Aboriginal Affairs and Northern Development Canada | Affaires autochtones et Développement du Nord Canada

The Hay River

Water Monitoring Activities in the Hay River Region

Kátłoʼdehé at Enterprıse

Kátłoʼdehé ıs the South Slavey Dene name for the Hay Rıver. In Chıpewyan, the Hay Rıver ıs Hátłʼoresche. In Cree, ıt ıs Maskosį̀-Sį̀pıy.

The Hay River is a culturally significant river for Northerners and an integral part of the Mackenzie River Basin. Given its importance, there are several monitoring initiatives in the region designed to better understand the river and to detect changes. The information collected through these programs can also help to address questions that people may have. While amounts vary from year to year, the volume of water in the Hay River has remained relatively stable since monitoring began in 1963. Only a slight increasing trend in winter flow was revealed. Some changes in water quality were also found, such as increasing trends in phosphorus and decreasing trends in calcium, magnesium and sulphate. This means that the levels of these substances have changed since sampling began in 1988. Further work is needed to understand the ecological significance of these trends.

Overall, the water quality and quantity of the Hay River is good. Continued monitoring activities will increase our knowledge of this important river and identify change. It is important that all water partners work closely together on any monitoring initiatives.

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This Publication is also available in French under the title: La Rivière Hay : activités de
surveillance de l’eau dans la région de la rivière Hay.

The Hay River:

- is a culturally significant river for Aboriginal and non-Aboriginal Northerners.
- is an integral part of the Mackenzie River Basin.
- originates in northeastern British Columbia. The Hay River flows east into Alberta and the Hay-Zama Lakes region. From there, the river continues to flow east and is joined by its major tributary, the Chinchaga River. The Hay River then flows north for 702 kilometres and eventually discharges into the west basin of Great Slave Lake, Northwest Territories.
- on average, 115,000 litres of water passes by the town of Hay River each second. By comparison, the Slave River has an average annual flow rate of 3,400,000 litres each second.

The Hay River at Paradise Gardens

The Hay River watershed (Figure 1):

- covers an area of 51,700 square kilometres.
- supports the traditional lifestyle of residents from the communities of Enterprise and Hay River as well as the K'atl'odeeche and West Point First Nations in the NWT and in Alberta, the communities of Indian Cabins, Steen River, Meander River, Zama City, Habay, Chateh (Assumption), Rainbow Lake, Hutch Lake, Slavey Creek and Lutose.
- provides important habitat for a wide variety of fish, animals and migratory birds.
- supports resource development including forestry and oil and gas activities.
- has a very low population density, with less than two people per km^2 in most of the basin. The Town of Hay River, located at the mouth of the river on Great Slave Lake, is the most heavily populated community in the basin, with a population of approximately 3,600 people.

Top: Pat Martel of the K'atl'odeeche First Nation assisting with water sampling on the Hay River
Bottom left: The Hay River at Alexandra Falls; Bottom right: The "Old Village" of Hay River

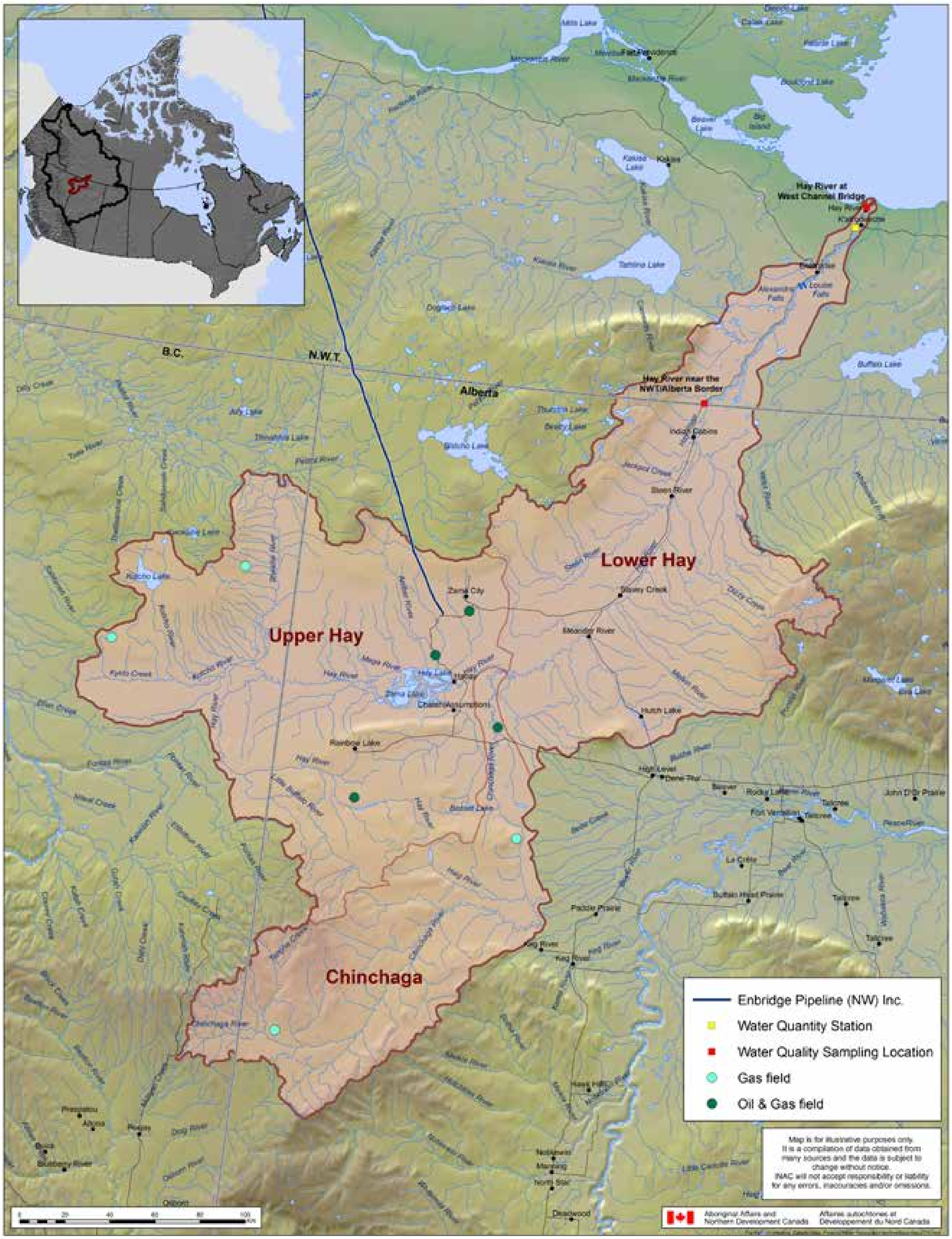


Figure 1: The Hay River Watershed

Purpose of the information in this handout

Data from Aboriginal Affairs and Northern Development Canada (AANDC) and Environment Canada (EC) were used to develop this handout. The objectives are:

- to provide a general overview of the current water quality, suspended sediment quality and flows in the transboundary reach of the Hay River
- to determine if water quality and flows have changed over time
- to help to address community concerns regarding the quality of water (based on the data collected) in the Hay River
- to share knowledge about some of the other water monitoring initiatives that are happening in the region

Some of these initiatives include:

- the Hay River flood forecasting research being carried out by the University of Alberta
- monitoring and management activities at the landfill by the Town of Hay River
- research taking place in the Tathlina Lake watershed
- the community-based water quality monitoring being supported by the GNWT (ENR) and Aboriginal Aquatic Resource and Oceans Management Program (AAROM)


Left to right: Robert Lamalice of the K'atl'odeeche First Nation preserving a water sample collected from the Hay River; The Hay River at the NWT/Alberta Border

Development in the Basin

Current resource development within the Hay River Basin is primarily oil and gas activity and forestry.

In the Northwest Territories, oil and gas exploration and production activities occur throughout the northwest slope of Caribou Mountains and the southeast areas of the Cameron Hills, which are important headwater areas for tributaries to the Hay River. In Alberta, oil and gas production developments occur primarily within the Hay-Zama Lakes area. The Enbridge (NW) Pipeline, completed in 1985, transports crude oil from Norman Wells in the Northwest Territories to Zama City in Alberta. The Enbridge Pipeline connects to a large network of operating oil and gas pipelines throughout Northern Alberta.

Although there are not any operating sawmills within the Basin, timber from within the region, particularly in and around the Chinchaga River area, are harvested for production.

Minor coal and mineral reserves exist within the Basin but there are not any active coal or metal mines.

Understanding water quality

Water quality varies naturally from place to place, with changing seasons, climate variations and the types of soil and rock through which the water moves. Water can carry plant debris, sand, silt and clay, making the water muddy or cloudy. This is measured as suspended solids.

Water also carries dissolved materials and metals from rocks, and dissolved salts such as calcium and magnesium. Nutrients in water such as phosphorous and nitrogen are important for aquatic plants. In general, these substances are not considered harmful to human or aquatic life.

There are generally three characteristics of water:

- Chemical (e.g. metal concentrations)
- Physical (e.g. temperature)
- Biological (e.g. bacteria, aquatic bugs and plants)

Although scientific measurements are used to describe the quality of water, it is not a simple thing to say that “this water is good”, or “this water is bad”. Water quality usually describes the water’s suitability for a particular purpose. For example, tap water that is perfectly good to drink might not be good enough for a sensitive species of fish because it lacks dissolved oxygen that fish need. On the other hand, bog or wetland water might taste bad and be smelly, but it is excellent water quality—for a bog and the plants and animals living there. When someone asks about water quality, they likely want to know if the water is good enough to drink and swim in, or if the quality of the water is suitable for aquatic plants and animals.

Guidelines are in place to protect water for aquatic life or specific uses, such as drinking and recreation. Comparing the levels of substances found in water to guidelines is one way to determine if the Hay River water quality is “good”. Good water quality generally means that the levels of substances are within the guideline values. The data from this study were compared to Health Canada’s Health-Based Guidelines for Canadian Drinking Water Quality and Recreational Water Quality, as well as to the Canadian Council of Ministers of the Environment (CCME) Guidelines for the protection of freshwater aquatic life.

Another way to understand water quality is to check whether water quality conditions have changed over time. Changes could be due to human activities and/or natural occurrences. This study looked at whether water quality has changed since 1988, when consistent sampling began in the Hay River at the NWT/Alberta Border.

What were the samples tested for?

Since 1988, 160 water and 12 suspended sediment samples have been collected from the Hay River and analyzed for many different substances. To understand the basic chemistry of the water and suspended sediment quality of the Hay River, samples are regularly analyzed for routine substances (such as pH, total dissolved solids, total suspended solids, alkalinity and organic carbon), nutrients (including phosphorus) and major ions (like calcium and magnesium). These types of measurements provide an indication of the natural conditions of the water. Is it clear? Is it salty? Is it nutrient-rich?

To help address concerns regarding development activities, water and suspended sediment samples are also tested for metals such as aluminum, arsenic, copper, lead, vanadium and zinc, as well as compounds such as organochlorine pesticides, PCBs and hydrocarbons. Some of these substances can be natural, but some are known to be associated with development activities. Certain metals and organic compounds can arrive in the North through the air from other parts of Canada and the world.

What data were used in this assessment?

Water and suspended sediment data for this assessment were obtained from the long-term sampling site located on the Hay River at the NWT/Alberta Border. Environment Canada (with financial support from Alberta Environment) has been collecting water samples from this location since 1988. Water and suspended sediment samples have also been collected by Aboriginal Affairs and Northern Development Canada (AANDC) since 2004. AANDC has been working with the K’atl’odeeche First Nation since 2010.

Flow data were obtained from the hydrometric (flow) monitoring station located on the Hay River at the Town of Hay River which has been operated by Environment Canada (Water Survey of Canada) since 1963.

These monitoring locations were established to characterize the water quality and quantity conditions in the Hay River near the Alberta/Northwest Territories provincial/territorial boundary.

Water quantity

The Water Survey of Canada operates a hydrometric (flow) monitoring station approximately 17 kilometres upstream of Great Slave Lake on the Hay River. The station has been in operation since 1963 and is jointly funded by AANDC and Environment Canada (EC). Water levels are recorded every day, year-round, and are then converted to an estimated flow value. Water quantity or flow is reported as the volume of water coming down the river per unit of time and it is generally measured in cubic metres per second (m^3/s). One cubic metre is equal to 1000 litres.

An average annual hydrograph is a graph that shows the average flow for a given day based on an average calculated from the data over a number of years. The Hay River hydrograph has a pronounced peak in May which clearly shows the importance of snow melt in the spring. The area under the hydrograph provides the average total annual flow volume. On average, about 3.6 billion cubic metres of water flow into Great Slave Lake each year via the Hay River (Figure 2).

> 1 cubic metre = 1000 litres = the amount of water that could fit into the back of a pickup truck

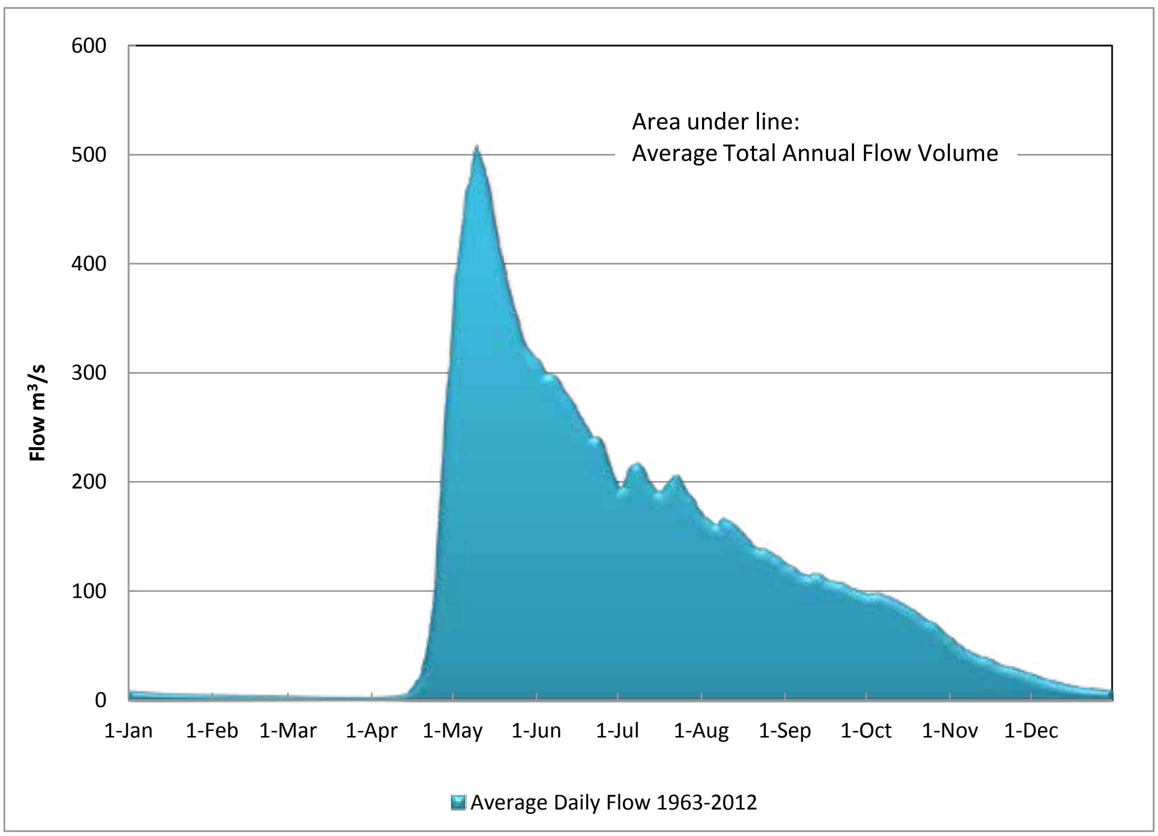


Figure 2: Hay River at Hay River average annual hydrograph, 1963-2012

Hydrographs can also show record high and low flow amounts that have been recorded on a particular day (Figure 3). For example, if you would like to know the highest or lowest flow recorded since 1963 on August 1 for the Hay River, the answer would be 569 m^3/s and 16 m^3/s, respectively. If you would like to know the average flow for the Hay River on November 5, the answer would be 51 m^3/s.

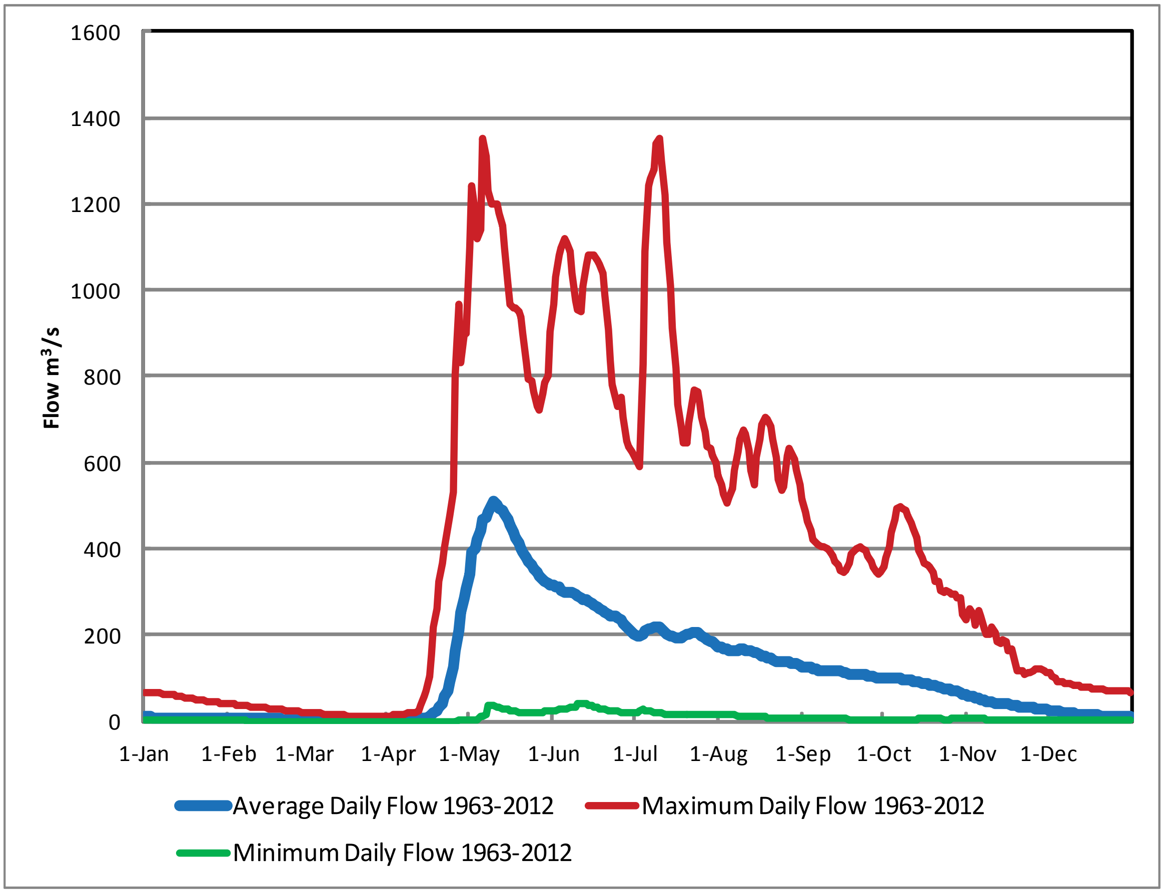


Figure 3: Hay River at Hay River average, maximum and minimum daily flows, 1963-2012

The annual hydrograph illustrates the average daily flow values for any one particular year (Figure 4). It is important to look at individual years in order to understand the amount of variability which can occur year-to-year in the same river. For example, in Figure 4, the shape of the hydrographs in 1989 and 1995 are similar, with both years indicating that flow events occurred at similar times (peaking in May and decreasing over the summer). However, the amount of water (volume) that the river contributed to GSL each year was very different, as shown by the differences in the height of the peaks. Also of note in Figure 4 is the shape of the 1988 hydrograph which is very different from the two other years graphed. In 1988, peak flow occurred in early July (rather than May) due to a series of large summer rain events in the watershed.

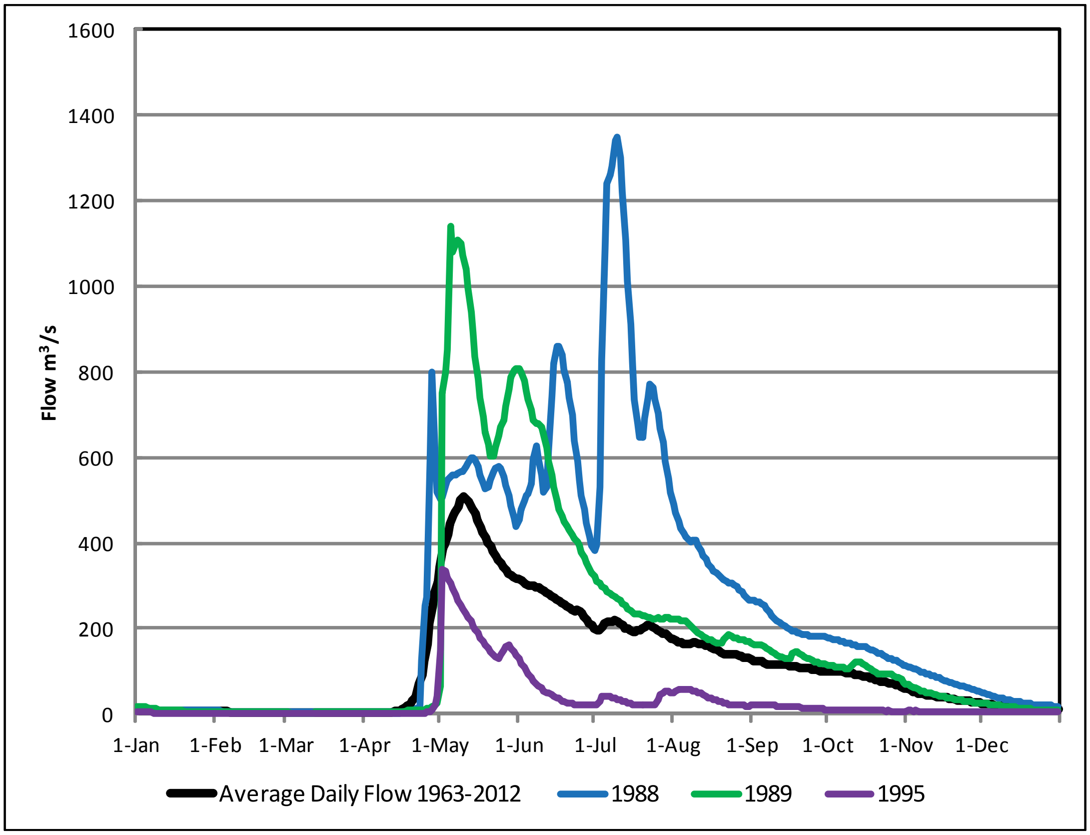


Figure 4: Hay River at Hay River annual hydrographs for 1988, 1989 and 1995

Have flows changed over time?

Like most rivers, the flow of the Hay River varies considerably both within any given year and year-to-year. Sometimes, however, we want to know if there is more or less water in the Hay River now than in past years. To answer this question, the data were examined for long term trends. The data were separated by season to ensure that a trend in one season did not mask a trend in another season. So we asked questions such as:

- Do the spring, summer, fall or winter flow data demonstrate a change over time?
- Does the entire flow dataset show any increases or decreases over time?

Based on the data, a moderate increasing trend in flow was found during the winter only. This winter trend was not strong enough to create a trend in the total annual flow volume (combined seasons). This means that although winter flows appear to be slightly higher in recent years than in past years, the spring, summer, fall and total annual flows (combined seasons) remain stable.

Hay River ice jam flooding: University of Alberta research project

The Town of Hay River is prone to severe ice jams and consequent flooding during spring break-up, often resulting in considerable damage to and loss of property. For example, during the spring breakup in 2003, residents of the West Point First Nation and Vale Island had to be evacuated from their homes. In addition, flights were disrupted at the Hay River Airport and severe bank erosion occurred near homes on the K'atl'odeeche First Nation Reserve. Most recently, minor flooding occurred on Vale Island during breakup in 2006 and an ice jam adjacent to the West Point Fishing Village in 2005 and 2007 meant that residents were briefly evacuated. The most recent severe flooding occurred in Hay River in spring 2008.

Town of Hay River flooding, 2008 [Photo courtesy of F. Hicks, University of Alberta]

The University of Alberta, supported by AANDC, started a research project to study how ice jams form and break up, to better understand and predict these events. The results of this study have been used to produce revised breakup forecasting models for the Town of Hay River, including:

- models that can predict expected breakup severity two to three weeks before breakup
- models that provide several hours of warning of the timing and magnitude of waves of ice and water from the release of upstream ice jams

These forecasting models are meant to be user-friendly and are currently being tested in collaboration with the Town Flood Watch Committee.

What leads to a big flood at the Town of Hay River?

According to the University of Alberta research, flooding seems to be strongly related to the peak flow in the river during the snowmelt period. Peak flow is the maximum flow in the river caused by melting snow. There is more flow when there is a lot of snowmelt runoff entering the river from upstream, especially if the snow melts very quickly and the runoff comes down the river over a very short period of time. Rainfall during breakup can speed up the snowmelt. As Figure 5 shows, moderate to large floods are more common when the peak spring flow is high–that is, 1000 m^3/s or greater. The risk of flooding is greatly reduced when the peak spring flow is less than 675 m^3/s.

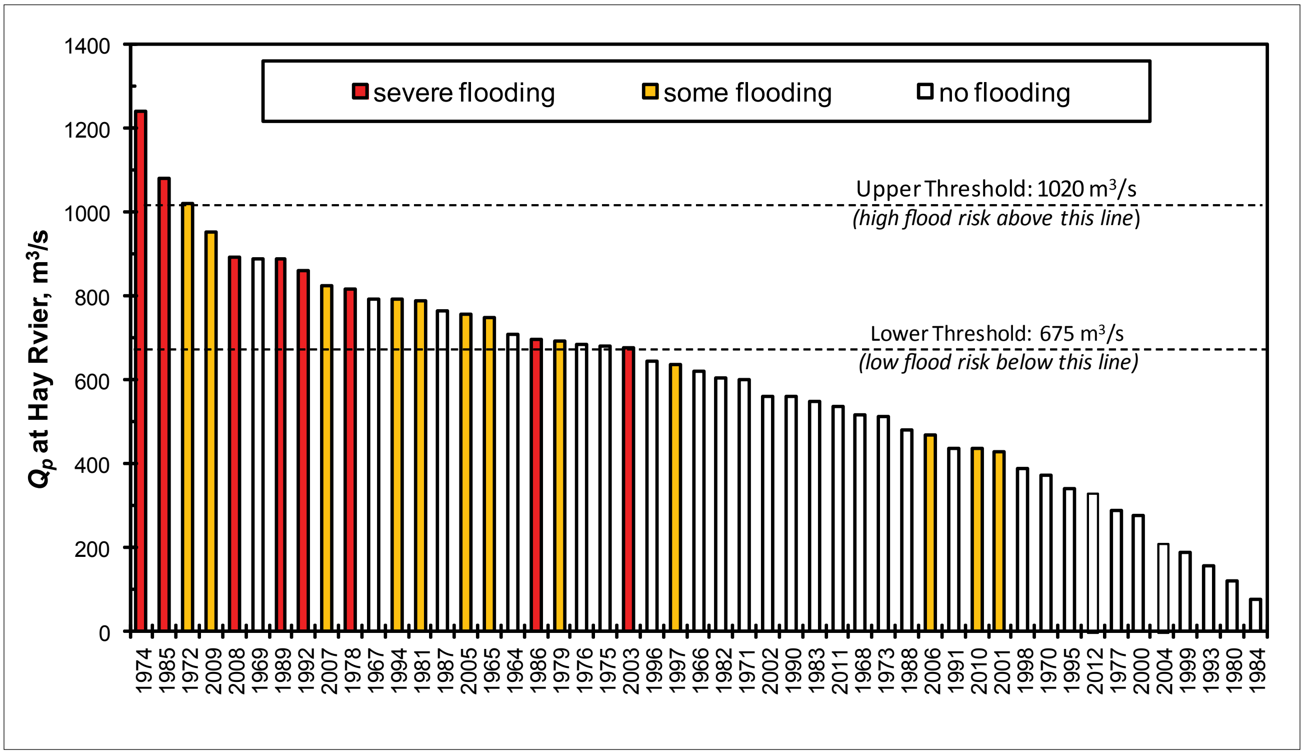


Figure 5: Effect of peak spring (snowmelt) flow on flood severity at the Town of Hay River (University of Alberta)

Where was the water in the fall of 2012?

During the fall of 2012, record low water flow volumes were recorded from October 22nd to 25th. While volumes remained low for the rest of the winter, they were no longer record lows. To provide a comparison, two other low water years were chosen (1980 and 1995, Figure 6). The total volume of water recorded in 2012 was more than twice as much as what was recorded in either 1980 or 1995, yet even in those low water years, the river recovered to more normal levels the following year.

As noted earlier, there was a modest increase in winter baseflow over the monitoring period but no other significant trends were found. Therefore, the fact that record low flows occurred over the four days in October 2012 should not be of concern at this time. The record low water can most likely be attributed to slightly below average precipitation in the upper part of the Hay River basin in 2012, as well as the onset of freeze-up during those days.

"Last fall, the Hay River was impassable by jet boat. Quads were being driven on the river where water once was and people could almost walk right across Alexandra Falls."

Trevor Beck,
Hay River Métis Local Métis Nation (February, 2013)

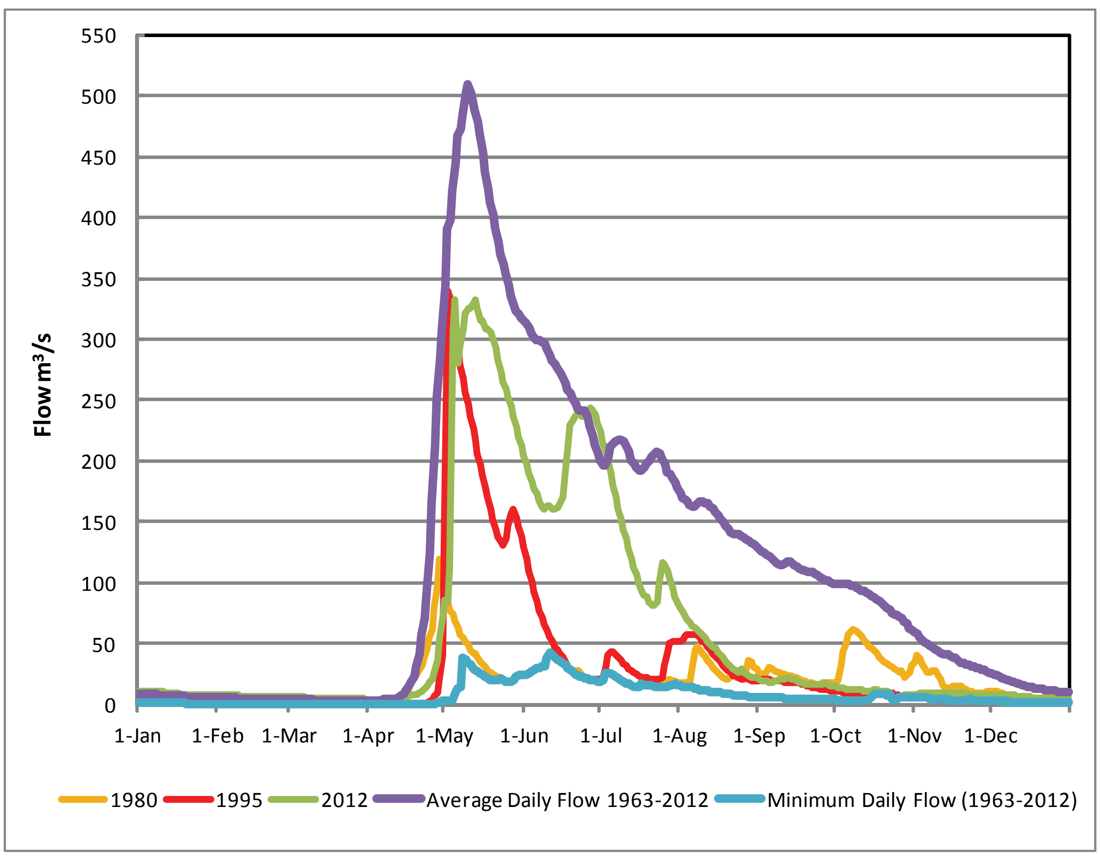


Figure 6: Comparing low water years (1980, 1995 and 2012) of the Hay River

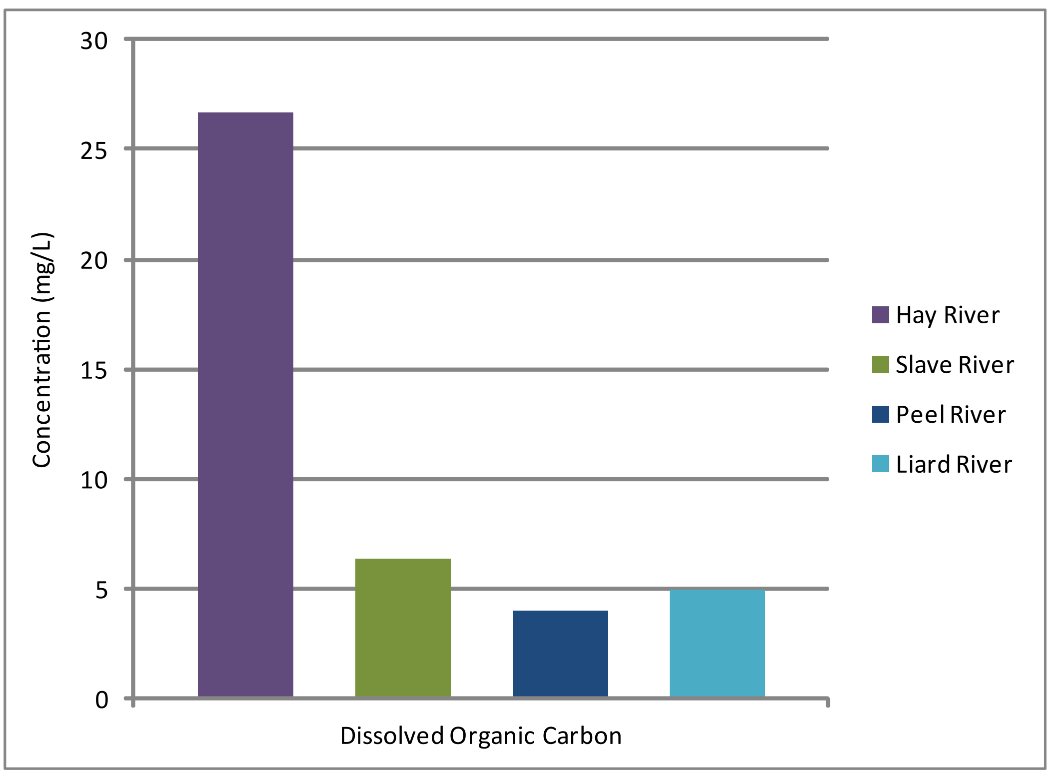
How is the water quality in the Hay River?

Good. The Hay River is safe for swimming and drinking after filtering and boiling for one complete minute. Additional detail is provided on page 28.

A little more on Hay River water quality...

> The colour of the Hay River is similar to the colour of water when you overwater a houseplant.

One of the most distinguishing features of the Hay River is its colour. The distinct tea-like colour is due to the presence of humic substances, tannins and lignins, which are natural compounds found in the soils through which the river flows. Humic substances are the end product of decaying organic matter. They are naturally present in soils, surface water, peat bogs, shales and areas underlain by coal. Tannins and lignins are part of a natural group of organic substances in soil, produced by decaying vegetation. Although the water is not specifically analyzed for these substances, their presence can be determined by measuring the levels of dissolved organic carbon (Figure 7).

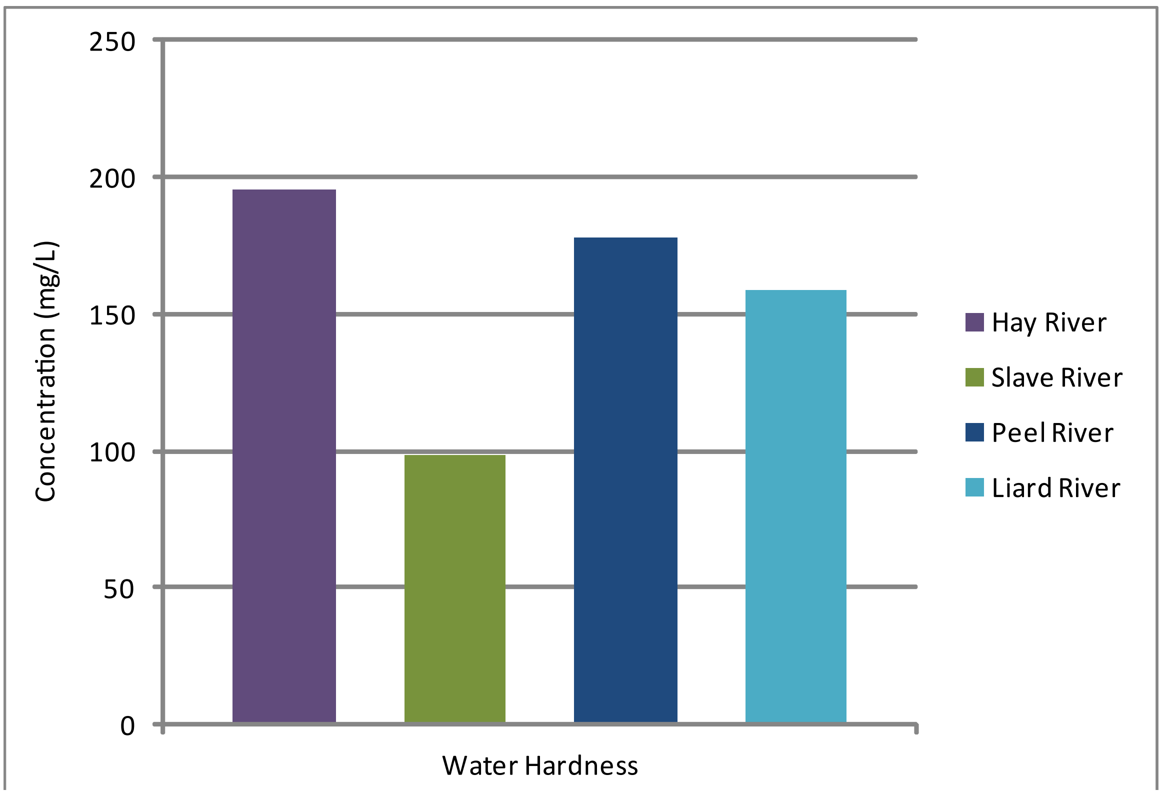


Hay (n=144; 1988-2010) Slave (n=208; 1980-2010) Peel (n=160; 1980-2010) Liard (n=208; 1980-2010) Data Source: Environment Canada

Figure 7: Comparing the average concentrations of dissolved organic carbon of the Hay, Slave, Peel and Liard Rivers. Humic substances, tannins and lignins, are complex natural organic compounds that give the Hay River its distinct tea-like colour.

Similar to the water in the Peel and Liard Rivers, water in the Hay River is considered 'hard' (Figure 8). High levels of calcium and magnesium are principally what makes water hard. Given the underlying dolomite (calcium magnesium carbonate) and limestone (calcium carbonate) formations in portions of the Hay, Liard and Peel basins, it is not surprising to find hard water in these rivers. Hard, or "mineralized" water, means you might need more soap to make bubbles when washing dishes. Hard water may also cause scaling or build-up in your tea kettle.

mg/L = milligrams/litre = ppm (parts per million) = one drop in a bathtub of water or 1¢ in $1 million dollars



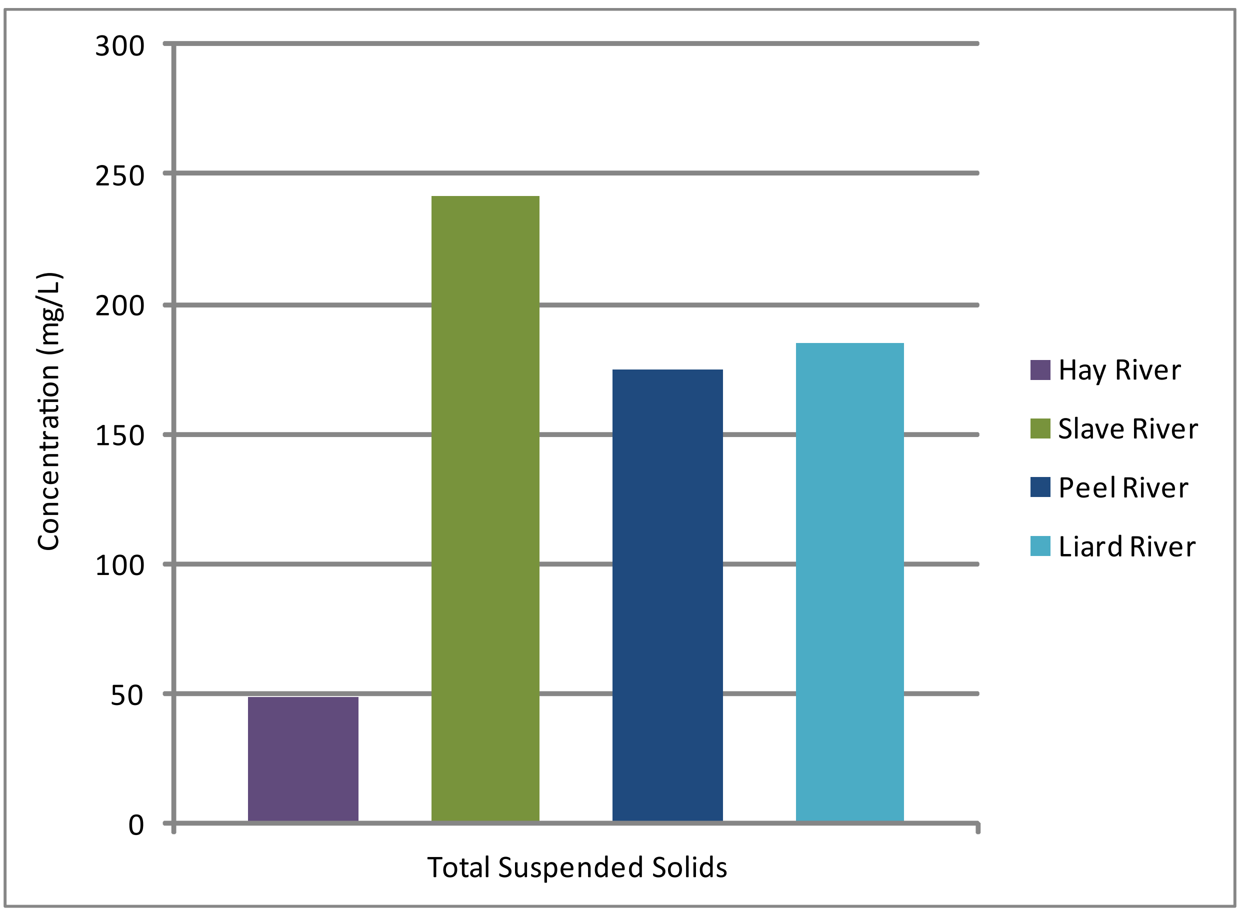
Hay (n=135; 1988-2010) Slave (n=177; 1980-2010) Peel (n=148; 1980-2010) Liard (n=213; 1980-2010) Data Source: Environment Canada

Figure 8: Comparing the average concentrations of water hardness between the Hay, Slave, Peel and Liard Rivers

Decreasing trends were revealed for calcium, magnesium and water hardness as well as sulphate, alkalinity and conductivity. This means that levels of these substances are lower now than they were when sampling began in 1988. In contrast, pH, a measure of the acidity or basicity of water, although still within the range of natural waters, has increased over time. Further work is needed to understand the ecological significance of these trends.

Nutrients such as nitrogen (N) and phosphorus (P) are essential ingredients required for the growth of plants. They may exist in a number of chemical forms (organic, inorganic, dissolved or particulate) as they move through the air, water and terrestrial environments. Relative to the Precambrian Shield, nutrient inputs from the Interior Plains region are high. The relatively high values for nitrogen and phosphorus reflect a greater natural nutrient supply from the more productive soils of the Interior Plains that have shallow, organic-rich wetland areas. Analysis of the Hay River water quality data revealed increasing trends in both phosphorus and nitrate/nitrite. An increasing trend in phosphorus was also revealed in the Slave River. Work is underway to try to learn why these rivers are showing these trends.

To measure the amount of Total Suspended Solids (TSS) in the river, a water sample is collected and sent to the laboratory. The technicians filter the water; the solids that are trapped by the filter are measured and reported as TSS. TSS can include a wide variety of material, such as clay, silt, sand, and decaying plant and animal matter. Large rivers with fast-moving water can pick up, suspend and move larger materials more easily than small, slow-moving waters. Generally, larger rivers carry more suspended solids. Relative to the other major NWT transboundary rivers, the Hay River has lower levels of suspended solids (Figure 9).



Hay (n=149; 1988-2010) Slave (n=210; 1980-2010) Peel (n=168; 1980-2010) Liard (n=201; 1980-2010) Data Source: Environment Canada

Figure 9: Comparing average concentrations of total suspended solids between the four major transboundary rivers, the Hay, Slave, Peel and Liard Rivers

Seasons also greatly influence the amount of suspended solids. Generally, the level of suspended solids is highest in the spring (May) when water levels are high, and lower during the fall (August) and winter (January) when water levels are lower. This relationship can be seen in Figure 10. Since most metals in rivers attach to the suspended solids, metal levels tend to be high when the sediment load is high (Table 1).

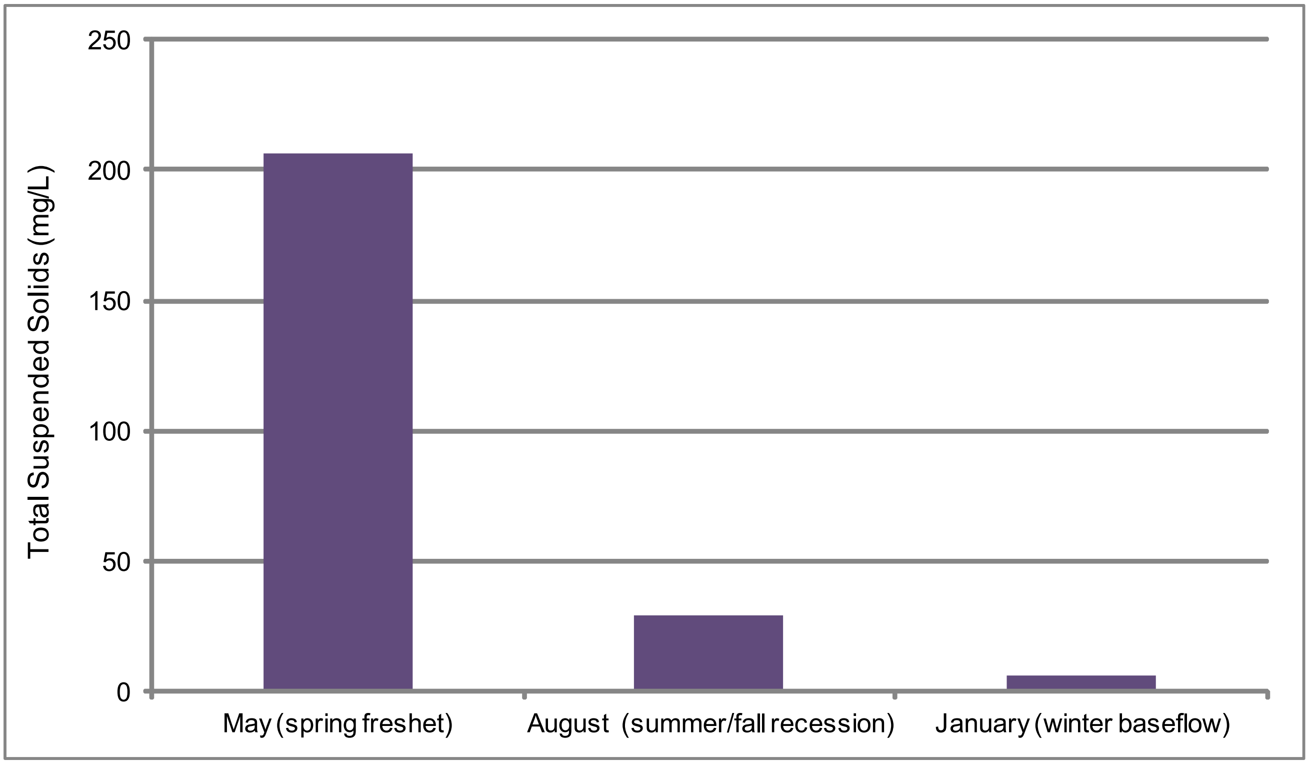


Figure 10: Comparing average concentrations of total suspended solids in the Hay River between May, August and January

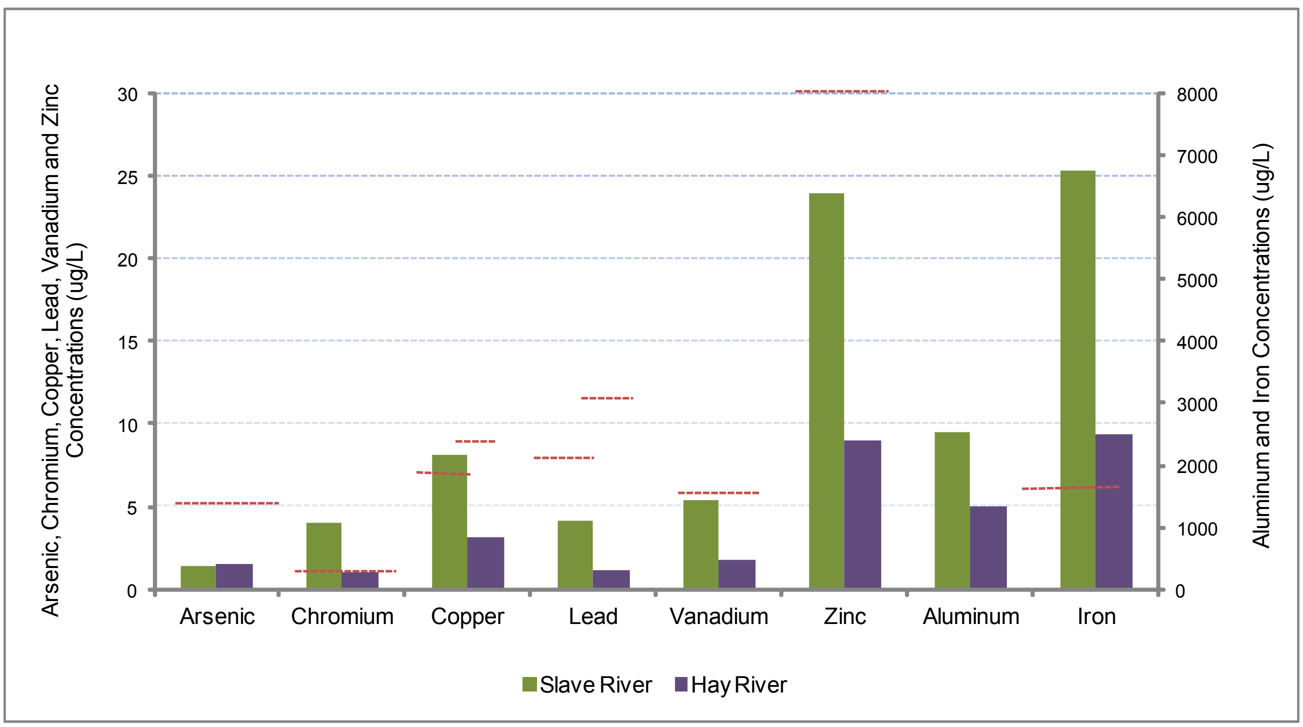
The Hay River - note the distinct tea-like colour of the water

Table 1: Comparing average concentrations of select total metals in the Hay River between May, August and January. Note that when the levels of total suspended solids are low, metals concentrations are low.

	May	August	January
	TSS_{avg}=206 mg/L	TSS_{avg}=29 mg/L	TSS_{avg}=6 mg/L
Aluminum (µg/L)	1919	330	68
Chromium (µg/L)	3.25	0.64	0.30
Copper (µg/L)	6.71	3.12	2.81
Vanadium (µg/L)	5.82	1.40	0.51
Zinc (µg/L)	22.9	5.5	4.8

Due to the relationships between river size (i.e. flow/volume), suspended solids and metal concentrations, rivers that carry a lot of suspended solids tend to carry a lot of metals. In the next figure, the levels of metals in the Hay River are compared to those in the Slave River.

It can be clearly seen that the Slave River carries more metals to Great Slave Lake than does the Hay River (Figure 11). This is mainly because the Slave River has more water and a higher suspended sediment load than the Hay River.



Data Source: Environment Canada [Slave (1980-2010) Hay (1988-2010)]

Figure 11: Comparing the average concentrations of select total metals between the Slave and Hay Rivers. Red dotted lines are the CCME guidelines for the protection of aquatic life. Note that the guidelines for copper and lead are corrected for water hardness (based on average hardness levels in each river). At this time, a guideline for total aluminum does not exist.

How do metal levels in the Hay River compare to water quality guidelines?

Metals, such as copper and zinc, are natural and essential to biochemical processes that sustain life. However, at high concentrations, these same metals can affect aquatic life. The toxicity and bioavailability of metals depends on the form in which they occur. Dissolved metals are generally thought to be important for the health of aquatic organisms as it is this form that may cause effects. Metals attached to particles in the water are not taken up as easily by aquatic bugs and fish.

Total metal levels in the Hay River were compared to the National (CCME) guidelines for the protection of aquatic life. When a particular CCME guideline was not available, the British Columbia guidelines were used. To date, total metals, including antimony, beryllium, cobalt, molybdenum, thallium and uranium, are within their respective guidelines. Some total metals, such as arsenic, lead, manganese, selenium, silver, vanadium and zinc, have exceeded their respective guideline on occasion (less than 25%[1] of the time). Other total metals, such as cadmium, chromium, copper and iron, have exceeded their respective guideline more frequently (more than 25% of the time).

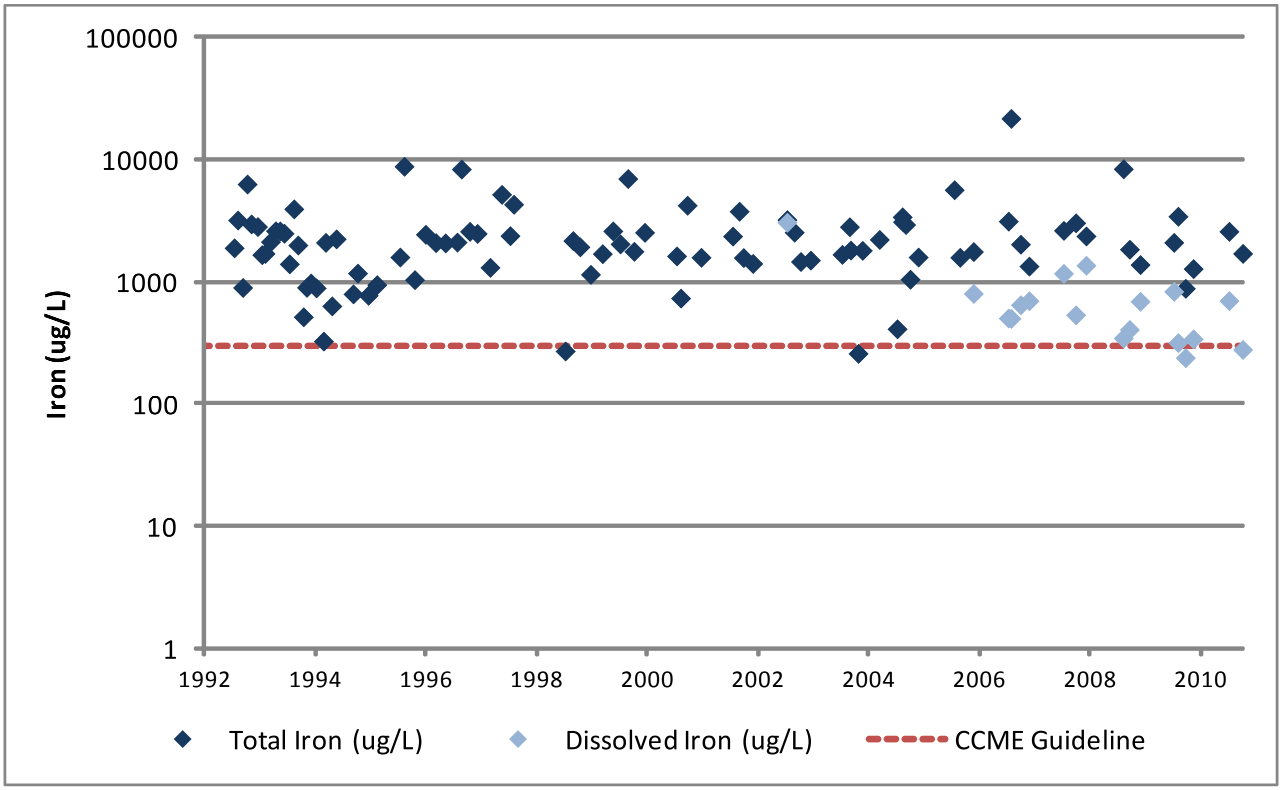
While both sets of guidelines are useful for a quick assessment of the river, they do not take into account specific conditions that make each river unique, such as the naturally high levels of organic carbon in the Hay River. An example is shown with iron and arsenic (Figures 12 and 13).

Figure 12 shows that the levels of iron in the water samples collected from the Hay River range from 257 to 21,500 micrograms per litre (µg/L). Almost all of the values exceed the aquatic life guideline of 300 µg/L (Figure 12). Is there reason for concern? Not necessarily. As no trend in total iron was found based on the data analyzed, it is likely that the total iron levels in the Hay River are naturally in this range. As a result, different guidelines might be necessary for different rivers. Water quality guidelines developed for a specific river are called "water quality objectives". Therefore, a higher site-specific water quality objective for total iron may be more appropriate for the Hay River. The same can be said for chromium and copper, metals that also routinely exceeded their respective guideline.

Over 25 different kinds of metals (both dissolved and total) are analyzed in each water sample collected from the Hay River. Dissolved metals are not visible in the water, like salt once it's dissolved. Total metals include both the dissolved metals AND the metals that are attached to particles suspended in the water (like pepper, these particles are visible floating in the water).

µg/L = micrograms/litre = ppb (parts per billion) = one drop in a large lake or 1¢ in $10 million dollars

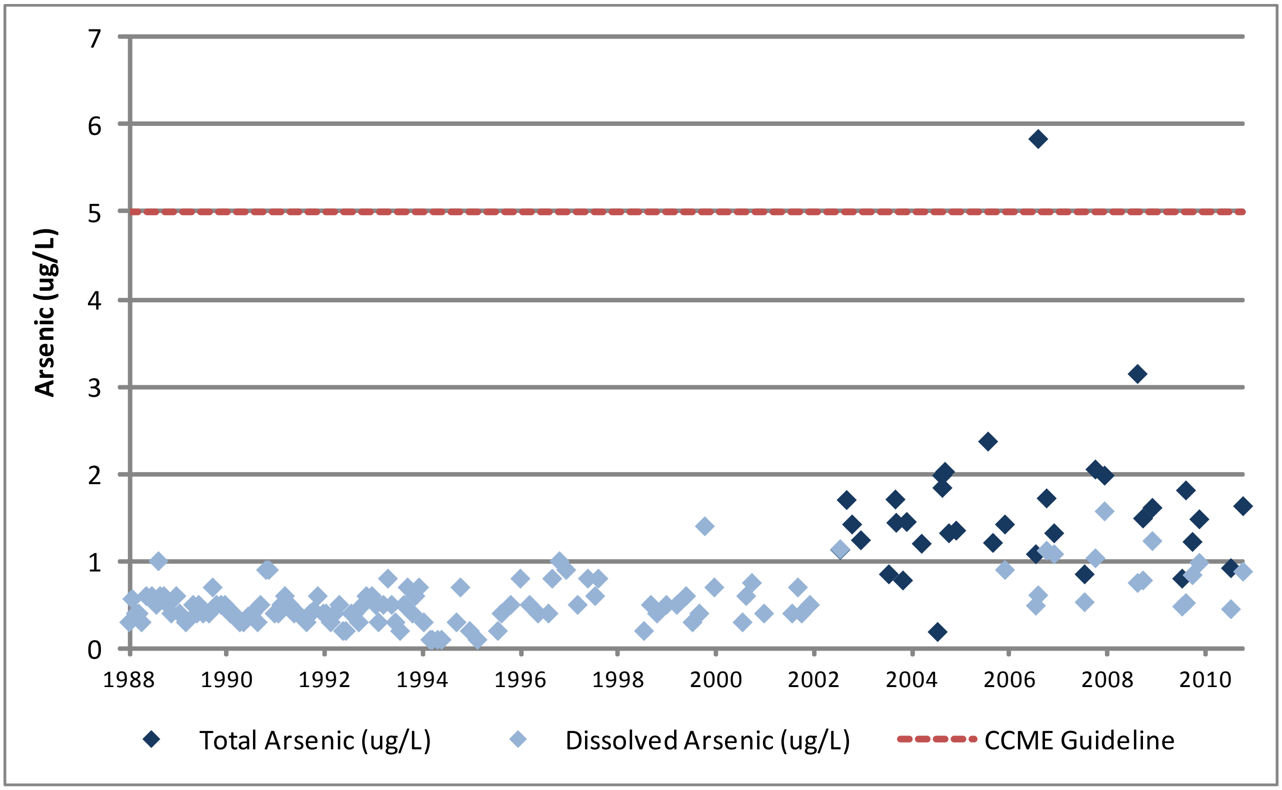
[1] 25% is an arbitrary number to differentiate between metals that exceed the guideline frequently to those that exceed the guideline less often.



Data Source: Environment Canada

Figure 12: Iron concentrations in the Hay River (1993-2010). Note that each diamond represents the amount of iron measured in one litre of water collected on a particular day.

In contrast, some metal levels are lower than the generic guideline. Figure 13 shows that total arsenic levels in the Hay River range from 0.2 to 5.8 µg/L with only one value exceeding the aquatic life guideline of 5 µg/L. Based on the arsenic data that have been collected to date, it is likely that the total arsenic levels in the Hay River are naturally in this range. Accordingly, a lower site-specific water quality objective for total arsenic may be more appropriate for the Hay River.



Data Source: Environment Canada

Figure 13: Arsenic concentrations in the Hay River (1988-2010). Note that each diamond represents the amount of arsenic measured in one litre of water collected on a particular day.

As site-specific water quality objectives are based on the existing water quality conditions of the specific river in question, objectives would provide a more relevant set of numbers against which future data could be compared. Also, site-specific objectives would help to evaluate the levels of substances, such as phosphorus, that presently do not have a generic guideline. Currently, the development of site-specific water quality objectives for the Hay River is being considered as a component of a transboundary water management agreement between Alberta and the Northwest Territories.

Are there persistent organic pollutants (POPs) in the water or suspended sediment of the Hay River?

The Hay River at the NWT/Alberta Border monitoring program includes the analysis of water and suspended sediment samples for human-made contaminants such as pesticides and polychlorinated biphenyls (PCBs).

Where possible, results were compared to the CCME guidelines for the protection of aquatic life. Guidelines do not exist for suspended sediment, so to provide some context, comparisons were made to bottom sediment guidelines.

Since 1994, 28 Hay River water samples have been analyzed for up to 40 different pesticides. Of these, guthion, HCB and pp-DDE were each detected on one occasion. Lindane was detected six times.

In May 2009, guthion was found in a water sample collected from the Hay River. It has not been detected since. Guthion is a pesticide used to control worms on fruit such as apples and cherries. Due to the potential risks to farm workers and aquatic ecosystems, the United States Environmental Protection Agency and the Pest Management Regulatory Agency of Health Canada decided that guthion would be phased out by September 2013.

HCB (hexachlorobenzene) is a fungicide used on wheat. It has not been used in Canada since 1972, however it can be released to the environment as a by-product during the production of chlorinated solvents and/or other pesticides. pp-DDE is a breakdown product of DDT, a chemical that was used in North America until 1972 to control pests. DDT is still used by some tropical countries to control malaria. Both HCB and pp-DDE were found in the water sample collected in June 1999. Neither has been detected since.

> Persistent Organic Pollutants (POPs) are made by humans. Some are pesticides for killing insects or diseases that attack crops. Some, such as polychlorinated biphenyls or PCBs, were used in electrical equipment. POPs are of concern as they can cause harm to living things and last a long time in nature. Most POPs in the North arrive through air or water currents from other parts of Canada and the world.

Lindane is the common name for a compound called hexachlorocyclohexane. Although the use of lindane as an agricultural pesticide has been banned, it is still used in some shampoos which are used to treat head and body lice. Lindane has not been detected in any samples collected from the Hay River since 2003.

In all instances, the concentrations of the pesticides detected in the water of the Hay River were low and below the CCME guidelines for the protection of aquatic life.

Of the 12 suspended sediment samples collected and analyzed for pesticides since 1995, triallate was the only substance detected and only on one occasion in July 2012. Triallate is an herbicide used to control weeds when growing certain legumes and grasses. At this time, no guideline exists for triallate in sediment.

In 1994, total PCBs were detected in two of the water samples that were collected from the Hay River. Although local and atmospheric sources of PCBs are possible, contamination from the laboratory is suspected because PCBs have not been found in any of the 14 water samples collected since that time. The level of detection used to measure PCBs is very small (ng/L; parts per trillion) and because of this, even a minor quality control issue in the laboratory could lead to sample contamination. Environment Canada and AANDC will continue to monitor for PCBs in the Hay River.

To date, total PCBs have not been found in any of the suspended sediment samples collected from the Hay River.

Polycyclic Aromatic Hydrocarbons (PAHs)

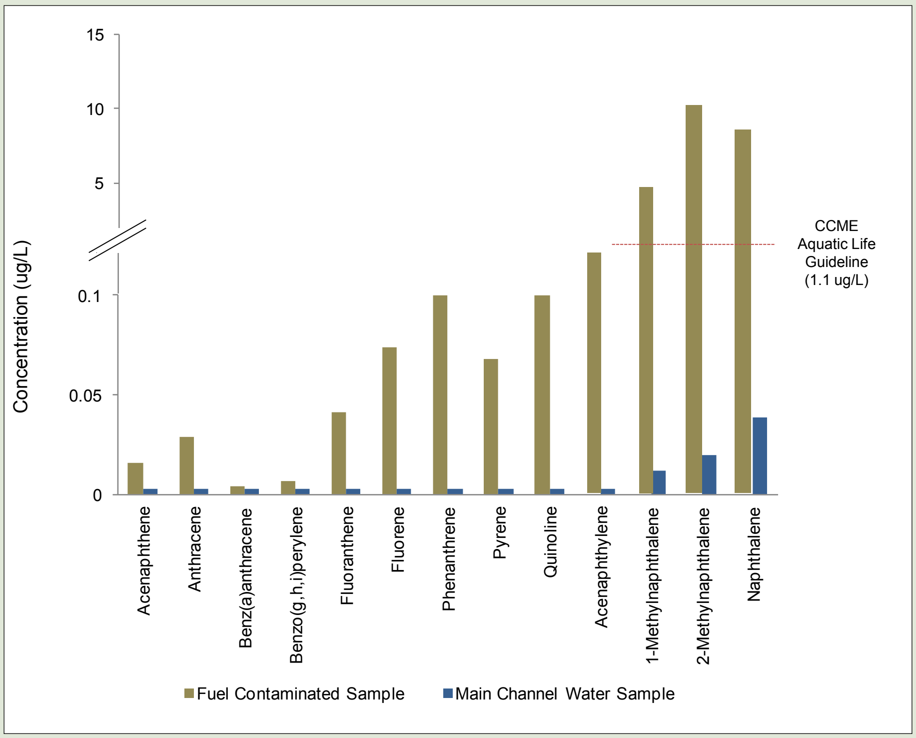
Hydrocarbons have both natural and human made sources. PAHs have been detected in both the water and suspended sediment samples collected from the Hay River.

Between 1994 and 2010, 35 water samples and 12 suspended sediment samples have been analyzed for up to 24 different hydrocarbons. Of these, seven different compounds have been detected in water on one occasion or more. In suspended sediment, 19 different compounds have been detected on one occasion or more. Observed concentrations in all samples were below the CCME guidelines for the protection of aquatic life.

Hydrocarbons, also referred to as polycyclic aromatic hydrocarbons (PAHs), are chemical compounds that are present in air, water and soil in small amounts virtually everywhere. Natural sources include forest fires, volcanic eruptions and natural oil and gas deposits. PAHs are also associated with industrial projects such as oil sands, conventional oil and gas activities and urban runoff. It can be difficult to differentiate between PAHs that are natural and PAHs that are present as a result of human activity. PAHs can cause harm to living things.

Case Study

Following an AANDC sampling event in September 2011, it was noticed that the two-stroke outboard motor on the boat had sputtered several small droplets of fuel on to the water. AANDC staff deliberately collected the fuel-contaminated water from the back of the boat and sent the sample to the laboratory to be analyzed along with the other Hay River main-channel water samples for comparative purposes. The water quality results of that comparison are shown in Figure 14.



It doesn't take much fuel to render water unsuitable for freshwater aquatic life. Unintentional leaks and spills, even small ones, do occur. We are all responsible for keeping our water clean. Take care when filling your outboard motor to avoid gas spills and if possible, use fuel efficient outboard motors which burn less gas and are better for the environment.

Data Source: Aboriginal Affairs and Northern Development Canada

Figure 14: Comparing the hydrocarbon results of a fuel-contaminated water sample to a water sample collected from the main channel of the Hay River. The CCME aquatic life guideline for naphthalene and its derivatives is 1.1µg/L. 2-methylnaphthalene in the contaminated sample exceeded the guideline by more than 10 times.

The levels of hydrocarbons, in particular naphthalene, in the fuel-contaminated water sample should stand out. Naphthalene is a polycyclic aromatic hydrocarbon made from crude oil or coal tar. It is also produced when things burn (e.g. cigarette smoke, car exhaust and smoke from forest fires) and may be found in domestic sewage and storm-water runoff. It is also present in gasoline and diesel fuels so it is not surprising that it was detected in the fuel-contaminated sample collected from the river. While most of the naphthalene from the water's surface would have evaporated into the air, some may have stuck to the particles in the water.

In 2011, the analysis of alkylated PAHs were added to the monitoring program. Alkylated PAHs are PAH compounds containing a straight carbon side chain. These compounds have been known to be specifically associated with oil and gas activities. Under the current program, more than 50 different hydrocarbons are analyzed in the water and suspended sediment samples that are collected. Alkylated PAHs can be detected by the laboratory at much lower detection limits than the conventional hydrocarbon compounds. As a result, several of these alkylated compounds have been detected at low levels in the samples that have been collected since 2011. Does this mean that there are now more hydrocarbons in the Hay River than there were before 2011? Not necessarily. It means that alkylated PAHs are good indicators of hydrocarbons in the river and will continue to be part of the monitoring program so that future levels can be compared to them. Unfortunately at this time, there are no guidelines for alkylated PAHs.

To further understand hydrocarbon levels in the Hay River, the Department of Environment and Natural Resources of the Government of the Northwest Territories recently partnered with the Dehcho First Nations AAROM (Aboriginal Aquatic Resource and Oceans Management) Program to support a community-based monitoring program for the Hay River. The program involves the collection of surface water samples, similar to what Environment Canada and AANDC do, as well as the deployment of passive samplers. Passive samplers are used to measure dissolved hydrocarbons. These samplers are very useful as they are left in the river upstream of the West Channel Bridge during the open-water season, for up to one month and therefore may detect hydrocarbons in the river that could be missed with conventional surface water sampling. The 2012 ENR results showed that the levels of dissolved hydrocarbons in the Hay River were all below the northern rivers background level (15ng/L) and a lot lower than levels that can affect wildlife and human health. Results will be presented to community members this year.

Clockwise from left: Robert Lamalice of the K’atl’odeeche First Nation helping to deploy passive samplers in the Hay River (these samplers remain in the river for up to one month); The beautiful Hay River near the NWT/Alberta border; Beaver and moose (Robert shared with us that the Hay River region is good habitat for these animals); Wild mint growing along the shores of the Hay River (this herb is harvested in the late summer)

Can I drink the water?

In Canada, the responsibility for drinking water safety is shared between the territorial, federal and municipal governments. The day-to-day responsibility of providing safe drinking water to the public generally rests with the Government of the NWT, while municipalities usually oversee the day-to-day operations of drinking water treatment facilities.

In conjunction with the provinces and territories, Health Canada developed the "Guidelines for Canadian Drinking Water Quality". These guidelines are used by every jurisdiction in Canada and are the basis for establishing drinking water quality requirements for all Canadians.

These guidelines are intended to be applied to treated tap water– not source water such as the Hay River. However, since "Can I drink the water directly from the river?" is an important question, the water quality results from the Hay River were compared to Canadian treated drinking water quality guidelines. As expected, due to the amount of suspended solids of the Hay River, not all metals met the guidelines. Many metals attach to the particles that are floating in the river water. However, when the water samples were filtered, removing the suspended solids, the drinking water quality guidelines for metals were met. This means that most of the metals can be removed by simply filtering the water.

It is very important to remember that no surface water can be guaranteed to be safe for drinking without treatment. Although waters in the North are generally of excellent quality, people should always be prepared to boil or disinfect all drinking water. Health Canada and the GNWT recommend heat as the oldest, safest and most effective method of purifying water. Bring the water to a rolling boil for at least one minute to remove bacteria. If the water is cloudy, as it often is in the Hay River, filter the water before boiling. Filtration of source water prior to boiling will provide additional protection.

Additional information on drinking wilderness water in the NWT can be found at: http://www.hc-sc.gc.ca/ewh-semt/pubs/water-eau/outdoor-plein_air-eng.php and http://www.maca.gov.nt.ca/operations/water/homepage.asp.

Remember to filter and boil river water before drinking it!

Town of Hay River Solid Waste Disposal Facility (the Dump): Water Monitoring

The Hay River Solid Waste Disposal Facility (SWDF) accepts all municipal and commercial waste from the Town of Hay River and the K'atl'odeeche First Nation. The SWDF is located approximately 200 m from the west bank of the river, seven kilometres south of the Town of Hay River. As part of their operating water licence, the Town is required to monitor surface water runoff and seepage quality from the SWDF. Public concerns have been raised about contaminants from the facility reaching the Hay River.

In 2001, the Town contracted EBA Consultants to carry out a groundwater quality sampling program. Based on the groundwater data reviewed, it seemed possible that the landfill was influencing groundwater quality, and that leachate[2] may be entering the Hay River. In 2009, another groundwater study was carried out. At that time, it was recommended that groundwater wells be sampled twice a year, and that surface water samples from Hay River be collected to understand background water quality. To date, the Town has installed eight groundwater wells– four of which are solely for the biotreatment pad– in and around the landfill. As well, two surface water sampling sites were monitored; one upstream and one downstream of the SWDF on the Hay River (Figure 15). Although the groundwater quality has been altered by the dump, the surface water quality results to-date show no evidence that the Hay River is being affected by the landfill. The Town continues to monitor surface and groundwater as a condition of their water licence.

In 2010, the Mackenzie Valley Land and Water Board (MVLWB) asked the Town, as part of their licence renewal, to design and implement a Drainage and Seepage Study. The results of the study suggested that better runoff and leachate management is required, including monitoring enhancements to improve the consistency and validity of the current sampling program.

In addition, the MVLWB recently asked the Town to reassess the location of its surface and groundwater monitoring sites to ensure that the current sampling frequency is adequate, and that the right substances are being measured. The Town is working on implementing this enhanced monitoring program, and results from the 2013 sampling season and assessment will be reviewed in 2014. The results of this review will be used to confirm the adequacy of the monitoring network, to formulate recommendations to improve waste management and operational efficiency, and to increase the lifespan of the facility.

Annual reports for the past few years are available on the MVLWB registry at http://www.mvlwb.ca. For more information, please contact Dustin Dewar at the Town of Hay River (867) 874-6522.

[2] Flowing water that drains from a landfill, having incorporated mineral, metals and contaminants, is called leachate.

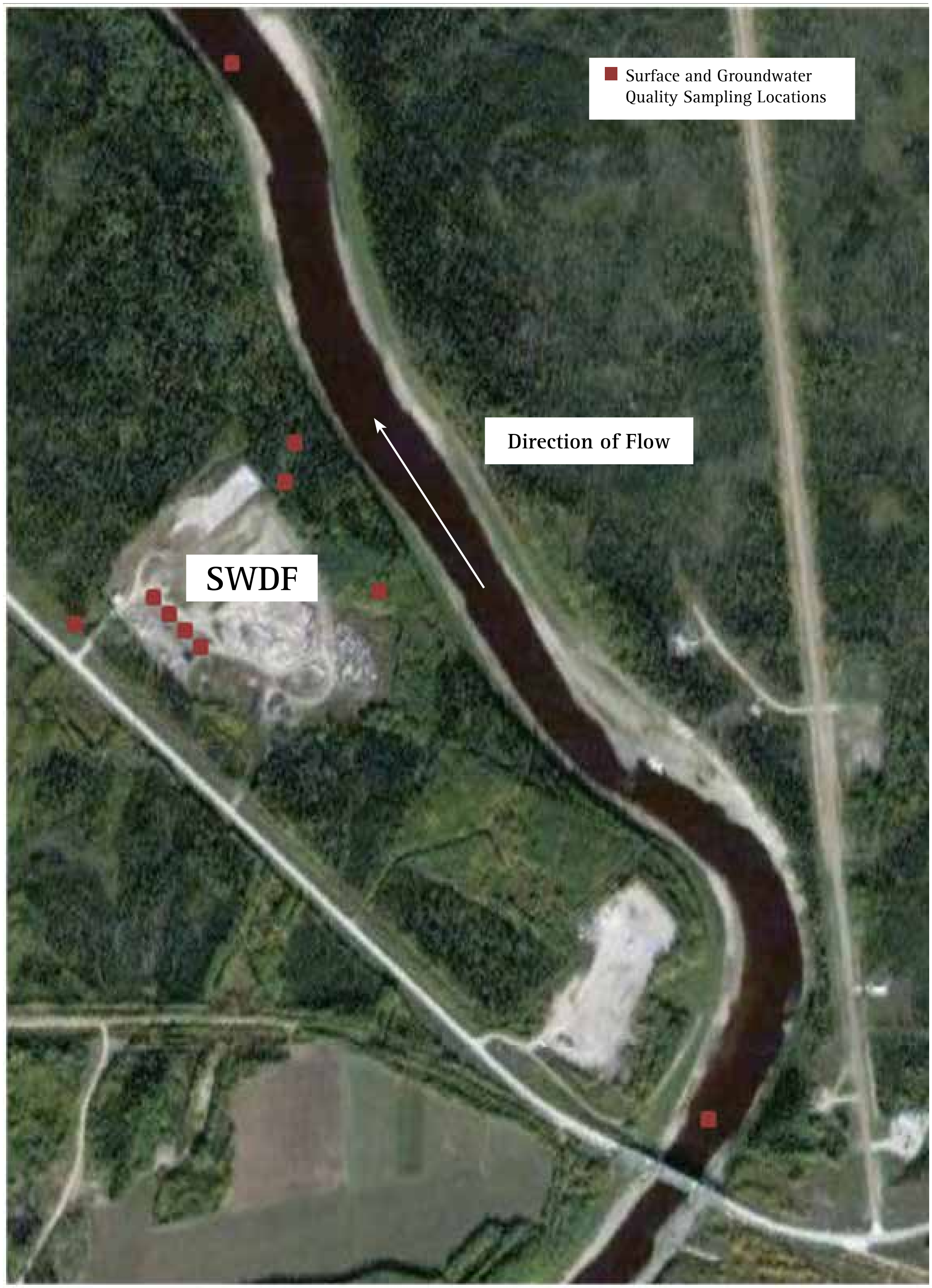


Figure 15: The Solid Waste Disposal Facility in relation to the Hay River. Note this map also shows the locations of the surface and groundwater quality sampling locations.

Investigating the cumulative impacts of environmental change and development in the Tathlina Watershed: CIMP-AANDC and Ka'a'gee Tu First Nation

The Cameron Hills, located in the southwestern area of the NWT, are the location of one of the few producing oil and gas fields in the Northwest Territories. As of 2013, five natural gas and six oil wells in the region are producing. Water in the area drains in two directions: north into the Kakisa River watershed, and southeast into the Hay River watershed (Figure 16). These regions are culturally significant for local First Nations, specifically the Ka'a'gee Tu and K`atl`odeeche First Nations. Band members and their ancestors have lived, hunted, trapped and fished in the area for thousands of years.

The Ka'a'gee Tu First Nation (KTFN) and the Cumulative Impact Monitoring Program (CIMP) of AANDC have initiated a multi-disciplinary research program in the Tathlina and Kakisa watersheds to investigate environmental change and the cumulative impacts of development and commercial fishing on the region.

Tathlina Lake supports a small commercial fishery, which employs KTFN members and contributes significantly to the economy of the community. Resource pressures and environmental change in the region have led the KTFN to question the effect of these influences on the current and future health of the aquatic system of the Tathlina watershed. The key community questions which direct the research within the program are "*Is the water safe to drink, are the animals and fish safe to eat, and will this change in the future?*"

This program was initiated and coordinated by the KTFN and CIMP, and involves the community, universities and government. An environmental coordinator, based in Kakisa, is employed as part of the research program. The coordinator is responsible for managing day-to-day activities and making sure that the program addresses questions of community concern.

Several water quality monitoring sites have been established that are equipped with continuous instream sampling equipment for most of the year (Figure 16). As well, water samples are analyzed for substances such as metals that may be associated with oil and gas activities. These data are also essential to establish an understanding of baseline water quality in the region to compare against future changes.

Detailed investigations were conducted in 2012-2013 in the Cameron Hills to evaluate the influence of oil and gas development on the Cameron River and lakes in the Cameron Hills. Investigations have included:

1) retrieving sediment cores from lakes adjacent to oil and gas facilities to examine historic contaminant loading over time

2) carrying out a nationally accepted protocol (Environment Canada – CABIN) to evaluate the aquatic health of streams, including information on water, sediment quality and contaminant loads in stream invertebrates

3) deploying passive membrane devices (PMD) along the reach of the Cameron River to monitor for the presence of hydrocarbons in the river

Results from this work will be presented to community partners once analysis is complete, beginning in December 2013. The information may also help inform possible future monitoring in the area which drains to the Hay River basin.

The Cameron River

Figure 16. The Cameron Hills in relation to the Hay River and Kakisa River watersheds. This map shows the location of oil and gas wells and monitoring sites in the region as well as the direction of surface water flow (blue arrows).

Next steps

Water quality and quantity continue to be monitored in the Hay River. Ongoing monitoring and sharing of information by all water partners are important to ensure the continued health of the Hay River in the Northwest Territories. Future results will be communicated as new information becomes available.

To help ensure that water and aquatic ecosystems in the NWT are managed cooperatively in a way that maintains healthy and diverse ecosystems, the governments of Canada (AANDC) and the Northwest Territories (ENR) are working with the Government of Alberta (Alberta Environment) to develop a bilateral water management agreement between Alberta and NWT. The process has been informed by the NWT Water Stewardship Strategy, which was jointly developed by AANDC, the GNWT and Aboriginal Groups. The transboundary agreement will provide guidance for the development of site-specific water quality and quantity objectives and ecosystem health indicators. These will result in a common and agreed-to set of conditions regarding water quality, water quantity and ecological integrity for the Alberta/NWT transboundary region.

The Hay River at Sunset

The Hay River

Thank you for your contribution to this handout!

Organization	Contribution
K'atl'odeeche First Nation	Field Assistance and Traditional & Local Knowledge as part of the AANDC Hay River Water and Suspended Sediment Monitoring Program
Hay River Métis Government Council, Northwest Territory Métis Nation	Field Assistance and Traditional & Local Knowledge as part of the AANDC Hay River Water and Suspended Sediment Monitoring Program
Ka'a'gee Tu First Nation and the Cumulative Impacts Monitoring Program (CIMP) of the Department of Aboriginal Affairs and Northern Development (AANDC)	Information regarding the Tathlina and Kakisa Watersheds Monitoring Program
Dehcho First Nations Aboriginal Aquatic Resource and Oceans Management Program (AAROM) and the Department of Environment and Natural Resources of the Government of the Northwest Territories (GNWT)	Information regarding the Hay River Passive Sampling Program
Fresh Water Quality Monitoring and Surveillance (Arctic and Athabasca Watershed) of Environment Canada	Long term water quality data for the Hay River
Water Survey of Canada of Environment Canada	Long term water quantity data for the Hay River
Town of Hay River	Information regarding the Water Quality Monitoring Program at the Hay River Solid Waste Disposal Facility
University of Alberta	Information regarding the Hay River Ice Jam Flooding Research Program

For more information, please contact Andrea Czarnecki, Aquatic Quality Scientist (AANDC) at 867-669-2509. If I can't help, I will be happy to direct you to the appropriate organization.