Integrating Indigenous Knowledge into a Community Contaminant & Climate Change Monitoring Program

Kluane First Nation Community Report

2013

Prepared by the Yukon River Inter-Tribal Watershed Council

ONE PEOPLE-ONE RIVER

Yukon River Inter-Tribal Watershed Council

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Acknowledgments

This project would not have been possible without collaboration from Kluane First Nation (KFN) and in particular the KFN Lands, Resources and Heritage Departments. We are deeply grateful to the individual community members and staff who contributed their knowledge to this research by participating in the focus group and interviews including Chief Mathieya Alatini, Sharon Buyck, Bob Dickson, Dennis Dickson, Janice Dubois, Agnes Johnson, Derek Johnson, George Johnson, Kathleen Johnson, Keith Johnson, Lena Johnson, Trudy Macleod, Jeff Mills, Geraldine Pope, Grace Southwick and Colin Wright. The YRITWC is thankful for Isaiah Gilson, KFN Youth Intern, for his assistance. We are also grateful to the United States Geological Survey and ALS Laboratory Group for water quality analysis. We are also grateful for our project partner at the University of Alaska, Anchorage Department of Geography and Environmental Studies. This research was funded in part by the First Nations and Inuit Health Branch of Health Canada. It has not been subjected to any Health Canada review and therefore does not necessarily reflect the views of the Ministry. No official endorsement should be inferred. Kwȁnȁschis!

Project Team

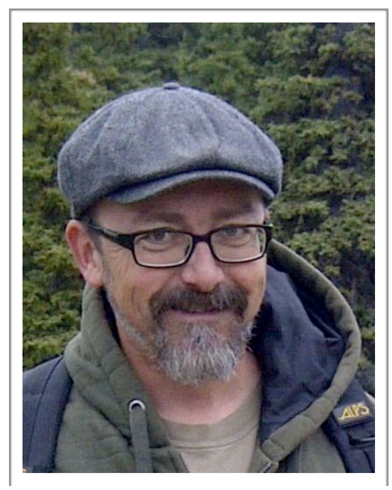
Nick Wilson
Social Scientist
YRITWC
nwilson@yritwc.org

Jody Inkster
Environmental Technician, YRITWC
jinkster@yritwc.org

Ryan Toohey
Science Director, YRITWC
rtoohey@yritwc.org

Shannon Donovan
Assistant Professor of Environmental Studies, University of Alaska Anchorage
smdonovan@uaa.alaska.edu

Isaiah Gilson
KFN Youth Intern



Sam Gallagher
Environmental Technician,
YRITWC

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Introduction

This report details the results of the Yukon River Inter-Tribal Watershed Council's community-based research project "Integrating Indigenous Knowledge and Public Health Concerns into a Community Contaminant and Climate Change Monitoring Program" conducted with Kluane First Nation (KFN).

Climate change and environmental degradation pose significant threats to Arctic and Sub-Arctic freshwater systems and their Indigenous inhabitants. Scientific studies indicate that these regions are among the first to experience the impacts of climate change (Serreze et al. 2000; ACIA 2005; Hinzman 2005; IPCC 2007). Indigenous peoples whose subsistence livelihoods rely on the lands and waters within their traditional territories are closely connected to their local geography and consequently, they are among the first to feel the effects of climate change (Berkes, Folke, and Gadgil 1995; Nyong, Adesina, and Osman Elasha 2007; Turner and Clifton 2009). Furthermore, environmental degradation other than climate change also has significant implications for subsistence livelihoods. Contaminants transported from local and long-range sources are known to impact traditional food systems in the Arctic and Sub-Arctic (Kuhnlein and Chan 2003). The Indigenous inhabitants of the Yukon River Basin have identified the impacts of climate change and environmental degradation on the Yukon River and its tributaries as major threats to their lives and livelihoods.

During open floor discussions at the Yukon River Inter-Tribal Watershed Council's (YRITWC) Summit in August of 2011, First Nations discussed concerns about their health risks, unpredictable events of climate change, and exposure to contaminants. First Nations called on the YRITWC staff to assist them with conducting community-based research to assess and monitor climate change and contaminants within their traditional territories (See Figure 1).

Text Box 1. What is the Yukon River Inter-Tribal Watershed Council?

> The Yukon River Inter-Tribal Watershed Council is a treaty-based Indigenous grassroots organization consisting of 70 First Nations and Tribes, dedicated to the protection and preservation of the Yukon River Basin.

Figure 1 Map of the Yukon River Basin

Text Box 2 What Is Indigenous Knowledge?

Indigenous knowledge of the environment, also referred to as Traditional Ecological Knowledge (TEK), is defined as "a cumulative body of knowledge and beliefs handed down through generations by cultural transmission, about the relationship of living beings (including humans) with one another and with their environment. Further, TEK is an attribute of societies with historical continuity in resource use practices; by and large these are non-industrial or less technologically advanced societies, many of them indigenous or tribal" (Berkes 2008: 7).

"The Kluane First Nation at this time does not want to adopt an official definition of Traditional Knowledge. Therefore for the purpose of this policy KFN adopts the following description of Traditional Knowledge:

- hunting and fishing sites
- spiritual sites
- pictographs, petro glyphs
- symbols
- traditional or sacred songs and stories
- medicinal plants (which could be used to market new medication or cosmetics)
- genetic information and resources (DNA from human remains)
- First Nation's place name (which tells a story, legend, history or other TK values and beliefs)
- Traditional knowledge originated in the First Nation's traditions, constantly evolves over time, and has contemporary applications"
  (Kluane First Nation 2012, 4).

This project integrates Indigenous Knowledge of the environment into a community contaminant-monitoring program (i.e., heavy metals, hydrocarbons, nutrients, and bacteria) for five Yukon First Nations. The main question that this project aimed to answer was two-fold:

1. What concerns do First Nations have regarding climate change, public health, and contaminants?
2. What are the baseline levels of contaminants within these communities?

During this project, the YRITWC worked with the First Nations of Selkirk, Tr'ondëk Hwëch'in, Kluane, White River and Carcross/Tagish in developing their research project and increasing scientific capacity of First Nation members. This report details the results of the research conducted with KFN.

Community Context

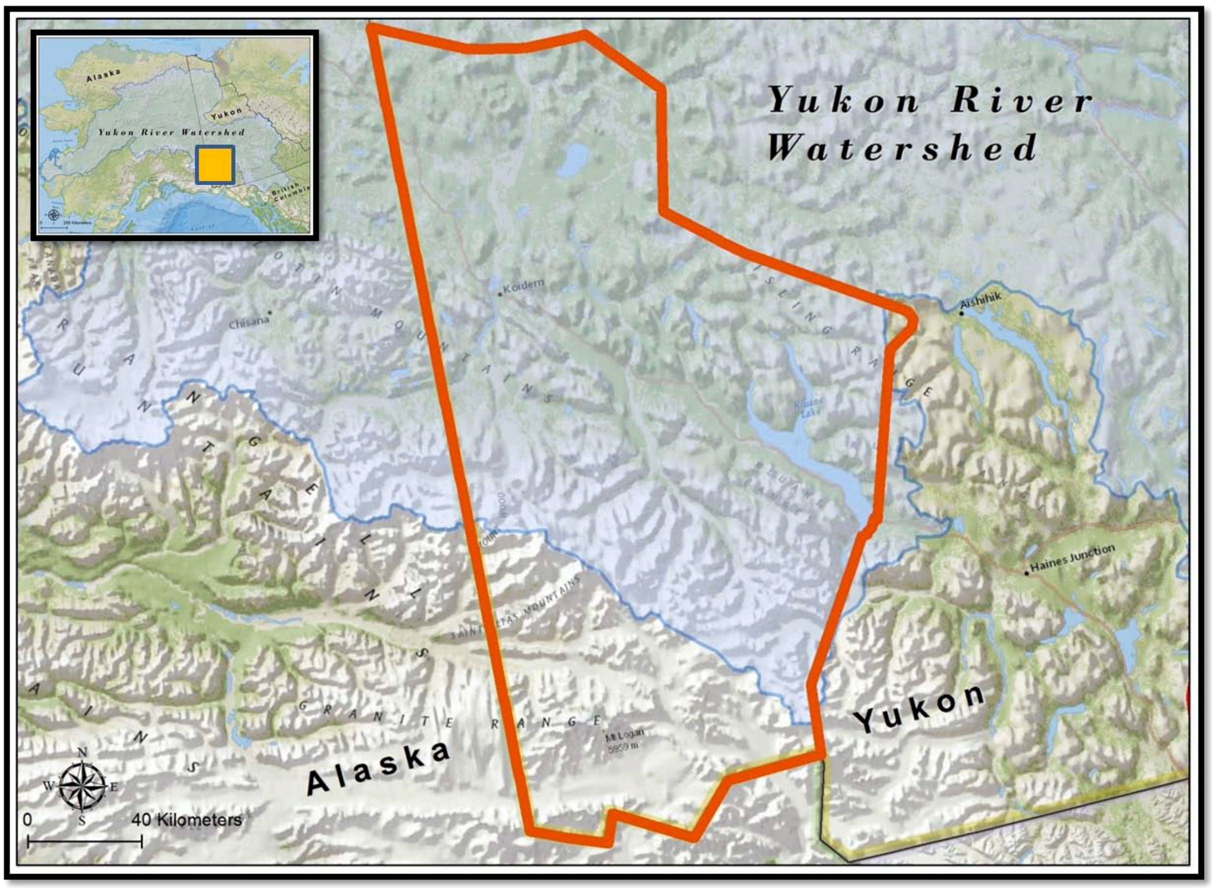
The traditional territory of KFN spans a vast area in the interior of the Yukon Territory (See Figure 2 – Map Kluane First Nation Traditional Territory). The administrative headquarters for KFN is located in Burwash Landing, YT, along the shores of Kluane Lake. Some KFN citizens also reside in nearby Destruction Bay, YT. The Southern Tutchone peoples have maintained subsistence livelihoods, including hunting, fishing and trapping, throughout the Kluane Lake area for millennia (Government of Canada 2004). In 1943, the Kluane lost access to a portion of their traditional territory with the creation of Kluane National Park.[1]

Kluane First Nation is comprised of Southern Tutchone peoples. Southern Tutchone is part of the Athapaskan language group. The people of Kluane First Nation are closely associated with the Champagne/Aishihik First Nation, also Southern Tutchone people and with the Upper Tanana people, with whom they

[1] http://www.cyfn.ca/ournationskfn

were once grouped together by the Department of Indian Affairs. The Upper Tanana people have since separated to form White River First Nation. As of 2004, KFN reported 206 members, with approximately 120 living outside of Burwash Landing and Destruction Bay. KFN has signed both their land claims and self-government agreements (Government of Canada 2004).

Figure 2 Map Kluane First Nation Traditional Territory



Research Design

This project is characterized by a community-based participatory approach. Community-Based Participatory Research (CBPR) is, first and foremost, designed to meet the needs of local communities: "In contrast to more traditional investigator-driven research, CBPR begins with an issue selected by, or of real importance to, the community, and involves community members and other stakeholders throughout the research process, including its culmination in education and action for social change" (Minkler and Wallerstein 2011, 1–2). This project also has a multidisciplinary research design, meaning that it uses methods from both the social and biophysical sciences to examine First Nation concerns related to the impacts of contaminants and climate change on water.

In the summer and fall of 2012, the YRITWC research team conducted interviews and a focus group with members of KFN. Semi-structured interviews were conducted with key stakeholders to gather in depth information on the importance of water for the community as well as concerns about changes in water resources as a consequence of either contamination or climate change. Fifteen interviews were conducted in total. Four out of fifteen community members were Elders. The remaining eleven participants were middle-aged community members. Three of the participants were KFN staff. Interview participants were asked to describe the importance of water to their community and any changes in water resources they observed within their traditional territory. Interview participant's observations of change contributed to the identification of water quality sites of concern.

A focus group was held at the Jacquot Hall in Burwash Landing, YT on September 5th, 2012. Three people attended the focus group. Two of the focus group participants also completed an interview. Therefore, a total of sixteen individuals participated in this research.

During the focus group the YRITWC used on a participatory mapping exercise as a primary means for gathering data(Donovan et al. 2009). Where possible, focus group participants identified, mapped and discussed sources of contamination and the associated impacts on water resources. Using ArcGIS, a map of the KFN traditional territory was projected onto a screen and focus group participants took turns identifying sites of concern on the map. A laser pointer was used to indicate the exact location. Sites of concern were recorded as points in ArcGIS 10, a spatial mapping program. A note taker recorded the site descriptions provided by participants including the suspected source of contamination. A total of 14 sites of concern were identified.

The YRITWC had funds available to sample at five sites. During the focus group, the YRITWC used a voting process to prioritize the top ten sites of concern. Each of the focus group participants was provided ten stickers and was directed to place the stickers on their areas of greatest concern. Participants could put more than one sticker next to a given site name. The names of all sites were written on a piece of paper and participants placed stickers next to the sites they felt should be prioritized for water sampling.

The next step of the research process was to collect water samples from each of the five prioritized sites. Water sampling was conducted between August and October of 2012. YRITWC environmental technicians conducted water sampling with the youth intern and staff from the KFN Lands, Resources and Heritage Departments.

The research was designed in accordance with the Kluane First Nation Draft Traditional Knowledge Policy allowing us to provide research data to the KFN

Archive for future use. Research data will not be released without the consent of the individuals involved. Copies of all interview data were returned to the KFN Heritage Department for this purpose. The YRITWC consider this an important step in the research process as it allows First Nations to maintain traditional knowledge for their own use. This community research report allows the YRITWC research team to return the results of this research to the community in a usable format.

Youth Capacity Building

Youth capacity building is another important aspect of the project. In each community, the YRITWC worked with one youth Intern, identified by the First Nation as between the ages of 16-25. The youth were an important addition to the research team. Each of the youth received training in water quality sampling and in some cases permafrost monitoring. The youth interns assisted with focus groups and helped YRITWC environmental technicians with water sampling. Their in-depth knowledge about the community and surrounding area was invaluable to the project. Isaiah Gilson was the KFN youth intern and he received a certificate for the water quality training.

Results and Analysis

The Importance of Water to Kluane First Nation

Water is important to the people of Kluane First Nation for many reasons. Interview participants were asked to answer the question '*Why is Water Important to Your Community?*' Their responses reveal that water is essential to all aspects of life or as one interview participant put it, "it's the necessity of life, right?"

> "I think it's important because it sustains our life. We're at the headwaters of the whole watershed. It's important that we take care of it so everybody downstream can benefit." (KFN Community Member)

> "Lots of people still, like some of the older people still get water, but they go certain places. My mom has a place called Duke Meadow. Down below, they call Spring Creek. So they get water from there and haul it back. It's a lot fresher, but they won't go to the lake and get water." (KFN Community Member)

> "A lot of people still do fishing. They depend on fishing for our traditional food. There are still people who drink the water. I think water is important to us because we need it to survive. Not only us, but animals like moose and ducks and then we live off of them too, so water is very important [to us]." (KFN Community Member)

During the research project, many uses of water were identified (See Figure 3). Water from various sources is used for drinking. Participants explained that they use primary and secondary sources of water for consumption. Primary sources include delivered water from the water treatment centre and some private wells. Secondary drinking water sources include water from Kluane Lake, and various creeks and springs. Many KFN Elders stated that they prefer water from secondary sources over treated water, which tastes of chlorine. Other KFN community members stated that they often used these other sources when they are out on the land or at camp. Water also provides important habitat for a diversity of fish and other wildlife. Bodies of water, such as Kluane Lake are also used as a transportation corridor both in times of open and frozen water. The uses identified above make it easy to see why water is integral to all aspects of subsistence livelihoods, which are central to First Nation culture and identity.

Figure 3 Why is water important to Kluane First Nation?

Documenting the importance of water is fundamental to establishing a community climate change and contaminants monitoring program for two reasons: 1) It allows us to understand how changes in water resources are impacting people 2) Cultural connections to water are also the inspiration for protecting water resources. The following section details the concerns that were raised about water quality and contaminants during the research process.

Observations of Changes in Water Resources

The purpose of this project was to understand the impacts of contaminants and climate change on water and public health for Yukon First Nations. The following sections detail community water quality concerns and the results of baseline contaminant monitoring completed during the project and describe community observations of climate impacts.

Community Water Quality and Quantity Concerns

KFN community members described a number of concerns about water quality and quantity during interviews and the focus group. Their concerns included the impacts various land uses including mining, sewage, landfills and development such as the historic construction of the Alaska Highway by the US Army and the proposed Gladstone Diversion Concept[2] and Alaska Pipeline Project[3] (See Figure 4). In many cases, maintaining existing water quality was identified as a priority in areas important for subsistence fishing and hunting.

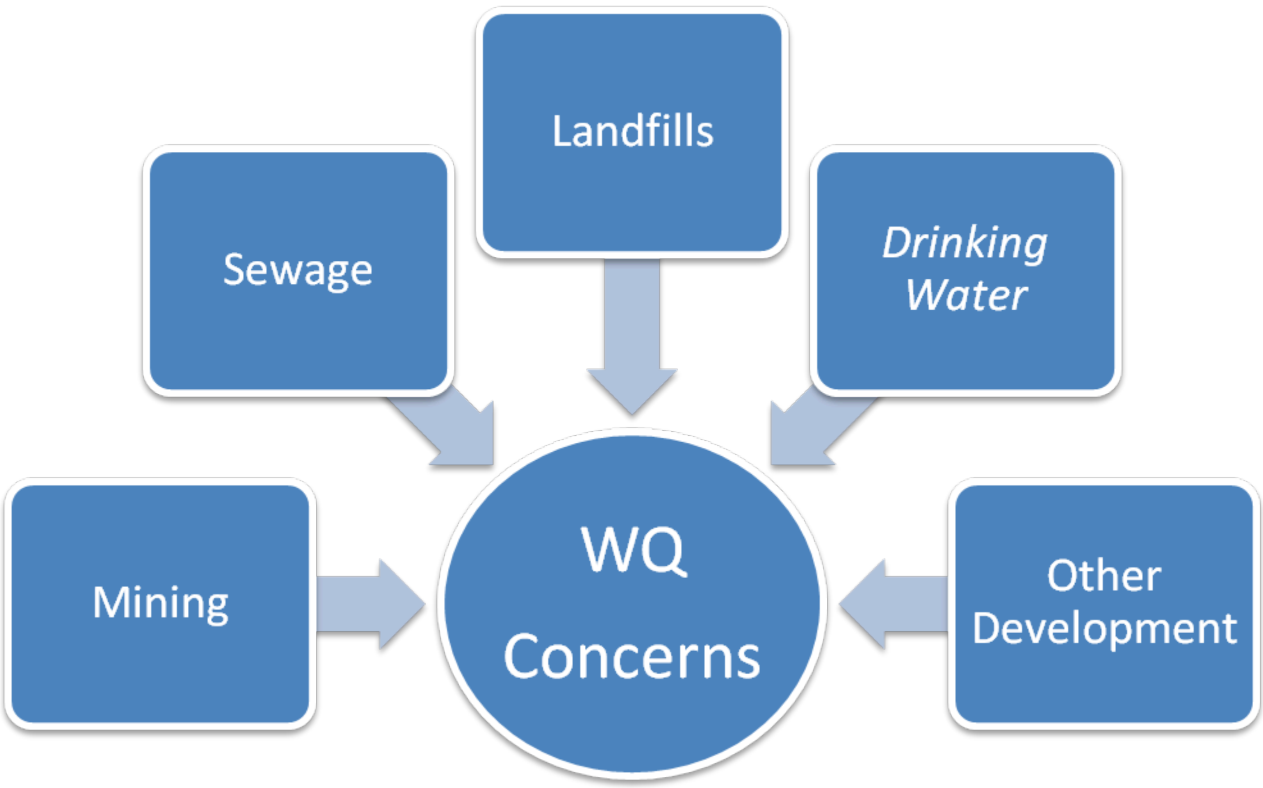
> "A lot of big resource development is starting to happen around here, namely the [development in] Quill Creek. I don't know how much water they are going to be using, but they are going to be using it to mill their concentrates. I suppose they get it out of the Donjek River." (KFN Community Member)

> "Hydro is a big thing here, because electricity power is generated by diesel for this area, and hydro dams are the alternative, but it's not environmentally sound. Like the Gladstone Lakes are proposed for development as a water reserve. What their planning to do is going to destroy the whole valley to create a big reserve to supply water during the winter months to the Aishihik Dam. And we're not benefitting from that. All that energy created by the Aishihik Dam does not benefit this area of the Alaska Highway. Period." (KFN Community Member)

[2] http://www.yukonenergy.ca/energy/projects/gladstone/
[3] http://www.emr.gov.yk.ca/oilandgas/ahpp.html

The specific sites associated with these concerns are identified on the contaminants map that was created during the focus group (See Figure 5 and 6). Fourteen specific sites were identified. Sites identified during interviews were subsequently added to the map. Detailed descriptions of these sites were recorded (See Appendix A).[4]

Figure 4 Types of Land Uses Impacting Water Quality Identified by KFN



[4] The sites of concern identified during the course of this research should not be considered an exhaustive list.

Figure 5 Participatory Contaminants Map in the KFN Traditional Territory

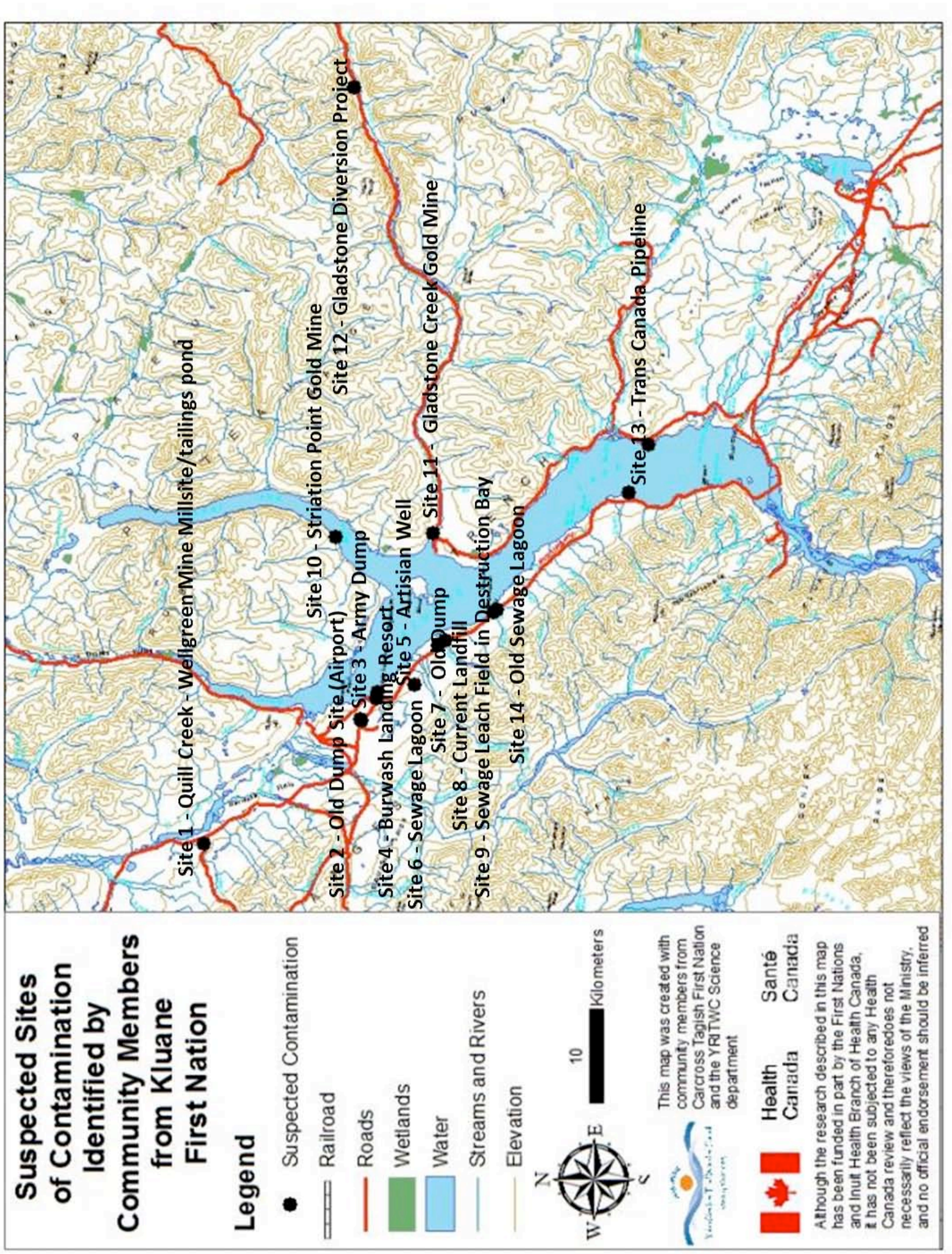
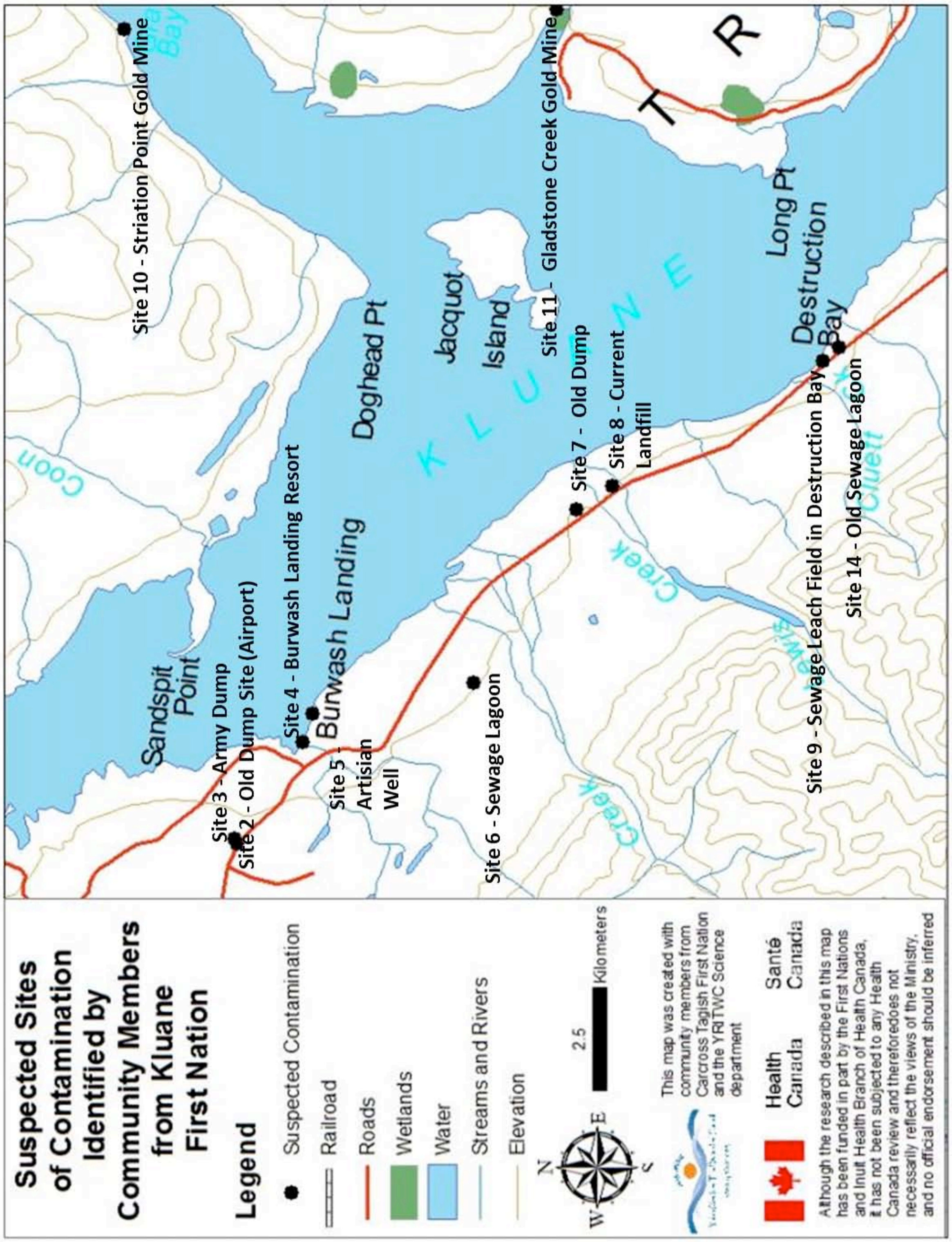


Figure 6 Water Quality Sites between Destruction Bay and Burwash Landing



The Health Canada grant provided YRITWC with funding to conduct water sampling at five of the sites that were identified during the research process. A voting process was used to prioritize a total of ten water quality sites. Water was sampled for heavy metals, hydrocarbons nutrients, and bacteria samples.

Water Quality Parameters and Physical Tests

Water was tested for a variety of parameters. A suite of metals, nutrients, bacteria, and hydrocarbons were analyzed at ALS Environmental Laboratory. The Yukon River Inter-Tribal Watershed Council, Indigenous Observation Network (including C/TFN), and US Geological Survey's Water Quality Monitoring Program are working together to collect baseline water quality samples for each of the sites identified by this project. For each sample collected, analysis was performed for the following dissolved parameters: major ions (alkalinity, chloride, sulphate, calcium, magnesium, sodium and potassium), some trace metals, nutrients (ammonium and nitrate), dissolved organic carbon, and stable water isotopes (deuterium and oxygen-19). Temperature, pH, and dissolved oxygen were measured in the field at each site. The following section provides a description of the water quality parameters mentioned above.

Metals

A suite of 19 metals was analyzed for this project. These metals are often naturally occurring; however, the Canadian Guidelines for Drinking Water Health Canada (2012b) indicates that the concentration of dissolved metals can be elevated by sewage effluent, mining effluent, landfill run-off, soil erosion, weathering of rocks, industrial waste, leachates from plumbing materials, air emissions, and irrigation. There is no evidence that the metals aluminum, calcium, sodium, iron, magnesium, manganese, selenium, and zinc have adverse health effects (*Ibid.*).

Guidelines have been developed to ensure treated drinking water with no offensive taste, as consumers may seek alternative sources that are less safe.

Major Ions (Anions and Cations)

Major anions include alkalinity, chloride (Cl), and sulphate (SO_4). Major cations include sodium (Na), potassium (K), magnesium (Mg), calcium (Ca), and some trace metals. Major ions come mostly from natural (geologic) sources and make up most of what is dissolved in water.

Alkalinity is a measure of the water's ability to buffer or balance acid-producing substances. Carbonates, bicarbonates, hydroxides, borates, silicates, phosphates, and some organic substances are represented by alkalinity. It is affected by the bedrock, soils and vegetation (EMAN-North 2005, 3–14).

Chloride is a useful parameter because it behaves conservatively; that is, it tends not to participate in chemical reactions and so the amount going into a river is and the coming out tend to be equal. Chloride concentrations can be used to determine the origin of a water sample and to track long-term trends.

Sulphate is also a nutrient; and some bacteria known as sulphate-reducing bacteria thrive from sulphate consumption. These bacteria reduce sulphate to hydrogen sulphate and this also reduces available oxygen in water. These bacteria can change mercury's chemical form and render it toxic to birds, mammals, and fish (Schuster and Toohey 2012).

Potassium is important because it is a nutrient for aquatic life.

Bacteria

The bacteria samples were collected for total coliform and *Escherichia coli* (*E. coli*). Coliform bacteria are a group of rod-shaped bacteria commonly found in the environment. Fecal coliform bacteria are found in intestines of mammals and humans. Total coliform bacteria are not likely to cause illness, but their presence indicates that a water supply may be vulnerable to contamination by more harmful microorganisms. *E. coli* are the only member of the total coliform group of bacteria that is found only in the intestines of mammals and humans. The presence of *E. coli* in water indicates recent fecal contamination and may indicate the possible presence of disease-causing pathogens like bacteria, viruses, and parasites. Although most strains of *E. coli* bacteria are harmless, certain strains may cause illness. These bacteria are known to grow well in warm temperatures. Fecal coliform bacteria often cause bladder and kidney infection or intestinal inflammation. When *E. coli* bacteria move outside of the intestine they cause disease with symptoms that include stomach cramps, diarrhea, nausea, and vomiting. Boiling drinking water will kill microorganisms but not viruses (Health Canada 2012b).

Hydrocarbons

Hydrocarbons sampled included Volatile Organic Compound (VOC) (e.g. gasoline), Polycyclic Aromatic Hydrocarbons (PAH) (e.g. creosote), Light Extractable Petroleum Hydrocarbons (LEPH) and Heavy Extractable Petroleum Hydrocarbons (HEPH) (e.g. diesels, greases, waxes, lubricating oils, and hydraulic oils).

VOCs are organic compounds containing one or more carbon atoms that have high vapour pressures and evaporate quickly to the atmosphere. VOC emissions result from natural and man-made sources and examples would be from vegetation, forest fires, and animals. Man-made sources in Canada are from the transportation sector, the use of solvents and solvent containing products, and industrial sources (Environment Canada 2010).

PAHs are emitted into the environment from both natural and human sources. Examples would be from forest fires, aluminum smelters, creosote, metallurgical and coking plants, and deposition of atmospheric PAHS. PAHs are relatively non-volatile and of low solubility in water and are mostly absorbed to particulate matter and can be transported and degrade over time. PAHs degrade very slowly in sediments, an important environmental sink for PAHs (Health Canada 2007).

LEPHs are a group of hydrocarbons that contains petroleum hydrocarbons with a carbon range of C10-19 with the exception of some PAHs in the same weight range. The Contaminated Sites Regulations explain HEPH contain a carbon range of C19-32 (Yukon Government 2011).

Nutrients

Nutrients include, among other elements, nitrogen (N) and phosphorous (P). Both of these nutrients are important for aquatic life. In excess these nutrients can alter water quality by reducing oxygen in the water from the increase of algae growth. Sewage effluent and agriculture can increase nutrient levels. Most nutrients test will look for total oxidized nitrogen (NO2 + NO3) because NO2 is poisonous to fish and is known to contribute to the overgrowth of algae. Nitrate (NO_3) is a nutrient and too much can cause algae blooms and contribute to the depletion of available oxygen in water for aquatic life. Ammonium (NH4) is also measured because in high concentrations it can be toxic to fish and other animals (YRITWC 2012, 44).

Dissolved Organic Carbon

Dissolved Organic Carbon (DOC) is the first available nutrient in the food chain. This nutrient is not a health concern on its own; however, it can attract heavy metals such as mercury and cadmium. When these metals increase in concentration by moving up the food chain they become toxic for wildlife and humans. Arctic rivers are generally low in DOC but levels are higher with surrounding wetlands (YRITWC 2012, 44).

Stable Water Isotopes

The stable isotopes of water, deuterium or hydrogen-2 (H2) and oxygen-18 (O18) are measured to determine a water sample's "signature" or "fingerprint". They can be used to trace the origin and movement of a water sample. Groundwater has a different signature than rainwater. Lake water has a different signature than glacial melt water (YRITWC 2012, 44).

Field pH

The measure of pH is of the basic and acidic nature of a solution and varies with the amount of hydrogen ions present in water. Aquatic life tends to thrive in a particular range of pH values and this depends on their stage of life and environment. If their living environment fluctuates outside of that range they could die or become ill. A pH range of 6.0 to 9.0 provides a healthy environment for freshwater fish and invertebrates (YRITWC 2012, 43).

Dissolved Oxygen

Dissolved Oxygen (DO) is the amount of available oxygen in the water. Oxygen gets into water by aeration (rapid water movement), diffusions from the air, and as a product of photosynthesis. A high level of dissolved oxygen in drinking water is good because it makes the water taste better; however, high levels of dissolved oxygen can speed up corrosion of water pipes. If the concentration levels of total dissolved gas in water go over 110% it can be harmful to aquatic life. Fish and aquatic invertebrates can experience 'gas bubble disease' and die. The amount of DO that an aquatic organism needs is dependent on the species of the animal, the water temperatures, the animal's physical state, and the pollutants present in the water. At higher temperatures fish use more oxygen because their metabolic rate increases. Research suggests that 4 - 5 mg/L is the minimum amount of DO that can support a large and diverse fish population. Good fish habitat generally averages around 9 mg/L of DO. Fish die when DO levels fall below 3 mg/L (YRITWC 2012, 43).

Conductance

Conductance refers to the ability of a water sample to conduct electricity. Electrical current is transported by the ions that are present in the water. All of the dissolved solids in water are either negatively charged ions (anions, discussed above) or positively charged ions (cations, similarly discussed above). The total concentration of ions dissolved in water is commonly called total dissolved solids (TDS). The conductance of water generally increases as the number of ions increases; therefore a higher conductivity reading means that there are more anions and cations present in the water and therefore a higher TDS (YRITWC 2012, 43).

Total Dissolved Solids (TDS)

Total dissolved solids are not known to cause any human health problems, but are more likely to have aesthetic influences; they can contribute to the corrosion of water pipes. Elevated TDS can cause drinking water to taste unpleasant and look murky in appearance. Water becomes saline at extremely high levels of TDS; therefore, water is not recommended for drinking when the TDS reads above 500 mg/L or when specific conductance is above 750 uS/cm. Occasionally high levels of TDS cause gastrointestinal irritations.

Location of Water Quality Sampling

Community members and KFN staff selected five water quality sites throughout the KFN traditional territory. Table 1 provides background information for these samples, including their location and the types of contaminants for which they were sampled.

Samples were collected from Kluane Lake (at Burwash and at Destruction Bay), Quill Creek, Copper Joe Creek, and Lewis Creek. Several types of samples were sent to the ALS Environmental laboratory in Whitehorse, Yukon. Hydrocarbon samples were collected for petroleum contamination concerns in Lewis Creek and Kluane Lake. Bacteriological and nutrient samples were collected for drinking, sewage, agricultural, and landfill concerns in Lewis and Copper Joe Creek. Metal samples were collected for mining effluent concerns in Quill Creek. Additional samples of the YRITWC kits were sent to the United States Geological Survey (USGS) in Boulder, Colorado. These kits include: major ions, metals, nutrients, dissolved organic carbon, and stable water isotopes. YRITWC will need to follow-up with KFN with USGS data.

Table 1 Kluane First Nation Water Quality Sites Sampled

Site Name	Site ID	GPS Coordinates (DD)	ALS Samples	Analysis	YRITWC Kits (Y/N)	Suspected Contaminants	Date
Quill Creek Above	KFN01	61.50595, -139.33174	Metals	Total metals in water.	N	Tailings pond. Heavy metals.	Sept. 05, 2012
Quill Creek Below	KFN02	61.51938, -139.32501	Metals	Total metals in water.	Y	Tailings pond. Heavy metals.	Sept. 05, 2012
Kluane Lake-Burwash Landing Resort	KFN03	61.35851, -138.99797	Hydrocarbons	BTEX+VPH+MTBE+ Styrene in water GCMS/FID. LEPH & HEPH CSR	Y	Old Fire Hall. Gas station, Resort	Sept. 05, 2012
Lewis Creek Above	KFN04 A	61.29293, -138.86710	Hydrocarbons, Metals, Bacteria, Nutrients	Nitrite Nitrogen by Ion Chromatography. Nitrate Nitrogen by Ion Chromatography. BTEX+VPH+MTBE+Styrene in water GCMS/FID. E.coli and Total by Colilert (Health). LEPH & HEPH, CSR by SF. Total Metals in water (DW). NO2, NO3, NO2+NO3. Total P in water by colour. Diss. Orthophosphate in water by colour.	N	Landfill concerns.	Sept. 06, 2012
Lewis Creek Below	KFN04 B	61.29712, -138.85907	Hydrocarbons, Metals, Bacteria, Nutrients	Nitrite Nitrogen by Ion Chromatography. Nitrate Nitrogen by Ion Chromatography. BTEX+VPH+MTBE+Styrene in water GCMS/FID. E.coli and Total by Colilert (Health). LEPH & HEPH, CSR by SF. Total Metals in water (DW). NO2, NO3, NO2+NO3.	Y	Landfill concerns.	Sept. 06, 2012

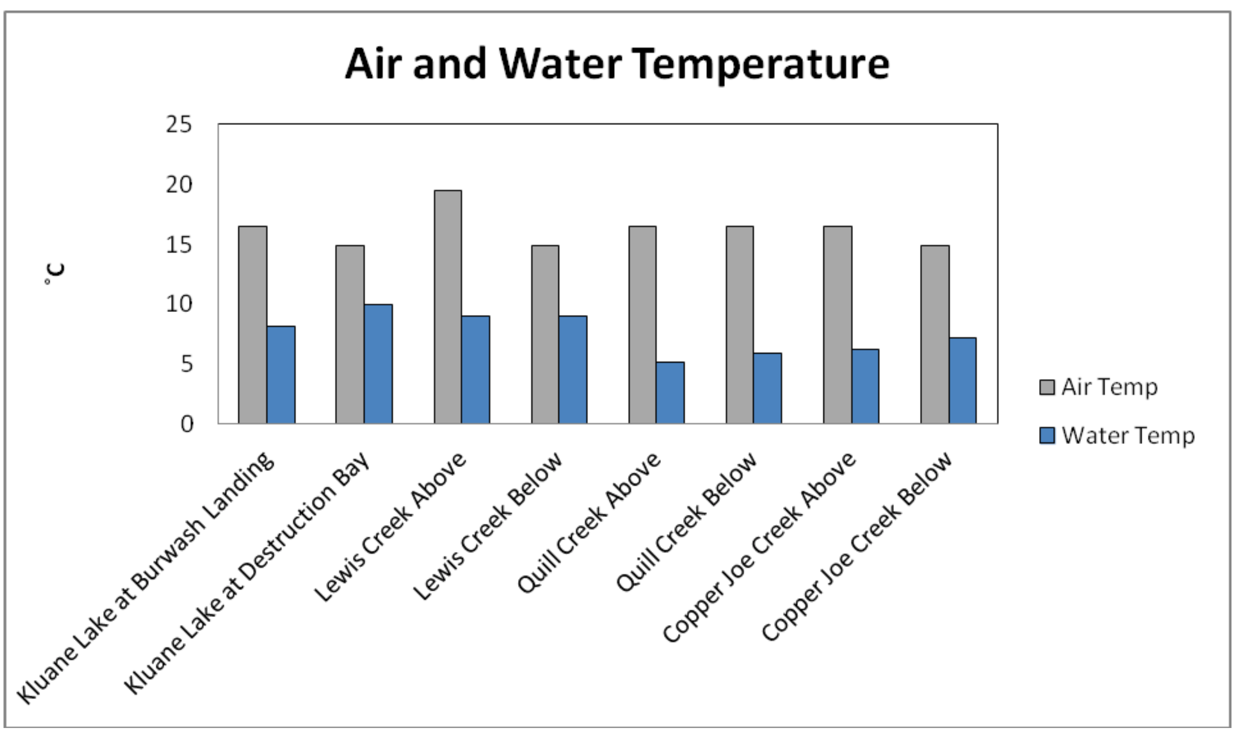
				Total P in water by colour. Diss. Orthophosphate in water by colour.			
Copper Joe Creek Above	KFN05 A	61.31500, -138.94673	Nutrients, Bacteria	Nitrite Nitrogen by Ion Chromatography. Nitrate Nitrogen by Ion Chromatography. E.coli and Total by Colilert (Health). NO2, NO3, NO2+NO3. Total P in water by colour. Diss. Orthophosphate in water by colour.	N	Sewage lagoon.	Sept. 06, 2012
Copper Joe Creek Below	KFN05 B	61.32677, -138.93164	Nutrients, Bacteria	Nitrite Nitrogen by Ion Chromatography. Nitrate Nitrogen by Ion Chromatography. E.coli and Total by Colilert (Health). NO2, NO3, NO2+NO3. Total P in water by colour. Diss. Orthophosphate in water by colour.	Y	Sewage lagoon.	Sept. 06, 2012
Kluane Lake-Below Talbot Arm Septic Field-Destruction Bay	KFN06	61.25439, -138.80069	Nutrients, Bacteria	Nitrite Nitrogen by Ion Chromatography. Nitrate Nitrogen by Ion Chromatography. E.coli and Total by Colilert (Health). NO2, NO3, NO2+NO3. Total P in water by colour. Diss. Orthophosphate in water by colour.	Y	Septic field	Sept. 06, 2012

Analysis of Water Quality Samples

Generally, the YRITWC found the water quality to be within aquatic, recreational, and drinking water standards and guidelines. However, sampling at these sites occurred with respect to the suspected contaminants (i.e., if hydrocarbons were suspected, samples were analyzed for hydrocarbons not nutrients). Therefore, these sites may have other sources of contamination. Additional samples are needed to determine trends and to have a robust baseline to help identify physical and chemical changes.

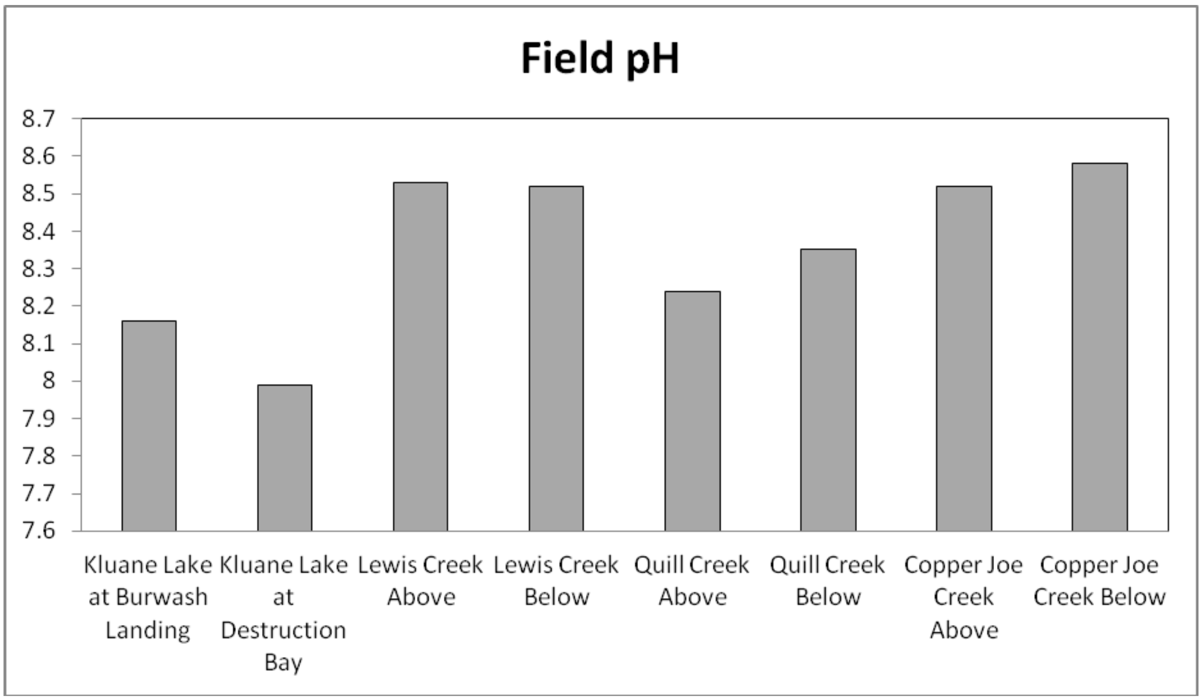
In Figure 7 field measurements of air and water temperatures are compared across all sites:

Figure 7 Air and Water Temperature



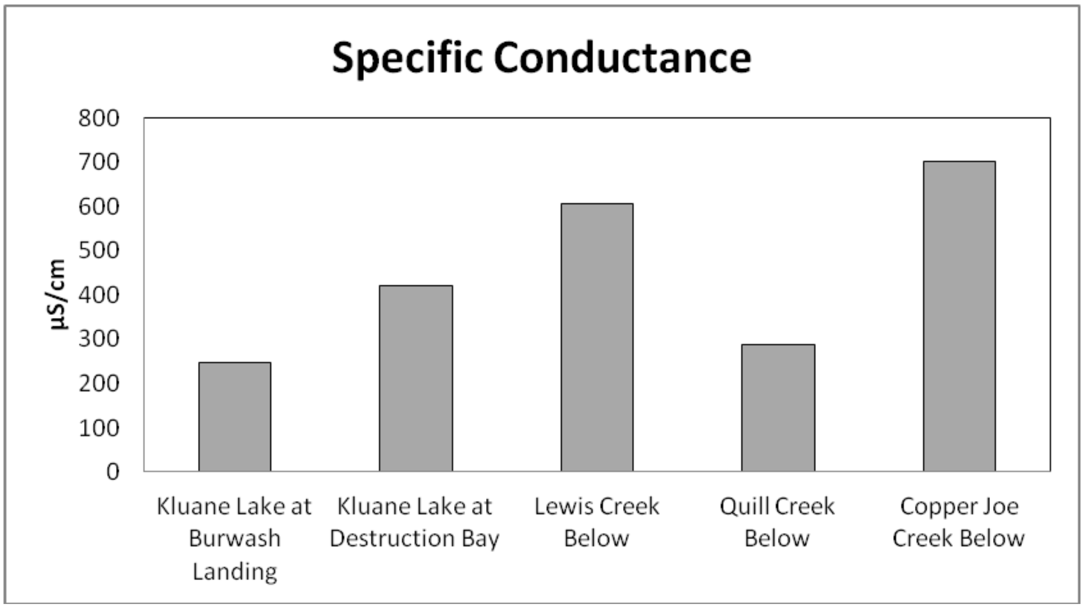
The pH field readings are in normal ranges for aquatic life, recreational water, and drinking water. All of the samples collected were slightly basic (as opposed to acidic or neutral). Waters within the Yukon River watershed have similar pH values (Figure 8).

Figure 8 Field pH



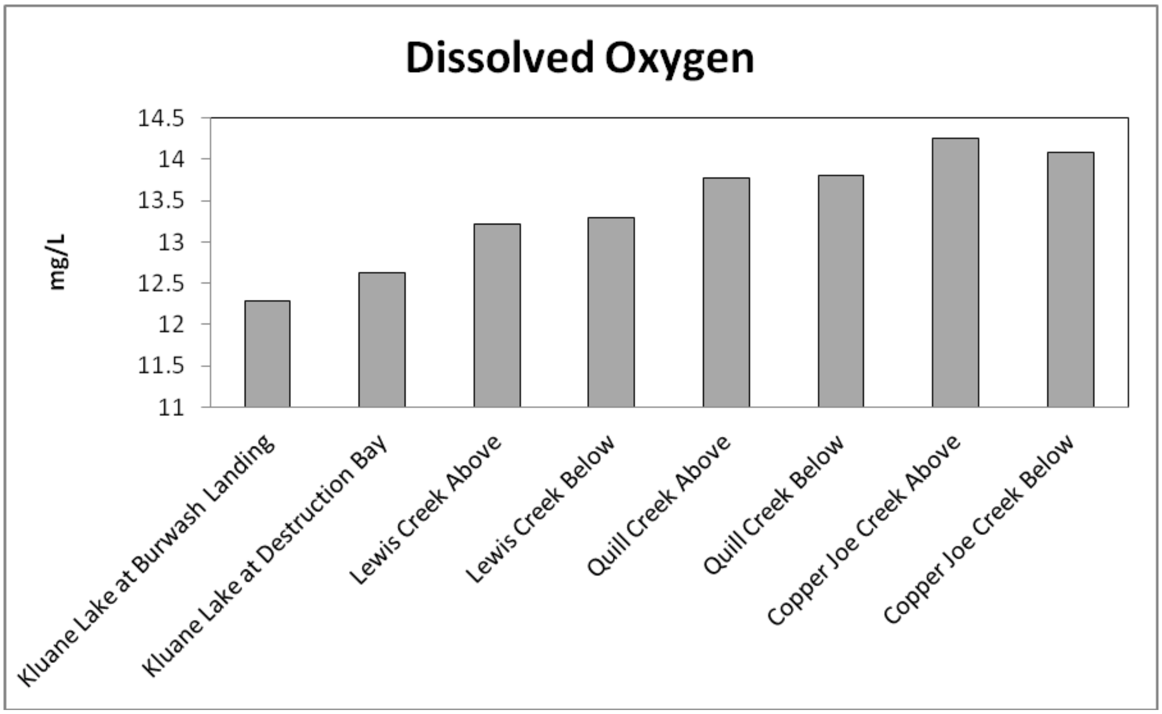
Specific conductance was analyzed at the USGS lab for all sites except for above samples at Lewis, Quill, and Copper Joe Creeks (See Figure 9).

Figure 9 Specific Conductance



Dissolved oxygen levels are within aquatic life standards (See Figure 10). The Canadian water quality guideline for the protection of aquatic life recommends a minimum concentration for DO in fresh water of 5.5 mg/L. The sample sites were well oxygenated.

Figure 10 Dissolved Oxygen



Several water quality guidelines and standards were applied to determine a threat of contamination in drinking water, recreational water, and aquatic habitat. Caution is needed when applying guidelines and standards to water quality analyses as there may be additional factors to consider, such as dilution, pH, or water hardness. Drinking water standards are referenced for the sole purpose of consumption in its raw state. There are no standards for raw drinking water as there needs to be a form of water treatment used for a standard to apply.

The guidelines and standards applied are Guidelines for Canadian Drinking Water Quality (CCME DW)[5], Guidelines for Canadian Recreational Water Quality (GCRWQ),[6] Canadian Environmental Quality Guidelines (CCME AW),[7] and Yukon Government Contaminated Sites Regulations (YCSR).[8] A committee of scientists, experts, and government establish standards and guidelines to help determine maximum acceptable concentrations of water contaminants. No samples exceeded recreational water guidelines (See Table 2).

YRITWC sampling protocols were used to collect surface water by a grab sample technique. In addition to the contaminant sampling, the YRITWC collected

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[5] Health Canada publishes the Guidelines for Canadian Drinking Water Quality and they are developed by a committee of Federal-Provincial-Territorial governments (Health Canada 2012). This guideline has set out Maximum Acceptable Concentrations (MAC) in drinking water for microbiological, chemical, and radiological contaminants. Also physical characteristics of drinking water, such as taste and odour have standards set to avoid consumers from seeking unreliable alternatives. Although Canadian drinking water supplies are generally of excellent quality, is it natural for water from these sources to contain elements of all of the substances they come in contact with. These can include minerals, silt, vegetation, fertilizers, and agricultural run-off. Most of these substances are not harmful to human health; some of them make be dangerous to vulnerable populations including children and the elderly. The Health Canada Drinking Water Guideless provide parameters that all drinking water systems to seek to meet or exceed in order to provide safe drinking water (Health Canada 2012b).

[6] The objective of Health Canada's Guidelines for Canadian Recreational Water Quality is the protection of public health. These guidelines outline current scientific knowledge of health and safety issues related to the recreational use of water. These mainly include "the risk of infection from contact with pathogenic microorganisms, and illness or injury as a result of physical or chemical properties of the water" (Health Canada 2012a).

[7] The Canadian Environmental Quality Guidelines are nationally recognized science-based goals for environmental quality. They are defined as "numerical concentrations or narrative statements that are recommended as levels that should result in negligible risk to biota, their functions, or any interactions that are integral to sustaining the health of ecosystems and the designated resource uses they support" (CCME 2013).

[8] The Yukon Government's Contaminated Sites Regulations (CSR) establishes standards for drinking water, aquatic life, irrigation, and livestock. These standards ensure water is suitable for direct use and is clean enough to protect water uses on adjacent properties (Yukon Government 2012).

kits including major ions, metals, nutrients, dissolved organic carbon, and stable water isotopes for United States Geological Survey analysis.

Quill Creek

Two samples were collected above and below Wellgreen's mill site and tailing pond. Hydrocarbons, VOCs, and PAHs were not analyzed for this site. There were no metal concentrations in exceedance of guidelines and standards for drinking and recreational water (See Table 2). Selenium concentrations exceeded the Canadian Guideline for aquatic life (See Table 3 and Figure 12). There were no samples collected from the nearby tailing pond.

Kluane Lake at Burwash Landing

There were no hydrocarbons, VOCs, or PAHs detected in Kluane Lake at Burwash Landing (See Table 3). No aquatic life standards or recreational water guidelines were exceeded. No drinking water standards were applied, meaning this site had insufficient data to apply this standard.

Lewis Creek

Water samples were collected above and below the old landfill, which is now a transfer station. Total coliform bacteria were detected in the samples (See Table 2 and Figure 11). Coliform bacteria are natural occurring from vegetation and wildlife but in treated water systems there should be no presence of total coliform bacteria according to the Canadian Guidelines. *E. coli* was not detected at Lewis Creek. However, the recommended holding time of 30 hours was surpassed, which may have impacted the accuracy of the results. Hydrocarbons, VOCs, and PAHs were not detected (See Table 3). Nutrient levels were within guidelines or not detected (See Table 4). Total metal were not detected or they were below guidelines and standards for recreational and drinking (See Table 5). Aluminum and selenium concentrations exceeded water standards for aquatic life (See Figures 12 and 13).

Copper Joe Creek

Water samples were collected above and below Burwash's sewage lagoon. Nutrient levels were within standards or not detected. Total coliform bacteria were detected but *E. coli was not* detected (See Table 2 and Figure 11). However, the holding time of 30 hours was surpassed for reliable bacterial analysis. The aquatic life standards were not exceeded for the parameters analyzed (See Table 3).

Kluane Lake at Destruction Bay

Nutrient levels were within drinking water standards or not detected (See Table 3). Total coliform bacteria were detected but *E. coli was not* detected (See Table 2 and Figure 11). No aquatic life standards were exceeded (See Table 3).

Table 2 Parameters Exceed Drinking and Recreational Water Standards and Guidelines

Surface Water Body	Site	Water Quality Parameters that Exceed YCSR DW Standards	Water Quality Parameters that Exceed CCME DW Guidelines	Water Quality Parameters that Exceed GCRWQ
Quill Creek Above	KFN01	No	No	No
Quill Creek Below	KFN02	No	No	No
Kluane Lake at Burwash Landing	KFN03	No	No	No
Lewis Creek Above	KFN04A	Total Coliform	Total Coliform	No
Lewis Creek Below	KFN04B	Total Coliform	Total Coliform	No
Copper Joe Creek Above	KFN05A	Total Coliform	Total Coliform	No
Copper Joe Creek Below	KFN05B	Total Coliform	Total Coliform	No
Kluane Lake at Destruction Bay	KFN06	Total Coliform	Total Coliform	No

Table 3 Parameters Exceed Aquatic Life Water Standards and Guidelines

Surface Water Body	Site	Hydrocarbon, Volatile Organic Compounds, PAH	Water Quality Parameters that Exceed YCSR AW Standards	Water Quality Parameters that Exceed CCME AW Guidelines
Quill Creek Above	KFN01	-	No	Se
Quill Creek Below	KFN02	-	No	Se
Kluane Lake at Burwash Landing	KFN03	No	No	No
Lewis Creek Above	KFN04A	No	No	Al, Se
Lewis Creek Below	KFN04B	No	No	Al, Se
Copper Joe Creek Above	KFN05A	-	No	No
Copper Joe Creek Below	KFN05B	-	No	No
Kluane Lake at Destruction Bay	KFN06	-	No	No

Figure 11 Total Coliform Guidelines for Drinking Water

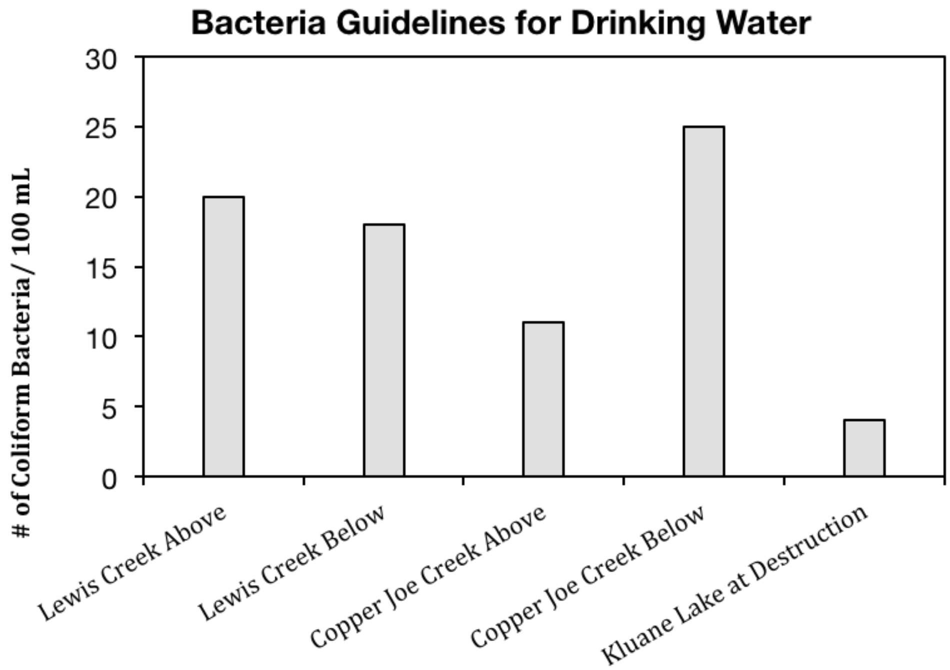


Figure 12 Selenium Guidelines for Aquatic Life

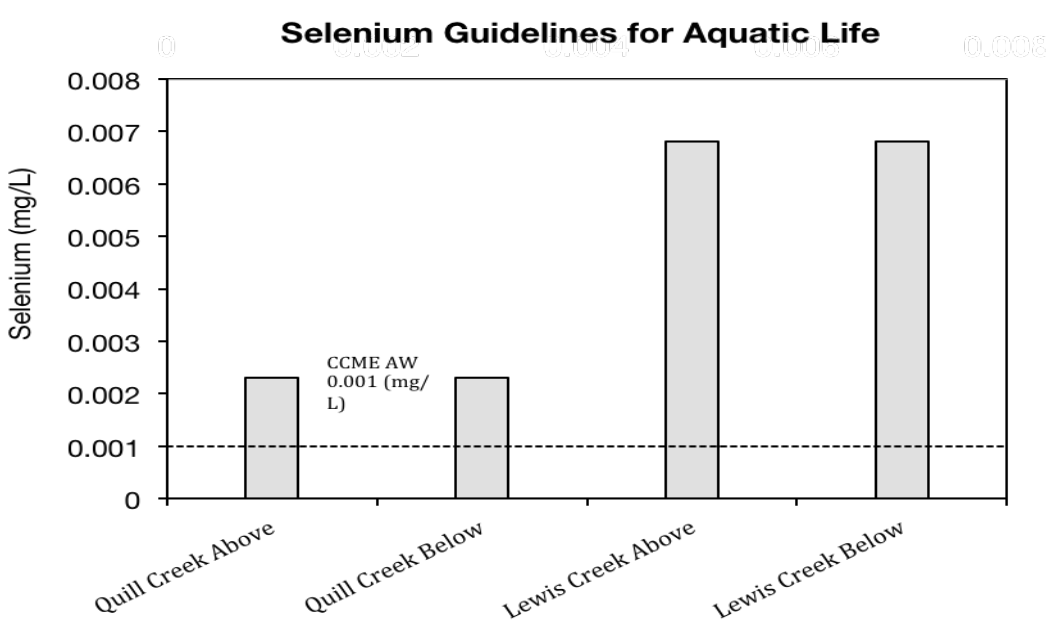
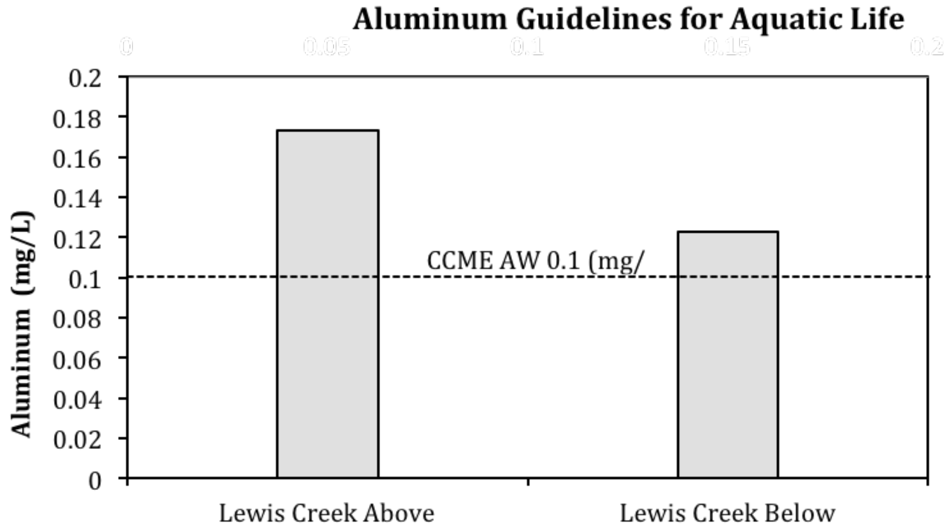


Figure 13 Aluminum Guidelines for Aquatic Life



Interpretation of Results

While some of these samples showed elevated levels of specific metals and bacteria, this year's sampling did not suggest any major contamination occurring within the selected water bodies. Within this report, we compare results from the selected water bodies to four different sets of Canadian water quality standards: Drinking Water Quality, Recreational Water Quality, Environmental Quality and Contaminated Sites Regulations. Each of these standards was designed for different uses of water resources. The Drinking Water Quality standards are the strictest and only applied to treated water (i.e., filtered, chlorinated, etc.). However, we wanted to compare these untreated water bodies to Drinking Water standards because of their use as drinking water sources. Natural water bodies generally contain a wide variety of bacteria, nutrients, and metals that varies depending on the geology, human and wildlife populations within the water body's watershed. Bacteria results (*E. coli* and Total Coliform) are just as likely to come from wildlife as they from humans. Within this study, we could not determine the source (human vs. wildlife). Therefore, the results from this year's sampling do not show any significant results of contamination.

However, this year's results only provide a very small amount of data (one sample at one point in time) with respect to the selected water bodies. We hope that future funding will allow YRITWC and KFN to monitor these sites throughout the open water season for two more years. Sampling throughout the open water season will give a much clearer picture about any risk of contamination. If increased and continued sampling continues to support the results found in this report, then this data becomes a valuable set of baseline monitoring data which KFN can continue to reference for many years in the future. At the very least, this data will allow KFN and the YRITWC to assess changes over the years to come.

Take home points from the Water Quality Analyses:

1. Total coliform bacteria were slightly higher at the downstream Copper Joe Creek site than the upstream site. This may suggest a small influence of the sewage lagoon. However, both upstream and downstream numbers of coliform bacteria were very low. *These numbers of coliform bacteria (both upstream and downstream)* should not be considered hazardous to public health.

2. While selenium results were elevated both at Quill and Lewis Creeks (above the guidelines for aquatic life), no significant differences were found between upstream and downstream sites. This suggests no influence of the tailings pond or landfill on the water quality.

3. While aluminum results were elevated at Lewis Creek (above the guidelines for aquatic life), no significant differences were found between upstream and downstream sites. This suggests no influence of the landfill on aluminum water chemistry

4. Much more sampling needs to occur to confirm or rule out any risk of contamination. The YRITWC and KFN have submitted proposals to fund water quality sampling for Year 2 of this project.

Observations of Climate Change

During interviews and focus groups, participants were asked if they had observed any changes in the environment that may be attributed to climate change. These observations included changes in the weather, water levels, river and lake ice regimes, plants, fish, wildlife and others. These observations are summarized in Table 10 – Observations of Climate Change in the Kluane First Nation Traditional Territory. Many of these observations are consistent with observations of climate change elsewhere in the Arctic and Sub-Arctic (ACIA 2005; Environment Yukon 2011). Each of these observations provides important information regarding the impacts that climate change may be having on the environment in this region. Each of these observations provides information regarding the impacts that climate change is having on the environment and the people who call this region home. In combination with concerns about the impacts of contaminants on water and results from water quality sampling, observations of climate change are important in understanding overall environmental change and

> "It used to be 30 or 40 below then. [A] long time ago it was cold. It was really cold. I noticed that changed too. I like it like this, but I know it's not good for the animals. I know that, but I'm ok with it. They get mixed up when it's cold, hot, cold, hot. The gophers would [sleep?] the middle of this month but they come back out. They think it's spring time." (KFN Community Member)

> "I think because of all the rain, that's why the waters so high. In the last few years, probably two or three years, that's all it does in the summer is just rain. We used to have nice hot summers, but now we don't have them really anymore, we have one day every couple of weeks if we are lucky." (KFN Community Member)

> "The deer and the cougars. It started at the same time probably 5 or 6 years ago. I think with them moving this way that it's getting warmer up here. I don't know why they are moving, but they are moving this way and they are kind of pushing our moose out because I hear there are people in Old Crow now that are getting moose." (KFN Community Member)

the affects these changes may be having on community members. The documented observations of climate change provide a basis for further research on the interactions between contaminants and climate change in specific aspects of the environment. The observations documented in this report could also be useful to the community as they seek to respond to climate change. This could include the development of community-based adaptation and mitigation programs.

> "I remember chopping holes in the ice when I was a kid and the ice would be 4, 5 feet thick and now you're lucky if you get three [feet] any winter. I can't remember the last time I had to chop 4 feet of ice. So definitely as far as temperature, it has warmed up considerably where the ice doesn't freeze to anywhere near the levels that it used it." (KFN Community Member)

Table 4 Observations of Climate Change in the Kluane First Nation Traditional Territory

Type of Change Observed	Examples of Change
Weather	• Warmer temperatures in the winter • Colder temperatures in the summers • Increased rain in the summer
Water Levels	• Increased water levels in lakes and streams
Permafrost	• Permafrost thaw leading to increased erosion
River and Lake Ice	• Reduced ice thickness • More open water on the Kluane Lake • Later freeze-up • Earlier break-up is occurring earlier
Plants	• Increased shrubs and grasses
Fish & Animals	• Reduced ground squirrel population • New birds (i.e., starlings) • Deer and cougars now inhabit the area • Moose are not rutting as early as they used to
Other	• Decrease in bees • New bugs in the area (i.e. spruce beetle) • Red algae on Kluane Lake

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Study Limitations

This project was limited by several factors. Time limitations impacted the project in two major ways. First, in high latitude regions, water sampling must take place within a four-month field season. The YRITWC was only able to take one water sample per site. The ability to take multiple samples throughout the open water season could have added a more complete picture of water quality trends. Second, time limitations also impacted the ability to integrate interview data into decision-making about water sampling. The YRITWC spent one week in each community. In general, the focus group was conducted at the beginning of the week in order to allow time for sampling to be completed in the following two days. Interviews were conducted at the same time as sampling. Often new information came to light that should have been incorporated into the water quality sampling plan. In the future, it would be useful to conduct interviews before focus groups are conducted.

The contaminants monitoring conducted during this project was limited to water quality sampling. As contaminated sites were identified, it became apparent that surface water was not always the appropriate sampling medium. Soil samples also would have been useful in identifying contaminants. Bacteria and nutrient samples had a short holding time in order to reach the labs within 30 hours of collection.

Conclusion and Next Steps

The purpose of this project was to initiate a community contaminant and climate change monitoring program. The preceding report documents the steps taken during the project to accomplish this task:

- **Documented the importance of water to KFN, which is a necessary first step for situating a community-based contaminants monitoring program.** Understanding the importance of water is fundamental to establishing a community climate change and contaminants monitoring program for two reasons: 1) It allows us to understand how changes in water resources are impacting people 2) Cultural connections to water are also the inspiration for protecting water resources;

- **Identified and mapped the sites of concern to community members.** The contaminant maps produced during this project document community concerns regarding the impact of contaminants on water resources in their traditional territory. While we were able to take water samples at ten of these sites, the maps can act as a resource for the community as they seek to further develop their water quality monitoring programs;

- **Conducted water quality sampling at five sites**. While some of these samples showed elevated levels of specific metals and bacteria, this year's sampling did not suggest any major contamination occurring within the selected water bodies. Further sampling is required. This year's results only provide a very small amount of data (one sample at one point in time) with respect to the selected water bodies.

Next Step: Identify sources of funding to conduct water quality monitoring of these sites for at least two years. Sampling throughout the open water season will give a much clearer picture about any risk of contamination. Continued sampling would allow for the establishment of a valuable set of baseline monitoring data which could be used as a reference for many years to come and allow for the assessment of changes over the years to come;

- **Documented observations of climate change.** Observations of climate change provide a basis for further research on the interactions between contaminants and climate change in specific aspects of the environment.

  Next Step: The observations documented in this report could also be useful to the community as they seek to respond to the impacts of climate change in their traditional territory. This could include the development of community-based adaptation and mitigation programs.

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Appendix A - Description of Community Identified Water Quality Sites of Concern

Site #*	Name	Suspected Contaminants	Description
1	Quill Creek (Wellgreen Mine tailings pond)	Mining	Tailings pond and mill site from Wellgreen mine located here. When there is a lot of precipitation.
2	Old Dump Site (Airport)	Leaching	Dump at airport may be influencing Kluane River.
3	Army Dump (Airport)	Leaching	Dump at airport may be influencing Kluane River. Contains old vehicles and fuel barrels.
4	Burwash Landing Resort	Fuel Spill	Old Fire Hall is located here. Fuel spills have occurred here. Concerns about the influence of this on Kluane Lake. Private property, need to sample the lake. Small creek downstream of old gas station, fuel spills.
5	Artesian Well/Geothermal Drilling	Sediments	Well drilled for geothermal heating. Stated that it reached 3000 m deep. Was capped off but there were concerns about the way this water might influence the lake.
6	Sewage Lagoon	Sewage	Copper Joe Cr. Problems with functioning of sewage lagoon. Pump sewage from all up and down the Alaska highway, outhouses etc. and deposit here.
7	Old Dump Site	Leaching	Influence on Lewis Cr. and groundwater. Scrap metal dump located here, now it is a transfer station. There are ground water testing tubes. We need to get permission from community services to sample these.
8	Current Transfer Station	Leaching	Current transfer station for Burwash Landing and Destruction Bay, YT. Concerned about influence on Lewis Cr. (Treat at same as site above)
9	Sewage Leach Field in Destruction Bay (Kluane Lake)	Sewage	Leach field for the Talbot Arm Motel, in Destruction Bay is not functioning properly. Earlier in the spring it was overflowing. Concerns about the influence on Kluane lake. Not online in Sept. 2012. They are pumping to the sewage lagoon. Sewage smell present. Would have been better to sample this spring, when the problem was more pronounced.

10	Striation Point Gold Mine (Kluane Lake)	Mining	Mine operating there. No serious concerns were raised regarding water quality at this point in time.
11	Gladstone Creek Gold Mine (Kluane Lake)	Mining	This mine has been operating for 30 years and there is good baseline data on the impacts of the mine on water quality. There are no present concerns about the mine. People would have concerns if another owner would begin to operate the mine.
12	Gladstone Diversion Concept (Yukon Energy)	Future Concern	Yukon Energy has a proposed project to divert water flowing from Gladstone Lakes into Kluane Lake and redirect it to the Sekulmun-Aishihik Lake system. In order to raise the water level. This is very important fish habitat (whitefish, pike, and grayling). The project would change the character of the lake. Concerns about impacts on aspects of the lake. Diverting from Yukon River drainage to Alsek River drainage.
13	TransCanada Alaska Highway Pipeline Project (Kluane Lake)	Future Concern/Natural Gas	Proposed crossing of Kluane Lake by Trans Canada Pipeline. Stalled for now, but represents future threat that people are concerned about. Proposed under water pipe 5.4 km route.
14	Old Sewage Lagoon (Kluane Lake)	Sewage	Area has been remediated, but others are still concerned what effect it might have in the case of heavy rains or floods.

* The sites identified in this chart should not be considered an exhaustive list.

Appendix B – Pictures of Water Quality Sites Sampled

Figure 14 Quill Creek Above

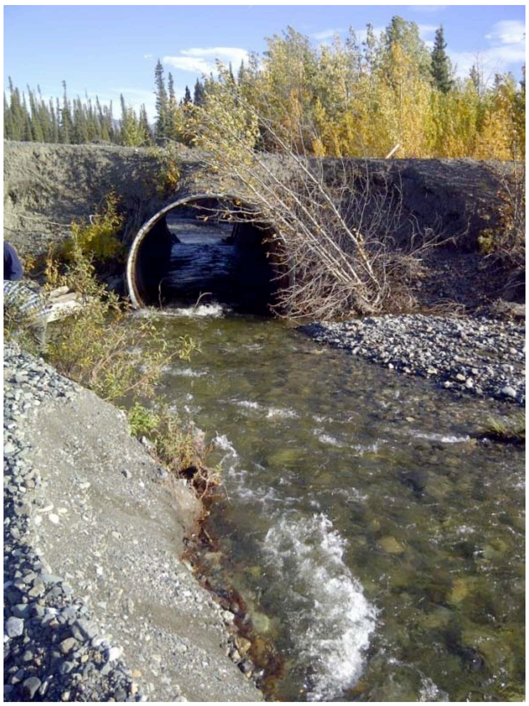

Figure 15 Quill Creek Below

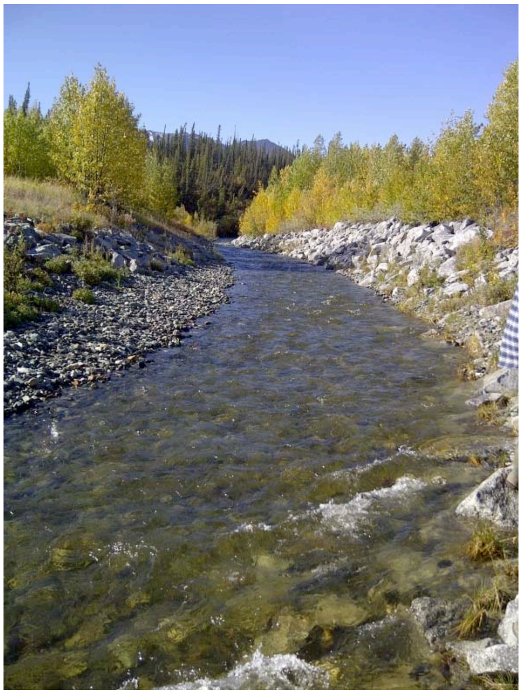

Figure 16 Kluane Lake at Burwash Landing

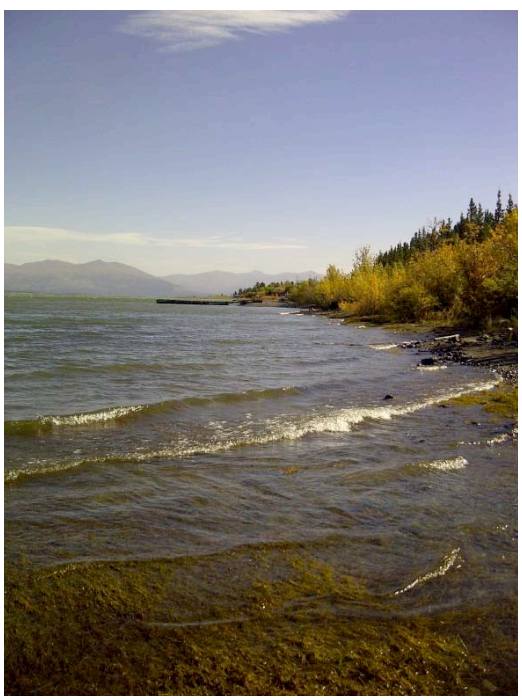

Figure 17 Lewis Creek Above

Figure 18 Lewis Creek Below

Figure 19 Copper Joe Creek Above

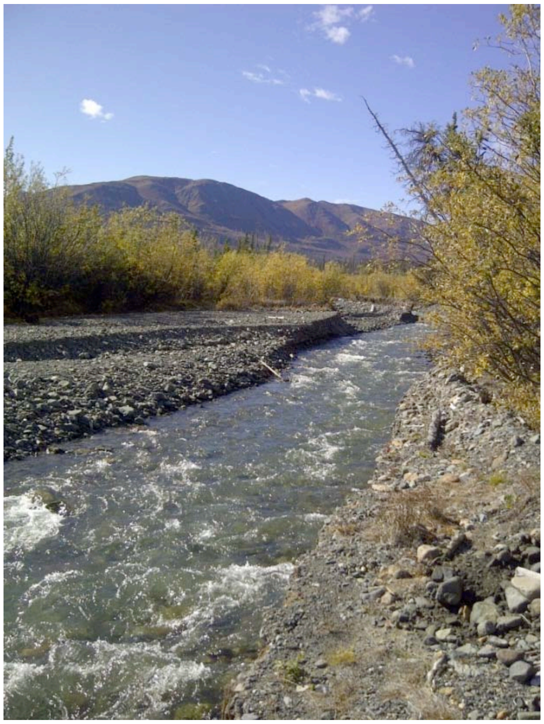

Figure 20 Copper Joe Creek Below

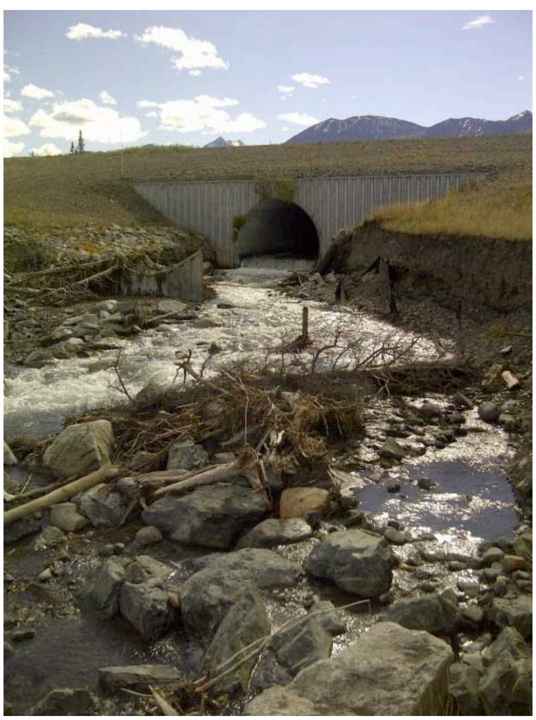

Figure 21 Kluane Lake at Destruction Bay

Appendix C – Useful Resources

1. Yukon Water: Here, you'll find information about Yukon's water resources. There is information about how water is used, managed and monitored (http://yukonwater.ca/-). The following is a listing of reference material from the yukonwater site:

Climate Change

Mayo Region Climate Change Action Plan (PDF 2.3 MB)

Climate Change Adaptation and Water Governance Report. (PDF 1.2 MB)

Summary of: Compendium of Yukon Climate Change Science: 2003-2011 (PDF 4.1 MB)

Compendium of Yukon Climate Change Science: 2003-2011 (PDF 2.3 MB)

Hydrology of the Bennett Lake Watershed: Contemporary Conditions and Potential Impacts of Climate Change (PDF 4.01 MB)

Yukon Water: An Assessment of Climate Change Vulnerabilities 2011 (PDF 10MB)

Yukon Water: A Summary of Climate Change Vulnerabilities 2011 (PDF 3.1MB)

Yukon Government Climate Change Action Plan (PDF 2.2 MB)

Climate Change and Water Intergovernmental Panel on Climate Change Technical Paper VI (PDF 7.11 MB)

Arctic Climate Impact Assessment (PDF, 1.62 MB)

United States Environmental Protection Agency National Water Strategy: Response to Climate Change (PDF, 11.4 MB)

Groundwater

Yukon Wide Long-Term Groundwater Monitoring Program, Community of Whitehorse Wells, 2001-2010 Monitoring Data Analysis (PDF 276 KB)

Water Monitoring

Yukon Snow Survey & Water Supply Forecast

The Yukon Snow Survey Bulletin and Water Supply Forecast is prepared and issued by Environment Yukon's Water Resources Branch three times annually after March 1, April 1, and May 1. The bulletin provides a summary of winter meteorological and stream flow conditions for Yukon, as well as current snow depth and snow water equivalent observations for 56 locations.

http://www.env.gov.yk.ca/monitoringenvironment/snow_survey.php-)

2. The Fresh Water Quality Monitoring & Surveillance Division focuses on regular monitoring, surveillance and reporting on fresh water quality, and aquatic ecosystem status and trends.

http://waterquality.ec.gc.ca/-

3. The Water Survey of Canada (WSC) is the national authority responsible for the collection, interpretation and dissemination of standardized water resource data and information in Canada. In partnership with the provinces, territories and other agencies, WSC operates over 2500 active hydrometric gauges across the country. http://www.ec.gc.ca/rhc-wsc/-

4. Environment impacts analysis; Contaminated sites monitoring; Assess and remediate Yukon Government contaminated sites.

http://www.env.gov.yk.ca/branches/environmental_programs.php-

5. Kwanlin Dun First Nation, Department of Heritage, Lands & Resources. Conduct continuous monthly seasonal water sampling at Michie Creek, southeast of Whitehorse.

http://www.kwanlindun.com/-

6. Ta'an Kwäch'än Council, Department of Lands, Resources and Heritage. Conduct seasonal continuous and continuous water chemistry sampling at sites within traditional TKC territory, on Takhini River, Flat Creek, Laurier Creek and Lake Laberge.

http://www.taan.ca/-

7. Water Resources Branch: Water-related strategic planning, policy development and implementation; Regional water quality/quantity monitoring and research; Provision of expert technical advice regionally and nationally; Enforcement and compliance of the *Waters Act* and water licences; Administration of water security deposits; Share responsibility for managing Yukon waters with five other Yukon Government departments including: **Health & Social Services** (drinking water & private sewage disposal), **Highways & Public Works** (water & sewage provision in unincorporated communities), **Energy, Mines & Resources** (regulate placer mining activities), **Executive Council Office, Water Board Secretariat** (water licensing process), **Community Services** (project management services for community infrastructure).

http://www.emr.gov.yk.ca/csi/index.html-

8. Health & Social Services monitors drinking water in town sites including Old Crow, Dawson City, Keno City, Mayo, Pelly Crossing (Selkirk First Nation), Carmacks (Little Salmon Carmacks First Nation), Faro, Ross River, Whitehorse, Haines Junction, Burwash (Kluane First Nation), Carcross Tagish, and Watson Lake. Sampling types include microbiological and water chemistry.

http://www.hss.gov.yk.ca/environmental_drinkingwater.php-

9. The **Yukon Water Board** is an independent administrative tribunal established under theWaters Act . The Board is responsible for the issuance of water use licences for the use of water and/or the deposit of waste into water.

http://www.yukonwaterboard.ca/-

10. YESAB was established under the *Yukon Environmental and Socio-economic Assessment Act* (YESAA), which came into full force November 28, 2005. YESAB is committed to delivering an assessment process that works well for all Yukoners as well as all stakeholders. YESAB's goal is to ensure the assessment process under YESAA is the best possible arrangement for all interests. http://www.yesab.ca/index.html-

11. Summary of Yukon water wells. Most current report dating May 11, 2006.

http://www.env.gov.yk.ca/pdf/YukonWaterWellsSummary.pdf-

12. Reference Condition Approach Bioassessment of Yukon River Basin Placer Mining Streams Sampled in 2006. http://www.geology.gov.yk.ca/pdf/MPERG_2007_2.pdf

13. Yukon Water Resources Hydrometric Program Historical Summary 1975 – 2004. http://www.env.gov.yk.ca/pdf/hydrometricmanual2005.pdf

Appendix D – Water Quality Data

Sample ID	KFN01	KFN02	KFN03	KFN04A	KFN04B	KFN05A	KFN05B	KFN06
Site Name	Quill Creek Above	Quill Creek Below	Kluane Lake at Burwash Landing	Lewis Creek Above	Lewis Creek Below	Copper Joe Creek Above	Copper Joe Creek Below	Kluane Lake at Destruction Bay
Site Coordinates	61.50595, -139.33174	61.51938, -139.32501	61.35851, -138.99797	61.29293, -138.86710	61.29712, -138.85907	61.31500, -138.94673	61.32677, -138.93164	61.25439, -138.80069
Date Sampled	05-SEP-12	05-SEP-12	05-SEP-12	06-SEP-12	06-SEP-12	06-SEP-12	06-SEP-12	06-SEP-12
Time Sampled	10:39	11:27	13:50	16:22	17:40	14:30	15:10	19:00
Matrix	Water	Water	Water	Water	Water	Water	Water	Water
Hardness (as CaCO3 in mg/L)	265	263	-	342	341	-	-	-
pH	8.24	8.35	8.16	8.53	8.52	8.52	8.58	7.99
Air Temp. (°C)	16.5	16.5	16.5	19.5	14.9	16.5	14.9	14.9
Water Temp. (°C)	5.2	5.9	8.2	9	9	6.2	7.2	10
Dissolved Oxygen (mg/L)	13.77	13.81	12.28	13.21	13.39	14.25	14.08	12.63
Anions and Nutrients (mg/L)								
Nitrate and Nitrite (as N)	-	-	-	0.0898	0.0849	0.145	0.139	0.0782
Nitrate (as N)	-	-	-	0.0898	0.0849	0.145	0.139	0.0782
Nitrite (as N)	-	-	-	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Orthophosphate-Dissolved (as P)	-	-	-	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Phosphorus (P)-Total	-	-	-	0.0027	0.0039	0.0040	0.0052	0.0044
Bacteriological Tests (#/100mL)*								
E. coli	-	-	-	<1	<1	<1	<1	<1
Coliform Bacteria - Total	-	-	-	20	18	11	25	4
Total Metals (mg/L)								
Aluminum (Al)	0.077	0.085	-	0.173	0.123	-	-	-
Antimony (Sb)	<0.00050	<0.00050	-	<0.00050	<0.00050	-	-	-

Arsenic (As)	0.00076	0.00075	-	0.00060	0.00067	-	-	-
Barium (Ba)	0.049	0.049	-	0.041	0.040	-	-	-
Boron (B)	0.16	0.16	-	0.14	0.15	-	-	-
Cadmium (Cd)	<0.00020	<0.00020	-	<0.00020	<0.00020	-	-	-
Calcium (Ca)	76.3	75.7	-	80.2	79.8	-	-	-
Chromium (Cr)	<0.0020	<0.0020	-	<0.0020	<0.0020	-	-	-
Copper (Cu)	0.0035	0.0036	-	0.0015	0.0013	-	-	-
Iron (Fe)	0.165	0.168	-	0.281	0.188	-	-	-
Lead (Pb)l	<0.00050	<0.00050	-	<0.00050	<0.00050	-	-	-
Magnesium (Mg)	18.2	17.9	-	34.5	34.4	-	-	-
Manganese (Mn)	0.0174	0.0162	-	0.0101	0.0080	-	-	-
Mercury (Hg)	<0.00020	<0.00020	-	<0.00020	<0.00020	-	-	-
Potassium (K)	0.85	0.88	-	1.03	1.06	-	-	-
Selenium (Se)	0.0023	0.0023	-	0.0068	0.0068	-	-	-
Sodium (Na)	4.8	4.8	-	9.5	9.4	-	-	-
Uranium (U)	0.00024	0.00023	-	0.00047	0.00046	-	-	-
Zinc (Zn)	<0.050	<0.050	-	<0.050	<0.050	-	-	-
Volatile Organic Compounds (mg/L)								
Benzene	-	-	<0.00050	<0.00050	<0.00050	-	-	-
Ethylbenzene	-	-	<0.00050	<0.00050	<0.00050	-	-	-
Methyl t-butyl ether (MTBE)	-	-	<0.00050	<0.00050	<0.00050	-	-	-
Styrene	-	-	<0.00050	<0.00050	<0.00050	-	-	-
Toluene	-	-	<0.00050	<0.00050	<0.00050	-	-	-
ortho-Xylene	-	-	<0.00050	<0.00050	<0.00050	-	-	-
meta- & para-Xylene	-	-	<0.00050	<0.00050	<0.00050	-	-	-
Xylenes	-	-	<0.00075	<0.00075	<0.00075	-	-	-
Surrogate: 4-Bromofluorobenzene (SS) %	-	-	84.4	84.9	84.4	-	-	-
Surrogate: 1,4-Difluorobenzene (SS)	-	-	85.0	84.4	84.7	-	-	-
Cation (ueq/L)								
Al 396.153	-	5.020	7.179613	-	4.711	-	3.493	4.962
Ba 455.403	-	45.609	21.26555	-	54.259	-	49.230	29.733
Ca 317.933	-	64.620	55.06066	-	69.109	-	76.915	49.401
Cu 224.700	-	3.516	-3.8516571	-	2.383	-	2.348	-0.431

Fe 259.939	-	17.650	148.23047	-	4.344	-	14.413	27.062
K-ax 766.490	-	0.629	0.56706475	-	0.775	-	1.359	1.767
Mg 279.077	-	18.758	17.85505	-	35.447	-	45.838	15.362
Mn 257.310	-	12.382	8.51039	-	4.038	-	0.686	3.377
Na 589.592 <50	-	4.337	2.99246	-	8.886	-	16.431	3.966
Ni 231.604	-	4.040	3.21468552	-	0.256	-	-0.767	-0.250
S 180.669	-	29.214	8.44256538	-	64.361	-	63.205	25.206
SiO2 251.609	-	7.333	9.783649	-	4.465	-	8.422	3.292
Sr 407.771	-	234.585	182.0682	-	572.940	-	475.815	312.309
Zn 213.857	-	17.079	19.33108	-	15.955	-	16.009	17.182
Dissolved Organic Carbon								
UV A@254nm (whole)	-	0.1468	0.5501	-	0.0286	-	0.0397	0.0379
Avg DOC [ppm]	-	5.57	26.39	-	1.45	-	2.30	2.02
SUVA	-	2.63	2.08	-	1.97	-	1.73	111.6
Alkalinity ueq/L	-	3293.42	3623.819	-	2897.561	-	4399.824	2554.854
Conductivity	-	477	385	-	646	-	751	396
Dissolved Oxygen								
SC	-	288.1	246.2	-	607	-	702	420.1
DO mg/L	-	13.81	12.28	-	13.3	-	14.08	12.63
DO %	-	110.8	105.1	-	115.9	-	116.6	111.6

* Both E. coli and coliform bacteria passed the 30hr holding time limit