the seven monitored creeks. Higher rankings denoted greater overall water quality, while lower rankings signified lesser overall water quality.

Stream Ranking Calculations based on Median Values for Eight Parameters							
City	**Calgary**				**Edmonton**		
Parameters	**Fish Creek**	**Nose Creek**	**West Nose Creek**	**Pine Creek**	**Whitemud Creek**	**Blackmud Creek**	**Mill Creek**
Dissolved Oxygen (mg/L)	10.00	9.13	9.37	9.40	8.00	8.31	8.67
Points	7	4	5	6	1	2	3
Ammonia Nitrogen (mg/L)	0.10	0.25	0.25	0.18	0.10	0.10	0.25
Points	7	5	5	6	7	7	5
Nitrate-nitrogen (mg/L)	0.15	0.61	0.94	0.14	0.04	0.02	0.03
Points	3	2	1	4	5	7	6
Phosphorus (mg/L)	0.09	0.10	0.08	0.12	0.03	0.04	0.13
Points	4	3	5	2	7	6	2
Water Temperature (°C)	15.4	15.5	12.3	12.5	17.3	16.4	16.5
Points	5	4	7	6	1	3	2
Turbidity (NTU)	10.0	25.5	13.5	10.0	10.0	14.0	10.0
Points	7	4	6	7	7	5	7
Conductivity (mS/cm)	0.50	0.85	0.76	0.70	0.63	0.64	0.65
Points	7	1	2	3	6	5	4
Benthic Macroinvertebrate Index	4.0	-2.5	1.5	0	-5	-5	-4
Points	7	4	6	5	2	2	3
Total Points	47	28	37	39	37	38	36
RANK	**1**	**6**	**4**	**2**	**4**	**3**	**5**

Table 4 Stream ranking calculations based on median values of 8 collected parameters.

Appendix 2. Benthic Macroinvertebrate Index

Aquatic macroinvertebrate sampling was conducted once on each of the 7 monitored creeks in October 2015. Macroinvertebrates are organisms without backbones, which are visible to the eye without the aid of a microscope. They live on, under, and around rocks and sediment on the bottoms of lakes, rivers, and streams. Aquatic biomonitoring can indicate preceding river conditions for weeks or months prior to collection.

Metrics can be used to analyze and interpret biological data by condensing lists of organisms and turning them into relevant biological information. The procedures and scoring index described here are based in part on guidelines for Volunteer Stream Monitoring developed by the US Environmental Protection Agency.

1. Select sample location in moving water
2. Thoroughly kick substrate while holding a 1m x 1m seine net downstream to collect organisms
3. Rinse sample from the net into a bucket and ensure all organisms are free of the net
4. Filter the bucket through a strainer to collect invertebrates while removing debris
5. Empty strainer into a shallow tub and carefully remove organisms with a dropper and isolate using an ice cube tray
6. Identify, count, and record organisms according to an invertebrate key
7. Safely release all organisms back into the stream

Table 5 displays total counts from each creek.

Invertebrate	Fish Creek	Nose Creek	West Nose Creek	Pine Creek	Whitemud Creek	Blackmud Creek	Mill Creek
mayfly nymph (PS)	-	8	2	-	-	-	-
stonefly nymph (PS)	2	-	-	-	-	-	-
caddisfly larva (MPT)	10	50	2	-	-	1	1
midge larva (PT)	2	50	40	-	10	5	50
crayfish (PT)	-	-	-	-	2	1	-
blackfly larva (PT)	1	-	-	-	-	18	-
amphipod (MPT)	-	-	1	-	-	-	3
TOTAL COUNT	**15**	**108**	**45**	**0**	**12**	**25**	**54**

Table 5 Total macroinvertebrate counts - October 2015.

Three categories of invertebrates were identified being pollution sensitive (PS), moderately pollution tolerant (MPT), and pollution tolerant (PT). Relative abundance was also established as rare, common, or dominant. Scores were calculated based on the scoring index below.

	Pollution Sensitive	Moderately Pollution Sensitive	Pollution Tolerant
Rare	3.5	2.0	-1.0
Common	5.5	3.0	-2.0
Dominant	7.5	2.5	-4.0

Table 6 Benthic macroinvertebrate scoring index

*Source: US Environmental Protection Agency (1997). Volunteer Stream Monitoring: A methods manual, Ch. 4 Macroinvertebrates and habitat: www.epa.gov/owow/monitoring/volunteer/stream/ums40.html

*Due to restricted access at the mouth of Pine Creek, an invertebrate sample could not be conducted and it was assigned a value of zero.

Appendix 3. Equipment and Parameters for Three Levels of Monitoring

Three levels of data collection were undertaken by CreekWatch as means to involve citizen science volunteers, increase the number of sampling events and to provide quality assurance. The following table summarizes the equipment and the physical and chemical parameters for each monitoring level used during 2015.

Summary of CreekWatch Monitoring Levels			
Monitoring Level	**Level One**	**Level Two**	**Level Three**
Equipment	**Manual Hach kits used several times a year per volunteer**	**YSI Probes used once per week by technicians**	**Lab analysis used once per year**
PHYSICAL	**Parameters Measured**		
Water Temperature (°C)	X	X	-
Turbidity (NTU)	X	X	X
Conductivity (mS/cm)	-	X	X
TDS (mg/L)	-	X	X
Salinity (ppt)	-	X	X
CHEMICAL	**Parameters Measured**		
Dissolved Oxygen (mg/L)	X	X	X
Ammonia Nitrogen (mg/L)	X	-	X
Nitrate-Nitrogen (mg/L)	-	X	X
Orthophosphorous (mg/L)	X	X	X
pH	X	X	X

Table 7 Summary of CreekWatch Monitoring Levels

Level One Monitoring

Level One monitoring equipment was purchased through Hach Canada and testing kits were housed in wheeled coolers for ease of transport and storage. Each portable lab cost approximately $600. Expectations were that each citizen science volunteer would collect data on their own free time at least 2-4 times through the open-water season. We had 8 volunteers in Edmonton, and 12 volunteers in Calgary.

Level Two Monitoring

YSI equipment was purchased from Hoskin Scientific Ltd. Each kit cost approximately $4,400. *Level Two* data was collected on a weekly basis between June-October by CreekWatch technicians using YSI Professional Plus instruments capable of measuring a range of parameters. Also included in the portable lab were two separate LaMotte 1200 Colorimeters – one for nitrate-nitrogen and one for phosphorus.

Level Three Monitoring

The collection of **Level Three** data was used once in 2015, and this involved a CreekWatch technician to collect and submit water samples to Exova for laboratory testing. Each laboratory analysis of a creek sample cost $214.

Cost Comparisons for Three Levels of Monitoring

Three different levels of monitoring allowed CreekWatch to make a unique comparison for accuracy and costs. There were advantages and disadvantages associated with each type of monitoring that included: instrument complexity, cost, calibration and maintenance, technique accuracy and precision, replacement costs for damaged equipment, and transportability. Lab analysis was the benchmark for all comparisons and while defined as the most accurate, it was the most expensive. The chart below depicts the cost of each monitoring level.

Cost Comparison for Three Levels of Monitoring			
Level	**Cost/Sample**	**% Cost**	**Notes**
Level Three Lab	**$214**	**100%**	**Per one site**
Level Two YSI Probes	**$47**	**22%**	**Per 100 Sites sampled**
Level One Hach Kits	**$7**	**3%**	**Per 100 Sites sampled**

Table 8 Cost comparison for Three Levels of Monitoring

Parameter	Method	Cost
Dissolved Oxygen	Drop count titration	$100.00
pH	Colour-disc	$123.37
Phosphate	Colour-disc	$144.35
Ammonia-Nitrogen	Test strips	$32.87
Turbidity	Secchi tube	$57.77
Temperature	Thermometer	$18.30
TOTAL		$476.66

Table 9 Cost breakdown of Level One equipment purchases

Unit	Parameters	Cost
YSI Pro Plus with Quattro Cable	pH, DO, temperature, TDS, conductivity	$3,519.00
LaMotte Colorimeter	Nitrate-Nitrogen	$658.00
LaMotte Colorimeter	Orthophosphate	$605.00
TOTAL		$4,782.00

Table 10 Cost breakdown of Level Two equipment purchases

Level One and Level Two monitoring were more cost effective than lab analysis, and provided reliably sound data as explained in Appendix 4.

Appendix 4. Accuracy Comparisons for Three Levels of Monitoring

The CreekWatch use of three different monitoring levels allowed a unique comparison for accuracy. The following two tables for dissolved oxygen and pH show the percent accuracy difference as referenced to lab results. All three monitoring levels were conducted at the same location, date and time. The "% difference" for Level Two Monitoring was calculated using the formula (Level Two reading – Level Three reading) / Level Three reading * 100). Here, a lower percentage difference is better because it is closer to the standard of lab analysis i.e. the results do not differ by much.

Dissolved oxygen and pH were the only parameters measured and comparable across all three levels of monitoring.

Comparing Accuracy Across Three Levels of Monitoring for pH				
Location	Level Three Lab Results	Level Two YSI Probe Comparison	Level One Hach Kit Comparison	Mean % Difference for both YSI and Hach Kits
Nose Creek	8.18	7%	1%	4%
W. Nose Creek	8.24	4%	0%	2%
Fish Creek	8.29	5%	-2%	1%
Pine Creek	8.37	4%	-3%	0%
Whitemud Creek	8.12	3%	-1%	1%
Blackmud Creek	8.14	3%	-3%	0%
Mill Creek	8.34	5%	-2%	1%

Table 11 Comparing Instrument Accuracy Across Three Levels of Monitoring for pH - October 2015

Comparing Accuracy Across Three Levels of Monitoring for Dissolved Oxygen (mg/L)				
Location	Level Three Lab Results	Level Two YSI Probe Comparison	Level One Hach Kit Comparison	Mean % Difference for both YSI and Hach Kits
Nose Creek	8.20	20%	-2%	9%
W. Nose Creek	10.90	-9%	-36%	-22%
Fish Creek	9.30	13%	8%	10%
Pine Creek	9.60	19%	-17%	1%
Whitemud Creek	9.10	2%	15%	8%
Blackmud Creek	8.10	18%	11%	14%
Mill Creek	10.70	3%	-7%	-2%

Table 12 Comparing Accuracy Across Three Levels of Monitoring for Dissolved Oxygen - October 2015

Comparing the accuracy of three levels of monitoring is a way to examine the accuracy of each level of data that is reported. By means of these comparisons, we can speak to the accuracy of the data we are collecting. With the data collected in Level One and Two being relatively close, there is definitely a trade-off for the cost effectiveness of using volunteer water quality monitoring equipment as a valuable means to collect data.

The network of volunteers contributed credible useable data while monitoring urban creeks in Alberta. Both Level One and Level Two data collection revealed comparable results to lab analysis.

Appendix 5. RiverWatch Website and Data Entry Platform

The RiverWatch website (www.riverwatch.ab.ca/science/data) has been developed to support a data input and graphing platform. The creation of a database, by Web3 Marketing in Edmonton, allows for the uploading of water quality data and is an essential part of virtually preserving the data collected through CreekWatch. This allows for ease of data collection, input, and synthesis amongst online viewers. Our volunteers are trained on how to input data to the website. This information is then available for immediate public viewing, allowing for trend analysis, graphing, and comparison amongst the creeks.

Data entry

Each volunteer is assigned a unique user ID with a secure PIN in order to access the data entry portion of the website. This ensures accuracy of data inputted. Users are prompted to fill in each page completely before moving forward to mitigate input error. Drop-down menu allows differing levels of equipment to be compared against other levels. Having a user ID allows RiverWatch to track who is collecting information, determine the frequency and duration of each sample collected, and monitor the number of samples collected at each selected site.

Data viewing

Once data has been submitted, it becomes publicly available on the site. Anyone who visits www.riverwatch.ab.ca/science/data will be able to view the data. Simply select a site, an indicator, and timespan as seen in the photo below. The second photo displays the graphing capabilities.

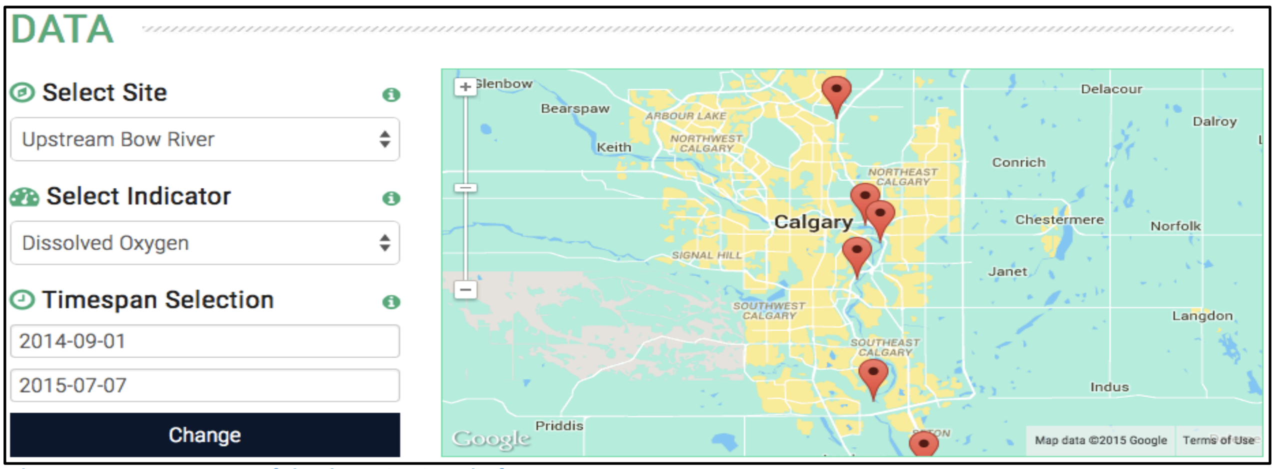

Photo 7 - Screen capture of the data-viewing platform

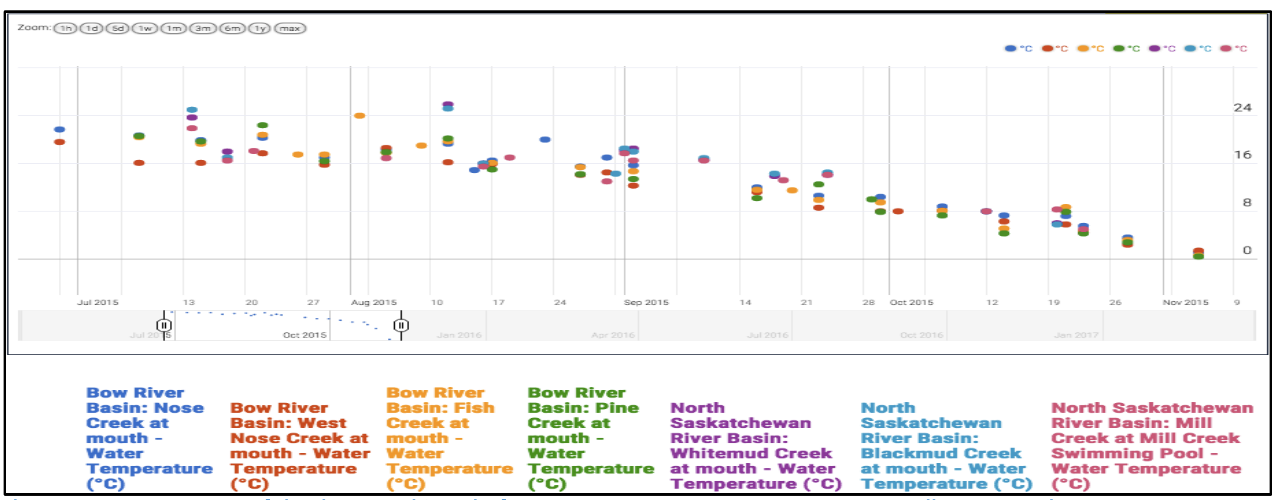

Photo 8 - Screen capture of the data-graphing platform, temperature measurements across all seven creeks

Appendix 6. Box-and-Whisker Plots for all monitored Physical and Chemical Parameters

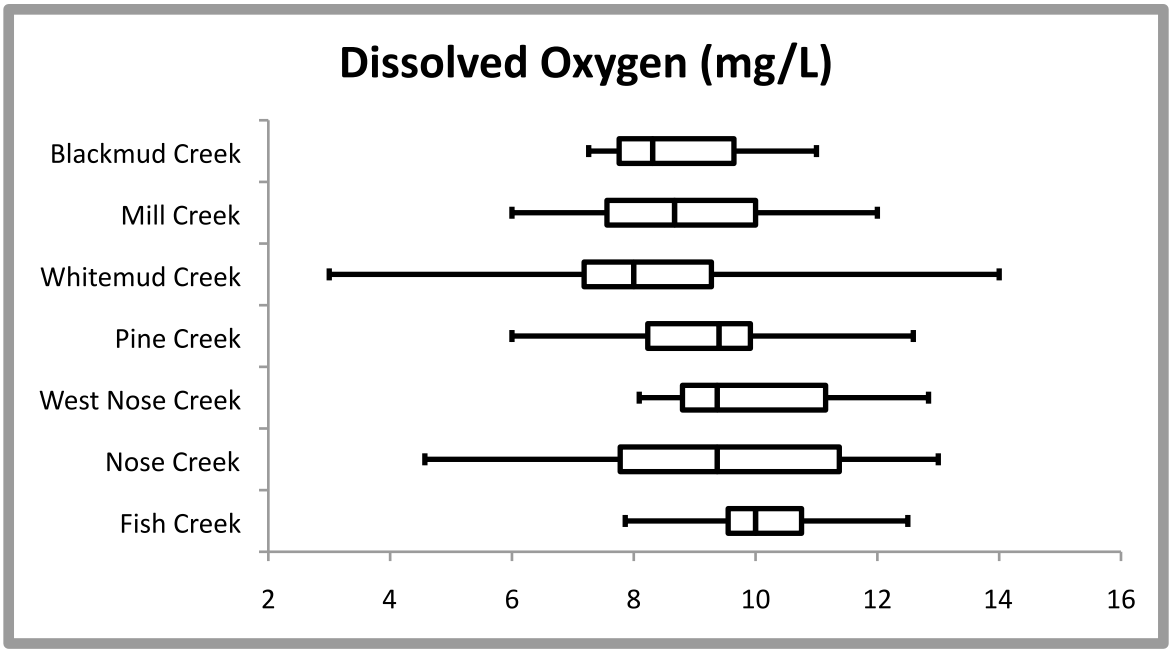

Figure 1 Distribution of data shown in a box-and-whisker plot for dissolved oxygen

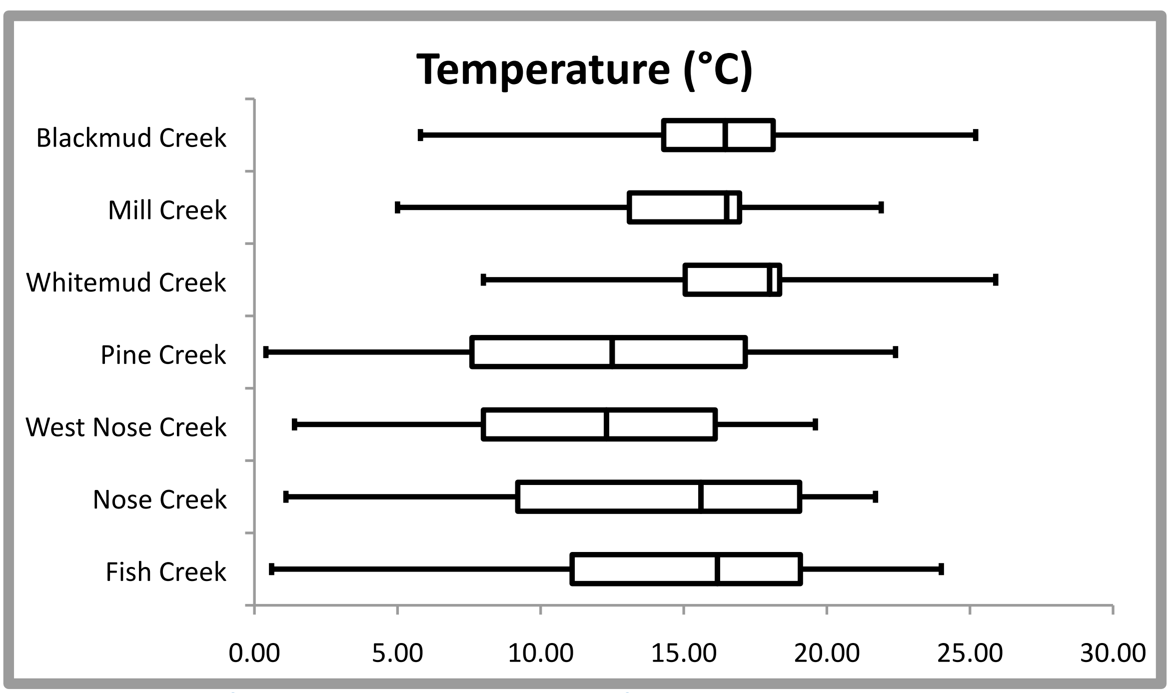

Figure 2 Distribution of data shown in a box-and-whisker plot for temperature

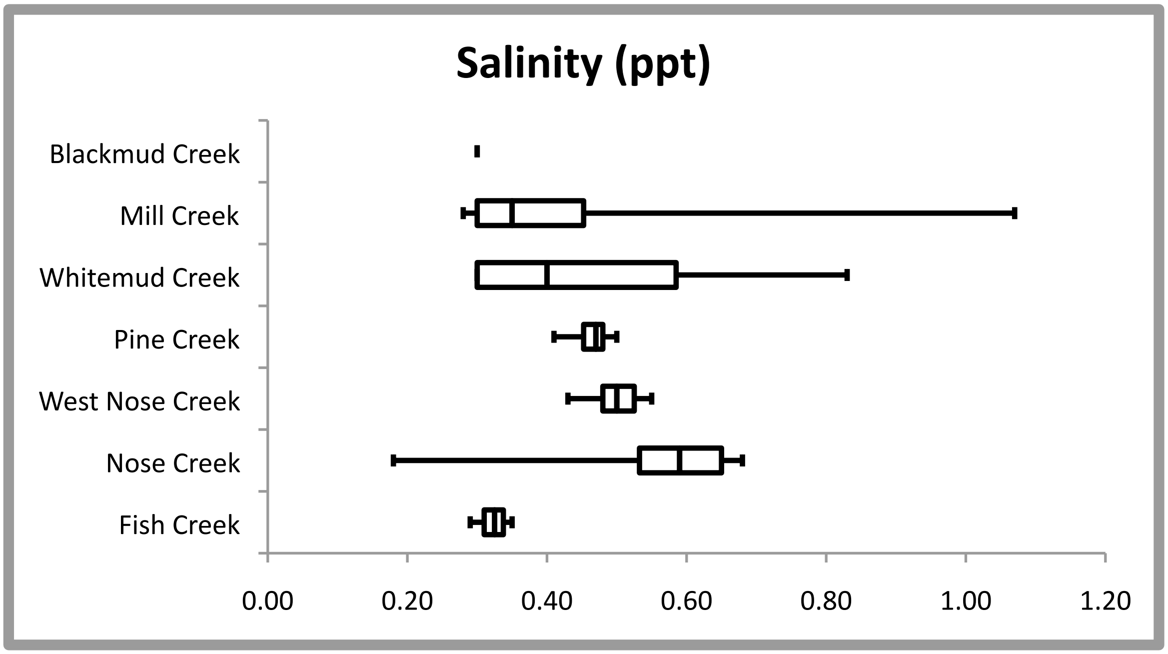

Figure 3 Distribution of data shown in a box-and-whisker plot for salinity

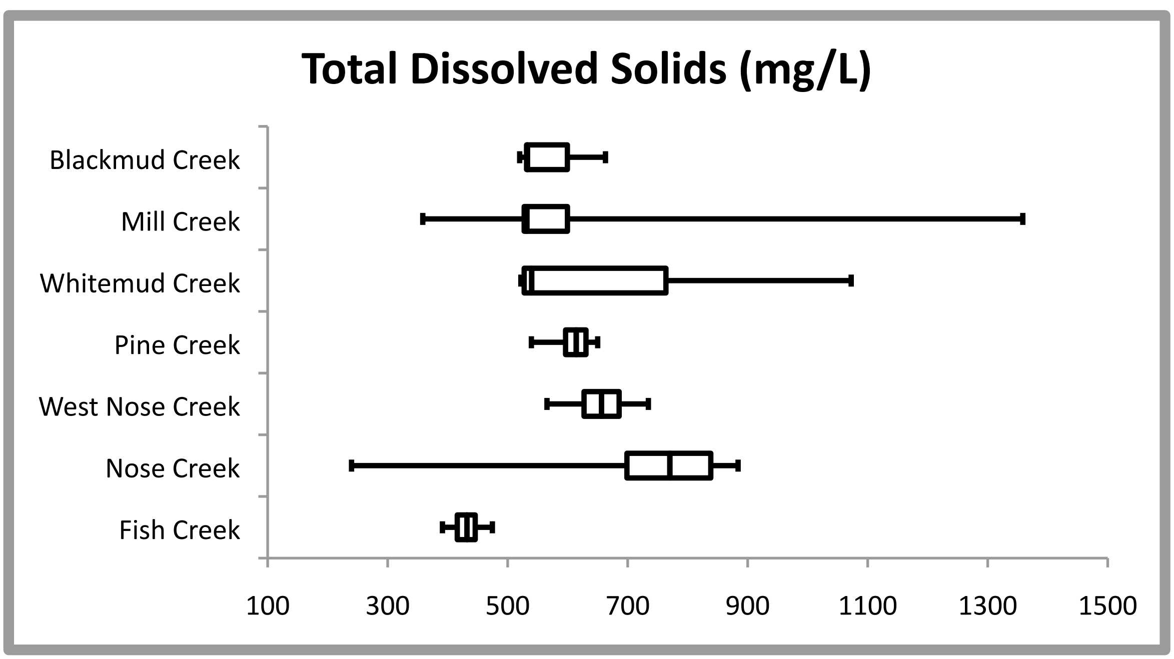

Figure 4 Distribution of data shown in a box-and-whisker plot for total dissolved solids

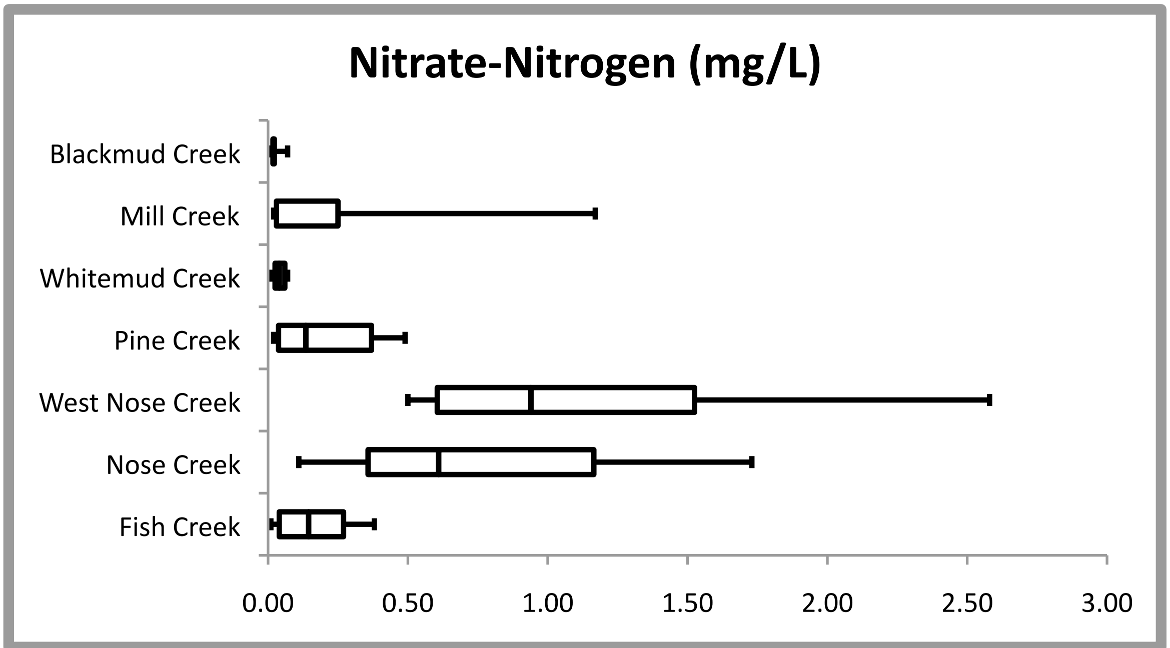

Figure 5 Distribution of data shown in a box-and-whisker plot for nitrate-nitrogen

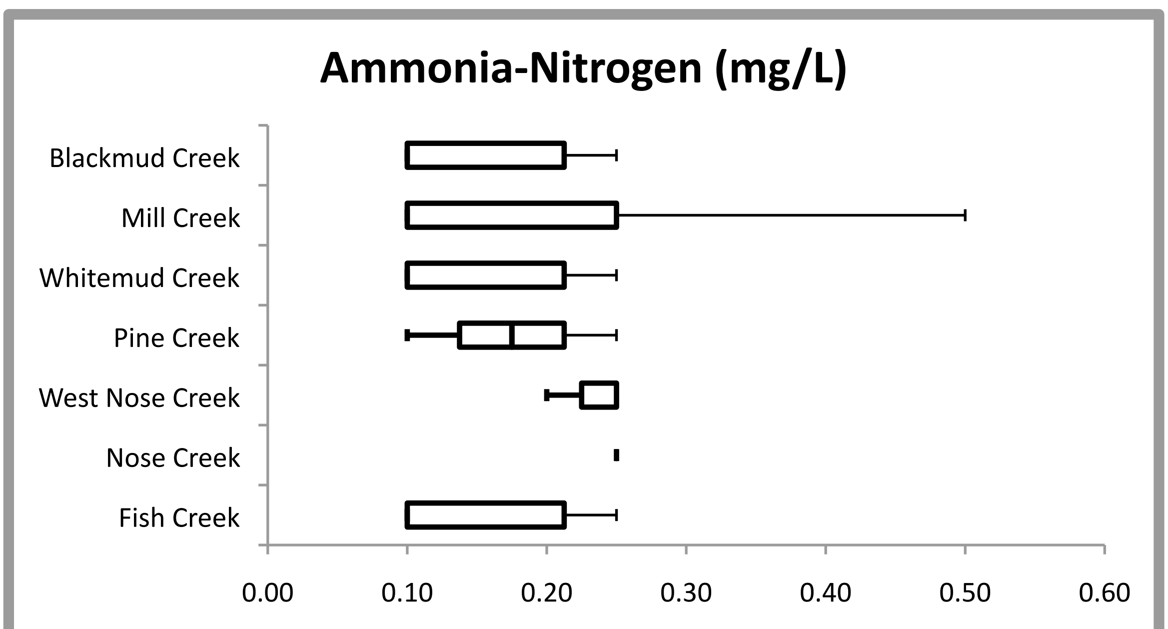

Figure 6 Distribution of data shown in a box-and-whisker plot for ammonia-nitrogen

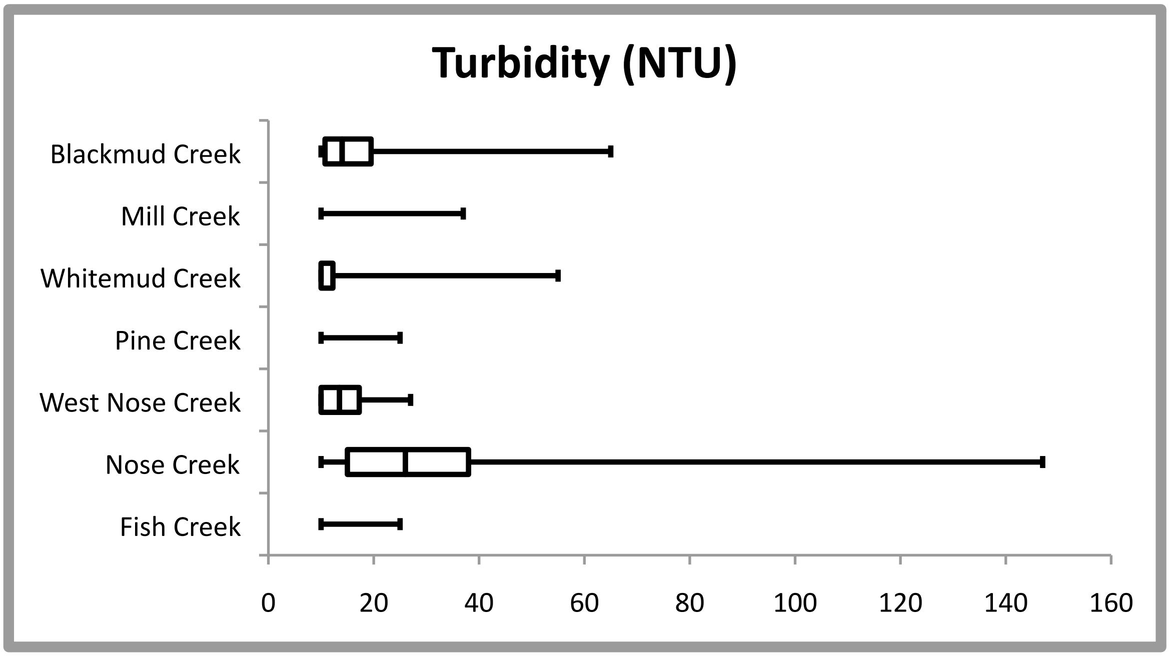

Figure 7 Distribution of data shown in a box-and-whisker plot for turbidity

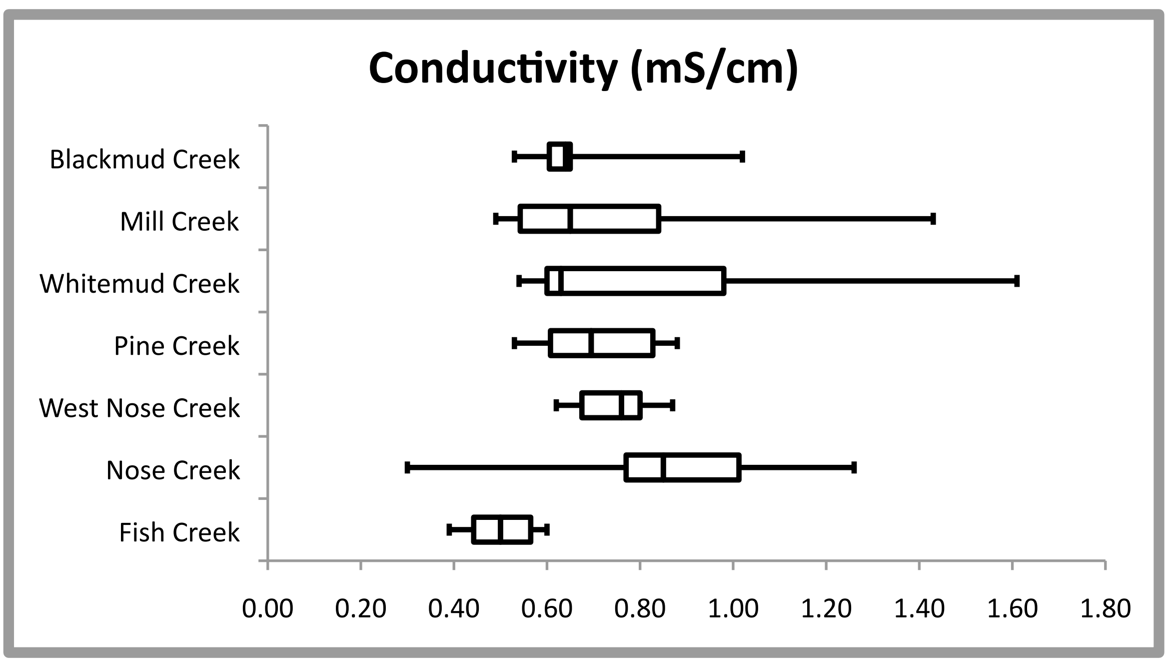

Figure 8 Distribution of data shown in a box-and-whisker plot for conductivity

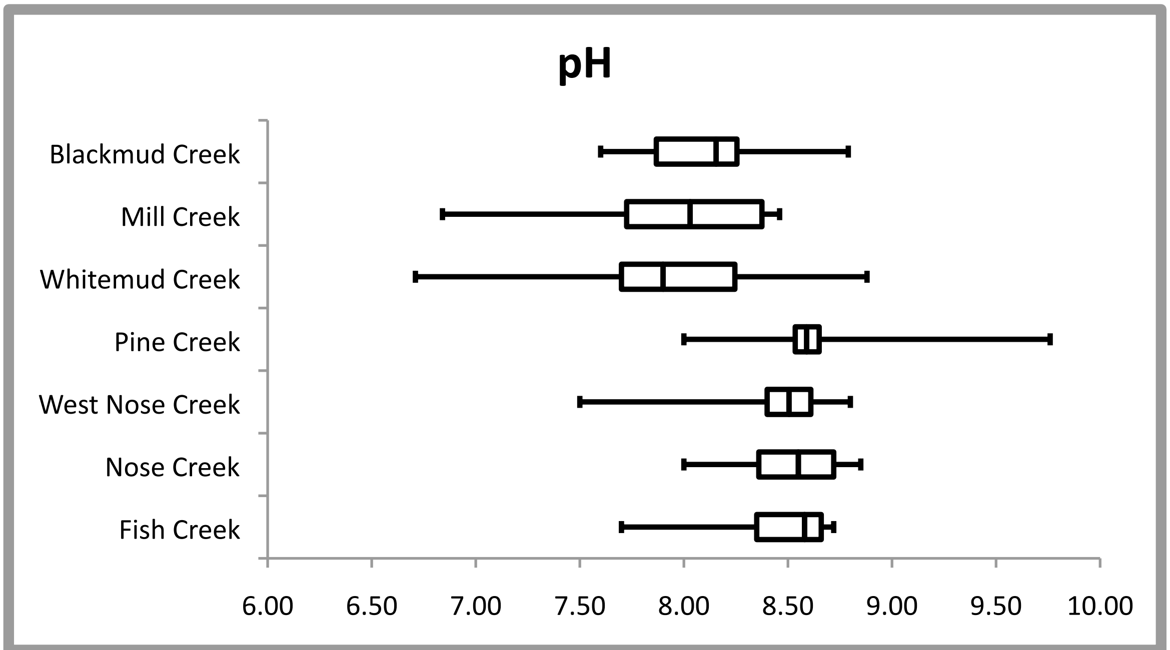

Figure 9 Distribution of data shown in a box-and-whisker plot for pH

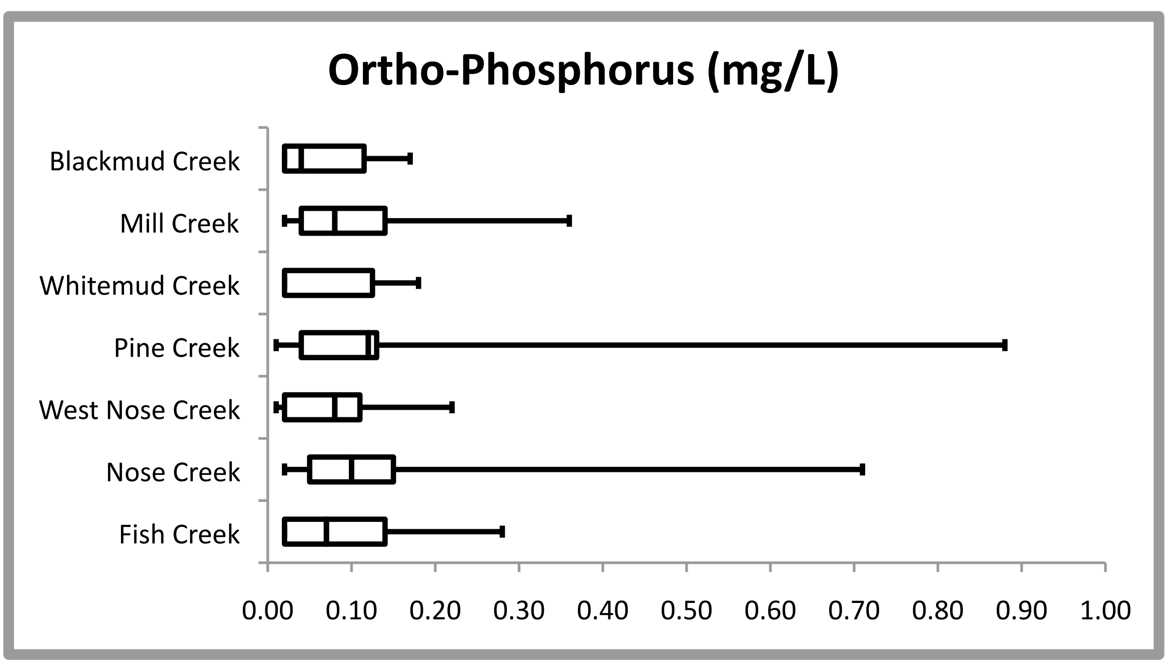

Figure 10 Distribution of data shown in a box-and-whisker plot for orthophosphorus

Appendix 7. Creek Water Quality Summary – Fish Creek (Calgary, Alberta)

Primary Site Name: Fish Creek at mouth
Site Location Data – GPS: 50.904326, -114.010253
Watershed: South Saskatchewan River Basin

Stream Profile: Fish Creek originates in Kananaskis Country before traveling east through Tsuu T'ina First Nation and then ultimately reaching Calgary before entering the Bow River. The upper sections of Fish Creek are primarily forested, while the middle section is more agricultural and grassland coverage, and urban land use is more prominent near the creek mouth. The lower portion also receives stormwater discharge from the City of Calgary's encompassing residential neighborhoods. Within Calgary's city limits, Fish Creek is popularly known as the largest urban park in Canada, stretching 19 kilometers from east to west. Offering a variety of trail networks for walking, biking, or hiking, the park offers an easily accessible urban resource.

Site Photo:

Photo 9 - A view upstream, facing west near its confluence with the Bow River in Fish Creek Provincial Park

Data Summary: Fish Creek water quality summary 2015

Water Quality Parameter	Fish Creek Summary 2015				
	Mean	Median	Max	Min	Number
Dissolved Oxygen (mg/L)	10.11	10.00	2.50	7.86	23
Ammonia-Nitrogen (mg/L)	0.15	0.10	0.25	0.10	6
Nitrate-Nitrogen (mg/L)	0.16	0.15	0.38	0.01	16
Phosphorus (mg/L)	0.10	0.09	0.28	0.02	23
pH	8.43	8.58	8.72	7.70	23
Water Temperature (°C)	13.5	15.4	24.0	0.60	23
Turbidity (NTU)	10.95	10.00	25.00	10.00	21
Conductivity (mS/cm)	0.50	0.50	0.60	0.39	18
TDS (mg/L)	430	432	474	391	18
Salinity (ppt)	0.32	0.33	0.35	0.29	18

Table 13 Fish Creek Data Summary 2015

Appendix 8. Creek Water Quality Summary – Nose Creek (Calgary, Alberta)

Primary Site Name: Nose Creek at mouth
Site Location Data – GPS: 51.044963, -114.019647
Watershed: South Saskatchewan River Basin

Stream Profile: Nose Creek's headwaters extend all the way through the northern reaches of Rocky View County and into Mountain View County. Covering such a large geographical area at roughly 75 kilometers in length, there are many different land uses that have the potential to impact the creek. The land coverage is primarily agricultural, with urban influences as it travels through the town of Crossfield, and the cities of Airdrie and Calgary. It final stretch travels past the Calgary Zoo before reaching the Bow River.

Site Photo:

Photo 10 - A view downstream looking south 100m from its confluence at the Bow River

Data Summary: Nose Creek water quality summary 2015

Water Quality Parameter	Nose Creek Summary 2015				
	Mean	Median	Max	Min	Number
Dissolved Oxygen (mg/L)	9.49	9.37	13.00	4.57	22
Ammonia-Nitrogen (mg/L)	0.25	0.25	0.25	0.25	3
Nitrate-Nitrogen (mg/L)	0.76	0.61	1.73	0.11	18
Phosphorus (mg/L)	0.13	0.10	0.71	0.02	22
pH	8.52	8.55	8.85	8.00	21
Water Temperature (°C)	13.8	15.6	21.7	1.1	22
Turbidity (NTU)	32.9	26.0	147.0	10.0	21
Conductivity (mS/cm)	0.87	0.85	1.26	0.30	20
TDS (mg/L)	734	770	884	239	20
Salinity (ppt)	0.56	0.59	0.68	0.18	20

Table 14 Nose Creek Data Summary 2015

Appendix 9. Creek Water Quality Summary – West Nose Creek (Calgary, Alberta)

Primary Site Name: West Nose Creek at mouth
Site Location Data – GPS: 51.130073, -114.047870
Watershed: South Saskatchewan River Basin

Stream Profile: West Nose Creek is a significant and permanent tributary to Nose Creek that drains a third of the entire Nose Creek Watershed. Originating in the northwestern portion of the watershed, it travels 65 kilometers before joining Nose Creek near the Calgary International Airport.

Site Photo:

Photo 11 - Looking upstream facing west 100m from its confluence with Nose Creek

Data Summary: West Nose Creek water quality summary 2015

Water Quality Parameter	West Nose Creek Summary 2015				
	Mean	Median	Max	Min	Number
Dissolved Oxygen (mg/L)	9.86	9.37	12.84	8.09	21
Ammonia-Nitrogen (mg/L)	0.23	0.25	0.25	0.20	3
Nitrate-Nitrogen (mg/L)	1.10	0.94	2.58	0.50	19
Phosphorus (mg/L)	0.09	0.08	0.22	0.01	21
pH	8.48	8.51	8.80	7.50	20
Water Temperature (°C)	11.4	12.3	9.6	1.4	21
Turbidity (NTU)	14.3	13.5	27.0	10.0	18
Conductivity (mS/cm)	0.74	0.76	0.87	0.62	19
TDS (mg/L)	652	656	734	565	19
Salinity (ppt)	0.50	0.50	0.55	0.43	19

Table 15 West Nose Creek Data Summary 2015

Appendix 10. Creek Water Quality Summary – Pine Creek (Calgary, Alberta)

Primary Site Name: Pine Creek at mouth
Site Location Data – GPS: 50.844988, -113.961947
Watershed: South Saskatchewan River Basin

Stream Profile: Pine Creek enters the Bow River at Policeman's Flats just south of Calgary. The headwaters are found 20km west on the Ann and Sandy Cross Conservation Area near Priddis, Alberta. It travels through agricultural and ranchland before its confluence, along with two golf courses on the edge of Calgary.

Site Photo:

Photo 12 - Looking upstream facing west 100 m from its confluence with the Bow River

Data Summary: Pine Creek water quality summary 2015

Water Quality Parameter	Pine Creek Summary 2015				
	Mean	Median	Max	Min	Number
Dissolved Oxygen (mg/L)	9.37	9.40	2.59	6.00	19
Ammonia-Nitrogen (mg/L)	0.18	0.18	0.25	0.10	2
Nitrate-Nitrogen (mg/L)	0.22	0.14	0.49	0.02	16
Phosphorus (mg/L)	0.17	0.12	0.88	0.01	19
pH	8.62	8.59	9.76	8.00	19
Water Temperature (°C)	11.9	12.5	22.4	0.4	19
Turbidity (NTU)	10.8	10.0	25.0	10.0	18
Conductivity (mS/cm)	0.71	0.70	0.88	0.53	18
TDS (mg/L)	610	614	650	539	18
Salinity (ppt)	0.46	0.47	0.50	0.41	18

Table 16 Pine Creek Data Summary 2015

Appendix 11. Creek Water Quality Summary – Whitemud Creek (Edmonton, Alberta)

Primary Site Name: Whitemud Creek at mouth
Site Location Data – GPS: 53.505454, -113.561679
Watershed: North Saskatchewan River Basin

Stream Profile: Whitemud Creek is a major tributary of the North Saskatchewan River and provides many vital terrestrial and aquatic ecological functions in the southwest portion of Edmonton. Whitemud Creek was named during the Palliser Expedition for the white-coloured mud along the creek's banks. The ravine provides ample opportunity for hiking and interactions with nature through old growth coniferous forests, deciduous and mixed-wood forests, meadows, and riparian communities.

Site Photo:

Photo 13 - A view upstream facing south 100m from its confluence with the North Saskatchewan River

Data Summary: Whitemud Creek water quality summary 2015

Water Quality Parameter	Whitemud Creek Summary 2015				
	Mean	Median	Max	Min	Number
Dissolved Oxygen (mg/L)	8.07	8.00	14.00	3.00	11
Ammonia-Nitrogen (mg/L)	0.15	0.10	0.25	0.10	6
Nitrate-Nitrogen (mg/L)	0.04	0.04	0.07	0.01	7
Phosphorus (mg/L)	0.07	0.03	0.18	0.02	12
pH	7.98	8.01	8.88	6.71	12
Water Temperature (°C)	16.4	17.3	25.9	6.0	12
Turbidity (NTU)	18.0	10.0	55.0	10.0	6
Conductivity (mS/cm)	0.85	0.63	1.61	0.54	7
TDS (mg/L)	673	540	1072	522	7
Salinity (ppt)	0.47	0.40	0.83	0.30	7

Table 17 Whitemud Creek Data Summary 2015

Appendix 12. Creek Water Quality Summary – Blackmud Creek (Edmonton, Alberta)

Primary Site Name: Blackmud Creek at mouth
Site Location Data – GPS: 53.454896, -113.546976
Watershed: North Saskatchewan River Basin

Stream Profile: The headwaters of Blackmud Creek are located near the town of Nisku. It meanders north, crossing Highway 2 before entering the Edmonton city limits. Within the City limits, Blackmud Creek offers ample opportunities to enjoy nature through interactions made available at numerous urban parks. The eventual confluence is located in Mactaggart Sanctuary where it joins Whitemud Creek before traveling the final distance to the North Saskatchewan River.

Site Photo:

Photo 14 - A view upstream facing east at its confluence with Whitemud Creek in Mactaggart Sanctuary

Data Summary: Blackmud Creek water quality summary 2015

Water Quality Parameter	Blackmud Creek Summary 2015				
	Mean	Median	Max	Min	Number
Dissolved Oxygen (mg/L)	8.82	8.31	1.00	7.26	11
Ammonia-Nitrogen (mg/L)	0.15	0.10	0.25	0.10	6
Nitrate-Nitrogen (mg/L)	0.03	0.02	0.07	0.01	8
Phosphorus (mg/L)	0.07	0.04	0.17	0.02	12
pH	8.10	8.16	8.79	7.60	12
Water Temperature (°C)	16.1	16.4	25.2	5.8	12
Turbidity (NTU)	22.3	14.0	65.0	10.0	6
Conductivity (mS/cm)	0.67	0.64	.02	0.53	7
TDS (mg/L)	568	533	663	520	7
Salinity (ppt)	0.41	0.40	0.50	0.30	7

Table 18 Blackmud Creek Data Summary 2015

Appendix 13. Creek Water Quality Summary – Mill Creek (Edmonton, Alberta)

Primary Site Name: Mill Creek at Mill Creek Swimming Pool
Site Location Data – GPS: 53.520047, -113.473965
Watershed: North Saskatchewan River Basin

Stream Profile: Mill Creek flows through south central Edmonton before entering the North Saskatchewan River. Named after a flourmill established in 1878 near the creek's mouth, it enters Edmonton's City limits through passing beneath Anthony Henday Drive. It eventually opens up into Mill Creek Ravine that offers scenic views and hiking opportunities within the bustling city of Edmonton. Sections of the creek are engineered underground to accommodate City infrastructure, and this includes the final section of the creek that enters the North Saskatchewan River through a raised culvert. The City of Edmonton is currently exploring the potential of resurfacing the north portion of the creek.

Site Photo:

Photo 15 - A view upstream facing southeast in the Mill Creek Ravine

Data Summary: Mill Creek water quality summary 2015

Water Quality Parameter	Mill Creek Summary 2015				
	Mean	Median	Max	Min	Number
Dissolved Oxygen (mg/L)	8.75	8.67	12.00	6.00	13
Ammonia-Nitrogen (mg/L)	0.22	0.25	0.10	0.50	7
Nitrate-Nitrogen (mg/L)	0.24	0.03	1.17	0.02	9
Phosphorus (mg/L)	0.12	0.08	0.36	0.02	14
pH	7.95	8.03	8.46	6.84	14
Water Temperature (°C)	14.5	16.5	21.9	5.0	15
Turbidity (NTU)	14.1	10	37	10	9
Conductivity (mS/cm)	0.75	0.65	1.43	0.49	8
TDS (mg/L)	632	532	1358	358	8
Salinity (ppt)	0.45	0.35	1.07	0.28	8

Table 19 Mill Creek Data Summary 2015

Appendix 14. The HSBC Water Programme

Water is a huge and growing global challenge. It is essential to all human activity and a fundamental driver of all socio-economic growth but, as a resource, it is under strain from population growth, development and climate change. HSBC is investing its time and resources into the HSBC Water Programme because water is vital to healthy communities. The Water Programme is a 5-year US$100m program aiming to provide and protect water sources, inform and educate communities in need, and enable people to prosper and drive economic development worldwide.

HSBC has invested US$150,000 over two years to support CreekWatch. Taking place on urban tributaries in Edmonton and Calgary, CreekWatch uses a Citizen Science approach on water quality data collection and monitoring through 2015 and 2016.

HSBC funding has initiated the CreekWatch Pilot Project 2015-16. The first-year experimented with developing a citizen science framework and tools to monitor stormwater in a sample of Edmonton and Calgary creeks. We worked alongside Ruth Legg, Sustainability Manager with HSBC, to develop and coordinate specific events and timelines for the CreekWatch Project. Significant milestones achieved include:

- formation of an advisory panel of consulting, municipal and provincial experts
- design and implementation of a water quality monitoring plan
- investigation of cost-effective and accurate water quality monitoring equipment
- selection of sampling locations along six creeks in Calgary and Edmonton as determined by an advisory panel
- coordination of citizen science training for 24 community and corporate volunteers
- creation and distribution of ten portable water quality monitoring units
- design, coding and completion of a website platform for data input and graphing
- 178 site visits with data collection

To find out more information, visit www.thewaterhub.org

Photo 16 - CreekWatch participants collecting water quality data at the mouth of Fish Creek in Fish Creek Provincial Park

Appendix 15. RiverWatch Institute of Alberta

For twenty years, RiverWatch has helped more than 100,000 secondary students across Alberta participate in authentic science, recording observations and collecting data that is contributing to a growing understanding of the health of Alberta's major rivers. Water quantity and quality continue to be critical issues in the 21st century. Climate change, industrial expansion and growing municipalities impact Alberta's water resources. Hands-on experiences like RiverWatch are an effective means to convey the importance of water in Alberta and encourage environmental stewardship.

Photo 17 - A raft full of eager participants learning about the health of Alberta's rivers

Photo 18 - Riverside water quality monitoring to determine the health of the river

The RiverWatch Science Program engages youth in the health of our river systems. RiverWatch is the most widely-used water education field study available to Alberta's grade 8-12 science students. Students are guided through a day of travel along a 10 km section of river aboard large, inflatable rafts fully equipped as mobile water quality laboratories. RiverWatch is a non-profit education organization and recipient of the Prime Minister's National Award for Teaching Excellence.

The day spent floating on the river is, for some students, the first view they have ever had of this vitally important resource flowing through their communities. More significantly, it is likely the first time they have considered their own impact on the river and on the lives of all other inhabitants downstream. It is the hope that these young people will go on to become successful students, good stewards of our rivers and ultimately contribute to a better quality of life for all.

Photo 19 - A group of participants paddling down a quick stretch of water in Calgary