Climate Adaptation Strategies

An Intergenerational effort to combine Indigenous Knowledge and Western Science

A 2013-14 community report prepared for
Kluane First Nation
by the Yukon River Inter-Tribal Watershed Council

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This 2013-14 community report was prepared for Kluane First Nation by the Science Department of the Yukon River Inter-Tribal Watershed Council and by Dr. Shannon Donovan of University of Anchorage Alaska. For further information, please contact Jody Inkster (jinkster@yritwc.org) or Dr. Edda Mutter (emutter@yritwc.org) via email or by phone: 867-393-2199.

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Kwänäschis!

Table of Contents

Table of Figures

INTRODUCTION

The YRITWC

The Yukon River Inter-Tribal Watershed Council (YRITWC) is an Indigenous grassroots organization, consisting of 70 First Nations and Tribes, dedicated to the protection and preservation of the Yukon River watershed. The YRITWC accomplishes this by providing First Nations in Yukon and northern British Columbia and Tribes in Alaska with technical assistance. We facilitate the development and exchange of information, coordinate efforts between First Nations and Tribes, undertake research, and provide training, education and awareness programs to promote the health of the watershed and its Indigenous peoples.

> Our Mission
>
> "We, the Indigenous Tribes/First Nations from the headwaters to the mouth of the Yukon River, having been placed here by our Creator, do hereby agree to initiate and continue the clean up and preservation of the Yukon River for the protection of our own and future generations of our Tribes/First Nations and for the continuation of our traditional Native way of life."

Previous collaborations between the YRITWC and KFN

This report presents the results of the second project the YRITWC has successfully implemented together with Kluane First Nation (KFN) through Health Canada's "Climate Change and Health Adaptation Program for Northern First Nations and Inuit Communities."

The first project, "Integrating Indigenous Knowledge and Public Health Concerns into a Community Contaminant and Climate Change Monitoring Program", was delivered in 2012-13. The project involved the YRITWC working with five First Nations (Kluane, White River, Tr'ondëk Hwëch'in, Selkirk and Carcross/Tagish) to identify various forms of environmental change and related public health challenges.

Over 100 people, including 33 Elders, participated in the first project: 61 community members were interviewed and 49 participated in focus groups. One of the consistent conclusions from each community called for a greater inclusion of youth to transfer traditional knowledge and help formulate climate change and heath adaptation strategies.

The five First Nations collectively identified 95 sites of concern for contamination. Each community specifically prioritized five sites that were suspected of degrading water quality due to climate change and human activities (mining, wastewater discharge, fuel delivery and storage, etc.). 65 surface water grab samples were collected and analyzed for a suite of indicator parameters selected to address community concerns. Each of the partner First Nations emphasized the need to continue monitoring the sites for 3-5 years.

Current project overview

Over the course of the past year, the YRITWC has continued to work with the same five First Nations (Kluane, White River, Tr'ondëk Hwëch'in, Selkirk and Carcross/Tagish) to implement a second project through Health Canada's "Climate Change and Health Adaptation Program for Northern First Nations and Inuit Communities."

This year's project involves developing climate adaptation strategies based upon intergenerational Traditional Knowledge and cutting-edge western science. The project is titled, "Climate Adaptation Strategies: An Intergenerational Effort to Combine Indigenous Knowledge and Western Science" and has two primary objectives:

1. Continue monitoring sites of concern for contamination, and
2. Facilitate an intergenerational dialogue between youth and Elders on climate change adaptation planning to promote community health.

The following pages detail the implementation of our project, organized according to the objectives mentioned above.

Water quality in the traditional territory of KFN

What is "water quality?"

Water quality is really just a measure of the suitability of water for a particular use. Some water is great for drinking and is referred to as being "potable." Some water is not potable (not suitable for drinking) but might make healthy fish habitat or be great for watering your garden.

We cannot tell if a water sample is safe for drinking, or suitable for any other use, just by looking at it. We need to measure certain characteristics of the water, which might be physical, chemical or biological. We can divide the characteristics we are measuring into a few groups, which are discussed below.

Water quality standards

In order to decide whether water is suitable for a particular use or unsuitable for that use, we need water quality standards. Basically, we need to designate the use of a water body (river, creek, pond, lake, etc.) and use water quality criteria to protect that use and prevent contamination. "Designating the use" of a water body, means deciding if it is fit or safe for swimming, fishing, drinking, and watering crops or some other function. "Water quality criteria" are numbers and other requirements that our samples have to meet in order to prove that the water is suitable for its use. In this report, we use the Canadian Guidelines for the Protection of Aquatic Life (CCME, 1987) to evaluate water quality in KFN's traditional territory.

Sites with suspected contamination

As part of the previous project, "Integrating Indigenous Knowledge and Public Health Concerns into a Community Contaminant and Climate Change Monitoring Program" (2012-13), the YRITWC facilitated a participatory mapping exercise with citizens of KFN. Participants identified, discussed, and mapped (using ArcGIS) sources of contamination and potential impacts on water resources.

A total of 14 sites of concern were identified. The YRITWC then coordinated a voting process whereby participants prioritized the sites of concern. Water samples were collected between August and October of 2012 from the five sites decided to be of highest priority:

1. Quill Creek (quydb1b)
2. Kluane Lake at Burwash Landing (klydb1b)
3. Lewis Creek (lcydb1b)
4. Copper Joe Creek (cjydb1b)
5. Kluane Lake at Destruction Bay (klydb2b)

Descriptions of each of these sites can be found in Appendix A. These five sites are illustrated on the accompanying map of KFN's traditional territory (Figure 1).

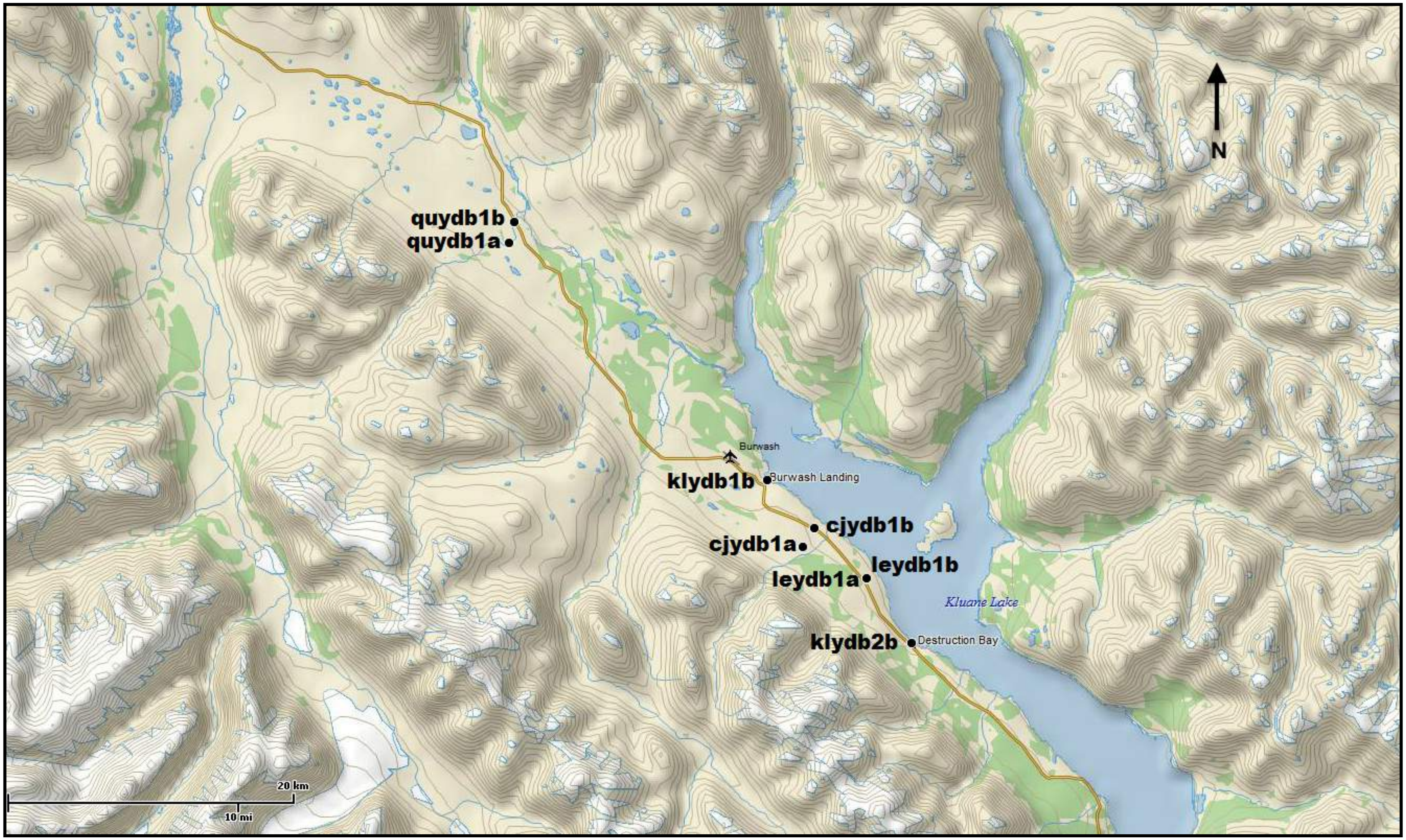
Water samples were again collected from these five sites in 2013. Table 1 presents the dates of sample collection for each of the sites. Lewis Creek was not sampled in 2013 because it was dry at the time of the site visit.

Table 1: Dates of sample collection and class of contaminants analyzed

Sample Date	Site Name	Hydrocarbons	Metals	Bacteria	Nutrients
Sept. 12	Quill Creek Below		x		
	Kluane Lake at Burwash Landing	x	x		
Sept. 13	Lewis Creek Below	*No sample collected (Lewis Creek dry at time of site visit.)*			
	Copper Joe Creek Below		x	x	x
	Kluane Lake at Destruction Bay		x	x	x

The results of analysis of water samples collected in 2012 and 2013 are presented in Appendix B. The results are discussed in detail in the following sections (Field parameters and Laboratory parameters).

Figure 1: Map of KFN's Sampling Sites



Field parameters

Field parameters are the characteristics of water that we measure directly in the field when we go out and collect water samples. Field parameters include temperature, pH, dissolved oxygen, and conductance.

TEMPERATURE

Temperature tells us how hot or cold the water is. Temperature can affect the ability of water to conduct an electrical current, to hold oxygen and certain dissolved solids, and to undergo various reactions so it is very important to measure every time we take a sample. While temperatures can vary greatly (even within the day), consistently high water temperatures are detrimental to many fish species (including salmon, whitefish, and others).

PH

pH is a measure of how acidic or basic the water is. The range of pH values goes from zero to fourteen. Low values of pH indicate acidic waters whereas high values of pH indicate basic waters. The number seven is right in the middle so it is considered neutral. pH can affect the concentration of the other parameters that are dissolved in the water (particularly metals) so it is a very important indicator of water quality. The Canadian Guidelines for the Protection of Aquatic Life establish a range of acceptable pH values from 6.5 - 9.0 (CCME, 1987). No exceedances of the Canadian Guidelines for the Protection of Aquatic Life were found (Appendix B).

DISSOLVED OXYGEN

Even though you cannot see it, water contains a dissolved gas: oxygen. Oxygen gets into the water from the surrounding air and from plants that are undergoing photosynthesis. The oxygen dissolved in water is critical for aquatic life (fish and other organisms) living in it. If dissolved oxygen levels become too low, aquatic life could be stressed or even die. The Canadian Guidelines for the Protection of Aquatic Life state the following lowest acceptable dissolved oxygen concentrations (CCME, 1987):

- For cold water biota: early life stages = 9.5 mg/L
- For cold water biota: other life stages = 6.5 mg/L

In 2012, the dissolved oxygen concentration in Kluane Lake at Burwash Landing was acceptable but in 2013, it was slightly below the lowest acceptable dissolved oxygen concentration for cold water biota: early life stages established by the Canadian Guideline for the Protection of Aquatic Life (Figure 2). It is likely that this was a temporary and minor deviation from acceptable dissolved oxygen levels. Continued monitoring of Kluane Lake at Burwash Landing is recommended to better understand the natural variation of dissolved oxygen concentrations at this site.

Conductance

Conductance is a measure of how well water can conduct an electrical current. Water can conduct electrical currents because it contains dissolved charged particles called ions (discussed below). Conductance depends on the amount of solids dissolved in the water: pure water has a low conductance whereas seawater has a high conductance. When the conductance goes up or down, it is telling us something about the amount of dissolved solids in the water.

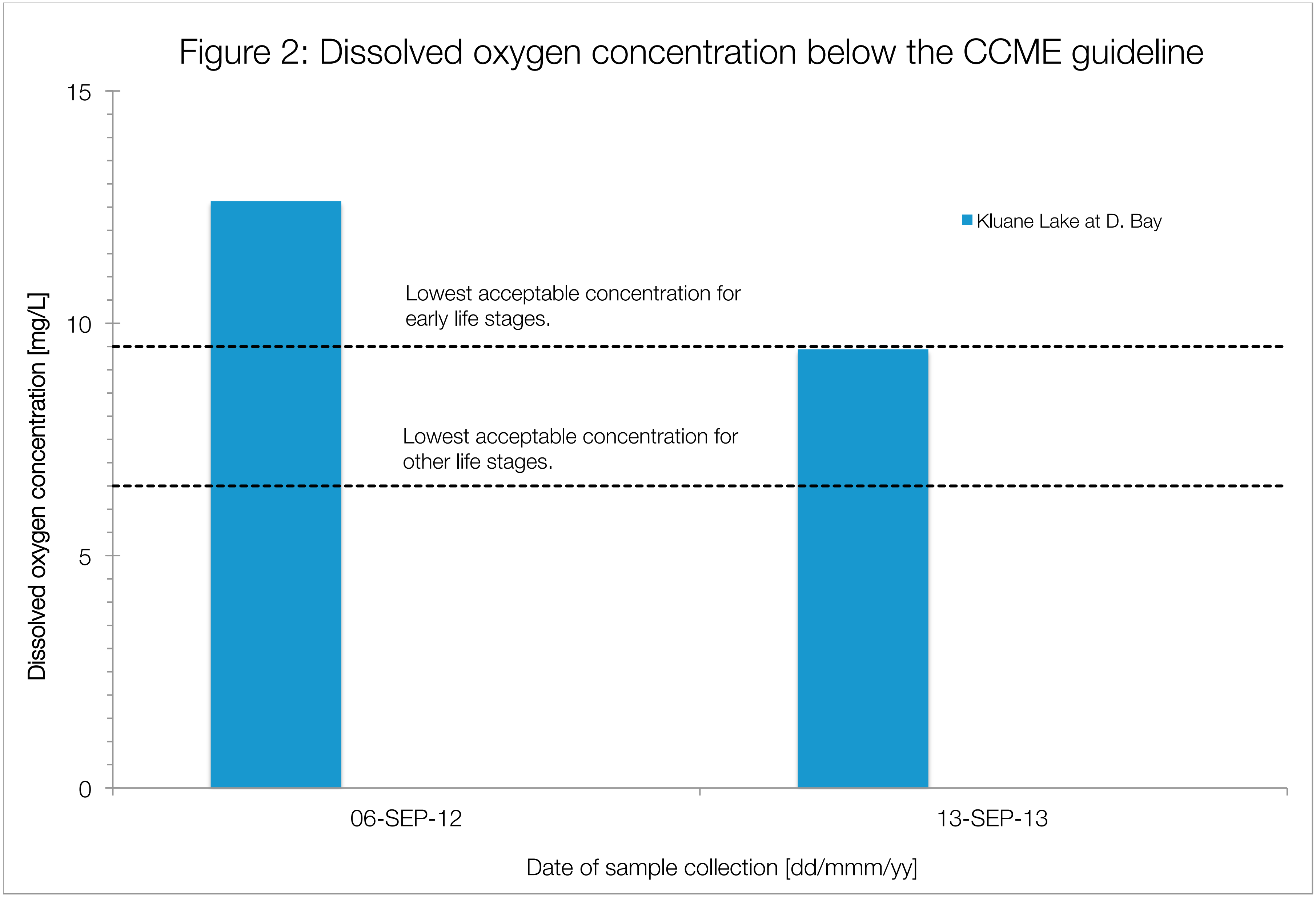


Figure 2: Dissolved oxygen concentration below the CCME guideline
15
10
5
0
Dissolved oxygen concentration [mg/L]
Kluane Lake at D. Bay
Lowest acceptable concentration for
early life stages.
Lowest acceptable concentration for
other life stages.
06-SEP-12
13-SEP-13
Date of sample collection [dd/mmm/yy]

Laboratory parameters

Laboratory parameters are the characteristics of water that are measured in a laboratory using the samples collected earlier in the field. Laboratory parameters include major ions, nutrients, bacteria, metals, and hydrocarbons. Analysis of major ions, select nutrients, and select metals was conducted in 2012 at the United States Geological Survey (USGS) National Research Laboratory in Boulder, Colorado. Analysis of bacteria, nutrients, metals, and hydrocarbons was conducted in 2012 and 2013 at a private laboratory (ALS) in Whitehorse and Vancouver.

Major ions

Ions are dissolved particles that have charge; anions are negatively charged ions whereas cations are positively charged ions. *Major* ions represent the vast majority of what is dissolved in water and include bicarbonate, sulphate and chloride (the major anions) and calcium, magnesium, sodium and potassium (the major cations).

All water samples contain ions, which typically come from natural sources. The rocks and soil around the Yukon River watershed naturally contain abundant anions (mostly bicarbonate) and cations (mostly calcium). When water (from rainfall, snowmelt or any other source) comes into contact with rocks and soil, reactions take place and ions dissolve into the water. We measure these ions to understand how the water is reacting with its environment, to assess the quality of the water and to monitor for possible sources of contamination.

Samples collected from KFN's traditional territory were only analyzed for major ions in 2012. No exceedances of the Canadian Guidelines for the Protection of Aquatic Life were found (Appendix B).

Nutrients

A nutrient is a chemical that an organism needs to live and grow. Nutrients are essential for life but too many of them can degrade habitat for aquatic life and pollute drinking water. Too many nutrients in the water can cause algae to grow excessively and lower the dissolved oxygen in the water, which can impact fish and other aquatic life. This is called eutrophication. Natural sources of nutrients include soils and decaying plant materials (fallen leaves, grass, etc.).

Sometimes nutrients dissolved in water come from human or animal wastes, fertilizers, or industrial wastewater.

There are three nitrogen-bearing nutrients that we analyzed in your water samples: nitrate, nitrate and ammonium. We also analyzed total phosphorus, orthophosphate, and dissolved organic carbon (commonly referred to as "DOC"). DOC is a measure of many organic molecules that are dissolved in water. No exceedances of the Canadian Guidelines for the Protection of Aquatic Life were found (Appendix B).

Bacteria

Samples were collected for analysis of total coliforms and Escherichia coli (E. coli). The term "total coliforms" refers to a group of rod-shaped bacterial species commonly found in water, in soil, and on vegetation. It is common for raw or untreated water samples to contain total coliforms. Total coliforms are analyzed in standard tests of drinking water because their presence indicates contamination of a water supply by an outside source. Total coliforms were detected in all of the samples analyzed for this parameter (Appendix B). The presence of total coliforms is not a threat to aquatic life or recreational water use; however, water containing total coliforms should not be used as drinking water without appropriate, prior treatment.

Fecal coliform bacteria are a subset of total coliform bacteria that are generally, but not necessarily, fecal in origin (i.e., related to excrement). E. coli is a species of fecal coliform bacteria that is specific to fecal material of warm-blooded animals, including humans. The presence of E. coli in water samples therefore indicates recent fecal contamination and the potential presence of microorganisms (viruses, protozoa, other bacteria) capable of causing illness. Most strains of E. coli are harmless but certain strains (such as E. coli O157:H7) are pathogenic (able to cause disease). E. coli was not detected in any of the samples analyzed for this parameter (Appendix B).

METALS

In both 2012 and 2013, we analyzed samples for a suite of 19 metals. The analysis was for “total metals”, which includes the metals content both dissolved in the water and present in the particulates suspended in the water. Analysis of select dissolved metals was also conducted in 2012. Metals dissolved and suspended in water are often naturally occurring; however, their concentration can be elevated by human-derived sources including mining, sewage effluent, landfill run-off, and industrial waste.

In 2012, the aluminum concentration in Lewis Creek was found to exceed the Canadian Guideline for the Protection of Aquatic Life (Figure 3). We were not able to collect a sample from Lewis Creek in 2013 because the creek was dry at the time of sample collection (September 2013). The aluminum concentration in the sample collected from Kluane Lake at Destruction Bay exceeded in 2013 but no metals sample was collected in 2012 (Figure 3). In 2013, the aluminum concentration in Copper Joe Creek exceeded the guideline. A sample for metals was not collected from Copper Joe Creek in 2012.

In 2012, the selenium concentrations in Quill Creek and Lewis Creek (measured at above and below sites) were found to exceed the Canadian Guideline for the Protection of Aquatic Life (Figure 4). In 2013, the selenium concentration in Quill Creek again exceeded the guideline (Figure 4). As mentioned above, we were not able to collect a sample from Lewis Creek in 2013 because the creek was dry at the time of sample collection (September 2013). The selenium concentration in the sample collected from Kluane Lake at Destruction Bay was below the laboratory detection limit in 2012 but was found to exceed the Canadian Guideline for the Protection of Aquatic Life in 2013 (Figure 4). In 2013, the selenium concentration in Copper Joe Creek exceeded the guideline (Figure 4).

Our 2012 sampling program showed no significant differences in aluminum or selenium concentrations at above and below sites for Quill Creek and Lewis Creek. This suggests no influence of the tailings pond or landfill on the water quality. Both aluminum and selenium are commonly found in surface water samples, because they tend to dissolve in water that is in contact with rocks and soils that naturally contain these two elements. Continued monitoring of these sites is recommended to better understand the natural variation of aluminum and selenium in the region.

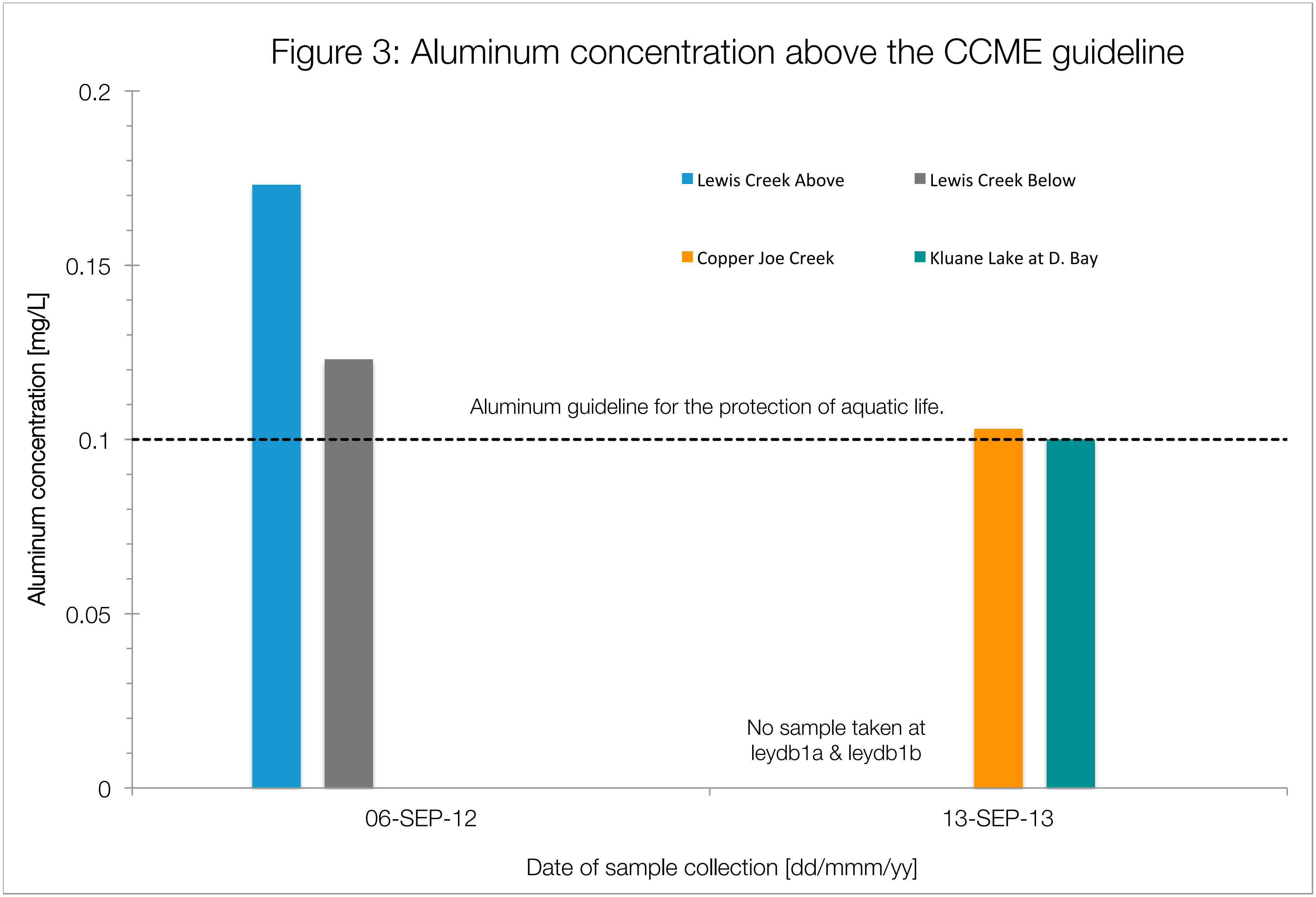


Figure 3: Aluminum concentration above the CCME guideline
0.2
0.15
0.1
0.05
0
Aluminum concentration [mg/L]
Lewis Creek Above
Lewis Creek Below
Copper Joe Creek
Kluane Lake at D. Bay
Aluminum guideline for the protection of aquatic life.
No sample taken at
leydb1a & leydb1b
06-SEP-12
13-SEP-13
Date of sample collection [dd/mmm/yy]

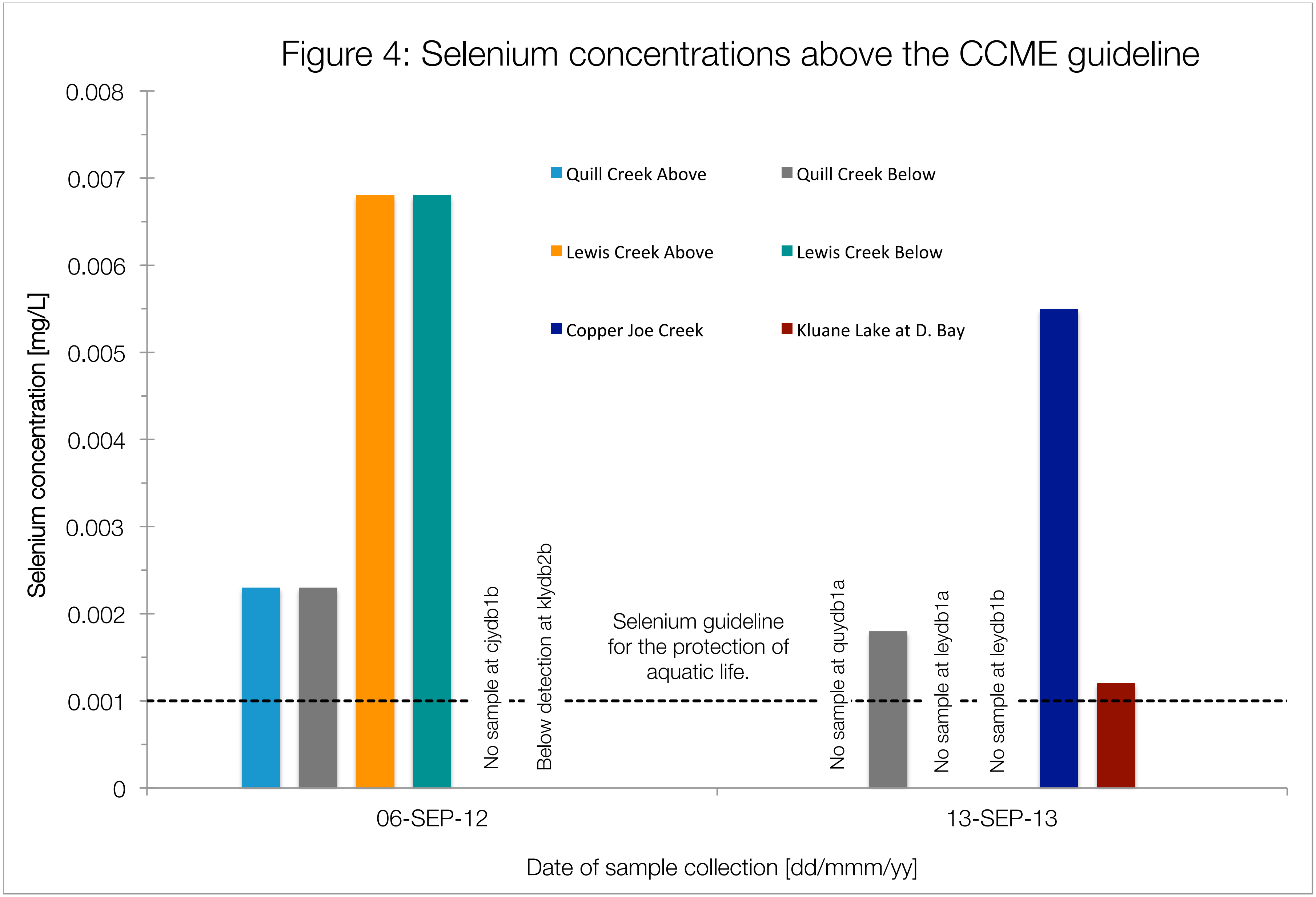


Figure 4: Selenium concentrations above the CCME guideline
Selenium concentration [mg/L]
0.008
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0
Quill Creek Above
Quill Creek Below
Lewis Creek Above
Lewis Creek Below
Copper Joe Creek
Kluane Lake at D. Bay
No sample at cjydb1b
Below detection at klydb2b
Selenium guideline for the protection of aquatic life.
No sample at quydb1a
No sample at leydb1a
No sample at leydb1b
06-SEP-12
13-SEP-13
Date of sample collection [dd/mmm/yy]

Petroleum hydrocarbons

Petroleum is a complex mixture of many organic compounds consisting entirely of hydrogen and carbon, known as hydrocarbons. Some petroleum hydrocarbon (PHC) compounds have been shown to have greater toxicity than others. In both 2012 and 2013, we analyzed samples for two groups of discrete PHC compounds:

1. Volatile organic compounds (including benzene, toluene, ethylbenzene, xylene and styrene; collectively referred to as "BTEX + styrene"), and
2. Polycyclic aromatic hydrocarbons (PAH).

Similarly, we analyzed samples for five groups representing the summation of all PHC compounds within a certain carbon range:

1. Volatile hydrocarbons (VH),
2. Volatile petroleum hydrocarbons (VPH),
3. Extractable petroleum hydrocarbons (EPH),
4. Light extractable petroleum hydrocarbons (LEPH), and
5. Heavy petroleum hydrocarbons (HEPH).

None of the PHC compounds analyzed in 2012 or 2013 was found to exceed the minimum detection limits of the laboratory (ALS; Appendix B).

Intergenerational dialogue

Background

During the first year of our project, we conducted focus groups and interviews to elicit concerns regarding the impacts of contaminants and climate change on water and public health with Elders and concerned citizens from the participating First Nations. These participants identified many climatic and non-climatic changes, many of which are impacting livelihoods. Participants also identified the need to engage with youth to find ways to mitigate or adapt to the impacts these changes are having on their communities. So in the second year of this project, we facilitated an intergenerational dialogue related to climate change between youth and Elders from the five participating First Nations.

The purpose of this dialogue was to create a platform for sharing intergenerational Traditional Knowledge (TK) regarding contaminants and climate change. Traditional knowledge has been defined as "a cumulative body of knowledge and beliefs handed down through generations by cultural transmission, about the relationship of living begins (including humans) with one another and with their environment" (Berkes 2008: 7). The sharing of TK is essential to the formation of mitigation and adaptation strategies and has been identified as a priority by our First Nations partners.

To help facilitate shared learning about TK between youth and Elders we developed a three-part workshop, which we ran with each of the five First Nations. First Nation Lands and Resources managers identified youth interns that assisted with workshop development and execution in each of the First Nations. Youth interns worked with YRITWC staff and Lands and Resource managers to recruit workshop participants, resulting in a total of 61 individuals participating in the five workshops. Workshops included the following three components: youth PhotoVoice activity, intergenerational knowledge sharing, and youth interviews.

Workshop description

YOUTH PHOTOVOICE ACTIVITY

The workshop began by engaging the youth in a PhotoVoice activity. PhotoVoice is a method of sharing ideas through a combination of photographs and written descriptions. Photography provides a unique opportunity for individual expression and when paired with a narrative explanation can give a glimpse into someone else's view of the world. It is a way to share experiences and communicate thoughts. Beginning two weeks prior to the workshop date, cameras were made available at KFN's Lands office and our intern contacted youth workshop participants to help explain the PhotoVoice activity. As part of the activity, youth were asked to bring 3-5 digital photos representing how the effects of climate change have impacted the health of their community. In advance of the workshop, youth were asked to write a brief narrative explaining the significance of each photo. To help in creating their narrative, youth were asked to consider questions like:

- What makes up your community?
- What kinds of environmental changes have you seen in your community?
- How have these changes affected your way of life?
- What do you think of when you hear the words "Climate Change"?

At the workshop, the digital photos taken by the youth were uploaded onto a laptop and projected using an LCD projector. The youth participants took turns discussing their photos and associated narratives. In an effort to capture the significance of the photos, the youth worked together to develop a short caption summarizing what the photo means to them. The YRITWC staff created a PowerPoint presentation of the photos and captions. A collection of these photos and captions were also made into a custom-made calendar for each participating First Nation.

INTERGENERATIONAL KNOWLEDGE-SHARING

During the second part of the workshop, we brought together Elders, youth and other interested community members for a luncheon to discuss strategies for addressing environmental and public health concerns. In an effort to build on the relationships and TK established in during year 1 of this project, we invited the same Elders to participate in the 2013 luncheons. During the luncheon, Elders talked to youth about their concerns regarding the environment and the impacts climate change has had on their community. Youth then presented the PowerPoint presentation of their PhotoVoice activity to the Elders. Elders and youth then engaged in a guided-discussion facilitated by YRITWC staff related to the changes seen and potential strategies for adapting to them. Through this discussion, the participants were asked to help complete a table that contained the following questions by writing answers on sticky notes and sticking the notes to hanging flip chart paper:

- How does this change affect you?
- How do you know the change is happening?
- In what ways can the community adapt to the change now?
- How about in the future?
- Who needs to be involved?
- What timeline should be followed?

At the end of the workshop, the flip chart papers were collected. An example of raw data generated through this exercise can be seen in Figure 5. YRITWC staff recorded a summary of the ideas and strategies discussed.

Figure 5: Example of data generation methodology at KFN workshop

YOUTH INTERVIEWS

To provide youth with an opportunity to share additional thoughts, we asked them to participate in videotaped interviews on a voluntary basis. Unfortunately, no youth volunteered.

Kluane First Nation's workshop

The Kluane First Nation's workshop was held on October 30, 2013 from 9:30 AM – 4:00 PM at Jacquot Hall in Burwash Landing, Yukon. A total of 11 individuals participated in this workshop and included four youth, five Elders, one community member and one observer. The four youth participated in the PhotoVoice activity and produced a PowerPoint presentation that highlights the impacts climate change has had on their community through photos and associated narratives. These photos and narratives can be found in an accompanying calendar or by contacting the YRITWC. No names are associated with the quotes as directed by KFN's Draft Traditional Knowledge Policy. Raw data collected during this project are available at KFN's Heritage Department.

As part of our analysis, we compiled the data generated through the workshop and were able to organize the data into the following four themes: Permafrost Degradation, Weather Variability, Wildlife, and Changing Hydrology. What follows is a summary of the discussion participants had related to these four themes.

PERMAFROST DEGRADATION

Workshop participants noted that degrading permafrost impacts many things including the structural integrity of buildings, the life of road systems, and food security due to loss of root cellars. Below is a summary of how workshop participants see climate change affecting permafrost in their community:

- Permafrost melt is causing buildings to shift suddenly. Until the 1960s they built houses directly on the ground with no shifty or sinking issues. Now there is a lot of movement.
- Climate change is causing forest fires to come through and melt permafrost, which creates more water.
- We need to educate engineers on how to manage/take care of permafrost to preserve it better...It's melting!

- Because of permafrost melting there is the slumping of heritage sites like graveyards.
- Melting permafrost has economic impacts. New buildings are not built right and in one year they are damaged.
- We would like to look at road systems that are built well to learn from them. Permafrost causes a lot of damage to our highways.
- It is no longer possible to have a root cellar or basement in this community because of permafrost disappearing. How do we get off the grid if we cannot use permafrost as a fridge?

WEATHER VARIABILITY

Another theme that emerged through the workshop was regarding increased weather variability as a result of climate change. Participants discussed changes in weather have created increased winds at cold temperatures, delayed and shortened winters, increased berry availability, more interest and opportunity for renewable energy. Below is a summary of how participants see climate change affecting weather in their community:

- The weather is less predictable: *"Unpredictable, bad weather brought waves right up to our house. That has never happened before!"*
- *"There should be snow for Halloween. Never in my lifetime have I experienced Halloween without snow here!"* In response, one Elder states, *"In 1964 there was no snow. We had to put dirt on traps instead of snow."*
- You used to be able to drive a truck across the lake at the end of September. Now there is no way it happens before December.
- Last year was the earliest it froze here.
- We have constant wind now. We never used to have wind when it was below 20 degrees.
- KFN is using renewable energy—mostly solar and geothermal, but wind soon, we hope! More renewable energy would be great. We need meetings and education on it.
- As temperature warms maybe water turbines would be a good fit for Burwash Landing. They were deemed not good for here about 20 years ago, but now, with more water and warmer temperatures, it could work! Let's research it again!
- There are two geothermal wells dug for a future greenhouse.
- Because there has not been any frost this year the berries are still around.

WILDLIFE

Kluane First Nation has observed impacts of climate change on wildlife. Workshop participants noted a wide range of impacts including: changes in migration patterns, decreased availability of some wildlife species for harvest and trapping, and increased spread of invasive species and wildlife-borne disease. According to workshop participants, climate change has had the following impacts on wildlife species:

- Swans are here later than they used to. Swans reside by Spring Creek.
- Frogs around Reed Creek. Their habitat has shifted locations.
- Fish do not spawn where they used to. We used to fish for whitefish during the first week of September. Now the whitefish do not come until October. People live on fish—trout in particular. Before you could get 200 fish now they only get one in Longs Creek.
- There are no grayling in Sweet Johnson because of beaver dams.
- There is an invasive grass that has taken over the old grass that used to exist here and was prime habitat for gopher. *"We are Gopher People. We use gopher for food and their skins for blankets. You need 96 gophers for a blanket."* With the invasive grass, gopher habitat has become very poor and their population has decreased in the area. Because of too much water (with glacial and permafrost melt), the sage is dying off. Sage is gopher food! A decrease in gopher causes a decrease it trapping. Trapping is a way of life and a long tradition here. With fewer habitats for good trapping they have to walk farther to find good trapping conditions. Elders cannot walk that far and the youth do not seem to be very interested in helping or learning. They transplanted 40 gopher, but it did not work, they all died. Reports were conducted on what is affecting them.
- If it is not cold an animal does not grow a pelt that is worth trapping for. The best trapping is after a long cold spell.
- Government has sprayed invasive species seeds all over the place. Youth tried to harvest local seeds by hand and reseed them, but it was just too labour intensive (attempted adaptation). How do we kill invasive species? One Elder says, mow them three times a year so that they cannot flower. Invasive species are moving from the highway to the bush.
- Rabbit populations are depleted but populations are slowly increasing. Gopher and rabbit are keystone species. Their presence affects bears because bears eat them.
- Now the farther south you go the later the rut. It used to happen all at once.

- Hundreds of thousands of caribou used to pass through here and with them came wolves. Caribou populations have decreased. Some of the Elders know what ritual needs to occur to bring the caribou back. We can do ceremonies to bring them back. Less caribou has resulted in a change in harvesting practices for the local people. Now they hunt moose and deer are beginning to come in. People eat deer now. But, with deer comes ticks and ticks affect other local animals like moose. Change in culture and hunting practice: now people do not spend a month at a time living in the mountains surviving off of caribou.
- Now bison are here. We need education on how to hunt and eat bison. Yellow fat on a moose is bad but yellow fat on a bison is fine/good. Elders will not eat bison. *"Everyone's preference is always to fall back on what you're familiar with."* There are health problems because people are switching away from wild game to processed food.
- There is a fear of rabies from bats coming in.

CHANGING HYDROLOGY

Workshop participants noted changing hydrology as a result of climate change which has impacted water systems, increased water levels and exposed cultural resources that were previously unknown. Below is a summary of how climate change has affected the hydrology of KFN's traditional territory from workshop participants' perspectives:

- Water may have been the highest ever here. Dock was destroyed.
- More creeks than there used to be because of glacial melt.
- Kluane River has more channels than ever before and it is also more dynamic.
- Water rose and washed away road. It came swiftly. Soon it will take away the graveyard. We should move the graveyard or put in bank enforcement.
- We have begun studying the depth of the lake more.
- Glacial silt = change in habitat.
- There is more silt build up than there used to be. At Sheep Mountain there is an island that is no longer an island in the spring because of the silt.
- *"Grease offends glaciers...don't fry bacon near a glacier."* According to traditional knowledge, customs should be observed and respected.
- With melting glaciers artefacts are being exposed and a dam is prohibited in the area because of the presence of artefacts. With artefacts present, increasing amounts of people are coming into the community to search for them. There needs to be a better method for locals to know that these people are coming in and where they will be digging? Locals complain that they find people digging

around in their back yard. Most visitors check in with KFN but the word does not get around to the rest of the community.

- With increasing water in the area the sage is dying off. *"Sage used to be used for our ceremonies and now it's disappearing."* Sage is also important gopher food.

In an effort to better summarize the data generated through the workshop, we further condensed the data into observations, impacts and adaptations associated with each of the four themes listed above as seen in Table 2.

In addition to comments made in the summaries above, workshop participants also noted:

- We recognize that it is an issue so we've been inspired to pursue renewable energy, we do not burn trash any more, and we are having discussions like this.
- We have international support now. Almost everyone believes in climate change.
- Elders can help us understand the changes that are occurring by giving us perspective: *"It used to be that way…now it is this way."*
- We can dig holes easier now and we get tans!

Table 2: Summary of climate change impacts seen by KFN workshop participants

	Permafrost Degradation	**Weather Variability**	**Wildlife**	**Changing hydrology**
Observation	• Slumping • Damage to buildings, roads & graves	• Increased temperatures variability • Thick ice forming later • Changing wind conditions	• Decrease in gophers • Increase in invasive species such as deer • Arrival of ticks and maybe rabies • Changing fish migration patterns	• Melting glaciers depositing more silt • Record high water levels
Impacts	• Emotional / spiritual-health affected by disturbances to graves • Safety concerns driving on the highway		• Loss of traditional hunting & trapping practices • Loss of knowledge for youth • Less nutrition from the land	• Exposure of artifacts • Road washouts • More glacial silt changing landforms and altering habitat
Adaptations	• Building on jacks & silts • Relocating graveyards • More consultation with Elders re: road construction • More participation in meetings	• Building of greenhouses	• Transfer and relocate gophers • Setting nets later • Start eating deer • Training re: hunting new species • Using traditional laws; invoking rituals	• Revisit potential micro-hydro projects • Collect, record, share stories re: glaciers

Next steps

The YRITWC developed and submitted a proposal for a third project through Health Canada's "Climate Change and Health Adaptation Program for Northern First Nations and Inuit Communities." We recently received notice from Health Canada that the project will be awarded funding!

The proposed third project is titled, "First Nation Climate Change Policy: a regional, Indigenous approach to climate change adaptation, health and water governance." The proposal included letters of support from KFN and the other four First Nations (White River, Tr'ondëk Hwëch'in, Selkirk, and Carcross/Tagish) that have been working closely with the YRITWC. The proposed project will build on the two years of work the YRITWC and these First Nations have successfully completed. The primary objective of the project is to facilitate the development of a Water Action Plan outlining how First Nations and their traditional knowledge can take action to address their concerns regarding the impacts of climate change and contaminants on water and health, and

The proposed project would involve the YRITWC co-developing and hosting a workshop to unite these five First Nations to develop a Water Action Plan based on their concerns about the impacts of contaminants and climate change on water and health in their traditional territories. The action plan will address the need to implement the YRITWC's "Yukon River Watershed Plan" (which was approved at YRITWC's summit in Mayo in August 2013) and articulate the role of First Nations in the Yukon Government's "Yukon Water Strategy."

References

Canadian Council of Ministers of the Environment (CCME), 1987. Water Quality Guidelines for the Protection of Aquatic Life. Accessed online (http://st-ts.ccme.ca/): January 2014.

Berkes, Fikret. 2008. Sacred Ecology. Routledge.

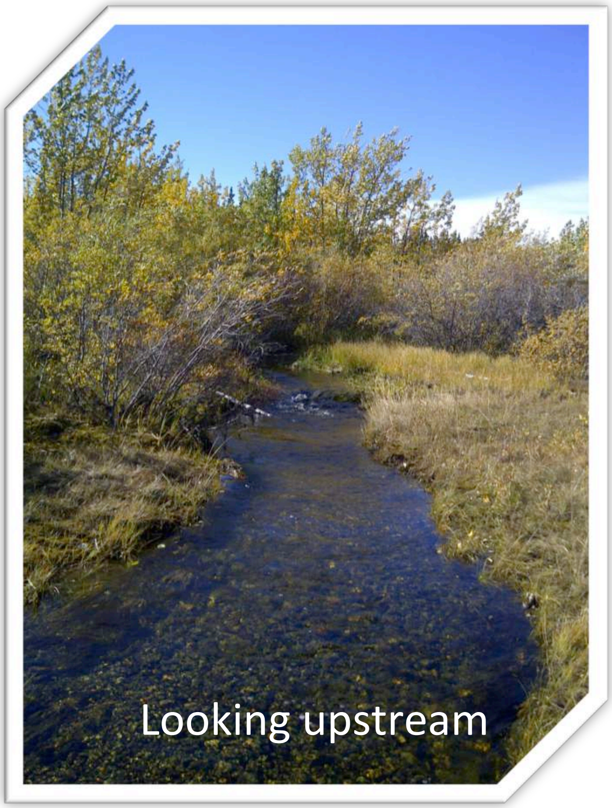
Appendix A: Site descriptions

Traditional territory:	KFN
Water body:	Copper Joe Creek
Site name:	cjydb1b
Coordinates:	N. 61.31615° W. 138.93268°
Contaminants of concern:	Bacteria from sewage lagoon
Date sampled:	Sept. 13, 2013

Looking upstream

Looking downstream

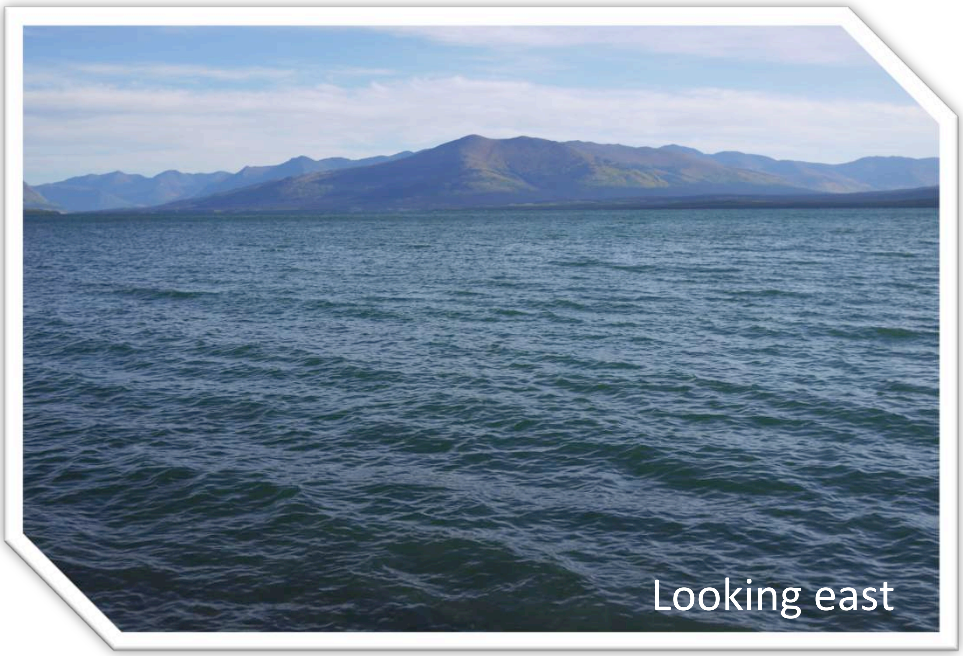
Traditional territory:	KFN
Water body:	Kluane Lake at Burwash Landing
Site name:	klydb1b
Coordinates:	N. 61.35848° W. 138.99815°
Contaminants of concern:	Hydrocarbons from fuel spills
Date sampled:	Sept. 12, 2013



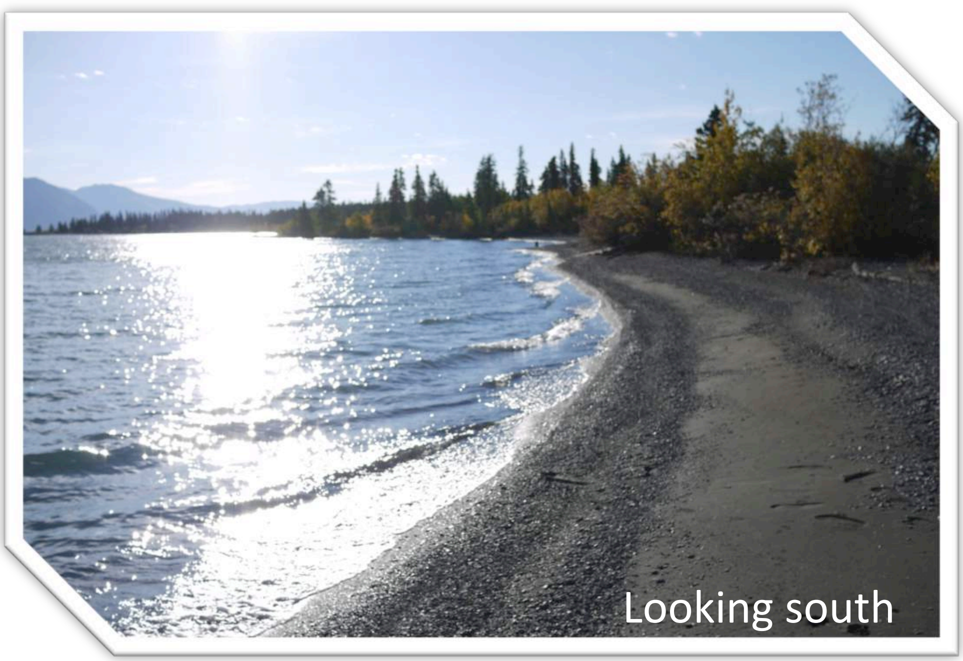
Looking upstream

Looking downstream

Traditional territory:	KFN
Water body:	Kluane Lake at Destruction Bay
Site name:	klydb2b
Coordinates:	N. 61.25430° W. 138.80063°
Contaminants of concern:	Bacteria from septic field
Date sampled:	Sept. 13, 2013



Looking east



Looking south

Traditional territory:	KFN
Water body:	Quill Creek
Site name:	quydb1b
Coordinates:	N. 61.51938° W. 139.32501°
Contaminants of concern:	Metals from mining activity
Date sampled:	Sept. 12, 2013

Appendix B: Water quality data

RESULTS OF ANALYSIS Legend: *Exceeds Guideline* | - *Not analyzed* | "<x" or "n.d." *Below detection level*

Sample ID	**CCME**	quydb1a	quydb1b		klydb1b		leydb1a	leydb1b	cjydb1a	cjydb1b		klydb2b	
Date Sampled	*Water Quality*	05-SEP-12	05-SEP-12	12-SEP-13	05-SEP-12	12-SEP-13	06-SEP-12	06-SEP-12	06-SEP-12	06-SEP-12	13-SEP-13	06-SEP-12	13-SEP-13
Time Sampled	*Guidelines*	10:39	11:27	12:15	13:50	13:30	16:22	17:40	14:30	15:10	10:30	19:00	09:55
ALS Sample ID	*for the Protection*	L1206044-1	L1206044-2	L1362851-6	L1206044-3	L1362851-7	L1206044-4	L1206044-5	L1206044-6	L1206044-7	L1362851-8	L1206044-8	L1362851-9
Matrix	*of Aquatic Life*	Water	Water	Water	Water	Water	Water	Water	Water	Water	Water	Water	Water
Field Parameters													
pH	6.5 - 9.0	8.24	8.35	8.41	8.16	8.09	8.53	8.52	8.52	8.58	8.55	7.99	7.48
Water temperature		5.2	5.9	6.83	8.2	6.74	9.0	9.0	6.2	7.2	3.48	10.0	8.72
Dissolved oxygen	6.5, 9.5	13.77	13.81	9.71	12.28	9.44	13.21	13.39	14.25	14.08	-	12.63	9.96
Specific conductance		282.9	288.1	253	246.2	197	600	607	705	702	425	420.1	363
Physical Tests													
Hardness (as CaCO3)		265	263	-	-	-	342	341	-	-	-	-	-
Hardness (as CaCO3)		v		273	211.03	207	-	-	-	380.83	388	186.63	197
Major Ions													
Alkalinity		-	201.0	-	221.1	-	-	176.8	-	268.5	-	155.9	-
Chloride (Cl)	640	-	0.7	-	1.4	-	-	1.4	-	0.6	-	1.7	-
Sulphate (SO4)		-	85.2	-	21.4	-	-	185.9	-	162.8	-	71.4	-
Calcium (Ca)		-	64.6	-	55.1	-	-	69.1	-	76.9	-	49.4	-
Magnesium (Mg)		-	18.8	-	17.9	-	-	35.4	-	45.8	-	15.4	-
Sodium (Na)		-	4.3	-	3.0	-	-	8.9	-	16.4	-	4.0	-
Potassium (K)		-	0.6	-	0.6	-	-	0.8	-	1.4	-	1.8	-
Nutrients													
Dissolved Organic Carbon (DOC)		-	5.57	-	26.39	5.57	-	1.45	-	2.30	26.39	2.02	-
Ammonium (NH4)		-	0.4	-	0.4	0.4	-	0.3	-	0.0	0.4	0.5	-
Nitrate and Nitrite (as N)		-	-	-	-	-	0.0898	0.0849	0.145	0.139	0.131	0.0782	<0.0051
Nitrate (as N)	13	-	-	-	-	-	0.0898	0.0849	0.145	0.139	0.131	0.0782	<0.0050
Nitrite (as N)	0.06	-	-	-	-	-	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Orthophosphate-Dissolved (as P)		-	-	-	-	-	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Phosphorus (P)-Total	Guidance framework	-	-	-	-	-	0.0027	0.0039	0.0040	0.0052	0.0145	0.0044	0.0069
Bacteriological Tests													
E. coli		-	-	-	-	-	<1	<1	<1	<1	<1	<1	<1
Coliform Bacteria - Total		-	-	-	-	-	20	18	11	25	7	4	6

RESULTS OF ANALYSIS Legend: *Exceeds Guideline* (shaded cells) | - *Not analyzed* | "<x" or "n.d." *Below detection level*

Sample ID	CCME	quydb1a	quydb1b		klydb1b		leydb1a	leydb1b	cjydb1a	cjydb1b		klydb2b	
Date Sampled	*Water Quality*	05-SEP-12	05-SEP-12	12-SEP-13	05-SEP-12	12-SEP-13	06-SEP-12	06-SEP-12	06-SEP-12	06-SEP-12	13-SEP-13	06-SEP-12	13-SEP-13
Time Sampled	*Guidelines*	10:39	11:27	12:15	13:50	13:30	16:22	17:40	14:30	15:10	10:30	19:00	09:55
ALS Sample ID	*for the Protection*	L1206044-1	L1206044-2	L1362851-6	L1206044-3	L1362851-7	L1206044-4	L1206044-5	L1206044-6	L1206044-7	L1362851-8	L1206044-8	L1362851-9
Matrix	*of Aquatic Life*	Water	Water	Water	Water	Water	Water	Water	Water	Water	Water	Water	Water
Total Metals													
Aluminum (Al)-Total	Fxn of pH	0.077	0.085	0.015	-	<0.010	0.173	0.123	-	-	0.103	-	0.100
Antimony (Sb)-Total		<0.00050	<0.00050	<0.00050	-	<0.00050	<0.00050	<0.00050	-	-	<0.00050	-	<0.00050
Arsenic (As)-Total	0.005	0.00076	0.00075	0.00069	-	0.00050	0.00060	0.00067	-	-	0.00048	-	0.00054
Barium (Ba)-Total		0.049	0.049	0.051	-	0.021	0.041	0.040	-	-	0.053	-	0.030
Boron (B)-Total	1.5	0.16	0.16	0.14	-	0.14	0.14	0.15	-	-	0.13	-	0.11
Cadmium (Cd)-Total	Fxn of hardness	<0.00020	<0.00020	<0.00020	-	<0.00020	<0.00020	<0.00020	-	-	<0.00020	-	<0.00020
Calcium (Ca)-Total		76.3	75.7	79.3	-	54.7	80.2	79.8	-	-	83.0	-	54.8
Chromium (Cr)-Total		<0.0020	<0.0020	<0.0020	-	<0.0020	<0.0020	<0.0020	-	-	<0.0020	-	<0.0020
Copper (Cu)-Total	Fxn of hardness	0.0035	0.0036	0.0028	-	<0.0010	0.0015	0.0013	-	-	0.0012	-	0.0011
Iron (Fe)-Total	0.3	0.165	0.168	0.052	-	0.040	0.281	0.188	-	-	0.158	-	0.157
Lead (Pb)-Total	Fxn of hardness	<0.00050	<0.00050	<0.00050	-	<0.00050	<0.00050	<0.00050	-	-	<0.00050	-	<0.00050
Magnesium (Mg)-Total		18.2	17.9	18.2	-	17.0	34.5	34.4	-	-	43.9	-	14.5
Manganese (Mn)-Total		0.0174	0.0162	0.0152	-	0.0110	0.0101	0.0080	-	-	0.0048	-	0.0088
Mercury (Hg)-Total	0.026	<0.00020	<0.00020	<0.00020	-	<0.00020	<0.00020	<0.00020	-	-	<0.00020	-	<0.00020
Potassium (K)-Total		0.85	0.88	1.05	-	0.67	1.03	1.06	-	-	1.75	-	2.49
Selenium (Se)-Total	0.001	0.0023	0.0023	0.0018	-	<0.0010	0.0068	0.0068	-	-	0.0055	-	0.0012
Sodium (Na)-Total		4.8	4.8	4.9	-	7.6	9.5	9.4	-	-	16.4	-	4.8
Uranium (U)-Total	0.015	0.00024	0.00023	0.00029	-	0.00015	0.00047	0.00046	-	-	0.00075	-	0.00083
Zinc (Zn)-Total	0.03	<0.050	<0.050	<0.050	-	<0.050	<0.050	<0.050	-	-	<0.050	-	<0.050

RESULTS OF ANALYSIS Legend: (shaded) *Exceeds Guideline* | - *Not analyzed* | "<x" or "n.d." *Below detection level*

Sample ID	CCME	quydb1a	quydb1b		klydb1b		leydb1a	leydb1b	cjydb1a	cjydb1b		klydb2b	
Date Sampled	*Water Quality*	05-SEP-12	05-SEP-12	12-SEP-13	05-SEP-12	12-SEP-13	06-SEP-12	06-SEP-12	06-SEP-12	06-SEP-12	13-SEP-13	06-SEP-12	13-SEP-13
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ALS Sample ID	*for the Protection*	L1206044-1	L1206044-2	L1362851-6	L1206044-3	L1362851-7	L1206044-4	L1206044-5	L1206044-6	L1206044-7	L1362851-8	L1206044-8	L1362851-9
Matrix	*of Aquatic Life*	Water	Water	Water	Water	Water	Water	Water	Water	Water	Water	Water	Water
Dissolved Metals													
Dissolved Metals Filtration Location		-	FIELD	-	FIELD	-	-	FIELD	-	FIELD	-	FIELD	-
Aluminum (Al)-Dissolved	Fxn of pH	-	0.0050	-	0.0072	-	-	0.0047	-	0.0035	-	0.0050	-
Antimony (Sb)-Dissolved		-	-	-	-	-	-	-	-	-	-	-	-
Arsenic (As)-Dissolved	0.005	-	-	-	-	-	-	-	-	-	-	-	-
Barium (Ba)-Dissolved		-	0.0456	-	0.0213	-	-	0.0543	-	0.0492	-	0.0297	-
Boron (B)-Dissolved	1.5	-	-	-	-	-	-	-	-	-	-	-	-
Cadmium (Cd)-Dissolved	Fxn of hardness	-	-	-	-	-	-	-	-	-	-	-	-
Calcium (Ca)-Dissolved		-	64.6	-	55.1	-	-	69.1	-	76.9	-	49.4	-
Chromium (Cr)-Dissolved		-	-	-	-	-	-	-	-	-	-	-	-
Copper (Cu)-Dissolved	Fxn of hardness	-	0.0035	-	n.d.	-	-	0.0024	-	0.0023	-	n.d.	-
Iron (Fe)-Dissolved	0.3	-	0.018	-	0.148	-	-	0.004	-	0.014	-	0.027	-
Lead (Pb)-Dissolved	Fxn of hardness	-	-	-	-	-	-	-	-	-	-	-	-
Magnesium (Mg)-Dissolved		-	18.8	-	17.9	-	-	35.4	-	45.8	-	15.4	-
Manganese (Mn)-Dissolved		-	0.0124	-	0.0085	-	-	0.0040	-	0.0007	-	0.0034	-
Mercury (Hg)-Dissolved	0.026	-	-	-	-	-	-	-	-	-	-	-	-
Nickel (Ni)-Dissolved	Fxn of hardness	-	0.0040	-	0.0032	-	-	0.0003	-	n.d.	-	n.d.	-
Potassium (K)-Dissolved		-	0.6	-	0.6	-	-	0.8	-	1.4	-	1.8	-
Selenium (Se)-Dissolved	0.001	-	-	-	-	-	-	-	-	-	-	-	-
Sodium (Na)-Dissolved		-	4.3	-	3.0	-	-	8.9	-	16.4	-	4.0	-
Uranium (U)-Dissolved	0.015	-	-	-	-	-	-	-	-	-	-	-	-
Zinc (Zn)-Dissolved	0.03	-	0.017	-	0.019	-	-	0.016	-	0.016	-	0.017	-
Volatile Organic Compounds													
Benzene		-	-	-	<0.00050	<0.00050	<0.00050	<0.00050	-	-	-	-	-
Ethylbenzene		-	-	-	<0.00050	<0.00050	<0.00050	<0.00050	-	-	-	-	-
Methyl t-butyl ether (MTBE)		-	-	-	<0.00050	<0.00050	<0.00050	<0.00050	-	-	-	-	-
Styrene		-	-	-	<0.00050	<0.00050	<0.00050	<0.00050	-	-	-	-	-
Toluene		-	-	-	<0.00050	<0.00050	<0.00050	<0.00050	-	-	-	-	-
ortho-Xylene		-	-	-	<0.00050	<0.00050	<0.00050	<0.00050	-	-	-	-	-
meta- & para-Xylene		-	-	-	<0.00050	<0.00050	<0.00050	<0.00050	-	-	-	-	-
Xylenes		-	-	-	<0.00075	<0.00075	<0.00075	<0.00075	-	-	-	-	-
Surrogate: 4-Bromofluorobenzene (SS)		-	-	-	84.4	96.6	84.9	84.4	-	-	-	-	-
Surrogate: 1,4-Difluorobenzene (SS)		-	-	-	85.0	100.3	84.4	84.7	-	-	-	-	-

RESULTS OF ANALYSIS	Legend:		*Exceeds Guideline*	-	*Not analyzed*	"<x" or "n.d."	*Below detection level*

Sample ID	**CCME**	quydb1a	quydb1b		klydb1b		leydb1a	leydb1b	cjydb1a	cjydb1b		klydb2b	
Date Sampled	*Water Quality*	05-SEP-12	05-SEP-12	12-SEP-13	05-SEP-12	12-SEP-13	06-SEP-12	06-SEP-12	06-SEP-12	06-SEP-12	13-SEP-13	06-SEP-12	13-SEP-13
Time Sampled	*Guidelines*	10:39	11:27	12:15	13:50	13:30	16:22	17:40	14:30	15:10	10:30	19:00	09:55
ALS Sample ID	*for the Protection*	L1206044-1	L1206044-2	L1362851-6	L1206044-3	L1362851-7	L1206044-4	L1206044-5	L1206044-6	L1206044-7	L1362851-8	L1206044-8	L1362851-9
Matrix	*of Aquatic Life*	Water	Water	Water	Water	Water	Water	Water	Water	Water	Water	Water	Water
Hydrocarbons													
EPH10-19		-	-	-	<0.25	<0.25	<0.25	<0.25	-	-	-	-	-
EPH19-32		-	-	-	<0.25	<0.25	<0.25	<0.25	-	-	-	-	-
LEPH		-	-	-	<0.25	<0.25	<0.25	<0.25	-	-	-	-	-
HEPH		-	-	-	<0.25	<0.25	<0.25	<0.25	-	-	-	-	-
Volatile Hydrocarbons (VH6-10)		-	-	-	<0.10	<0.10	<0.10	<0.10	-	-	-	-	-
VPH (C6-C10)		-	-	-	<0.10	<0.10	<0.10	<0.10	-	-	-	-	-
Surrogate: 3,4-Dichlorotoluene (SS)		-	-	-	68.7	88.0	68.3	90.7	-	-	-	-	-
Polycyclic Aromatic Hydrocarbons													
Acenaphthene		-	-	-	<0.000050	<0.000050	<0.000050	<0.000050	-	-	-	-	-
Acenaphthylene		-	-	-	<0.000050	<0.000050	<0.000050	<0.000050	-	-	-	-	-
Acridine		-	-	-	<0.000050	<0.000050	<0.000050	<0.000050	-	-	-	-	-
Anthracene		-	-	-	<0.000050	<0.000050	<0.000050	<0.000050	-	-	-	-	-
Benz(a)anthracene		-	-	-	<0.000050	<0.000050	<0.000050	<0.000050	-	-	-	-	-
Benzo(a)pyrene		-	-	-	<0.000010	<0.000010	<0.000010	<0.000010	-	-	-	-	-
Benzo(b)fluoranthene		-	-	-	<0.000050	<0.000050	<0.000050	<0.000050	-	-	-	-	-
Benzo(g,h,i)perylene		-	-	-	<0.000050	<0.000050	<0.000050	<0.000050	-	-	-	-	-
Benzo(k)fluoranthene		-	-	-	<0.000050	<0.000050	<0.000050	<0.000050	-	-	-	-	-
Chrysene		-	-	-	<0.000050	<0.000050	<0.000050	<0.000050	-	-	-	-	-
Dibenz(a,h)anthracene		-	-	-	<0.000050	<0.000050	<0.000050	<0.000050	-	-	-	-	-
Fluoranthene		-	-	-	<0.000050	<0.000050	<0.000050	<0.000050	-	-	-	-	-
Fluorene		-	-	-	<0.000050	<0.000050	<0.000050	<0.000050	-	-	-	-	-
Indeno(1,2,3-c,d)pyrene		-	-	-	<0.000050	<0.000050	<0.000050	<0.000050	-	-	-	-	-
Naphthalene		-	-	-	<0.000050	<0.000050	<0.000050	<0.000050	-	-	-	-	-
Phenanthrene		-	-	-	<0.000050	<0.000050	<0.000050	<0.000050	-	-	-	-	-
Pyrene		-	-	-	<0.000050	<0.000050	<0.000050	<0.000050	-	-	-	-	-
Quinoline		-	-	-	<0.000050	<0.000050	<0.000050	<0.000050	-	-	-	-	-
Surrogate: Acenaphthene d10		-	-	-	98.6	74.5	99.1	95.9	-	-	-	-	-
Surrogate: Acridine d9		-	-	-	102.7	80.9	102.8	97.0	-	-	-	-	-
Surrogate: Chrysene d12		-	-	-	99.1	73.9	97.5	94.6	-	-	-	-	-
Surrogate: Naphthalene d8		-	-	-	97.2	72.9	98.6	95.4	-	-	-	-	-
Surrogate: Phenanthrene d10		-	-	-	103.6	73.4	102.2	97.4	-	-	-	-	-