Bringing Water Quality Results Back to Your Community

2012 Results from the NWT-wide Community-based Water Quality Monitoring Program

Bear Mountain, Sahtu. Photo credit: GNWT/ Ryan Gregory

Northwest Territories Environment and Natural Resources

NWT-Wide Community-Based Water Quality Monitoring Program

Northern Voices, Northern Waters: NWT Water Stewardship Strategy (Water Strategy (2010)) was created by NWT water partners, including communities and Aboriginal, territorial and federal governments. Communities and Aboriginal Governments wanted to be more involved in and know more about water stewardship. Community-based monitoring (CBM) is an important way for NWT residents to be involved in water stewardship activities and is a key goal of the Water Strategy.

During the summers of 2012 and 2013, many NWT communities participated in the NWT-wide Community-based Water Quality Monitoring Program (CBM program). Thanks to the involvement and hard work of the communities and other water partners, the program is successfully underway.

One of the goals of the CBM program is to give NWT residents the opportunity to do water monitoring and answer community questions about water quality. Traditional and local knowledge and western science all play important roles in the CBM program.

Questions raised by community members that have guided the design of the CBM program include:

- Is the water healthy (at specific locations; related to local, regional, or outside-the-NWT concerns)?
- 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?

Environment and Natural Resources (ENR), Government of the Northwest Territories (GNWT), along with other water partners, have coordinating and supporting roles within the CBM program. These roles include:

- provide ongoing training and support to the community monitors to collect water samples using standard methods; and
- analyze the water quality data and provide results back to communities.

Other groups conduct water quality monitoring in the NWT and it is important to link all of the available information to help answer community questions and concerns about water quality.

NWT-wide Community-based Monitoring Water Quality Sites

What is Water Quality?

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

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Getting the results back to communities

The organizations involved in the CBM program have agreed that the monitoring results will be used for different levels of decision-making. The results are first shared with communities involved in the CBM program before being shared publicly. Communities are able to access the data collected and use it for local decision-making and other monitoring and research activities.

Trout Lake, Dehcho. Photo credit: Blair Carter

What data is presented in this brochure?

The CBM program uses sampling methods and different equipment to measure water quality. The different methods complement one another and together they provide useful information about water quality conditions at different places in the NWT. YSI sondes measures basic water quality parameters over longer periods of time. Grab water samples provide more detailed water quality information for a single point in time. To address some concerns related to contaminants in the water, the CBM program includes two types of equipment that can measure dissolved forms of oil and gas chemicals (PMDs) and metals (DGTs).

This brochure describes the way samples are collected and the different equipment used. The brochure summarizes water quality monitoring results sampled in 2012 between June and October.[1] All data from 2012 are not included, but communities can request further information to be provided to them. The results presented in this brochure provide information that can be helpful to communities and community members that are trying to answer questions such as those identified above. Providing monitoring results to communities on a regular basis is an important part of this program and ensures that communities have the opportunity to ask questions and provide feedback to guide the program to best meet their needs. This brochure was developed and distributed by ENR-GNWT in collaboration with the Centre for Indigenous Environmental Resources and support from the Walter and Duncan Gordon Foundation.

[1] 2013 CBM results will be presented in a separate brochure and distributed to NWT communities later in 2014.

Fort Good Hope, Sahtu. Photo credit: GNWT

Photo credit: GNWT

YSI Sondes measure temperature, pH, turbidity, dissolved oxygen, conductivity and chlorophyll-a every two hours for as long as the sondes are in the water. These measurements give us a basic understanding of the lake or river being monitored and can help us to see if there are changes over time. In 2012, a sonde was deployed around each community involved in the CBM program (a total of 13 sondes, with one sonde deployed in Trout Lake and one sonde at Island River).

Tulita, Sahtu. Photo credit: GNWT

Water Temperature

Water temperature tells us how warm or cold the water is.

Why is water temperature monitored?

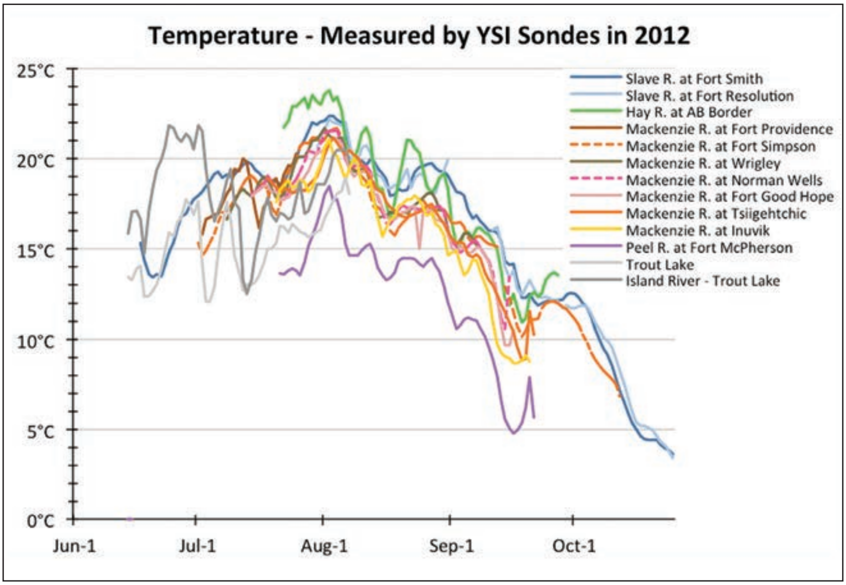
Measuring water temperature is an important part of water quality monitoring. Water temperature can have an effect on the kinds of plants, bugs and fish living in a river or lake.

Water temperature affects the amount of oxygen in the water. Fish need oxygen to breathe. Some fish can only live in colder water with lots of oxygen, so they move to deeper, colder water in the summer.

Water temperature gets colder as you go further north, as you go higher up (elevation) or as winter approaches. Human activity can affect water temperatures if warmer or colder water is released into a lake or river.

Results

The temperature results from the sonde show that the Slave and Hay Rivers in the southern NWT had the warmest water temperatures in 2012. Mackenzie River water was colder at the more northern sites, Tsiigehtchic and Inuvik, compared to the southern sites, Fort Simpson and Wrigley. The Peel River, which flows from the mountains in the Yukon, had the lowest water temperatures. Highest summer water temperatures were between 18-24°C at the end of July and decreased to between 3-14°C by mid-September.



Glossary of Units

°C: Degrees Celsius
NTU: Nephelometric Turbidity Units
mg/L: milligrams per litre
μg/L: micrograms per litre
ng/L: nanograms per litre
(1000000 ng = 1000 μg = 1 mg)
μS/cm: micro-Siemens per centimeter

pH

pH tells us how acidic or basic water is. The pH is measured on a scale of 0 (strongly acidic like battery acid) to 14 (strongly basic like bleach). Pure water has a neutral pH of 7 and rainfall is usually between pH 5-6.5. The pH of water is affected by the types of rock and soil (geology) that a river flows through. Water in the NWT is slightly basic because of the geology. The pH of water can change for natural (runoff from a storm) and human-caused (chemicals released to water or acid rain) reasons.

Why is pH monitored?

Trout, and other northern fish, can live in water that has a wide range of pH, from 4.1-9.5. Sudden shifts in pH can negatively affect plants, bugs and fish. At low (acidic) pH, some metals, like aluminum, lead or mercury, can change form and be taken up by plants, bugs and fish more easily.

Results

Across the NWT in 2012, the YSI sondes measured a pH range of 7.5 to 8.9, with an average of 8.3. The pH in 2012 was within range of long-term measurements by Aboriginal Affairs Northern Development Canada (AANDC) and Environment Canada (EC) at sites throughout the NWT.


Tulita, Sahtu. Photo credit: GNWT

Turbidity

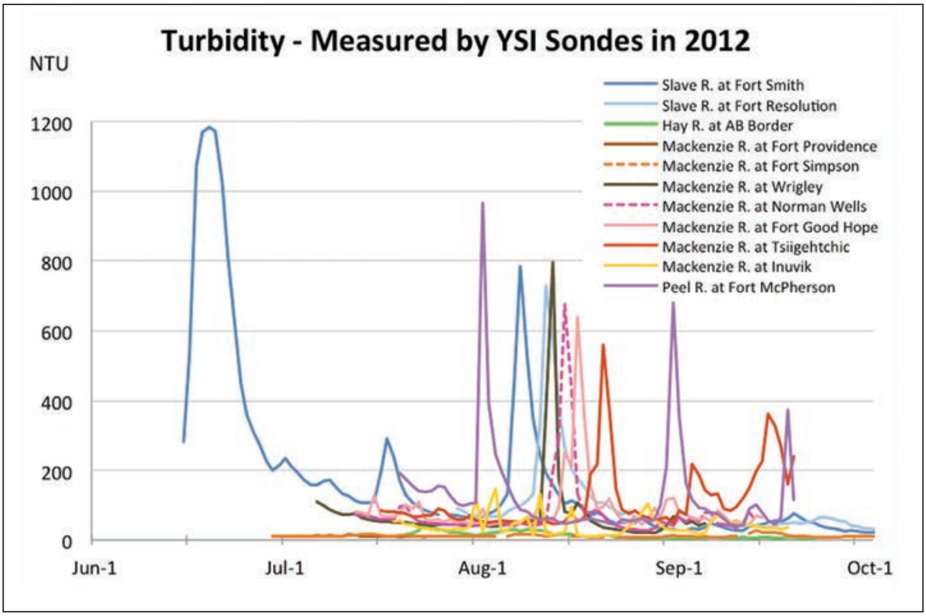
Turbidity tells us how cloudy the water is. Clearer water has lower turbidity, like under the ice in winter. The more silt, dirt, mud, clay or algae (particles) in the water, the higher the turbidity. Melting glaciers, forest fires, mining, logging or dredging activities can increase turbidity.

Why is turbidity monitored?

High turbidity can block light that plants need to grow. Large amounts of dirt in the water can make it harder for fish to see or breathe because their gills get clogged. Dirt can also cover and kill fish eggs laid on the bottom of a river or a lake. Contaminants can be attached to dirt and other particles. Contaminants attached to dirt are usually less available to be taken up by plants, fish, or bugs than those dissolved in water (like sugar in tea).

Results

In the NWT, a number of rivers have naturally high turbidity. On the Slave River in 2012, there were three turbidity peaks: in June from spring melt, and in July and in August when rain or high flows moved soil into the river. In August, a peak in turbidity travelled down the Mackenzie from Wrigley to Norman Wells, to Fort Good Hope and then to Tsiigehtchic. It took about 10 days for the water to travel from Wrigley to Tsiigehtchic. Turbidity decreased as the soil settled to the bottom or was diluted from other streams and rivers coming into the Mackenzie. Turbidity in 2012 was within range of long-term measurements by AANDC and EC at sites throughout the NWT.



Oxygen

Like animals living on the land, fish and bugs in the water need oxygen to breathe. Colder, fast-moving water, with lots of rocks to flow over and around, has more dissolved oxygen than slow-moving, warmer water.

Why is oxygen being monitored?

Increases in nutrients like nitrogen and phosphorous can increase the amount of algae in water. These increases can be from adding human or industrial waste, climate change or other sources. When a lot of algae die naturally and decay, dissolved oxygen can decrease and make it harder for fish to breathe. Most fish need more than 6.5 mg/L of dissolved oxygen to breathe. Most lakes and rivers in the Arctic do not have high levels of nutrients and algae, so fish kills under ice or during the warmest part of summer are rare.

Results

All of the dissolved oxygen measurements in 2012 were well above 6.5 mg/L and ranged from 7.9-13 mg/L.

Conductivity

When solids (like salts) are dissolved in water, the water can conduct (transfer) electricity. The dissolved solids come from the soils and rocks that water flows over. Conductivity is a measure of how easily electricity can move through water, which in turn tells us how much solid substances are dissolved in the water.Where there is little soil, conductivity is generally low. Waste from human activities can increase conductivity. Conductivity can also increase with higher water temperature. Conductivity for northern rivers is usually below 704 μS/cm, but the average is less than 300 μS/cm.

Why is conductivity monitored?

Large changes in conductivity can affect plants, bugs and fish.

Results

At sites throughout the NWT in 2012, conductivity was low and within normal range, from 173 to 455 μS/cm, with an average of 277 μS/cm.

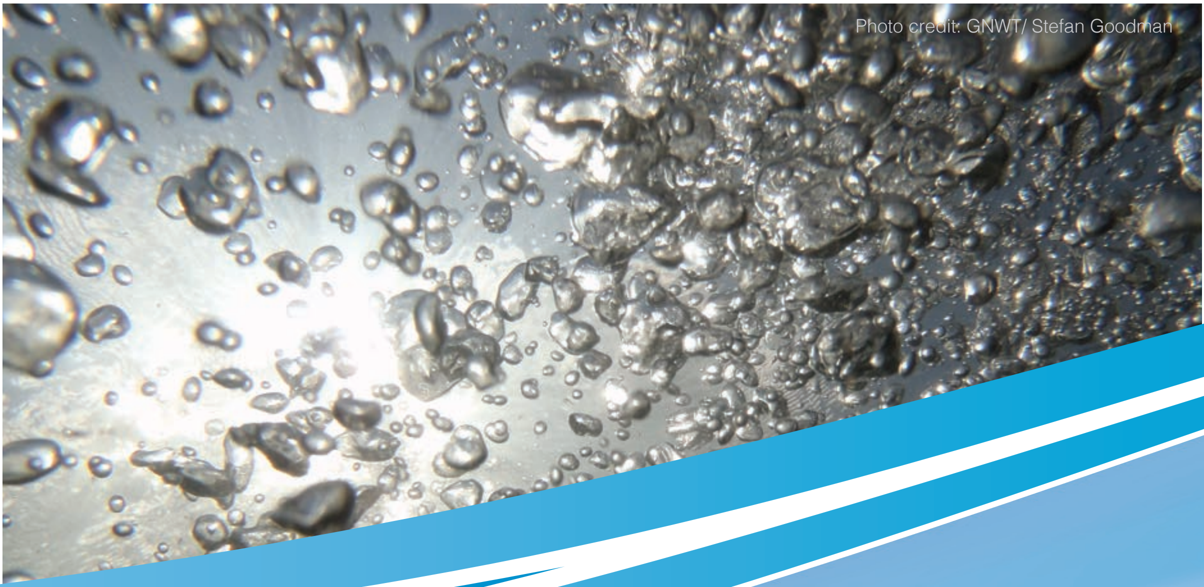


Photo credit: GNWT/ Stefan Goodman

Chlorophyll-*a*

Chlorophyll-*a* gives plants and algae their green colour. Measuring chlorophyll-*a* tells us how much algae is in the water. The amount of chlorophyll-a in the water is usually highest in late summer when there is the most plant growth.

Why is chlorophyll-*a* monitored? Algae can grow quickly and cause the water to look greener than usual. Human activities like putting human or industrial waste in water can increase nutrients and result in higher than normal amounts of algae. When a lot of algae die and decay, dissolved oxygen can decrease and make it harder for fish to breathe. High amounts of algae can make it harder for sunlight to get through the water. Most Arctic rivers and lakes have less than 8 *μ*g/L of chlorophyll-*a*. This low level is because it is cold and not as many nutrients are available for plants and algae to grow.

Results

The Chlorophyll-*a* measurements ranged from less than 1-8 *μ*g/L.

Tsiigehtchic, Gwich'in. Photo credit: GNWT

Photo credit: GNWT

PMDs (Polyethylene Membrane Devices) are passive samplers that stay in the water for one month, up to 4 times per summer, to measure oil and gas-related chemicals (hydrocarbons) dissolved in the water. PMDs act like sponges and pick up hydrocarbons in the water. PMDs are so sensitive that, if a cigarette smoker handles the PMDs, the hydrocarbons on their breath can affect the results.

Photo credit: GNWT

Diffusion Gradients in Thin-Films passive samplers (DGTs) act like sponges and pick up the toxic portion of dissolved metals in the water. DGTs are left in the water for 3 to 4 days. DGTs measure the concentrations of dissolved metals in the water over longer periods of time than sampling water on one occasion (a grab sample).

Hydrocarbons and Metals

Oil and gas chemicals (called hydrocarbons) and metals can be dissolved in the water (like sugar in tea) or attached to dirt in water (called particulate).

Rivers that carry more dirt (soil and other particles) in water often carry more metals because they are attached to dirt. Metals can come from natural (rock and soil) or human sources.

Hydrocarbons in water can occur naturally from forest fires and natural oil and gas deposits. Hydrocarbons can also be related to oil and gas development.

Why are hydrocarbons and metals monitored?

Hydrocarbons and metals dissolved in water are more able to get into plants, bugs and fish than those attached to dirt. Hydrocarbons and metals usually stay attached to dirt unless things like pH and temperature change. Fish reproduction and human health can be affected by certain levels of dissolved hydrocarbons and metals, so they are important to monitor.

Comparing Results to Guidelines and Long-term Data

Once water quality data has been collected it needs to be analyzed to see what the data means. One way to do this is to compare the data to guidelines that have been developed for specific substances. Guidelines are developed to tell us how much of a particular chemical or substance can be in the water before it might cause harm to fish and other living things. The CCME Canadian Water Quality Guidelines for the Protection of Aquatic Life were made for all of Canada, and are not specific for northern rivers. While these guidelines provide something we can compare to the data, they don't always account for the natural conditions (like more dirt, mud and silt in the water) of some of the northern rivers. Since metals attach to dirt, northern rivers sometimes have naturally high concentrations of some metals. Therefore, where CBM results show metal concentrations above the CCME guidelines, it is important to compare those results to similar rivers or lakes where metals in water have been measured for a long time, to see if the metals have been changing over time or if they are naturally high.

Comparing the data collected within the CBM program to long-term water quality data for the same lake or river is another way of interpreting what the data means. If metal concentrations from long-term monitoring have often (or always) been above the guidelines this means the river is likely naturally high in metals. In this situation, it is more important to look at whether metal concentrations have been increasing over time (which could be a cause for concern) or have stayed the same (which would mean things haven't changed, so less concern).

In Canada, there are no Canadian Guidelines for dissolved metals in water, just for the total amount of metals in water. Dissolved metals results from 2012 were compared to dissolved metal guidelines developed by the United States Environmental Protection Agency (USEPA). The guidelines used are called Criterion Continuous Concentration (CCC). These guidelines tell us the amount of dissolved metal that fish and other animals can be exposed to during longer periods of time without being harmed.

Frog Creek, Gwich'in. Photo credit: GNWT

There are no guidelines available for dissolved hydrocarbons in water. Dissolved hydrocarbons have been measured in northern rivers at around 15 ng/L. Scientists have found that fish health can be affected when dissolved hydrocarbons are above 400 ng/L.

Results

Dissolved metals

The DGTs collect dissolved forms of 11 metals:

- aluminum;
- iron;
- manganese;
- cobalt;
- nickel;
- copper;
- zinc;
- cadmium;
- lead;
- vanadium; and
- methyl mercury

In 2012, DGTs were deployed at 22 sites in the NWT. Afterwards, the DGTs were analyzed at Trent University in Peterborough, Ontario.

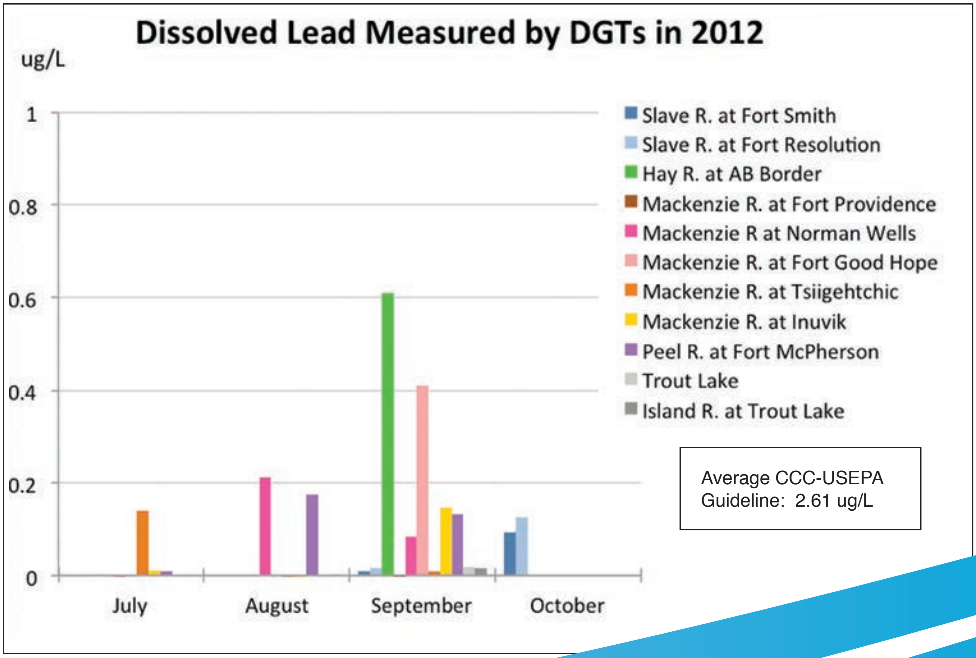
The average dissolved vanadium concentration for all NWT sites was 0.18 ± 0.09 ųg/L. The concentrations of Vanadium measured in NWT with the DGTs are approximately 500 times lower than the concentrations that are harmful to algae and fish.[3] There is no USEPA CCC guideline available for Vanadium.

[2] These findings have been reported in the following scientific papers:
- Sources and significance of alkane and PAH hydrocarbons in Canadian arctic rivers. (Yunker et al., 2002)
- Sensitivity of fish embryos to weathered crude oil: Part I. low-level exposure during incubation causes malformations, genetic damage, and mortality in larval pacific herring (Clupea pallasi). (Carls et al., 1999)

[3] Environment Canada, Health Canada (2010) Screening Assessment for the Challenge: Vanadium oxide (Vanadium pentoxide). Chemical Abstracts Service Registry Number 1314-62-1, September 2010.

Concentrations of dissolved nickel and lead were well below the USEPA CCC guidelines at all sites (see graph below showing dissolved lead measurements). The average USEPA CCC guideline for Dissolved Lead in 2012 was 2.61 ųg/L. While it may appear in this graph that dissolved lead increases from Norman Wells to Fort Good Hope, other samples from sites in between the two locations show there is variability in the data without a consistent increase, and always below the guideline. It is important to continue monitoring these sites to see if a pattern exists over time.

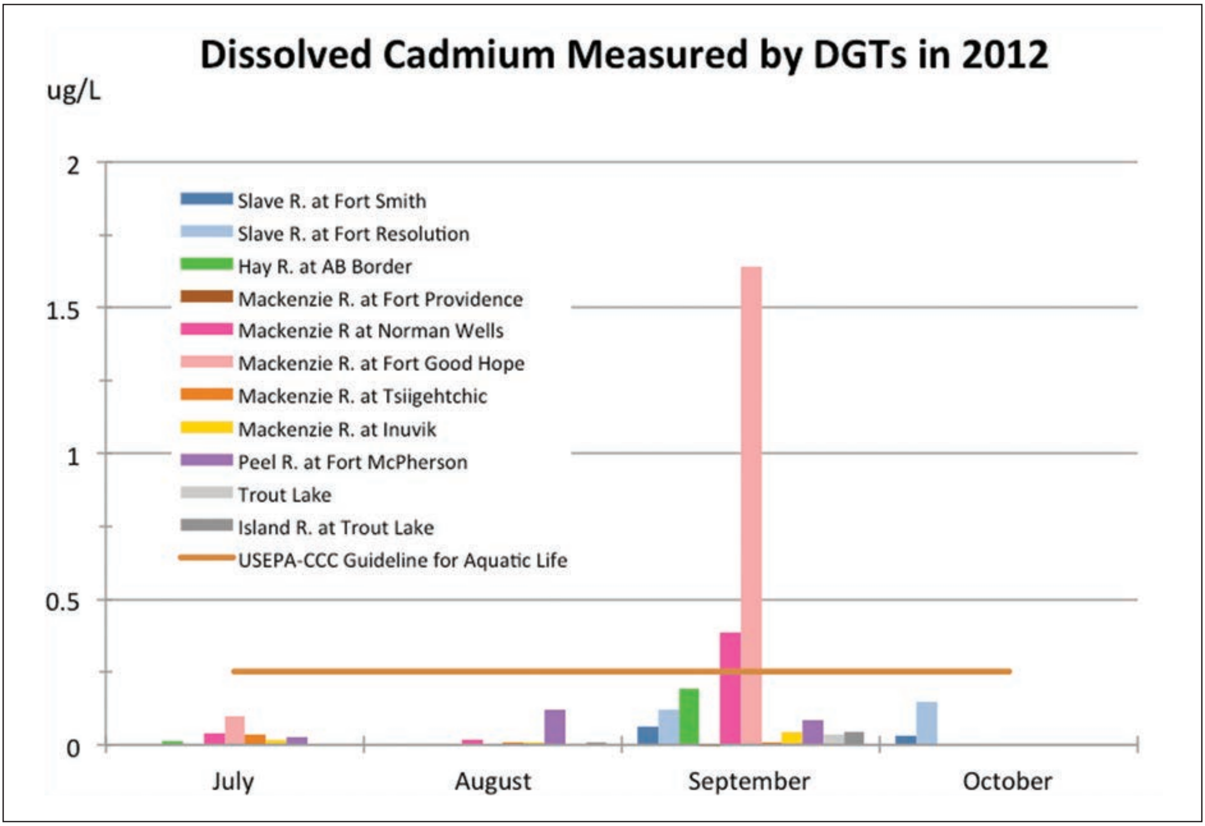
Dissolved copper, zinc and cadmium were sometimes measured at levels higher than the USEPA CCC Guidelines. The graph on the following page shows the dissolved cadmium concentrations measured in 2012 by DGTs. All dissolved cadmium concentrations were below the USEPA CCC guideline with the only exception of sites in Norman Wells and Fort Good Hope during the four day sampling period in September, 2012. The results from these specific sites are below the USEPA guideline for cadmium concentrations that fish and other animals can tolerate for shorter periods of time (USEPA CMC). While it may appear in the graph that dissolved cadmium increases from Norman Wells to Fort Good Hope, other samples from sites in between the two locations show there is variability in the data without a consistent increase. It is important to continue monitoring these sites to see if a pattern exists over time. We need to do further analysis to determine if these measurements are of concern or are normal for the Mackenzie River.



There are no guidelines available for dissolved aluminum, manganese, iron, and cobalt, but monitoring for these metals will continue to see if things change over time.

In 2012, dissolved methyl-mercury, the form of mercury that accumulates in plants, bugs and fish more easily, was measured by DGT. Total mercury (particulate and dissolved) was measured by grab water samples (for more information see section on grab samples).

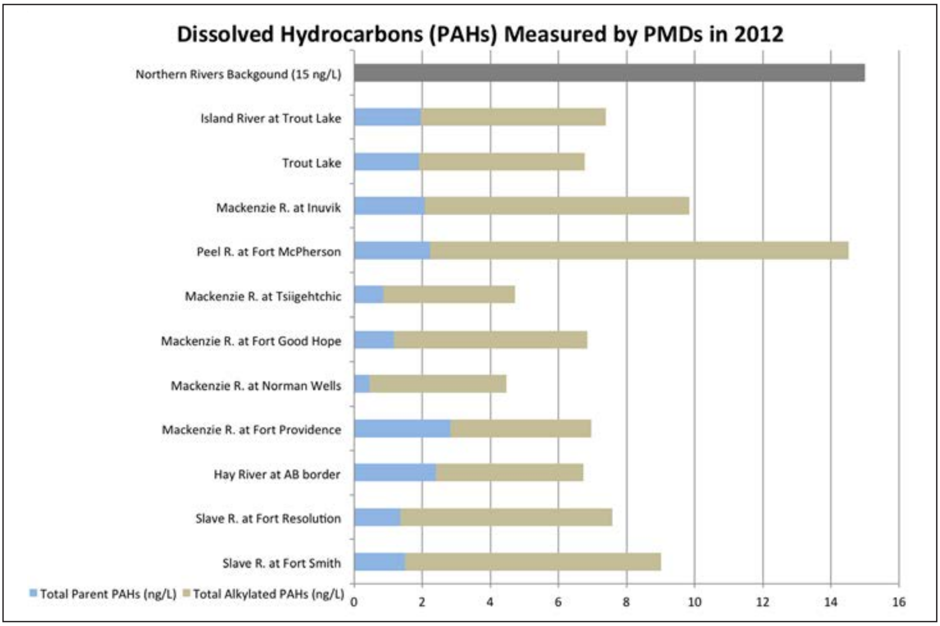
The analysis on methyl-mercury from the DGTs was not completed at the time this brochure was created, but will be included in future results reports. In 2012, mercury levels in grab water samples across the NWT were always lower than the detection limit. It is important to determine the mercury concentrations in water so that we can detect future trends if they occur. In 2013, grab water samples were measured using a technique that gets “ultra-low“ detection limits for mercury. These results will be included in a future brochure presenting 2013 CMB results.



Hydrocarbons

Hydrocarbon data presented in this brochure are grouped into two categories: alkylated, the form that has more impact on fish, bugs and plants, and parent; the form that has less impact on fish, bugs and plants. In 2012, PMDs were deployed at 22 sites in the NWT. The majority of the PMD samples were below 10 ng/L. Although well below levels that can affect fish health (400 ng/L), some of the highest levels of dissolved hydrocarbons in the NWT were found in water in the Peel at Fort McPherson (14.5 ng/L) , in the Mackenzie River at Inuvik (9.83 ng/L), and in the Slave River at Fort Smith (9.01 ng/L).

The results from the PMDs include the amounts of many individual hydrocarbons that are added up to give us total dissolved alkylated and parent hydrocarbons. When the results for the individual hydrocarbons are compared, the pattern (or signature) for the Slave River is similar to the pattern in the Alberta oil sands region, but at much lower concentrations.



What is a grab water sample?

A grab water sample is collected just below the surface of the water and tells us what is in the water at the time it is collected. Grab water samples are sent to Taiga Environmental Laboratory in Yellowknife where they are analysed. They are analysed for 75 parameters including pH, turbidity, conductivity, chlorophyll-a, nutrients and many total and dissolved metals. Grab water sample results can be compared to data from the YSI Sonde to double check that the Sonde is working properly. Grab water sample results can also be compared to long-term data sets.

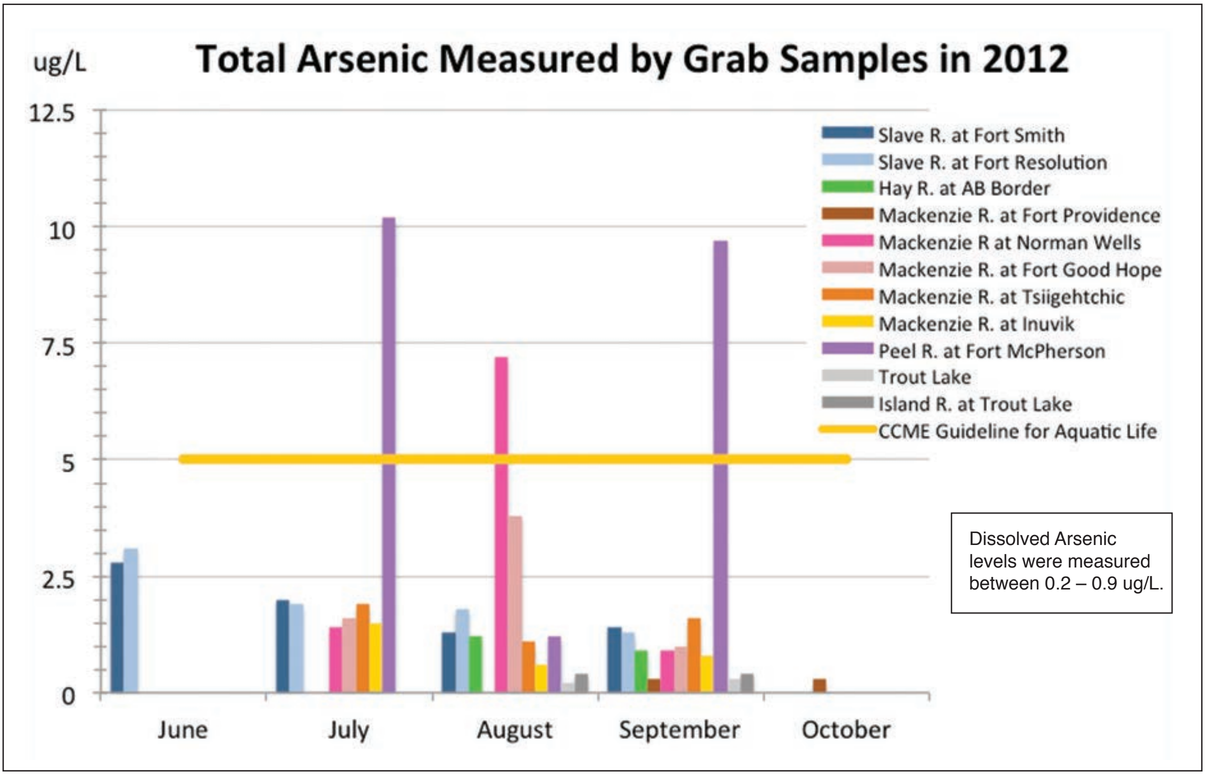
Photo credit: GNWT

Results

Some grab sample results are included in the 2014 Water Calendar and will also be available on the **nwtwaterstewardship.ca** website as they become available. Results for one parameter are presented below (total arsenic). If your community is interested in results for another parameter, please email: **nwtwaterstrategy@gov.nt.ca**

Arsenic is one parameter that is analyzed in a grab water sample. The data was compared with the Canadian Water Quality Guideline for the Protection of Aquatic Life for Arsenic. Some of the 2012 arsenic results were above the guideline for total arsenic (see graph to the right showing measurements for total arsenic). The vast majority of the arsenic in the water where guidelines were exceeded was attached to dirt (particulate form) and less available to plants, bugs and fish (the dissolved form). Metals were often higher during snow melt runoff (see Slave River) or after rain events (e.g. near Norman Wells in August, and Fort McPherson in July and September). All concentrations for total arsenic that were collected in 2012 were within the range of long-term data collected throughout the NWT. The long-term data for Peel River and Mackenzie River (at Norman Wells) show that exceedances have occurred in the past.

Photo credit: GNWT


Total Arsenic Measured by Grab Samples in 2012
ug/L
12.5
10
7.5
5
2.5
0
June
July
August
September
October
Slave R. at Fort Smith
Slave R. at Fort Resolution
Hay R. at AB Border
Mackenzie R. at Fort Providence
Mackenzie R at Norman Wells
Mackenzie R. at Fort Good Hope
Mackenzie R. at Tsiigehtchic
Mackenzie R. at Inuvik
Peel R. at Fort McPherson
Trout Lake
Island R. at Trout Lake
CCME Guideline for Aquatic Life
Dissolved Arsenic levels were measured between 0.2 – 0.9 ug/L.

Acknowledgements

Many communities and organizations participated in this CBM program. These groups are recognized for their time and efforts towards the program. Way to go!

- Aklavik – Renewable Resource Council, Hunters & Trappers Committee
- Behchokǫ̀ – Tłı̨chǫ 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 and ENR local office
- 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
- Inuvik – Hunters & Trappers Committee
- Kakisa – Ka'a'gee Tu First Nation
- Norman Wells – Renewable Resource Council and ENR local office
- Trout Lake – 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


Photo credit: Dehcho AAROM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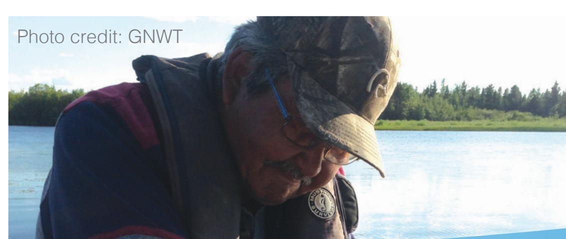
Photo credit: GNWT

Other Water Partners supporting the program:

- Centre for Indigenous Environmental Resources
- Dehcho Aboriginal Aquatic Resources and Ocean Management (AAROM)
- Inuvialuit Settlement Region Community-based Monitoring Program
- Ni Hat'ni Dene Program
- NWT Cumulative Impact Monitoring Program (NWT CIMP)
- Walter Duncan and Gordon Foundation
- Water Resources Division – Aboriginal Affairs Northern Development Canada


Photo credit: GNWT


Photo credit: GNWT

For more information about the CBM program and other NWT Water Stewardship Strategy initiatives, visit: **www.nwtwaterstewardship.ca**

Do you like this brochure? We welcome feedback on this and any ideas you have for how to communicate water quality results from the program to your community effectively and efficiently!

nwtwaterstrategy@gov.nt.ca


Photo credit: GNWT


Photo credit: GNWT

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Peel River, Gwich'in. Photo credit: GNWT

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