



Five year Technical Review of the  
NWT-wide Community Based  
Water Quality Monitoring Program  
[Plain Language Summary](#)



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If you would like this information in another official language, call us.

English

Si vous voulez ces informations dans une autre langue officielle, contactez-nous.

French

Kīspin ki nitawihitīn ē nīhīyawihk ōma ācimōwin, tipwāsīnān.

Cree

Tłıchq yatı k'è è . Dı wegodi newq dè, gots'ó gone de.

Tłıchq

ʔerihł'ís Dēne Sų́nė yatı t'a huts'elkēr xa beyáyatı theᓯᓯ ᓯat'e, nuwe ts'ēn yóftı.

Chipewyan

Edı gondı dehghá got'ıe zhatıé k'é é edat'éh enahddhę nıde naxets'é edahlı.

South Slavey

K'áhshó got'ı ne xədə k'é hederı ᓯedıhtı'é yerıniwę ní dé dúle.

North Slavey

Jii gwandak izhii ginjik vat'atr'ijāhch'uu zhit yinothn jı', diits'at ginohkhiı.

Gwich'in

Uvanittuaq ilitchurisukupku Inuvialuktun, ququaqluta.

Inuvialuktun

ᑕᐁᑦᑦᑦ ᑎᑎᑦᑦᑦᑦᑦ ᑭᑦᑦᑦᑦᑦᑦ ᑦᑦᑦᑦᑦᑦᑦᑦᑦ ᑦᑦᑦᑦᑦᑦᑦᑦᑦᑦᑦᑦᑦ, ᑦᑦᑦᑦᑦᑦᑦᑦᑦ ᑦᑦᑦᑦᑦᑦᑦᑦᑦᑦᑦᑦᑦ.

Inuktitut

Hapkua titiqqat pijumagupkit Inuinnaqtun, uvaptinnut hivajarlutit.

Inuinnaqtun

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# Introduction

During the development of *Northern Voices, Northern Waters: NWT Water Stewardship Strategy (2010)*, Northwest Territories (NWT) communities and Indigenous governments highlighted the need to be more involved in and know more about water stewardship.

The NWT-wide Community-based Monitoring (CBM) program started in 2012 in response to community questions about water quality. The goal of the monitoring program is to have communities involved in water stewardship and to collect water quality monitoring information to answer community questions about water quality. The program involves community members from 21 different communities in the NWT, staff from the Government of the Northwest Territories Department of Environment and Natural Resources (GNWT-ENR), and other water partners.

Questions from community members guided the design of the CBM program:

- Is the water healthy? Is it healthy at specific places?
- Do local, regional, transboundary concerns make the water unhealthy?
- Can we drink the water?
- Is the quality of the water changing?
- Is water quality affecting the health of fish and wildlife?
- Are stressors affecting water quality? Stressors might include climate change, development, municipal dumps, and sewage lagoons in the NWT.
- Are there cumulative effects of many different stressors on the water quality?

The CBM Program is designed to allow community members to decide where to monitor water quality and to provide community monitors with the tools to do the sampling themselves.

The GNWT and other water partners play coordinating and supporting roles within this program. These roles include:

- 1) providing ongoing training and support to the community monitors to collect water samples using standard methods
- 2) analyzing water quality data and providing results back to communities

In 2017, the GNWT hired independent consultants to look at all water quality data collected by the CBM program during the previous five years at the sites shown on the map on page 7. The consultants prepared a detailed technical report on the results as well as this plain-language summary that gives the highlights of the study.

The consultants used standard methods to look for water quality trends—the general direction in which water quality is changing over time—across the NWT. They also looked at the data quality to see if sampling procedures used by the CBM program were giving the data needed to answer community questions, and they answered several community questions.

Differences in water quality across the NWT seem to be related to the speed of water flow and the type of rocks the water is flowing through. Water quality in some regions is also changing due to climate change. Overall, the CBM program was found to be working very well, with only a few recommended adjustments.

## What is in this report?

- The NWT-wide Community-based Monitoring Program results
- Summary of regional differences in water quality
- Recommendations for improvements to the CBM program

# The Community-based Monitoring Program

There are over 40 water quality monitoring sites in the CBM Program. Sampling locations are shown on the map below. Sampling at these sites was conducted by community members three to four times during the open water season (between June and October) from 2012 to 2016. ENR staff supported the sampling by providing equipment, training, and other technical support.



Rita Carpenter sampling on the Mackenzie River near the community of Tsiigehtchic



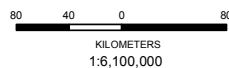
# NWT-WIDE COMMUNITY-BASED WATER QUALITY MONITORING PROGRAM – 2016 SITES

Government of  
Northwest Territories



**Legend**

- Community
- NWT-Wide Community-Based Water Quality Monitoring Program
- NWT winter road
- Major Road
- Tree Line
- Provincial - Territory Boundary
- Mackenzie Sub-Basins



**REFERENCES**

WATER QUALITY MONITORING SITES PROVIDED BY WATER RESOURCES DEPARTMENT - DNR  
 BASE DATA, ADMINISTRATIVE BOUNDARY 1:50,000  
 WATER FEATURES 1:1,000,000, ATLAS CANADA  
 WATERSHED DATA PROVIDED FROM GEBCO  
 DATUM: NAD83, PROJECTION: CANADA LAMBERTS CONFORMAL CONIC

**DISCLAIMER**

THIS MAP IS FOR ILLUSTRATIVE PURPOSES ONLY. ACTUAL FEATURE BOUNDARIES DEPICTED MAY NOT BE EXACTLY AS SHOWN. ENR WATER RESOURCES (GNWT) AND THE NWT CENTRE FOR GEOMATICS (GNWT) ARE NOT RESPONSIBLE FOR ERRORS OR DISCREPANCIES.

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# What the CBM program measures

To address community water quality concerns and questions, water is sampled at each community site three to four times between June and October, known as the open water period, by community members supported by ENR technical staff.

The CBM program uses four types of sampling equipment to sample water – YSI Sonde, grab samples, PMD (polyethylene membrane devices) and DGT (diffusion gradients in thin-films).

## YSI Sonde

Sondes are continuous samplers that can be placed in the water for the entire summer. Every two hours, the sonde automatically takes certain measurements. This data is downloaded when the sonde is removed from the water. The sonde measures temperature, pH, turbidity, dissolved oxygen, conductivity and chlorophyll-a.

The collection of this information is useful because the sonde stays in the water a long time (usually a month at a time), helping us see how water quality changes over time or during short-term events like rainstorms.



## Grab samples

To collect a grab sample, community environmental monitors fill up special bottles with water from the surface of the lake or river being monitored. These are sent to Taiga Environmental Laboratory in Yellowknife, NWT for analysis. There are around 70 substances that the lab measures including nutrients, ions and metals. Each grab sample provides a lot of information about the levels of different substances in the water at the time the sample was taken. Since the amount of a substance in water can change over time, it is useful to take more than one grab sample each summer.

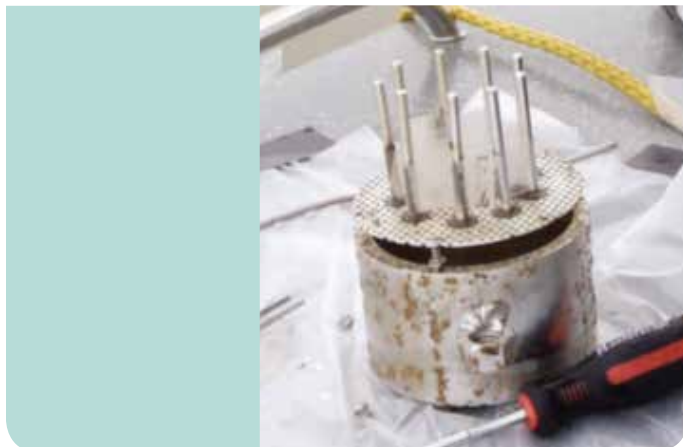






### **PMD (polyethylene membrane devices)**

PMDs are passive samplers the water flows through. They stay in the water for several weeks up to a month. They soak up oil and gas-related chemicals (called polycyclic aromatic hydrocarbons or just hydrocarbons) that are dissolved in the water. PMDs are more sensitive and more reliable for finding hydrocarbons than grab samples. PMDs are so sensitive that, if a cigarette smoker handles the PMDs, the hydrocarbons on their breath can affect the results.



### **DGT (diffusion gradients in thin-films)**

DGTs are passive samplers that act like sponges to pick up the portion of dissolved metals in the water. An example of something that dissolves in water is sugar in tea. Substances that dissolve in water are difficult to monitor over time; however, DGTs are left in the water for several days so they can measure the metals in the water over longer periods of time.



## **What is Water Quality?**

Water quality results tell us how suitable water is for drinking, and for plants, bugs and fish to live in. To describe water quality, we measure what makes up the water, including the chemical (e.g., metals), physical (e.g., temperature), and biological (e.g., chlorophyll) parts.



# Explanation of key monitoring substances

Although the CBM Program measures many different substances, this summary focuses on water properties such as turbidity, total dissolved solids and conductivity, metals and hydrocarbons.

## Turbidity

Turbidity tells us how cloudy the water is. Turbidity is a similar but slightly different measurement than total suspended sediments. The clearer the water, the lower the turbidity, like water under the ice in winter. The more dirt, silt, mud, clay or algae (particles) in the water, the higher the turbidity. Forest fires, melting permafrost and human activities can increase turbidity.

## Why is turbidity monitored?

There are natural sources of increased turbidity during times like spring break-up, due to increased runoff and natural erosion. High turbidity occurs naturally in many NWT rivers. Monitoring the water for turbidity provides us with a good understanding of the levels of contaminants in the water, as contaminants are often attached to dirt and other particles. Contaminants are substances that, if present in certain amounts, can negatively affect the water, plants, fish or bugs. Contaminants attached to dirt are usually less likely to be taken up by plants, fish or bugs than those dissolved in water.

## What turbidity looks like in water samples

Turbidity amounts in water are expressed as what are called nephelometric turbidity units, or NTU. The higher the measured turbidity in a water sample, the cloudier the water looks. Samples of water from the Mackenzie River north of Fort Simpson tend to be in the 100 to 250 NTU range due to high amounts of sediments entering from the Liard River. Turbidity in Great Slave Lake is usually below 10 NTU.





## Hydrocarbons and Metals

Metals can come from natural (rock and soil) or human sources. Chemicals in oil and gasoline (called hydrocarbons) present in water can occur naturally from forest fires or from natural oil and gas deposits. Hydrocarbons in water can also be related to oil and gas exploration or development projects.

Although metals and hydrocarbons can be dissolved in the water (like sugar in tea) they are often found attached to dirt in the water. Metals that do not dissolve in the water and attach to dirt are called particulate. Rivers that carry more dirt often carry more metals, but they may not carry more hydrocarbons. The amount of dirt in a river is measured by the level of total suspended solids.

Certain amounts and types of metals are needed to maintain human health and the health of other animals. For example, iron is a metal needed by humans but it can have negative impacts to humans or the things living in the water if amounts are too high.

### ***Why are hydrocarbons and metals monitored?***

The CBM Program measures metals that are both dissolved in water and attached to dirt (called total metals). Hydrocarbons and metals dissolved in water are more able to get into plants, bugs and fish than those attached to dirt. Fish reproduction and human health can also be affected by certain levels of dissolved hydrocarbons and metals. Hydrocarbons and metals usually stay attached to dirt unless things like pH and temperature change. Only a certain type of dissolved hydrocarbons, called polycyclic aromatic hydrocarbons (PAHs), are measured by the CBM Program. In this report, PAH levels are referred to as hydrocarbons.

## Total Dissolved Solids (TDS) and Conductivity

In addition to the solids that can be seen in the water, there are other solids (like salts) that are dissolved in the water. Dissolved solids may include things like minerals from rocks, salts from soil, organic matter from plants and animals, or those from community and industry wastewater.

Just like metal, water can conduct (transport) electricity. This is because there are salts dissolved in the water. Water with zero conductivity will not conduct electricity as it contains no salts; this condition does not occur in nature. Measuring conductivity means looking at how easily electricity flows through the water and how much dirt and salts are in the water. The dirt and salts come from rocks broken down by water flowing over them. Most of the Taiga shield is covered by rocks that do not get broken down easily; there is very little soil in this region. As a result, water in this area does not have high conductivity. In areas where there is rich soils and softer rock like the Taiga plains there is higher conductivity.

### ***Why are TDS and Conductivity measured?***

A TDS measurement gives us the amounts of all dissolved substances in the water. Although a TDS measurement does not tell us exactly which dissolved substances are present, high TDS levels can alert us to look more closely at that water body. Large changes in TDS or conductivity can affect plants, bugs and fish. Changes in the amount of dirt in the water can make it difficult for the fish and bugs to survive as it is hard for them to see, eat or breathe. Fish and other organisms that live in freshwater (low salts) may not survive if there are large changes in the saltiness of the water over a short period of time. Fish and animals that live in saltier water, such as cod in the ocean, are used to this salty water and can survive.



# How well is the CBM program working?

Independent consultants were asked to look at all the CBM data collected over the past five years (2012-2016) and check whether the program was working as intended or if improvements were needed. For example, the consultants looked at the raw data to check for sampling errors (like accidental sample contamination) and compared the CBM data to data collected by other organizations like Environment and Climate Change Canada (CCC). The consultants concluded the CBM Program produced good quality data that can be successfully used to find changes and trends in water quality across the NWT.

A summary of the identified strengths of the current CBM Program are listed below, along with some ideas for improvements. A detailed list for the program can be found in the technical report.



## Strengths of the CBM Program

- Data quality is excellent
- Data successfully used to find changes and trends in water quality across the NWT
- Training program is working well
- Good spatial coverage of sampling sites across the NWT
- Sampling methods and frequency are appropriate
- Sampling locations and substances relevant to community concerns
- Program is sensitive enough to capture water quality differences between communities and regions
- If there are more industrial developments in future, this data can provide baseline water quality information



## Recommendations

- Some sites could be removed without affecting the overall results
- Special studies would improve the use of PMD and DGT samplers
- Different statistical analysis of PMD data might help us understand the source of any hydrocarbons measured in the water
- Make sure the list of measured substances is consistent across sites
- Protocols for field measurements could be improved
- Winter sampling could improve understanding of water quality trends
- Data management could be improved



Katherine Manickum and Skye Lacroix sampling on the Mackenzie near Inuvik





# What affects water quality in the NWT?

Many factors influence water quality, both natural factors and from human activities. When the third party review looked at all the CBM data, it was found that variation in water quality across the NWT was due to the source of the water and the flow. In some regions, there is evidence that permafrost thawing, caused by warming temperatures, is affecting water quality. Forest fires are another factor that may temporarily change water quality over time. For further information about water quality in the NWT, contact ENR for status and trend reports that can help provide an additional and longer term context of these results.

Below, data from the mainstream of the Mackenzie River (from Fort Providence to Inuvik) is used to describe how different factors affect water quality in the NWT.

## Water quality depends on the water source

Many of the differences in water quality along the Mackenzie River are due to effects from the rivers and creeks that flow into it as it travels from the outlet of Great Slave Lake to the Arctic Ocean.

Water quality in the first section of the Mackenzie River, as it flows past Fort Providence, is like water in Great Slave Lake. It is generally clear with low turbidity and low amounts of other substances like metals or nutrients (for example, nitrogen from plant material). Water quality remains constant until the Liard River flows into the Mackenzie River from the south at Fort Simpson.

Water quality in the Liard River is very different from the water it is flowing into – most noticeably, the Liard River is very turbid and appears muddy. The differences in water quality are so large that they can be seen by satellite images. In the picture, the muddy (brown) waters of the Liard flow into the clear water from the first section of the Mackenzie River. The influence of the Liard River is so great that the Mackenzie River itself appears muddy as it flows north from Fort Simpson.



Why is the Liard River so muddy? Like other rivers flowing from the mountains into the Mackenzie River, the Liard River flows through lands where there is a lot of loose soil and where the rock washes into the water. Rivers that flow into the Mackenzie River from the east, like the Great Bear River at Tulita, tend to be clearer. Those rivers come from areas where rocks are harder and do not easily release substances like metals when water flows over them. Local water quality changes in the Mackenzie River depend on both the quality and quantity of rivers that flow into it.



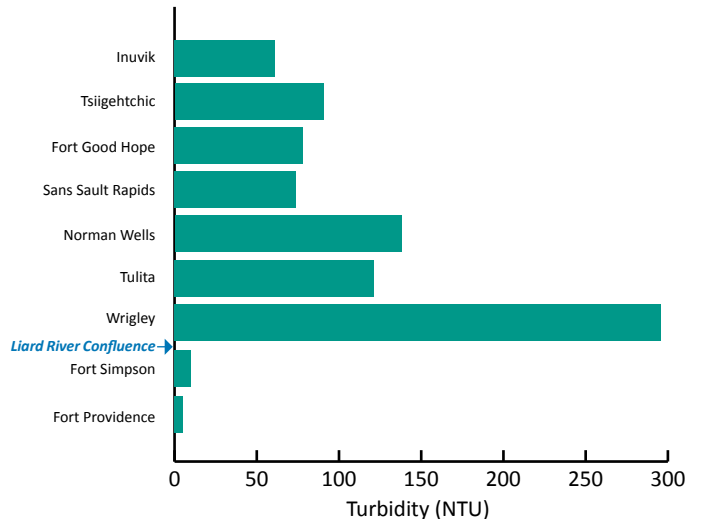
**A water body’s rate of flow affects the water quality**

As previously described, many metals in water attach to dirt in the water. In waters that are calm or that have a low flow rate like in lakes, the dirt particles tend to sink to the bottom because they are heavier than water. However, in fast flowing rivers, the force of the water causes dirt to come up from the bottom, or stay “suspended”, making the water turbid.

The adjacent picture shows what happens when the turbid waters of the Slave River enter Great Slave Lake at Fort Resolution. The satellite image shows how, close to the mouth of the river, mud and dirt from the Slave River are still suspended in the lake water, making it look muddy. But as the water in the lake slowly flows towards its outlet at the Mackenzie River, the dirt settles to the bottom and by the time the water has reached the midpoint of the lake, the lake water appears much clearer.

The majority of the Mackenzie River is deep and fast flowing. As shown in the graph, turbidity levels in the Mackenzie River increase sharply after Fort Simpson and stay high until Tsiigehtchic. As the water moves into the Mackenzie Delta, the water spreads out into many shallow channels, slowing down the rate of flow. By the time it reaches Inuvik, the amount of turbidity has decreased significantly.

**Turbidity Levels at Different Locations on the Mackenzie River - Average from 2012-2016**





### Thawing permafrost can change water quality

In the NWT, much of the ground is frozen year round. This is called permafrost. As a result of a warming climate, permafrost is gradually thawing. As it thaws, water previously captured in the ice along with local runoff flows across the land and picks up dirt with attached substances like metals, nutrients or salts. This water eventually makes its way into rivers or lakes. Permafrost thawing also makes the ground less stable and can be the cause of “slumps” (a type of mud slide) that releases sand, soil and rock into nearby water bodies.

Researchers at the GNWT have been studying permafrost across the North and have noticed many permafrost slumps in the Peel Plateau area in northwestern NWT. When comparing CBM data, this same region shows the highest levels of turbidity and associated metals in the rivers (the Peel and the Vittrekwa Rivers). Based on these observations, it is clear that permafrost thawing, caused by a changing climate, is affecting water quality in some regions of the NWT.

**The more turbid the water,  
the higher the amounts of some metals**

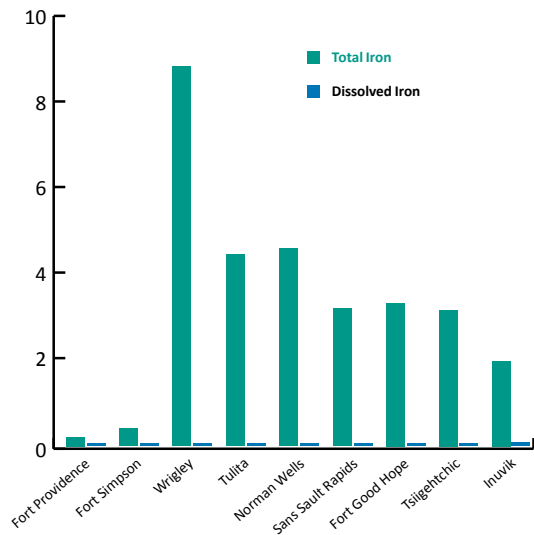


Photo from Google images, lake near Fort McPherson  
[www.cbc.ca/news/canada/north/n-w-t-scientists-predict-catastrophic-lake-drainage-due-to-thawing-permafrost-1.3158206](http://www.cbc.ca/news/canada/north/n-w-t-scientists-predict-catastrophic-lake-drainage-due-to-thawing-permafrost-1.3158206) (2015)

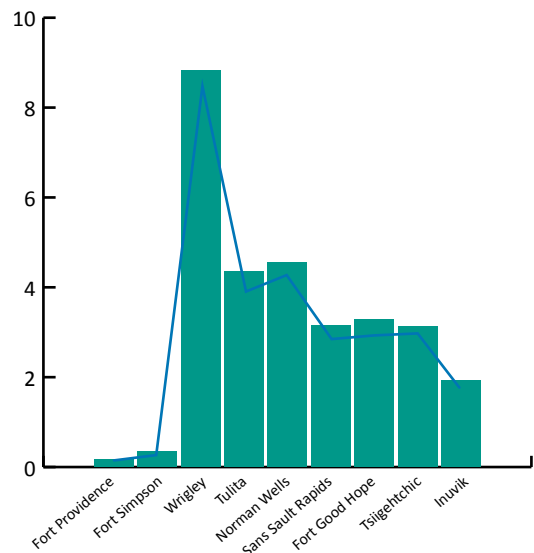
The CBM program data confirms that when turbidity is high in the water, so are the amounts of certain metals. The graph below shows the information for the metal iron. As turbidity increases in the river as it flows north, so does the amount of total iron. The graph below shows how, when the dirt or turbidity is removed from the water, the amount of dissolved iron left in the water is very low. This means that metals like iron are often attached to dirt particles in the water.

Metals dissolved in water are more of a concern than those attached to dirt. This is because dissolved metals are more easily absorbed by fish and other animals.

### Most of the total iron in the water is attached to dirt particles



### As turbidity increases in the Mackenzie River, so does the amount of total iron





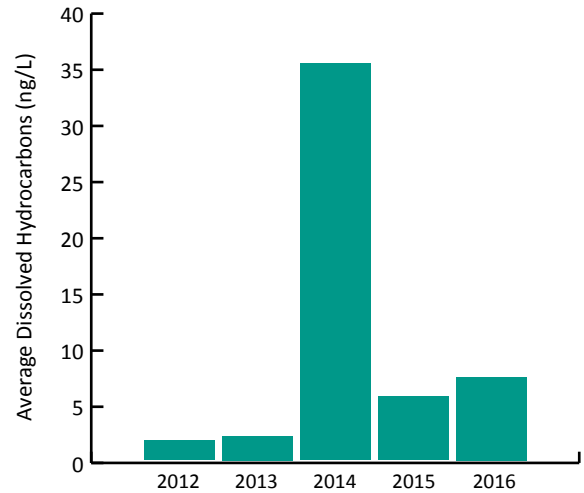


### Forest fires can change water quality

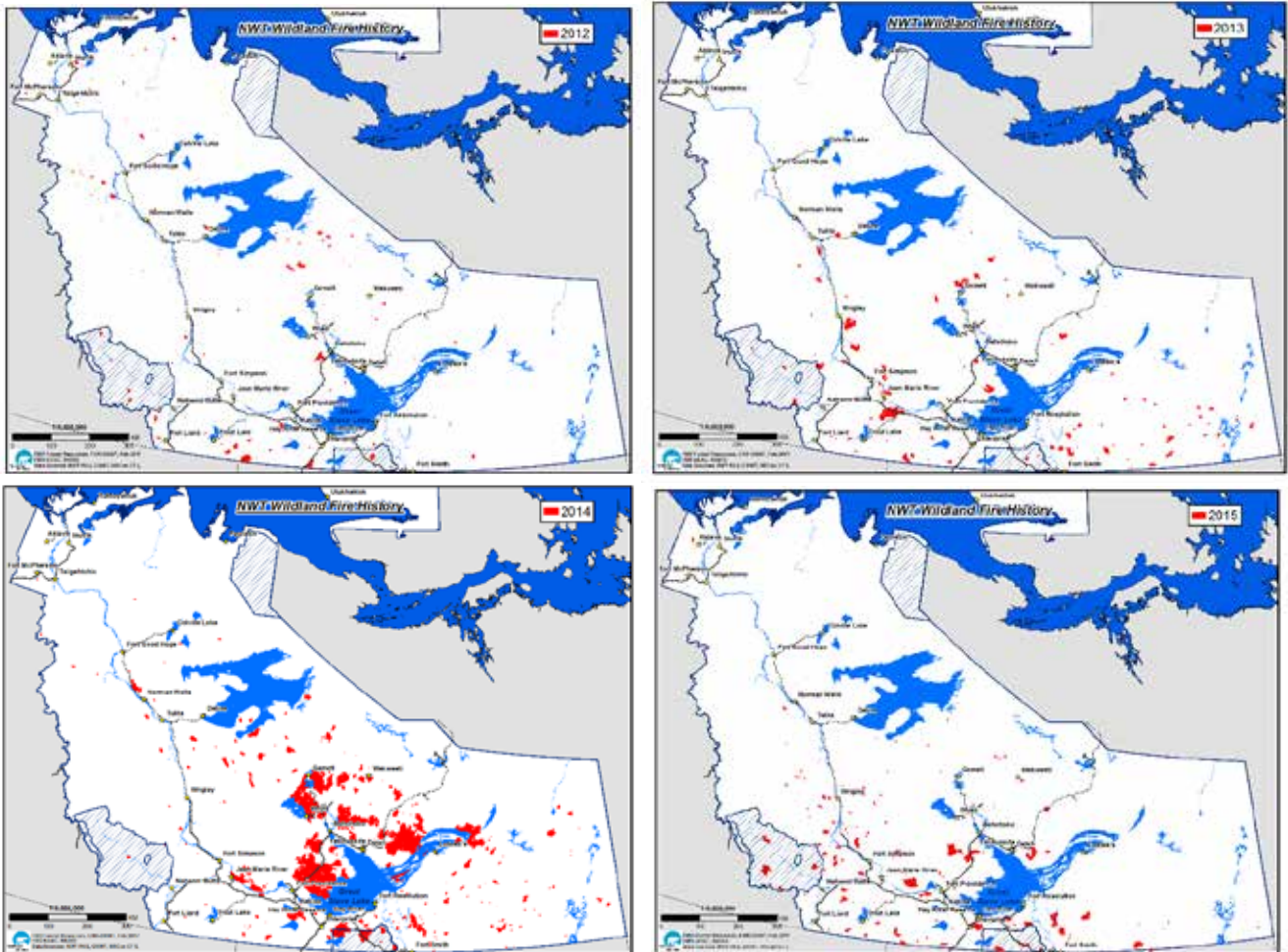
Hydrocarbons in water can occur naturally from forest fires, natural oil and gas deposits, as well as industrial or municipal activities.

Analysis of the hydrocarbon data from 2012 to 2016 showed that all measured amounts were much lower than the amount (400 ug/L) found to affect fish by the National Fisheries Institute of the Government of Alaska (Carls et al, 1999). The main pattern seen in the data is that most sites showed an increase in hydrocarbon amounts in the summer of 2014. Of all the years in which hydrocarbon data was collected, the extent of forest fires in the NWT was highest in 2014. Therefore, it is likely that the 2014 increase was due to hydrocarbons released from the high number of forest fires that same year.

### Hydrocarbon Amounts at the Mackenzie River Mainstem Stations



### The extent of wildland fires in the NWT 2013-2016





# Analysis of water quality data by region

Now that the CBM Program has been running for five years, it is possible to see trends and patterns in water quality across the North. Questions posed by communities can also be answered, understanding that monitoring over longer time periods always helps with certainty about conclusions.

Data was grouped by sites that were close together or that represented a distinct area of the NWT. The sites were grouped as follows:

- **Great Slave Lake Area** – 13 sites within the lake, in rivers that flow into the lake from the north (Marian and Yellowknife River), in rivers that flow into the lake from the south (Slave, Hay, and Kakisa River), and at the headwaters of the Mackenzie River near Fort Providence.
- **Sambaa K'e and Liard River Confluence** – 14 sites around Sambaa K'e, Nahanni Butte, Jean Marie River, Fort Simpson and Wrigley.
- **Tulita, Norman Wells and Fort Good Hope** – 19 sites on or around the Mackenzie River from Tulita to Fort Good Hope.
- **Mackenzie Delta and Peel River** – 7 sites around Fort McPherson, Tsiigehtchic and Inuvik



Melaine Simba retrieving PMD in Kakisa



# Comparison of CBM data to water quality guidelines

One way to understand what monitoring data really means is to compare it to guidelines that have been developed for specific substances.

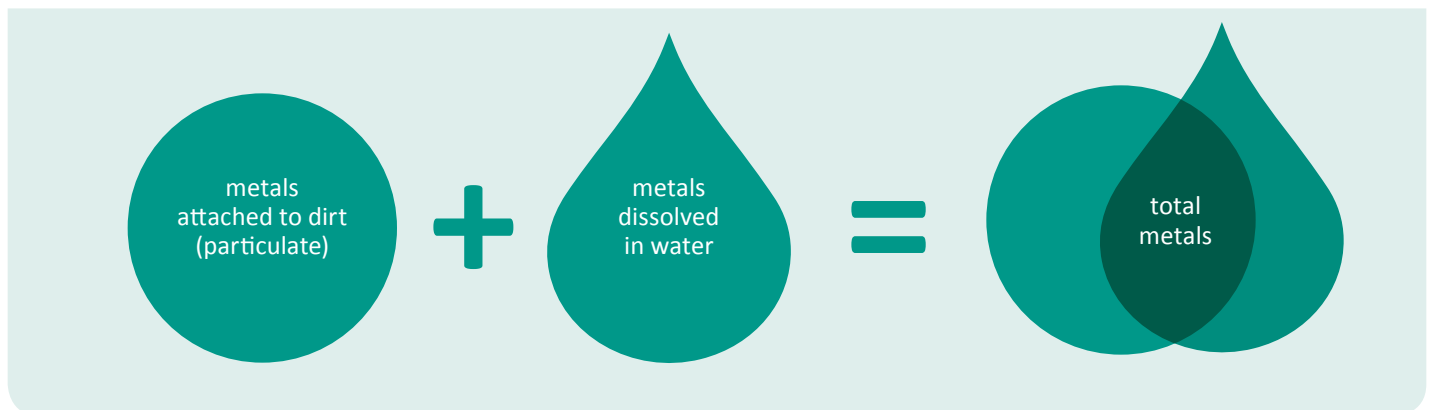
Guidelines tell us how much of a chemical or substance can be in the water before it might cause harm to fish and other living things. The Canadian Council of Ministers of the Environment (CCME) made the Canadian Water Quality Guidelines for the Protection of Aquatic Life. These guidelines cover all of Canada but are not specific for northern waters. These guidelines are for the total amount of a substance.

The guidelines don't always account for the natural condition of northern rivers. Northern rivers can have higher levels of dirt, mud and silt in the water. Since metals attach to dirt, northern rivers can have naturally high amounts of some metals and results can be above the CCME guideline values.

All grab water sample data were compared to the CCME guidelines. For grab water samples, around 70 substances were analyzed, of which there are guidelines developed for 28 substances. The most common substances to exceed the guidelines were total iron, total aluminum, total lead and total copper. All these metals are naturally high in waters with high turbidity. Since these metals are commonly attached to dirt in the water, removal of the dirt greatly decreases the amount of metals left in the water.



Narcisse Chocolate (boat driver) and Priscilla Lamouele (community monitor) watching Laura Krutko (ENR) label bottles on Frank Channel, Behchokò 2016



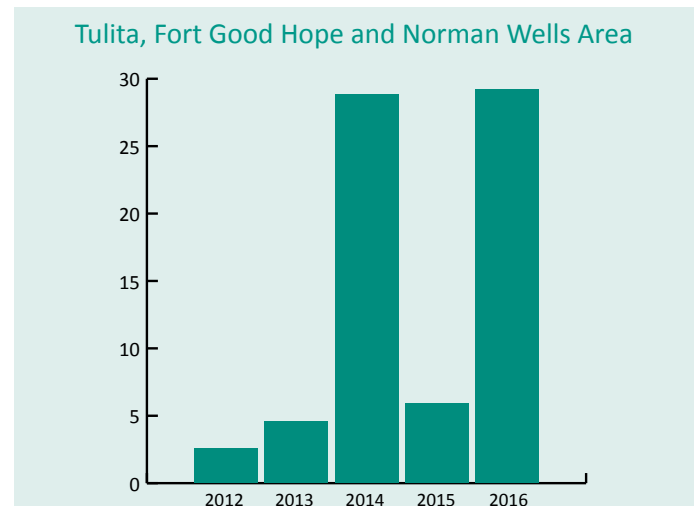
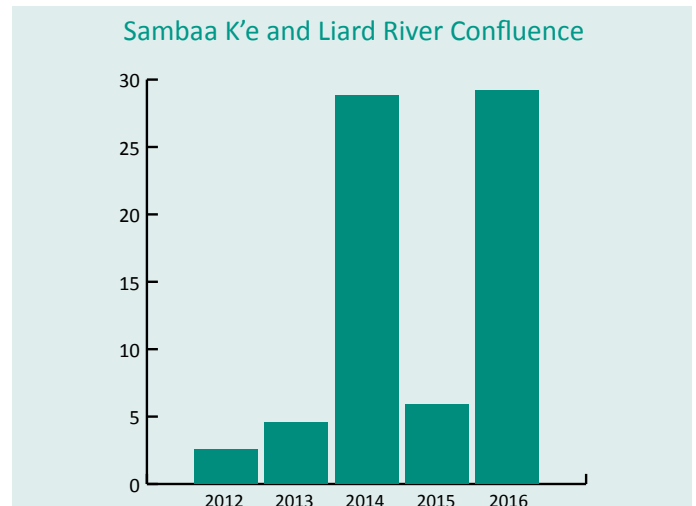
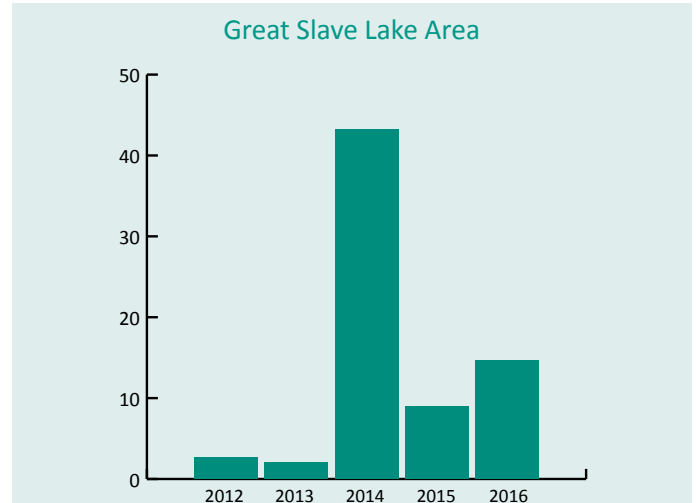
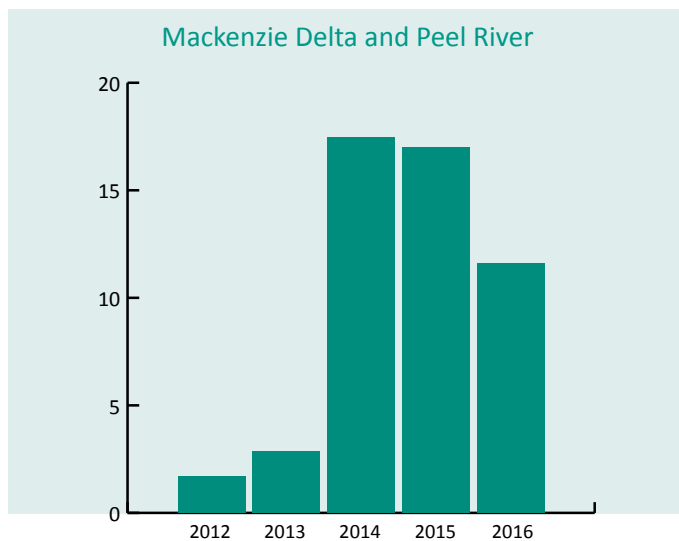


# Hydrocarbon results across the NWT

Hydrocarbon values changed at all locations over the past five years. The highest average amount of hydrocarbons measured in the CBM Program between 2012 and 2016 was 43 ng/L. That average occurred in 2014 in the Great Slave Lake area. Forest fires in that area were much worse in 2014 than in other years and it is possible that the slightly higher values that year were due to the fires.

While there are no CCME guidelines for hydrocarbons, scientists have found that values above 400 ng/L can affect fish health. Also, the World Health Organization has determined that a value higher than 10,000 ng/L indicates that there has been contamination by an industrial development. All of the measurements taken as part of the CBM Program are well below these values. Therefore, it is very unlikely these substances are affecting the health of the waters in the NWT.

**Average hydrocarbon amounts (in ng/L)  
between 2012 and 2016**





Ryan Gregory on the Mackenzie River near Norman Wells



# Great Slave Lake area Sampling sites



<p>Monitoring Stations and Sample Types. Great Slave Lake, Tributaries and Mackenzie River Headwaters.</p> <p>October 2, 2017</p>	<ul style="list-style-type: none"> <li>• Community</li> <li>■ DGT</li> <li>■ PMD</li> <li>■ PMD, DGT</li> <li>■ SONDE, PMD</li> <li>■ SONDE, PMD, DGT</li> <li>△ CBM Grab Station</li> </ul>	<ul style="list-style-type: none"> <li>● LTD Station</li> <li>⊕ ECC Stations</li> <li>+ WSC station (Active)</li> <li>— Highway</li> <li>— Stream</li> <li>■ Waterbody</li> </ul>	<p>Project 5-Year Review of Community Based Water Quality Monitoring Program Project #: J170001</p> <p>Project Lead: Derek Koster Prepared by: Kim Dalgaard Data Source: QMAP, Canvec, open kanada.ca Coordinate System: NAD 1983 Northwest Territories Lambert</p>
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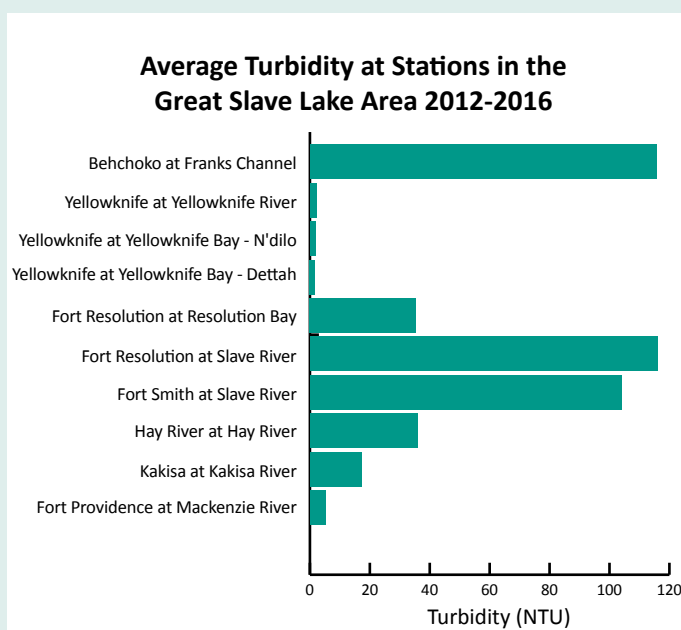
# Great Slave Lake area

## Results

Between 2012 and 2016, the CBM Program collected water quality data at 13 sites located both within Great Slave Lake and in rivers flowing into the lake.

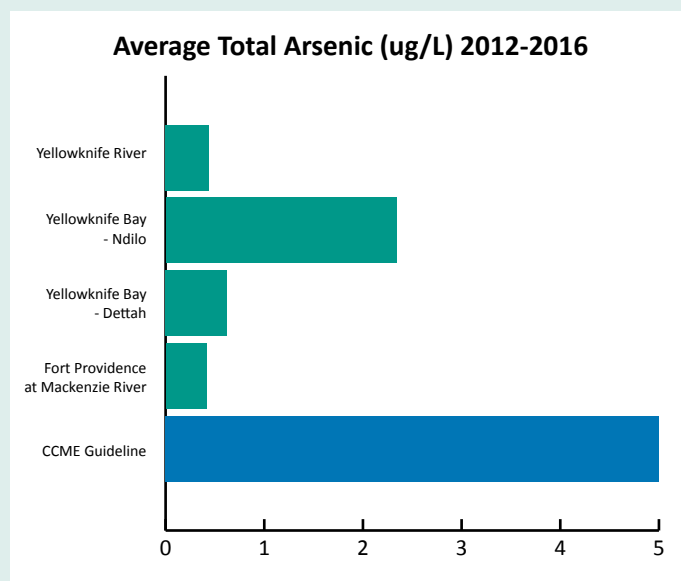
### What is water quality like in the Great Slave Lake area?

- Water flowing into Great Slave Lake from the Marian and Slave Rivers is very turbid (cloudy). Dirt coming into the lake from the rivers seems to settle out so that water at the lake outlet by Fort Providence is clear.
- Sites with low turbidity also had low amounts of other substances like metals or nutrients.
- Substances that were above the CCME guidelines most often included aluminum, iron, and copper. These metals often attach to dirt and total levels exceeded guidelines more often in waters with naturally high turbidity.
- Water quality in the Hay River is very different from the other rivers. For example, in the Hay River there are higher levels of nutrients and conductivity. This is likely because, unlike the other rivers, the Hay River passes through rich soils in wetlands before entering Great Slave Lake.
- Water quality in the Slave River at Fort Smith was very similar to water quality at Fort Resolution.
- The amount of total arsenic in Yellowknife Bay around Ndilo is higher than surrounding areas but still lower than the CCME guideline value. There is no increasing trend in arsenic at any station.



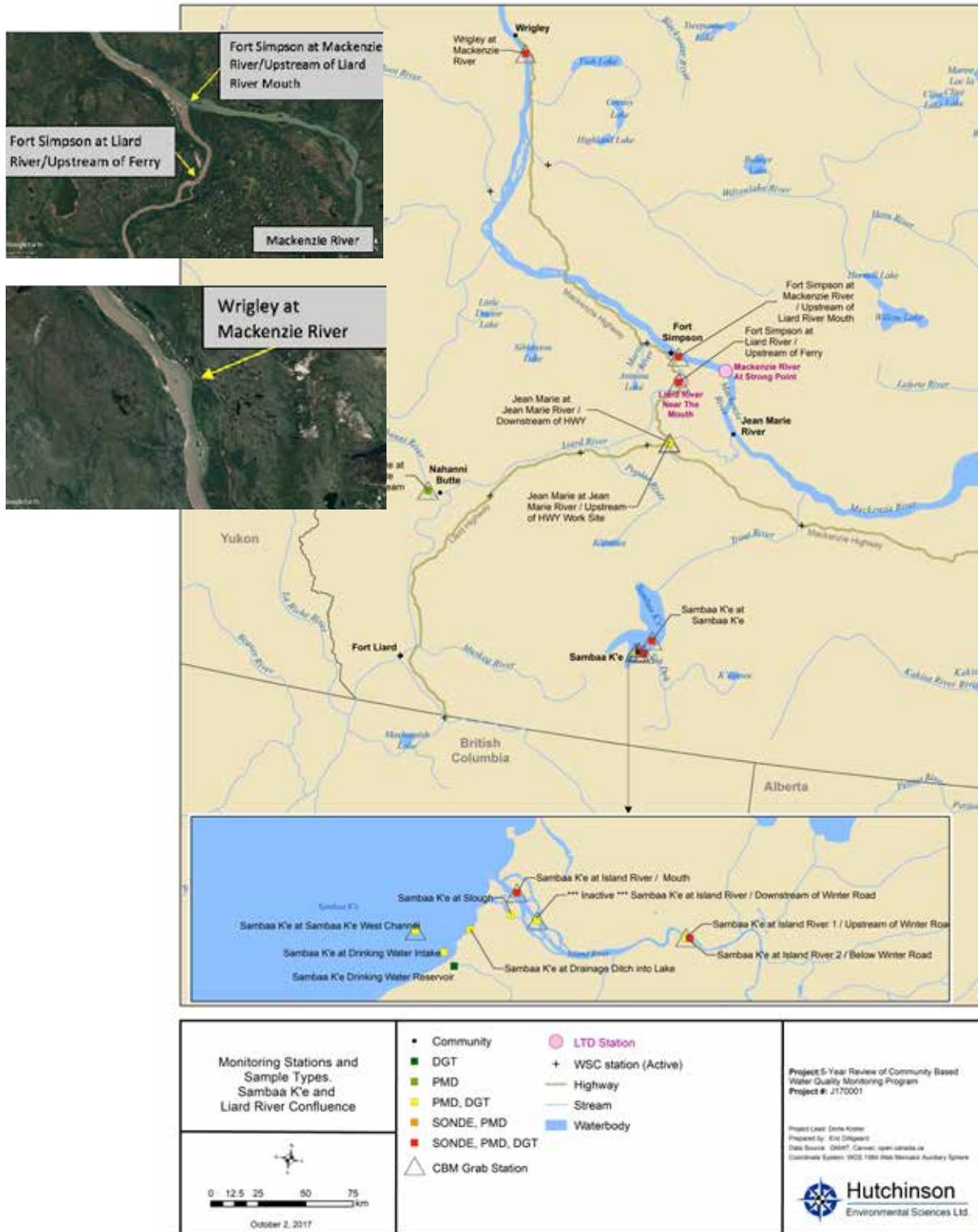
### Were there any important changes or trends in water quality between 2012 - 2016?

- As in other areas, hydrocarbon levels in this area were highest in 2014 but then decreased. Forest fires in this region were very extensive in 2014 and this may be the cause of the increased levels at that time.
- Hydrocarbon levels at all sites in this area were similar to each other and all remained well below values that would harm fish.
- There is a small trend of increasing conductivity in the Slave River, meaning that some dissolved substances have increased in that river over time. The trend can be seen at both Fort Smith and Fort Resolution. As there is only five years of data, this may not actually be a trend but instead just a reflection of natural variability in the river.
- There were no other important trends found in the analysis.





# Sambaa K'e and Liard River confluence area Sampling sites





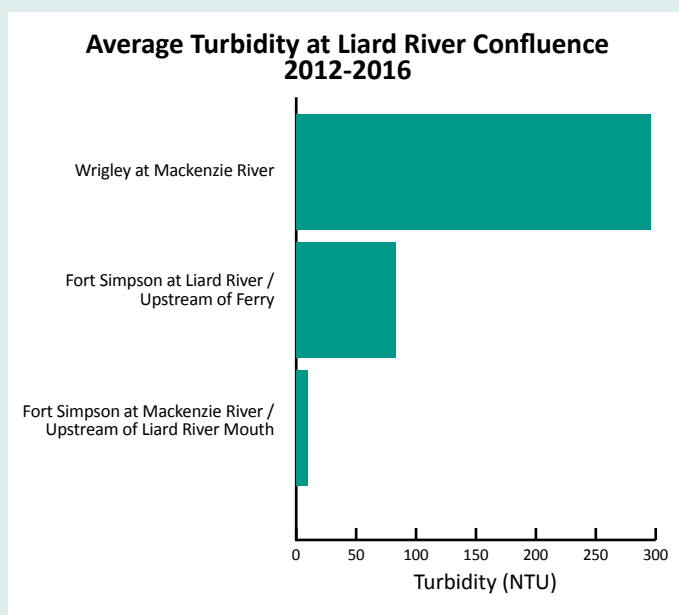
# Sambaa K'e and Liard River confluence area

## Results

Between 2012 and 2016, the CBM Program collected water quality data at 14 sites around Sambaa K'e, Nahanni Butte, Jean Marie River, Fort Simpson, and Wrigley.

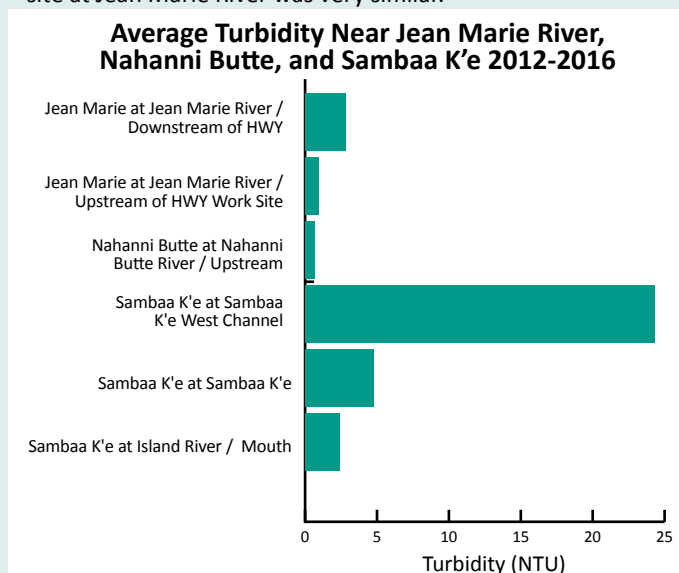
### What is water quality like around the confluence of the Mackenzie and Liard Rivers?

- Water quality in the Mackenzie River is generally clear with low amounts of total metals from Great Slave Lake until the point where the Liard River enters the system at Fort Simpson. This is because the Liard River carries high amounts of dirt in it which mixes in with the Mackenzie River. Changes to the water quality in the Mackenzie River at Fort Simpson can be seen in satellite images and confirmed by turbidity measurements at sites above and below the confluence (joining) of the two rivers.
- A satellite image shows that at the Wrigley sampling location, downstream of the Liard confluence, the water in the Mackenzie River is not completely mixed. On the east bank the water appears clear, while on the left bank the water is quite cloudy. As a result of this, the CBM data from the Wrigley station showed a lot of variability but overall had high turbidity.
- Several substances exceeded CCME guideline values, especially at the Liard and Wrigley sites. Substances that exceeded guidelines most often included total aluminum, iron, lead, and copper. These metals often attach to dirt and total levels exceeded guidelines more often in waters with naturally high turbidity.



### What is water quality like around Sambaa K'e, Jean Marie River and Nahanni Butte?

- Water quality at sites around Jean Marie River, Nahanni Butte and Sambaa K'e (Trout Lake) is quite different than sites on the Mackenzie River upstream of Fort Simpson. The water at these sites is much clearer, with turbidity levels at least 10 times lower than at Wrigley. Very few substances exceeded CCME guideline values at these sites.
- Water quality in and around Sambaa K'e has low turbidity with very few substances exceeding guideline values. Waters at the mouth of Island River have slightly higher amounts of turbidity, metals, and major ions than in Sambaa K'e.
- Water quality in the Nahanni Butte River is slightly different than at Jean Marie River or Sambaa K'e. Turbidity and some dissolved metals are higher at Nahanni Butte River. These differences are natural and related to the types of rocks at the source of each water body.
- Water quality upstream and downstream of the highway work site at Jean Marie River was very similar.

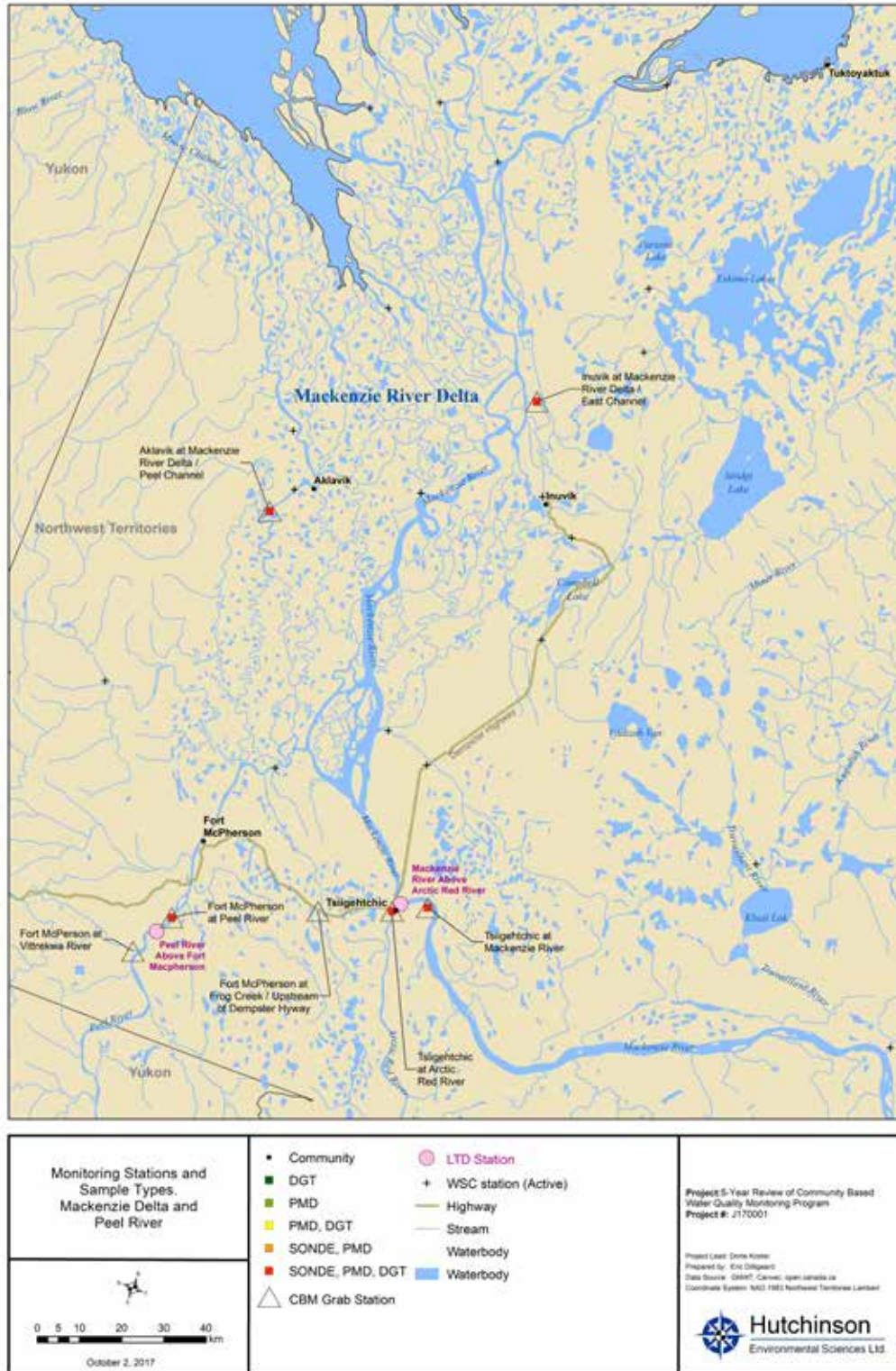


### Were there any important changes or trends in water quality between 2012 - 2016?

- Hydrocarbon levels varied throughout the years, with slightly higher levels occurring in 2015 and 2016.
- Hydrocarbon levels at all sites in this area remained well below values that would harm fish.
- There were no other important trends found in the analysis.



# Mackenzie Delta and Peel River Sampling sites



# Mackenzie Delta and Peel River

## Results

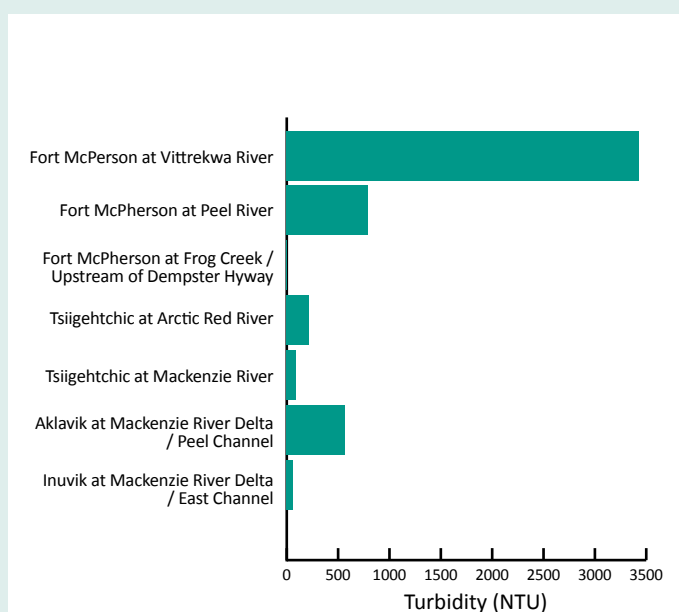
Between 2012 and 2016, the CBM Program collected water quality data at 7 sites around Fort McPherson, Tsiigehtchic, Aklavik and Inuvik.

### What is water quality like in the Mackenzie Delta and Peel River area?

- Water quality in the Mackenzie River at Inuvik and Tsiigehtchic is similar to that of other sites along the Mackenzie north of Wrigley.
- Several substances exceeded CCME guideline values especially at the Vittrekwa, Peel, and Aklavik sites. Substances that exceeded guidelines most often included total aluminum, iron, lead and copper. These metals often attach to dirt and total levels exceeded guidelines more often in waters with naturally high turbidity.
- Water quality in some parts of this region has likely been affected by a warming climate. This warming is causing the gradual thawing of permafrost in many areas of the Arctic including areas around the Peel River. As the permafrost thaws, the ground becomes less stable and causes "slumps" or mud slides that release sand, soil and rock into nearby water bodies. This has occurred in the Vittrekwa and Peel Rivers, where slumps have occurred nearby. This is likely why turbidity levels in these two rivers were measured to be 10 to 50 times higher than most other Mackenzie River sites.
- The effects of permafrost melting in the Peel Plateau area could also be seen at Aklavik where turbidity levels were about 5 to 10 times higher than other Mackenzie River sites.
- In addition to high turbidity, permafrost thawing also releases other dissolved substances into the water, including nutrients and total dissolved solids. While turbidity decreased between the Fort McPherson at Vittrekwa River station and the Fort McPherson at Peel River station, amounts of dissolved substances remained about the same.
- Water quality at Frog Creek, which flows into the Peel River, was very different from other stations. There were low amounts of turbidity, metals and nutrients, and is unlikely to have been affected by slumping of permafrost as seen in other areas. This station would not be expected to be affected by permafrost melting on the Peel Plateau.

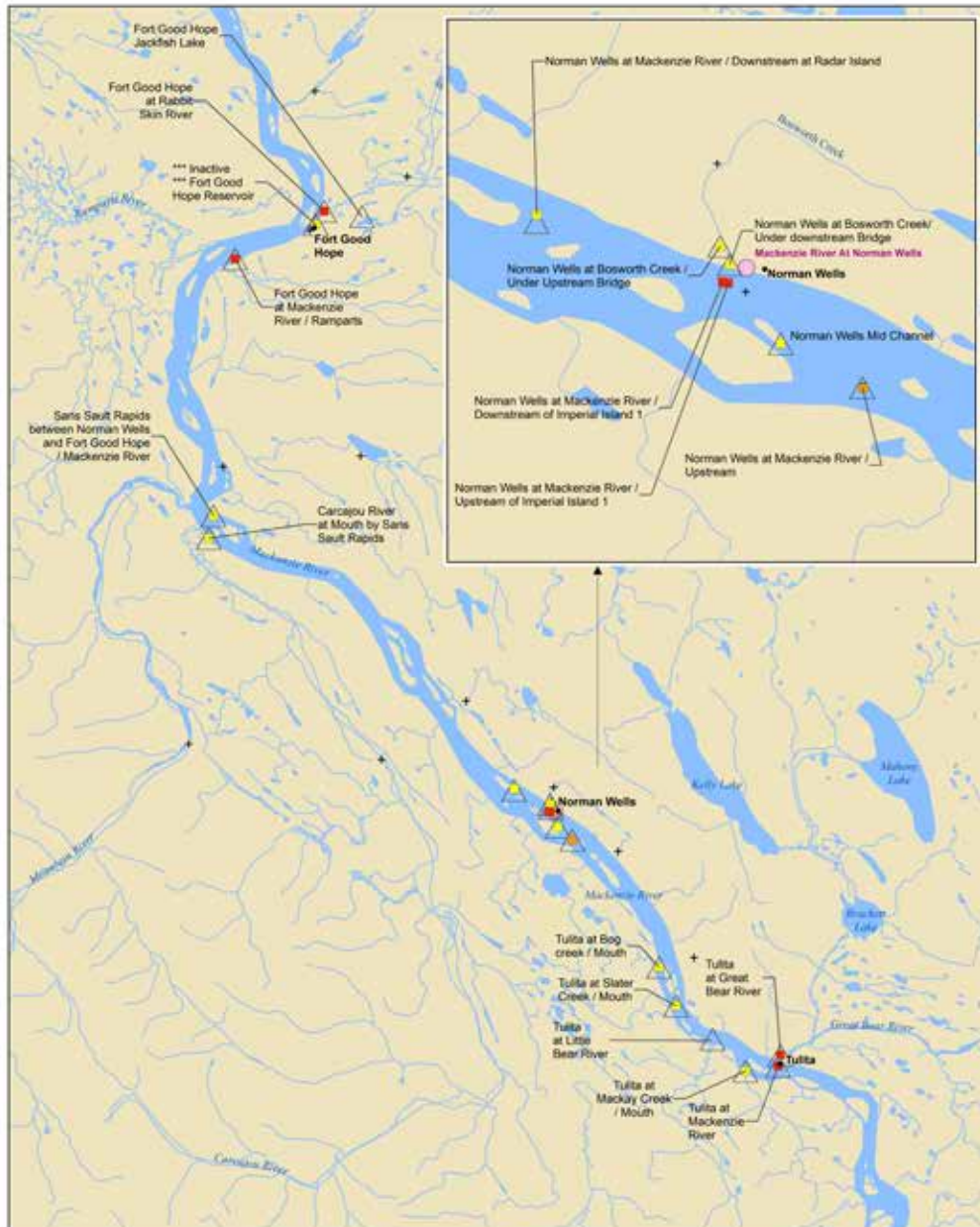
### Were there any important changes or trends in water quality between 2012 - 2016?

- As in other areas, hydrocarbon levels in this area were highest in 2014 but did not decrease in 2015 as much as in other regions. Levels did decrease further in 2016.
- Hydrocarbon levels at all sites in this area remained well below values that would harm fish.
- Permafrost has been thawing since before the CBM Program began. For this reason, it is not possible to tell if there is an increasing trend in water quality changes associated with a changing climate in this region.
- There were no other important trends found in the analysis.





# Tulita, Fort Good Hope and Norman Wells Sampling sites



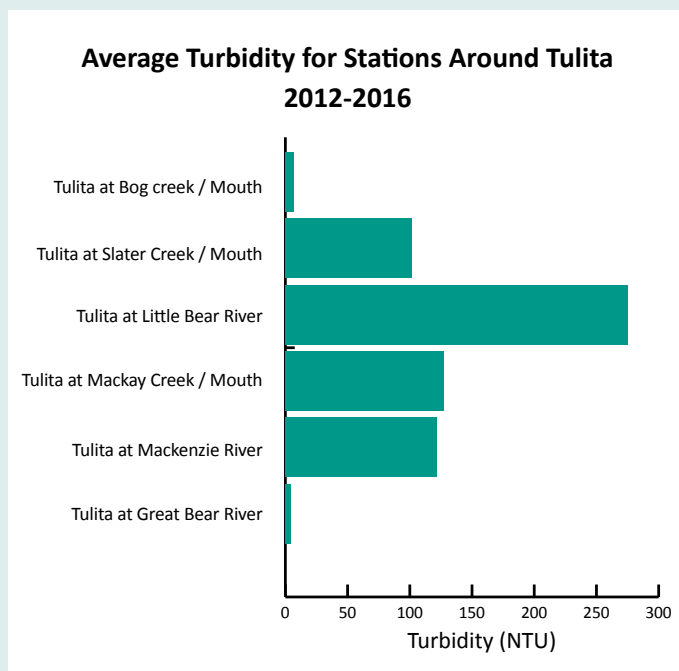
<p>Monitoring Stations and Sample Types. Tulita, Norman Wells and Fort Good Hope</p> <p>October 2, 2017</p>	<ul style="list-style-type: none"> <li>• Community</li> <li>■ DGT</li> <li>■ PMD</li> <li>■ PMD, DGT</li> <li>■ SONDE, PMD</li> <li>■ SONDE, PMD, DGT</li> <li>△ CBM Grab Station</li> </ul>	<ul style="list-style-type: none"> <li>● LTD Station</li> <li>+ WSC station (Active)</li> <li>— Stream</li> <li>■ Waterbody</li> </ul>	<p>Project: 5-Year Review of Community Based Water Quality Monitoring Program Project #: J170001</p> <p>Project Lead: Doris Kozar Prepared by: Erin O'Connell Data Source: ©2017, Corine, Open Canada.ca Coordinate System: WGS 1984 Web Mercator Auxiliary Sphere</p>
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# Tulita, Fort Good Hope and Norman Wells Results

Between 2012 and 2016, the CBM Program collected water quality data at 14 sites around Tulita, Fort Good Hope and Norman Wells.

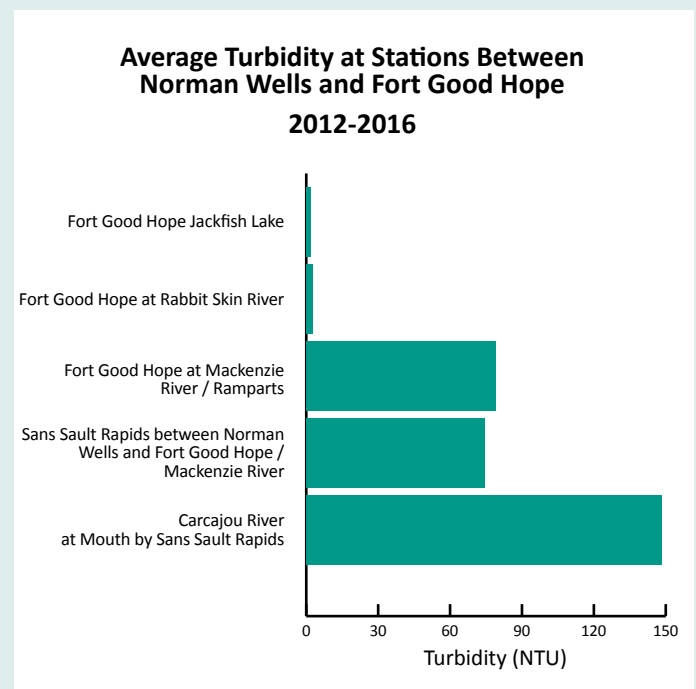
## What is water quality like in the Tulita area?

- Water quality at the station on the Mackenzie River near Tulita was similar to other sites on the Mackenzie River between Wrigley and Inuvik.
- There was a lot of variability between the five sites located on the rivers and creeks that flow into the Mackenzie River around Tulita. This is due to large differences in local conditions. For example, the Great Bear River flows from Great Bear Lake where the waters are clear and have low amounts of nutrients and metals (like Great Slave Lake). MacKay Creek, Slater Creek, and the Little Bear River flow from the western mountains and have much higher amounts of turbidity and metals.
- Substances that exceeded CCME guidelines most often included aluminum, iron and copper. These metals often attach to dirt and total levels exceeded guidelines more often in waters with high turbidity.



## What is water quality like in the Fort Good Hope area?

- Water quality at the two sites on the Mackenzie River near Fort Good Hope and the Sans Sault Rapids were similar to each other and to other sites on the Mackenzie River between Wrigley and Inuvik.
- Like other rivers that flow into the Mackenzie River from the western mountains, water quality at the Carcajou River had elevated turbidity, nutrients, major ions, and metals. Water quality at the Rabbit Skin River, which flows from the east, had low turbidity.

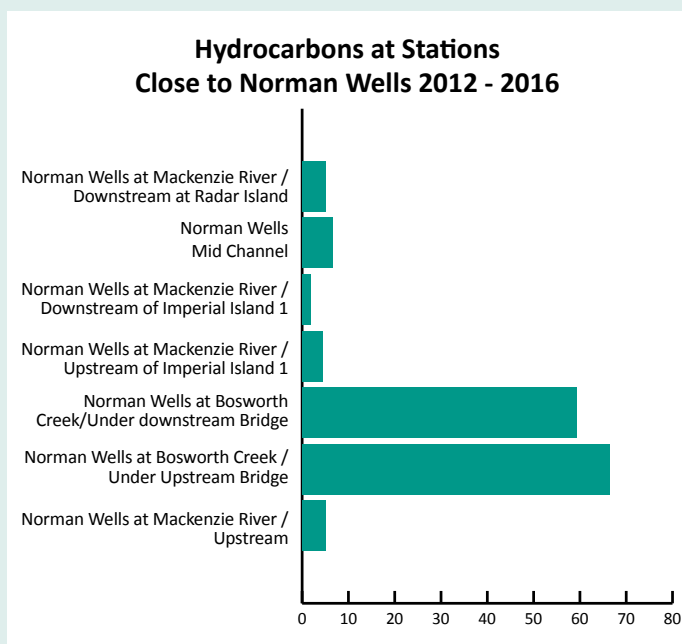


## What is water quality like in the Norman Wells area?

- Water quality results at the four sites on the Mackenzie River near Norman Wells were similar to each other and to other sites on the Mackenzie between Wrigley and Inuvik.
- Substances that exceeded CCME guidelines most often included aluminum, iron and copper. These metals often attach to dirt and total levels exceed guidelines more often in waters with naturally high turbidity.
- No major differences in water quality were found between the upstream, midstream and downstream sites on the Mackenzie River at Norman Wells. Importantly, levels of substances like hydrocarbons that can be related to natural oil and gas deposits or developments were similar to other sites on the Mackenzie and all below the researched values that would harm fish.
- Bosworth Creek flows from the east and through Norman Wells into the Mackenzie River. Water quality at the Bosworth Creek sites was quite different from the Mackenzie River sites. In Bosworth Creek, turbidity levels were much lower than the Mackenzie River but levels of total dissolved solids (TDS) and conductivity were much higher.
- Levels of hydrocarbons in Bosworth Creek were about 10 times higher than at sites in the Mackenzie River but still well below the level that would harm fish.

## Were there any important changes or trends in water quality between 2012 - 2016?

- As in other areas, hydrocarbon levels in this area were highest in 2014, possibly due to forest fires, but subsequently decreased.
- Hydrocarbon levels at all sites in this area remained well below values that would harm fish.
- There is a small trend of increasing conductivity and other dissolved substances in the Mackenzie River downstream of Norman Wells. Because there is only five years of data, it could be that this is not really a trend but is instead just reflective of the natural variability in the river.
- There were no other important trends found in the analysis.





# Findings and Recommendations

The goals of the CBM Program are to build community capacity for water quality monitoring and to make sure monitoring results are meaningful to community members. The main conclusions of this five year review of the CBM Program are:

- The Program produced excellent data that can be successfully used to find changes and trends in water quality across the NWT.
- Overall, differences in water quality across the NWT seem to be related to natural forces such as the type of rocks that water flows through and the speed of the water flow in different areas. Water quality in some areas is also being affected by a changing climate.
- There are areas where the program could be improved; for example, making sure there is consistent sampling of the same substances at all locations.
- More years of monitoring and data analysis are needed to fully answer all community questions and concerns.

The CBM Program was originally designed to answer some key questions and concerns of community members. In some cases, data collected over the five year period (2012 - 2016) can partially answer questions. In other cases, more data will be needed to answer questions fully. The table below gives answers or evidence related to community questions. In general, the sites the communities selected to sample are relevant to answer most community concerns. A few of the questions posed by community members cannot be answered by the current CBM design.

Strengths of the program include but are not limited to:

- It produced excellent quality data.
- It was possible to collect new water quality information in communities where little to no information was collected previously.
- Based on the quality of the data, it is clear the program is effective in training of community monitors.

Recommendations to improve the program include:

- Do special studies for the PMDs and DGTs to improve the time the devices are in the water.
- Work towards providing samples to the lab within their hold times to have the same substances (like bacteria, chlorophyll, biological oxygen demand) sampled for all sites.

These recommendations for the program increase the ability for information to support decision making.

With the involvement of community members from 21 NWT communities, GNWT- ENR support staff, and other water partners, the CBM Program has demonstrated partnerships can lead to meaningful monitoring and confidence in water quality data. The program is successfully working towards meeting the vision and principles of community-based water monitoring, as outlined in the NWT Water Stewardship Strategy.

Data for this program are available on Mackenzie DataStream <http://mackenziedatastream.ca> and any requested information or questions can be sent to [nwtwaterstrategy@gov.nt.ca](mailto:nwtwaterstrategy@gov.nt.ca).



# Answers to community concerns based on CBM program data from 2012 - 2016

Community Concern	Answers/Evidence provided by the CBM to address question
<b>General</b>	
<b>Is what is in the water changing over time and seasons?</b>	<ul style="list-style-type: none"> <li>• Currently, monitoring only takes place during the open water season. To understand seasonal changes, the CBM Program would have to monitor in winter as well.</li> <li>• Water may be changing seasonally in a few areas but more data is needed to know for sure.</li> </ul>
<b>Development and Land Use Change</b>	
<b>Are contaminants that can affect the health of fish and wildlife in the water?</b>	<ul style="list-style-type: none"> <li>• In general, water quality guidelines for the protection of aquatic life were only exceeded by total metals attached to dirt in turbid waters. Since high turbidity is natural in most areas, fish are likely adapted to the conditions.</li> </ul>
<b>Are stressors from climate change affecting water quality?</b>	<ul style="list-style-type: none"> <li>• Water quality data in the Peel River system show the effects of a changing climate. Slumping is having a big effect on water quality in some regions of the NWT.</li> </ul>
<b>Are contaminants potentially related to oil sands in the water?</b>	<ul style="list-style-type: none"> <li>• Potential contaminants (like dissolved hydrocarbons) from the oil sands were monitored through the PMD program. Levels were low across the NWT and their source could not be linked to upstream development.</li> </ul>
<b>Local Concerns</b>	
<b>What is the water chemistry in the various watersheds contributing to the Mackenzie River around Tulita?</b>	<ul style="list-style-type: none"> <li>• The water chemistry varies a lot in the different rivers that feed into the Mackenzie River around Tulita. In general, rivers flowing from the mountains in the west (like the Little Bear River) are much more turbid than waters flowing from the east (like the Great Bear River).</li> </ul>
<b>How does water quality compare upstream to downstream on the Slave River?</b>	<ul style="list-style-type: none"> <li>• The water quality in the Slave River at the Fort Smith and Fort Resolution sites was very similar.</li> </ul>
<b>Is permafrost slumping impacting water quality?</b>	<ul style="list-style-type: none"> <li>• Data collected by the CBM, along with research done by GNWT scientists, show that slumping is having an effect on water quality in the Mackenzie Delta and Peel regions in the NWT.</li> </ul>
<b>What is the water chemistry in the various watersheds contributing to the Peel River (including from differing geomorphological influences)?</b>	<ul style="list-style-type: none"> <li>• Water chemistry in the Peel and Mackenzie Delta region shows high values in turbidity, total dissolved solids, and metals due to permafrost melting and slumping in the Peel Plateau.</li> </ul>





<p><b>What is the difference in water chemistry, metals and hydrocarbons between Mackenzie Tributaries and the main river stem?</b></p>	<ul style="list-style-type: none"> <li>• Water quality depends on where the water is flowing from. For example, creeks, streams and rivers which flow from the western mountains into the Mackenzie River tend to show much higher amounts of turbidity and associated substances like metals.</li> <li>• So far, there isn't a noticeable difference in hydrocarbon levels between the Mackenzie River and its tributaries except at Bosworth Creek (close to Norman Wells); these values of hydrocarbons are well below the World Health Organization (WHO) benchmark for hydrocarbons.</li> </ul>
<p><b>Are contaminants related to oil and gas development at Norman Wells in the water? Are there differences upstream, midstream and downstream of oil and gas development in the area?</b></p>	<ul style="list-style-type: none"> <li>• There was no evidence that oil and gas development at Norman Wells is affecting the Mackenzie River.</li> <li>• Sites at Bosworth Creek had dissolved hydrocarbon levels that were up to 10 times higher than the sites on the Mackenzie River; these values of hydrocarbons are well below the WHO benchmark for hydrocarbons. There is no measurable effect of Bosworth Creek on the Mackenzie River at this time.</li> </ul>
<p><b>What are the impacts on water quality from the winter road and spills on the winter road? (Island River, Smbaa K'e)</b></p>	<ul style="list-style-type: none"> <li>• No differences were found between the Smbaa K'e sites for the amount of oil-related substances (hydrocarbons).</li> </ul>

Site-specific questions that the current CBM Program was not designed to answer:

- Does bridge construction affect water quality? (Ft. Providence)
- Are there effects from a hydrocarbon spill on the water in Smbaa K'e near the ditch?
- What is the metal loading for Arctic Red River?
- What is the impact of municipal dumps or legacy sites?
- What is the cumulative effect of stressors (including upstream development and climate change) on the water quality?



# Acknowledgments

Many communities and organizations participated in this CBM program. These groups are recognized for their time and effort towards achieving the program goals. Thank you!

- Aklavik – Renewable Resource Council, Hunters & Trappers Committee
- Behchokò – Tłjchò Government
- Dettah and N'dilo – Yellowknives Dene First Nation
- Fort Fitzgerald – Smith's Landing First Nation
- Fort Good Hope – Yamoga Land Corporation, Community Council, Métis Land Corporation and Renewable Resource Council
- Fort Smith – Métis Land Corporation, ENR local office, and Renewable Resource Council, Northwest Territory Métis Nation, Salt River First Nation, and the Town of Fort Smith
- Fort McPherson – Renewable Resource Council
- Fort Providence – Dehcho First Nation
- Fort Resolution – Deninu Kue First Nation and Fort Resolution Métis Council and the Hamlet of Fort Resolution.
- Fort Simpson – Liidlii Kue First Nation
- Hay River and Hay River Dene Reserve – K'atl'odeeche First Nation, Dehcho First Nation AAROM
- Inuvik – Hunters & Trappers Committee
- Kakisa – Ka'a'gee Tu First Nation
- Lutsel'Ke- Lutsel'Ke Dene First Nation
- Nahanni Butte – Dehcho First Nation
- Norman Wells – Renewable Resource Council and ENR local office
- Sambaa K'e – Sambaa K'e First Nation
- Tsiigehtchic – Gwichya Gwich'in Council and Renewable Resource Council
- Tulita – Fort Norman Métis Lands and Financial Corporation and ENR local office
- Wrigley – Pehdzeh Ki First Nation
- Yellowknife- North Slave Métis Alliance

## *Other Water Partners supporting the program:*

- Dehcho Aboriginal Aquatic Resources and Ocean Management (AAROM)
- Ni Hat'ni Dene Program
- NWT Cumulative Impact Monitoring Program (NWT CIMP)
- Walter Duncan and Gordon Foundation





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