2015 Water Quality Report

for the

Slave and Hay Transboundary Rivers

as a requirement of the

Alberta-Northwest Territories Bilateral Water Management Agreement

Surface water quality data collected during 2015

October 2017

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Executive Summary

The Bilateral Management Committee (BMC) has prepared this Annual Water Quality Report as a component of the 2015-2016 AB-NWT BMC Annual Report to the Ministers. The report provides an assessment of water quality data collected in the 2015 calendar year and the cooperative efforts of the AB-NWT water quality technical team in the 2015-16 fiscal year.

The Bilateral Water Management Agreement commits the jurisdictions to establish transboundary water quality triggers and objectives for rivers classified as Class 3. The Agreement defines water quality triggers as an early warning of potential changes in typical (Trigger 1) and extreme (Trigger 2) conditions, which requires Jurisdictional and/or Bilateral Water Management to confirm (BWMA, 2015). This report was prepared based on existing Interim Transboundary Water Quality Triggers. The BMC is currently working on the development of Transboundary Water Quality Objectives.

At the time of signing, the interim triggers selected to identify changes in typical and extreme water quality conditions were the 50^{th} percentile (Trigger 1) and the 90^{th} percentile (Trigger 2), respectively. For this 2015 assessment, the historical annual 50^{th} percentile and the historical seasonal 90^{th} percentile were used as Trigger 1 and 2, respectively.

This report presents the 2015 transboundary assessment results, which includes comparison of the Slave and Hay River conventional water quality data to Trigger 1 and Trigger 2. Trigger 1 was assessed by flagging a parameter if more than 50% of its values were greater than its historical annual 50^{th} percentile. Annual, seasonal and piece-wise trend assessments were reviewed for all Trigger 1 flagged parameters to determine if concentrations were changing over time. To assess Trigger 2, a parameter with concentrations above its historical seasonal 90^{th} percentile was flagged and for context, was compared to its respective historical maximum values (seasonal and annual). Any parameter above its respective seasonal maximum value was evaluated further in the following manner: 1) trend assessments were reviewed, 2) flow conditions were examined and, 3) values were compared to existing guidelines.

Results show no concern with 54 of the 66 (81%) water quality parameters monitored in the Slave River during 2015 when compared to Trigger 1. Among the 12 flagged parameters, pre-existing statistically significant increasing trends were revealed for nitrate/nitrite and dissolved sulphate (annually, open-water season), and dissolved sodium (open-water). An assessment of Trigger 2 also shows no concern with 59 of the 66 (89%) parameters when compared to Trigger 2. Seven of the 66 parameters (9/590 results) had values greater than Trigger 2 on one or two occasions. Of these, dissolved magnesium was above its respective historical seasonal maximum value but still below its historical maximum value.

In the Hay River, there were no concerns with 33 of the 41 (80%) water quality parameters monitored during 2015 when compared to Trigger 1. No statistically significant increasing annual trends were revealed for any of the 8 flagged parameters. An assessment of Trigger 2 also shows no concern with 34 of the 41 (83%) parameters when compared to Trigger 2. Seven of the 41 parameters (7/131 results) were greater than Trigger 2 on one occasion (in October). Of these, dissolved sodium and sulphate were above their respective historical seasonal maximum values but still below their historical maximum values.

Of the parameters that were flagged, dissolved magnesium (Slave River), dissolved sodium and dissolved sulphate (Hay River) are collectively known as major ions which are present in natural source waters from the weathering of rocks and materials in the surrounding landscape. Major ions are dissolved salt constituents in water and tend to vary inversely with flow due to dilution. High concentrations during low flow normally reflect the higher-mineralized composition of groundwater whereas low concentrations reflect the lower-mineralized water from snowmelt and/or rainfall runoff. In 2015, fall flows in both rivers were very low. The low flows likely led to the higher concentrations of dissolved magnesium, sodium and sulphate and elevated concentrations (but not above any trigger) of other dissolved parameters observed in both rivers at that same time. The concentrations of these dissolved ions were well below the available federal/provincial use protection guidelines[1], posing no risk to existing uses.

The BWMA also requires the reporting of any toxic, bioaccumulative and persistent substances that are detected in the surface water of the Slave and Hay rivers. During the summer of 2015, three water samples were collected from the Slave and Hay rivers and analyzed for fourteen substances subject to virtual elimination. Total polychlorinated biphenyls (PCBs) were detected on all three occasions in both rivers but concentrations were low, not posing any risk to aquatic life. Results suggest that atmospheric transport, historical residuals and/or laboratory contamination may be the potential sources of these PCBs. No other virtual elimination substances were detected in any of the 2015 water samples. Monitoring for PCBs and other substances subject to virtual elimination will continue.

Overall, the majority of water quality parameters assessed in 2015 from the Slave and Hay rivers were within their historical ranges. The new seasonal maximum values for dissolved magnesium (Slave River) and dissolved sodium and sulphate (Hay River) are likely attributable to low water levels. Special attention will be given to these parameters and any trending parameters in the 2016 annual assessment as they may indicate potential changes in water quality in response to climate change and/or upstream land uses.

[1] A guideline does not exist for magnesium.

Next Steps

When the Agreement was signed in March 2015, the Parties acknowledged that work was required in several areas to fully implement the Agreement. The Parties recognized that they would learn together through implementation. The following tasks are underway:

1) Jointly review and assess the 2016 Slave and Hay river water quality data. Special attention will be paid to the parameters that were flagged in 2015.
2) Review water quality monitoring undertaken by ECCC and the NWT. Discuss possibilities of merging the two sets of monitoring data to increase annual sample size.
3) Explore methods to better use water quality data from upstream water quality monitoring sites to inform transboundary water quality assessment.
4) Continue collecting water samples for mercury analysis so that interim water quality triggers for mercury can be developed for the Slave and Hay rivers in the near future.
5) Explore other test statistics to identify changes in transboundary water quality.
6) Continue to work towards the development of water quality objectives and finalization of water quality trigger methods.

Table of Contents

List of Figures

List of Tables

1. Background

In 1997, Canada, British Columbia, Alberta, Saskatchewan, the Northwest Territories and the Yukon signed the Mackenzie River Basin Transboundary Waters Master Agreement. The Master Agreement commits all six governments to the following principles:

1. Managing the Water Resources in a manner consistent with the maintenance of the Ecological Integrity of the Aquatic Ecosystem;
2. Managing the use of the Water Resources in a sustainable manner for present and future generations;
3. The right of each to use or manage the use of the Water Resources within its jurisdiction, provided such use does not unreasonably harm the Ecological Integrity of the Aquatic Ecosystem in any other jurisdiction;
4. Providing for early and effective consultation, notification and sharing of information on developments and activities that might affect the Ecological Integrity of the Aquatic Ecosystem in another jurisdiction; and
5. Resolving issues in a cooperative and harmonious manner.

The Master Agreement also provides broad guidance for negotiating individual bilateral agreements between Provincial and Territorial jurisdictions. In March 2015, the Alberta-Northwest Territories Bilateral Water Management Agreement (BWMA) was signed. The purpose of the BWMA is to establish and implement a framework to achieve the principles of the Master Agreement. The BWMA will facilitate improved monitoring and reporting of upstream effects from development. It includes provisions to create ecosystem objectives, such as water quality and quantity and biological objectives, to maintain the ecological integrity of transboundary water ecosystems.

As part of the implementation of the AB-NWT Bilateral Water Management Agreement, the Bilateral Management Committee has prepared this Annual Water Quality Report for the Ministers. This report is intended to:

i. Describe the transboundary water quality monitoring programs used to assess the surface water quality of the Slave and Hay rivers (Section 2);

ii. Describe the approach to the 2015 water quality assessment (Section 3);

iii. Present and discuss the results of the 2015 water quality assessment (Sections 4, 5 & 6);

iv. Describe the activities of the AB-NWT water quality technical team in the 2015-16 fiscal and, provide recommendations for future water quality-related tasks for upcoming years (Section 7).

2. Transboundary Water Quality Monitoring Programs

2.1. Slave River

Along the transboundary reach of the Slave River, there are two transboundary long-term water quality monitoring sites operated under two distinct water quality monitoring programs.

These include:

1) Long-term Monitoring Network, Slave River at Fitzgerald (1960 to present), led by Environment and Climate Change Canada (ECCC).

2) Transboundary River Water Quality and Suspended Sediment Monitoring Program, Slave River at Fort Smith (1990-present), led by the Government of the Northwest Territories (GNWT).

Water quality data collected from these locations was used for this assessment.

Since 1960, ECCC has operated the Slave River at Fitzgerald monitoring site as part of their Long-term Monitoring Network. The water quality monitoring site is located near the community of Fitzgerald in Alberta, approximately 20 km upstream from Fort Smith. Since monitoring began at this location, water samples have been collected from two to thirteen times a year. In 2015, water quality samples were collected on nine occasions, in January, February, March, June, July (2), August, September and October. These samples were analyzed for conventional parameters including physical parameters, major ions, nutrients and metals, as well as organic substances such as pesticides, PCBs and hydrocarbons.

Since 1990, Indigenous and Northern Affairs Canada (prior to April 1, 2014) and the GNWT (post April 1, 2014) have operated the Slave River at Fort Smith monitoring site as part of their Transboundary River Water Quality and Suspended Sediment Monitoring Program. The water and suspended sediment monitoring site is located below the Rapids of the Drowned near the Town of Fort Smith. Since monitoring began at this location, water and suspended sediment samples have been collected from one to twelve times a year. In 2015, water and suspended sediment samples were collected on three occasions during the open-water season. These samples were analyzed for conventional parameters including physical parameters, major ions, nutrients, total and dissolved metals, as well as organic substances such as pesticides, PCBs, hydrocarbons and dioxins and furans.

To fulfill the water quality reporting requirements of the Bilateral Water Management Agreement, the conventional water quality results generated from the Slave River at Fitzgerald monitoring site and the results for substances subject to virtual elimination generated from the Slave River at Fort Smith monitoring site were reviewed (Table 1). The Slave River at Fitzgerald and Slave River at Fort Smith monitoring sites are shown in **Error! Reference source not found.**.

Table 1: Slave River parameters reviewed for the 2015 water quality assessment

Parameter Grouping	**Parameters**
Physical Parameters	alkalinity, dissolved oxygen, pH, specific conductance, total dissolved solids, total suspended solids, turbidity
Major Ions	dissolved calcium, dissolved chloride, dissolved magnesium, dissolved sodium, dissolved potassium, dissolved sulphate
Nutrients	ammonia, dissolved nitrogen, nitrate/nitrite, dissolved organic carbon, particulate organic carbon, dissolved phosphorus, total phosphorus
Metals (dissolved and total)	aluminum, antimony, arsenic, barium, beryllium, bismuth, boron, cadmium, chromium, cobalt, copper, iron, lead, lithium, manganese, molybdenum, nickel, selenium, silver, strontium, thallium, uranium, vanadium, zinc
Virtual Elimination (VE) Organic Substances	aldrin, chlordane, dieldrin, endosulfan, endrin, heptachlor, hexachlorobenzene, hexachlorobutadiene, hexachlorocyclohexane (HCH; alpha, beta, gamma), mirex, DDD, DDE, DDT, toxaphene, PCBs, pentachlorobenzene

2.2. Hay River

Along the transboundary reach of the Hay River, there is one long-term transboundary water quality monitoring site (**Error! Reference source not found.**), operated under two distinct water quality monitoring programs:

1) Long-term Monitoring Network, Hay River near the Alberta/NWT Border (1988 to present), led by ECCC.

2) Transboundary River Water Quality and Suspended Sediment Monitoring Program, Hay River near the Alberta/NWT Border (1995-present), led by GNWT.

Since 1988, ECCC has operated the Hay River near the Alberta/NWT Border Monitoring Program. Samples were collected on a monthly basis from October 1988 to 1994 and have been collected three to six times a year since 1995. In 2015, water quality samples were collected on four occasions in April, May, July and October. These samples were analyzed for conventional parameters including major ions, nutrients and metals, as well as organic substances such as pesticides, PCBs and hydrocarbons.

Since 1995, Indigenous and Northern Affairs Canada (prior to April 1, 2014) and the GNWT (post April 1, 2014) have operated the Hay River near the Alberta/NWT Border monitoring site as part of their Transboundary River Water Quality and Suspended Sediment Monitoring Program. Since this program was started, water and suspended sediment samples have been collected from one to three times a year. In 2015, water and suspended sediment samples were collected three times per year during the open-water season and analyzed for conventional parameters including major ions, nutrients and metals as well as organic substances such as pesticides, PCBs and hydrocarbons.

To fulfill the water quality reporting requirements of the Bilateral Water Management Agreement, the water quality results for conventional and substances subject to virtual elimination generated from the Hay River near the Alberta/NWT Border were reviewed (Table 2).

Table 2: Hay River parameters reviewed for the 2015 water quality assessment

Parameter Grouping	**Parameters**
Physical Parameters	alkalinity, dissolved oxygen, pH, specific conductance, total dissolved solids, total suspended solids, turbidity
Major Ions	dissolved calcium, dissolved chloride, dissolved magnesium, dissolved sodium, dissolved potassium, dissolved sulphate
Nutrients	ammonia, dissolved nitrogen, nitrate/nitrite, dissolved organic carbon, particulate organic carbon, dissolved phosphorus, total phosphorus
Metals (total)	aluminum, antimony, barium, beryllium, boron, cadmium, chromium, cobalt, copper, iron, lead, lithium, manganese, molybdenum, nickel, selenium, silver, strontium, thallium, uranium, vanadium, zinc
Virtual Elimination (VE) Organic Substances	aldrin, chlordane, dieldrin, endosulfan, endrin, heptachlor, hexachlorobenzene, hexachlorobutadiene, hexachlorocyclohexane (HCH; alpha, beta, gamma), mirex, DDD, DDE, DDT, toxaphene, PCBs, pentachlorobenzene

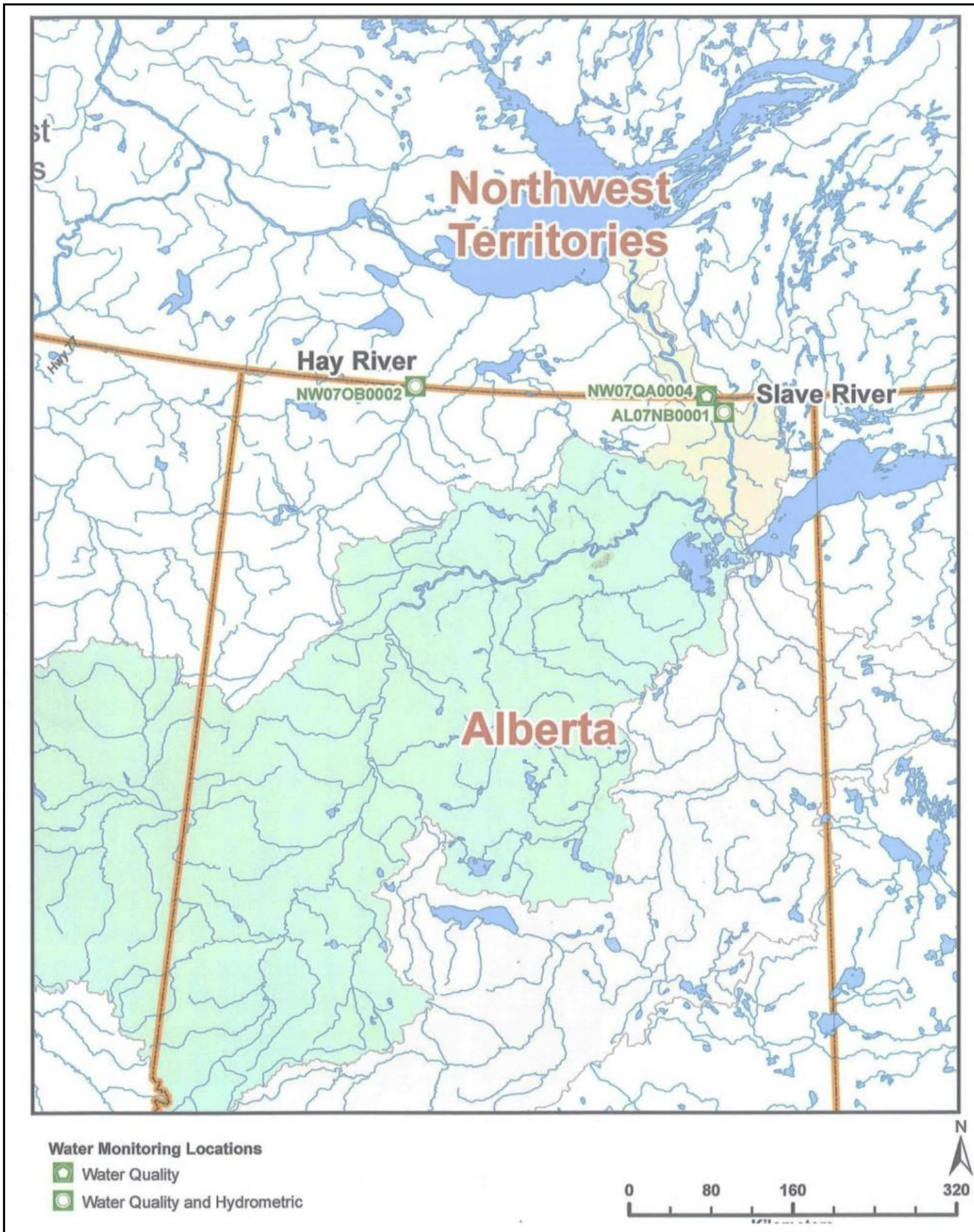

Figure 1: AB-NWT BWMA Water Quality Monitoring Sites

3. Approach to Annual 2015 Water Quality Assessment

3.1. Introduction

Under the Risk Informed Management (RIM) approach, the Hay and Slave rivers were classified as Class 3 Rivers. An important task associated with a Class 3 transboundary river designation is the development of site-specific water quality triggers and objectives. Site-specific water quality triggers and objectives provide an appropriate and relevant measure against which future water quality results can be compared and evaluated.

In the Agreement, a water quality trigger is defined as a pre-defined early warning of potential changes in typical (Trigger 1) and/or extreme (Trigger 2) conditions which results in Jurisdictional and/or Bilateral Water Management to confirm that change (BWMA, 2015). Triggers are an aid to manage water quality within the range of natural variability. Interim water quality triggers were calculated using the background concentration procedure (CCME 2003), where the ambient background concentrations of a parameter in water are determined and used to define the water quality triggers at the site under consideration. Where water quality parameters exhibited seasonal differences, seasonal interim site-specific water quality triggers were calculated.

A water quality objective is defined in the Agreement as a conservative value that is protective of all uses of the water body, including the most sensitive use (BWMA 2015). At the time of signing, water quality objectives had not been determined. The Parties agreed that the approach to develop and implement transboundary water quality objectives required further discussion and resources. The Parties also agreed that the task to develop water quality objectives is important and priority should be placed on their development.

While transboundary water quality objectives are being developed the BMC is assessing the water quality of the Slave and Hay rivers at the borders using the interim water quality triggers.

3.2. Data Preparation

To determine the historical range of water quality in the Hay and Slave rivers, the entire Hay River dataset (1969-2014) was retrieved from ECCC. The data for the Slave River was partially sourced by ECCC (1960-2010) and partially from the Joint Oil Sands Monitoring Program Initiative (2011-2012). HDR Incorporated was retained to prepare the data prior to the calculation of interim water quality triggers and assessment of long term temporal trends. A series of steps were undertaken to prepare the data. These steps are fully described in the Technical Report (HDR, 2015), but to summarize, the following steps were taken: 1) remove any data entry errors in the database, 2) identify parent samples and field blanks, and, 3) ensure consistency of parameter names and measurement units. HDR's preliminary data preparation also involved the categorization of each parameter by sample size, amount of censoring (i.e., data that is reported below laboratory method detection limits), and underlying distribution. These factors directly influence the types of statistical tests that can be used to assess trends and exceedances.

Scatter plots (time series) were produced for each parameter and visually inspected for unusual patterns, seasonality, data variability, missing values (data gaps), outliers and/or anomalous data values. From here, annual and seasonal summary statistics including counts of observations, counts of censored observations, means, medians, minimums, maximums and percentiles were calculated.

The time series for the Slave River was 1972-2012 (post-filling of the W.A.C Bennett Dam) and the time series for Hay River was 1988-2014 (when consistent sampling began on the river). The data records used for some parameters were shorter than the time series described above as some parameters have shorter monitoring records.

Previous Slave and Hay River water quality studies (WER AGRA, 1993; Sanderson et al., 1997 & 2012; Glozier et al., 2009) indicate that both rivers exhibited seasonality. The development of seasonal triggers is suggested in the BWMA. To this end, a year was divided into 4 seasons where possible: spring (May and June), summer (July and August), fall (September, October) and winter (from November to April). Where sample size was insufficient for developing 4-season triggers, the year was divided into 2-seasonal periods: open-water (spring, summer and fall) and under-ice (winter).

With the prepared historical dataset, annual and seasonal interim water quality triggers (i.e., 50th and 90th percentiles) were calculated for the Slave River at Fitzgerald and the Hay River near the Alberta/NWT Border monitoring sites. These can be found in Appendix E of the AB-NWT BWMA.

3.3. Interim Water Quality Triggers Assessment

Since the interim triggers are based on values (percentiles) that have been observed in the past, they provide a measure to assess potential changes in ambient water quality. As these triggers are set conservatively, not all observations above a trigger necessarily signal a concern, but can identify those parameters that should be examined further to determine if a change is occurring.

(1) Trigger 1 (Median) Assessment

Trigger 1 is intended to be a conservative early warning signal of changes in typical conditions. For this report, the annual median (50th annual percentile) was selected as the Interim Trigger 1 (hereinafter referred to as Trigger 1) and was calculated from historical ambient concentrations for all conventional parameters listed in Table 1 and Table 2.

To assess typical conditions, 2015 data were compared to Trigger 1. It is important to note that observations above the median are expected. Hence, for this report, a parameter was flagged if the number of observations above Trigger 1 occurred more often than what was expected in a typical year. For example:

Slave River

With 9 water samples collected from the Slave River in 2015, a parameter will:

- not be flagged if four or less observations are greater than Trigger 1 (i.e., less than half of the values (50%) are above Trigger 1)
- be flagged if five or more observations are greater than Trigger 1 (i.e., more than half of the values (50%) are above Trigger 1)

Hay River

With 4 water samples collected from the Hay River in 2015, a parameter will:

- not be flagged if 2 or less observations are greater than Trigger 1
- be flagged if 3 or more observations greater than Trigger 1

(2) Trigger 2 (90^{th} Percentile) Assessment

Trigger 2 is intended to be a conservative early warning signal of changes in extreme conditions (conservative upper bounds of water quality). Theoretically, 10% of observations for a parameter are expected to be above the 90^{th} percentile (Trigger 2). For this report, the seasonal 90^{th} percentile was selected as the Interim Trigger 2 (hereinafter referred to as Trigger 2) and was calculated from historical ambient concentrations for all conventional parameters listed in Table 1 and Table 2.

To assess extreme conditions, the 2015 observations were compared to Trigger 2. For both the Slave and Hay rivers, parameters were flagged if an observation was above Trigger 2.

(3) Evaluation of Flagged Parameters

Each flagged parameter was evaluated further. The Trigger 1 evaluation involved a one-step process whereas the Trigger 2 evaluation involved a two-step process.

(i) Evaluating Trigger 1 Flagged Parameters

- Long-term trends (annual, seasonal and annual step-wise) were examined for those parameters which exceeded Trigger 1.

  Is there a statistically significant trend developing? Is it in a direction of concern?

(ii) Evaluating Trigger 2 Flagged Parameters

- Values which exceeded Trigger 2 were compared to their respective historical annual and seasonal maximum values.

  - Long-term trends (annual, seasonal and annual step-wise) were examined for those parameters which exceeded historical maximum values (annual or seasonal).

    Is there a statistically significant trend developing? Is it in a direction of concern?

  - Flow conditions were examined.

    Was it an especially wet or dry year, season or month? What were water levels at the time of sampling?

  - Parameters which exceeded historical maximum values were compared to National and/or Provincial Water Quality Guidelines.

    How do the data compare to existing relevant water quality guidelines?

(iii) Further Evaluation

Unexplained Trigger 1 and 2 flagged parameters of concern will be prioritized and investigated. The investigative phase may include but not be limited to the following steps:

- Examine water quality data from upstream sampling locations such as Riviere Des Rochers, Athabasca River at Baseline 27 and Peace River at Peace Point.

  Are similar patterns in water quality evident upstream?

- Identify anthropogenic sources that are potentially responsible.

- Evaluate whether the existing monitoring program is adequate.

3.4. Toxic, Bioaccumulative and Persistent Substances Assessment

Virtual elimination (VE) refers to reducing, in the medium to long term, the concentration of designated substances to levels below or at the limits of measurable concentrations. To meet the objective of virtual elimination for substances that are human-made, toxic, bioaccumulative and persistent, the Parties to this Agreement are committed to pollution prevention and sustainable development. Substances subject to VE, monitored as part of this Agreement, are listed in Table 1 and Table 2. As part of the assessment, the 2015 organics data for substances subject to VE are reviewed, and the presence or absence of each is reported. The detection of any substances subject to VE is evaluated and discussed.

4. Results – Slave River

For this assessment, 590[2] individual conventional water quality results were compared to Trigger 1 and Trigger 2. These water quality results were generated from water samples collected from the Slave River at Fitzgerald in 2015 on 9 occasions (January, February, March, June, July (2 sampling events), August, September and October) by ECCC and analyzed for 66[3] different parameters.

4.1. Slave River 2015 Trigger 1 Assessment

As an initial screening step, the number of 2015 water quality concentrations that were higher than Trigger 1 was determined. If the number of observations higher than Trigger 1 was more than what was expected in a typical year (i.e., more than 50% of the values were above the median), the parameter was flagged. In 2015, 12 of the 66 parameters were flagged (Table 3).

Table 3: Slave River 2015 Trigger 1 Assessment Summary

Parameter	Trigger 1	Number of 2015 Observations higher than Trigger 1	Annual Trend?	Open Water Trend?	Under Ice Trend?
Alkalinity	84.25	6/9	no	no	no
Dissolved Calcium	28.25	6/9	no	no	↓
Dissolved Magnesium	6.56	7/9	no	no	no
Dissolved Sodium	6.19	5/9	no	↑	no
Dissolved Sulphate	18	7/9	↑	↑	no
Specific Conductance	210	7/9	no	no	no
Nitrate/Nitrite	0.07	8/9	↑	↑	n/a
Dissolved Boron	12.7	5/9	no	no	n/a
Dissolved Lithium	3.9	5/9	no	no	n/a
Total Molybdenum	0.63	5/9	↓	no	no
Dissolved Strontium	134	6/9	no	no	n/a
Dissolved Uranium	0.41	5/9	↔	↔	n/a

n/a: insufficient data to assess trend
↑: represents statistically significant increasing trend
↓: represents statistically significant decreasing trend
no: represents no statistically significant trend

[2] Four individual water quality results were not available from the laboratory. If all results had been available, 594 individual water quality results would have been available to compare to the interim water quality triggers.

[3] Although there are 70 parameters listed in Table 8 (BWMA, Appendix E4), 66 parameters were compared to Interim Trigger 1. The development of interim triggers is underway for dissolved mercury, total mercury, pH and dissolved oxygen.

4.2. Slave River 2015 Trigger 2 Assessment

To assess Trigger 2, the number of 2015 water quality observations with concentrations higher than Trigger 2 was determined. In 2015, 7 of the 66 parameters had one or two values above Trigger 2 (9/590 individual water quality results). The remaining 59 parameters all had concentrations below the corresponding 90th percentile (Trigger 2) values.

Concentrations of dissolved calcium, dissolved chloride, dissolved sulphate, total selenium and dissolved strontium were above Trigger 2 on one occasion, and dissolved magnesium and dissolved selenium concentrations were each above Trigger 2 on two occasions (Table 4).

Table 4: Slave River 2015 Trigger 2 Assessment Summary

Parameter	Trigger 2	2015 Observation above Trigger 2	Historical Seasonal Maximum Value	Historical Annual Maximum Value	National or Provincial Guideline	Trend in Corresponding Season?
Dissolved Calcium (fall)	30.7	31.6	41.7	41.7	--	no
Dissolved Chloride (summer)	5.90	6.52	6.78	11	640[1], 120[1,2] , 250[3]	no
Dissolved Magnesium (spring)	7.40	7.50	7.80	8.80	--	no
Dissolved Magnesium (fall)	7.42	7.91	7.86	8.80	--	no
Dissolved Sulphate (fall)	21.5	24.3	24.8	37.2	309[2], 500[3]	no
Dissolved Selenium (annual)	0.31	0.40	0.50	0.50	--	no
Dissolved Selenium (annual)	0.31	0.33	0.50	0.50	--	no
Total Selenium (annual)	0.38	0.50	0.88	0.88	1[1,2]	no
Dissolved Strontium (annual)	157	162	186	186	--	no

[1]CCME National Guideline for the Protection of Aquatic Life (chronic)
[2]Alberta Provincial Guideline for the Protection of Aquatic Life
[3]Health Canada Aesthetic Quality Guideline to address taste, odour and colour
--: guideline not available
↑: represents statistically significant increasing trend
↓: represents statistically significant decreasing trend
no: represents no statistically significant trend

4.3. Slave River 2015 Evaluation of Trigger 1 Flagged Parameters

Temporal trend assessment is an effective method to identify changes in water quality over time. Assessment of temporal trends has been done by graphical means supported with results from regression analyses. Temporal annual and seasonal trends were examined using the parametric Maximum Likelihood Estimates (MLE) non-detects regression at significance level α=0.05. As water quality data may not always trend in the same direction (i.e., monotonic) over the whole period of record, the piece-wise polynomial regression approach was also included as part of the trend assessment. This method allows a more thorough examination of the annual trend and helps to discern different patterns in the water quality data over time (HDR, 2015). Methods to assess long term trends are described fully in the Technical Report (HDR, 2015). All three types of trend assessment (annual, seasonal and piece-wise) were used to inform the Trigger 1 assessment.

Trend results were reviewed for the 12 parameters[4] that were flagged in the Trigger 1 assessment. Of these, dissolved sulphate, dissolved sodium and nitrate/nitrite exhibited statistically significant increasing annual trends (Table 3; HDR, 2017) and therefore have been evaluated further. A summary review of the trend results for these parameters follows.

[4] Parameters that exhibited a statistically significant increasing annual trend without being flagged during the Trigger 1 assessment include pH, dissolved organic carbon, dissolved nitrogen and total boron (HDR, 2017). The trend results for all Slave River parameters are summarized in Appendix 1 (Table 8).

4.3.1. Dissolved Sulphate

In 2015, concentrations of seven of the nine sulphate samples were above Trigger 1. Figure 2 is a scatter plot of the entire dissolved sulphate dataset (1978-2015) and illustrates how the data compare to Trigger 1 (annual median).

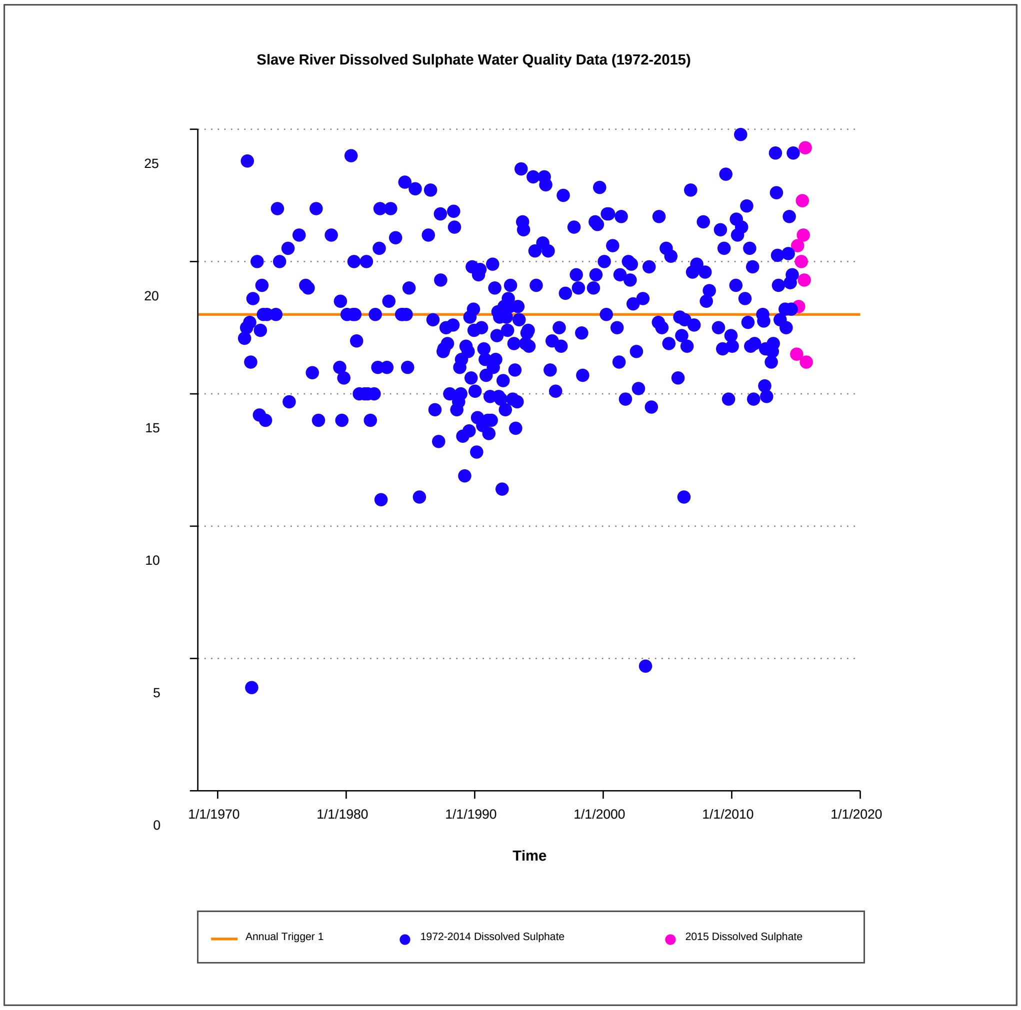

Figure 2: Slave River Dissolved Sulphate Water Quality Data (1972-2015)

The trend analysis for dissolved sulphate (Figure 3) revealed a statistically significant increasing annual trend (p= 0.0195) over the entire monitoring period. This trend seems to be driven by the levels of sulphate in the open-water season (p= 0.0083), rather than under-ice (p= 0.4733) (HDR, 2017). A high number of observations above the median value are usually anticipated for a parameter that is exhibiting an increasing trend. Moving forward, sulphate will continue to be monitored closely. A follow-up comparison will be made in the 2016 annual report, to see if such a tendency continues.

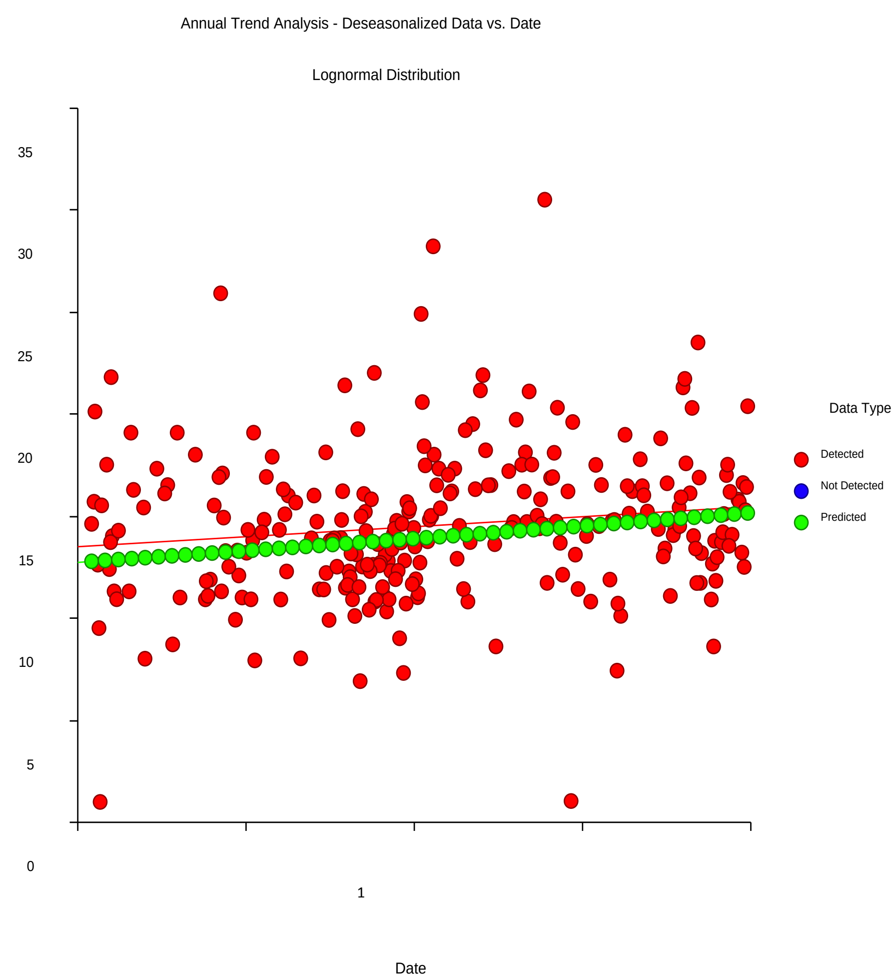

Figure 3: Annual Trend Analysis - Dissolved Sulphate in the Slave River (1972-2014)

4.3.2. Nitrate/Nitrite

In 2015, concentrations of eight of the nine nitrate/nitrite samples were above Trigger 1. Figure 4 is a scatter plot of the entire dissolved sulphate dataset (1978-2015) and illustrates how the data compare to Trigger 1 (annual median).

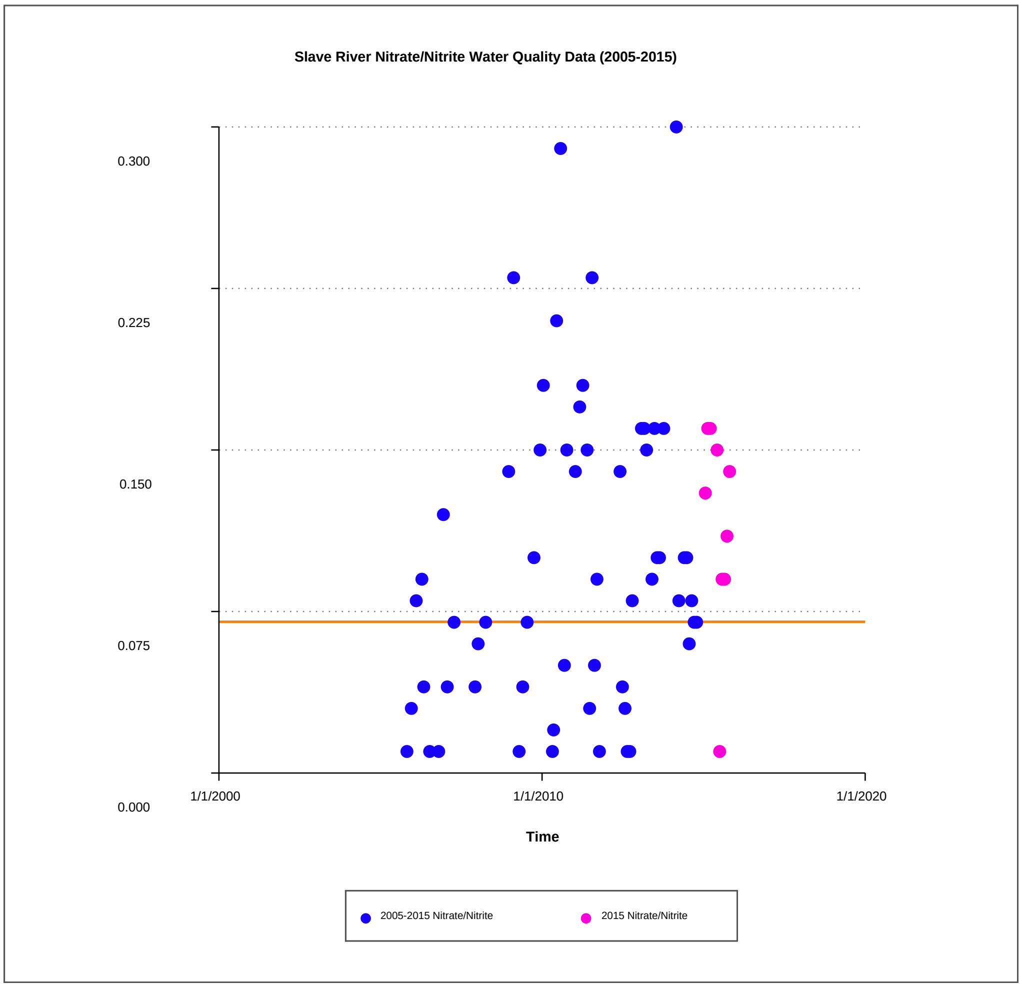

Figure 4: Slave River Nitrate/Nitrite Water Quality Data (2005-2015)

The trend analysis for nitrate/nitrite revealed a statistically significant increasing trend annually (p=0.0108) and during the open-water season (p=0.0045; Figure 5) (HDR, 2017). Upon closer review of the dataset for nitrate/nitrite, it was noted that there are missing open-water data during 2007 & 2008. Considering that nitrite/nitrite concentrations are generally higher in the open-water season than under-ice, these missing open-water data, during the early years of monitoring, may have influenced the trend results. To better understand the status and trends of nitrate/nitrite concentrations in the Slave River, the BMC will pay attention to this parameter in the following years and conduct additional exploratory analyses that will include examining the effect of the noted missing data on the trend results.

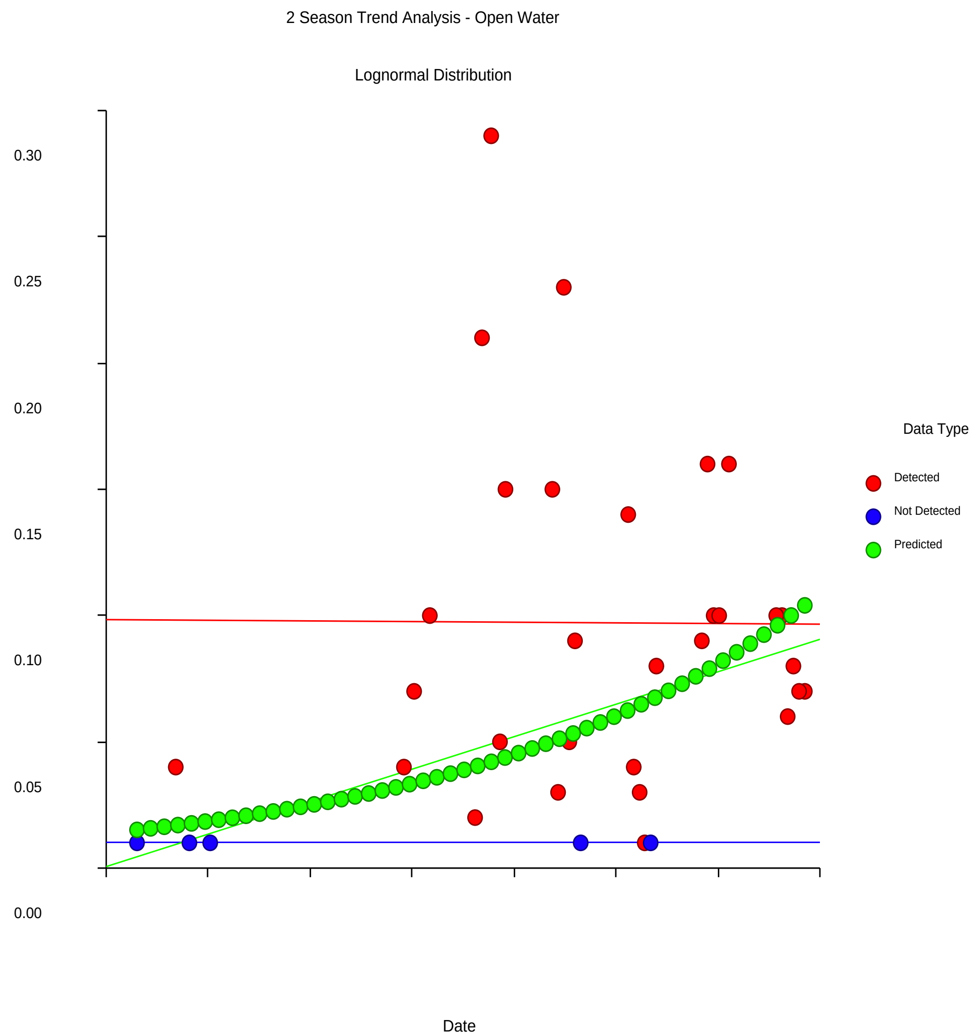

Figure 5: Open-Water Trend Analysis - Nitrate/Nitrite in the Slave River (2005-2014)

4.3.3. Dissolved Sodium

In 2015, concentrations of five of nine dissolved sodium samples were above Trigger 1. Figure 6 is a scatter plot of the entire dissolved sodium dataset (1978-2015) and illustrates how the data compare to Trigger 1 (annual median).

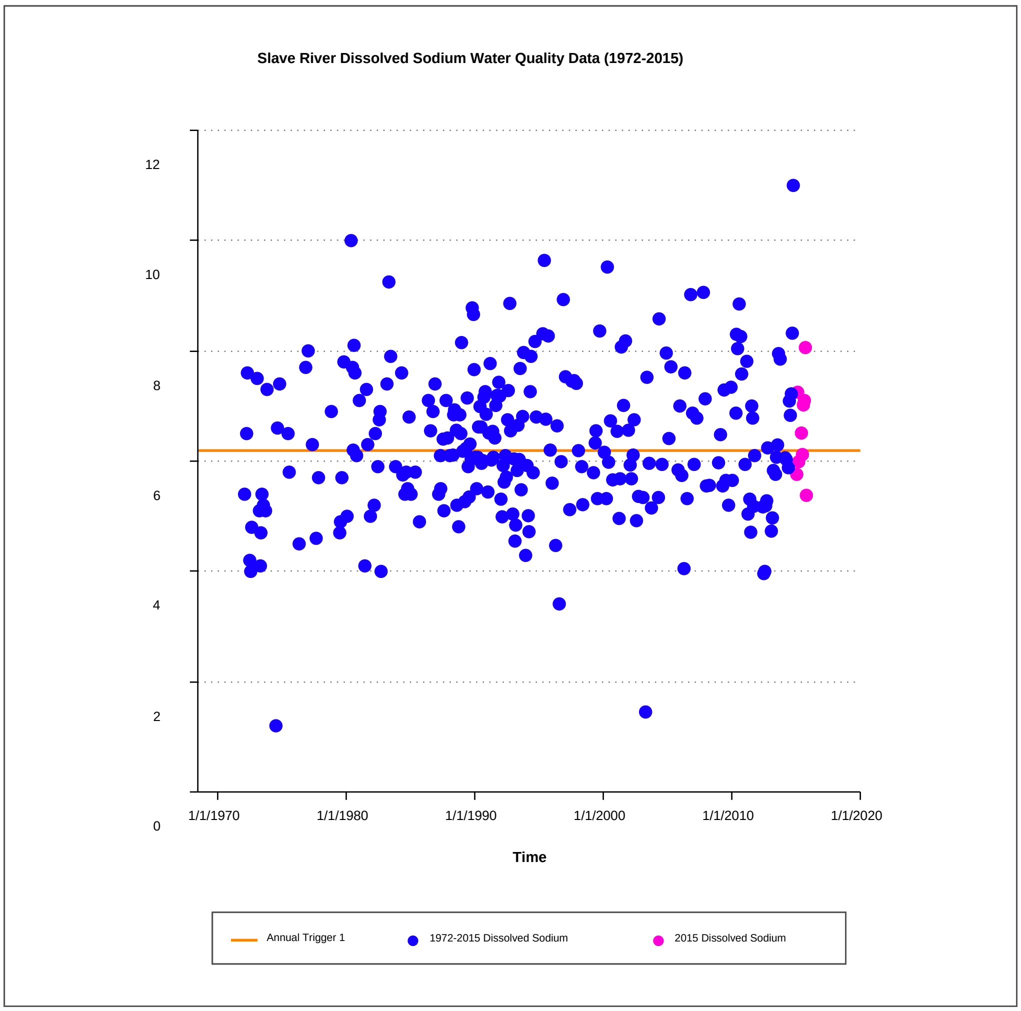

Figure 6: Slave River Dissolved Sodium Water Quality Data (1972-2015)

The seasonal trend assessment for dissolved sodium revealed a statistically significant increasing trend in the open-water season (Figure 7; p=0.0058) over the entire monitoring period. The under-ice data do not follow the same pattern as no significant trend was revealed (p=0.3407)

Following up with the piece-wise polynomial regression model, no significant trend was observed. While the results indicate no cause for concern, moving forward, annual and seasonal trends will continue to be monitored.

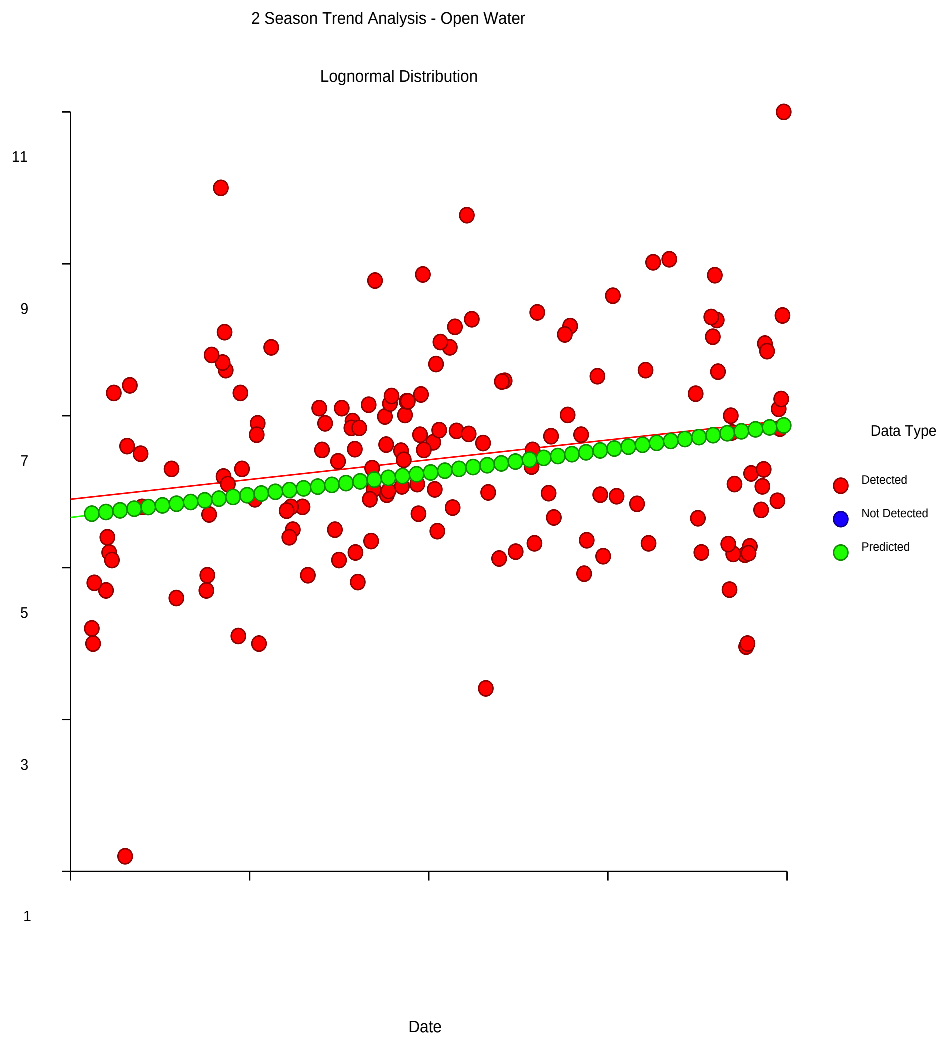

Figure 7: Open-Water Trend Analysis - Dissolved Sodium in the Slave River (1972-2014)

4.4. Slave River 2015 Evaluation of Trigger 2 Flagged Parameters

Of the 7 parameters that had concentrations above Trigger 2, only dissolved magnesium was above its historical seasonal maximum value, necessitating further evaluation (Table 4).

4.4.1. Dissolved Magnesium

Figure 8 is a scatter plot of the fall dissolved magnesium water quality data for the Slave River between 1978 and 2015. The scatter plot shows how the fall data compare to Trigger 2 (i.e., 90th percentile). On September 22, 2015, the dissolved magnesium concentration was 7.91 mg/L which is higher than the fall Trigger 2 (7.42 mg/L) and the historical fall maximum value of 7.86 mg/L (Table 4).

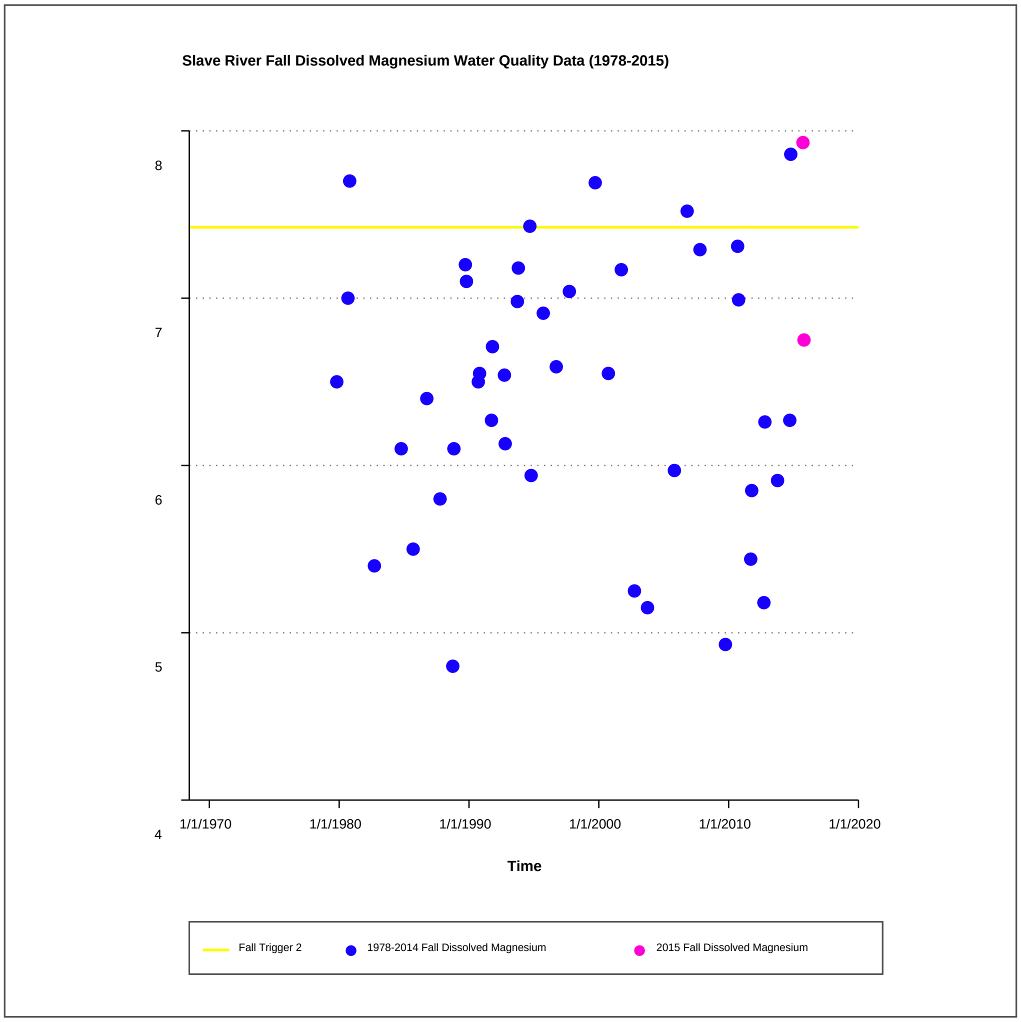

Figure 8: Slave River Fall Dissolved Magnesium Water Quality Data (1978-2015)

Figure 9 is a scatter plot of the entire dissolved magnesium dataset (1978-2015). None of the 2015 values (including the fall observation) were higher than the historical maximum value observed at this site (8.80 mg/L).

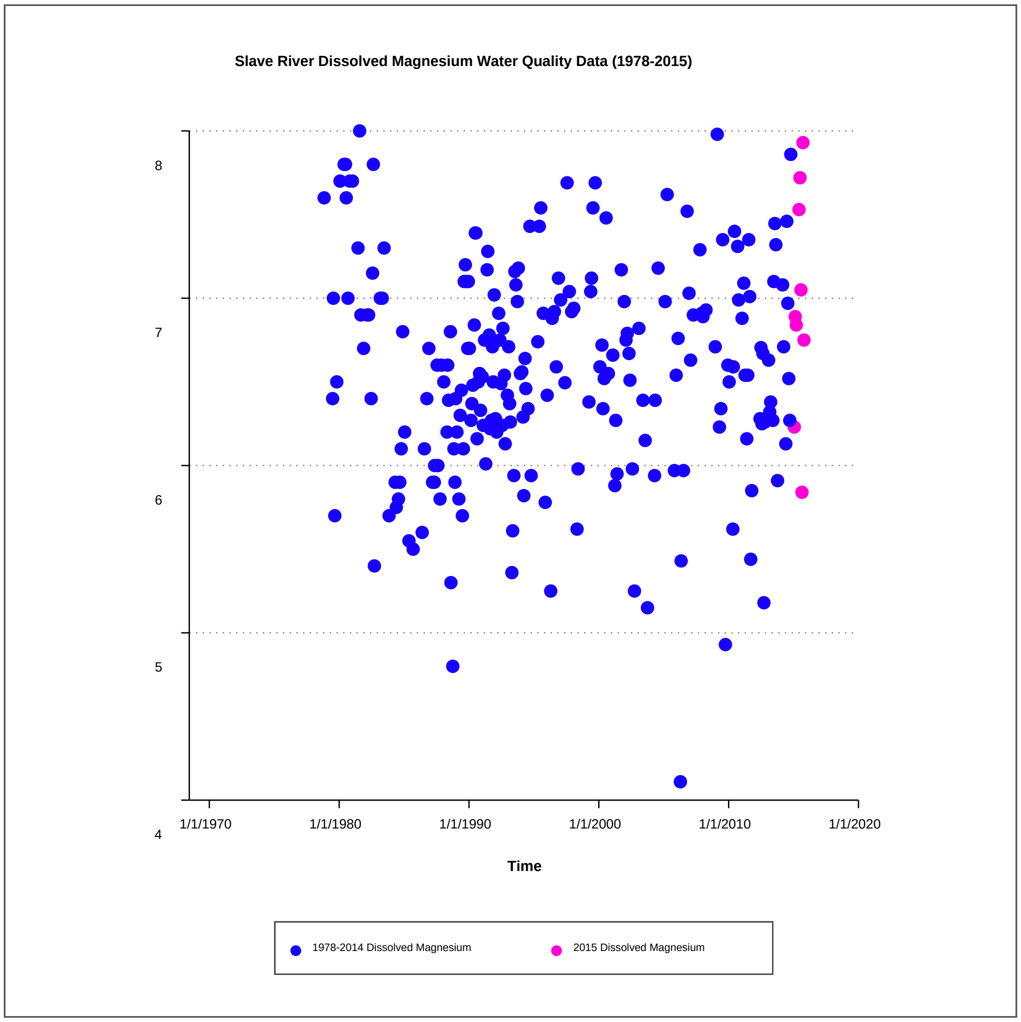

Figure 9: Slave River Dissolved Magnesium Water Quality Data (1978-2015)

Upon examination of the 2015 Slave River flow data, it was found that September 2015 flows were at historical minimum levels, as compared to the 1972 to 2014 daily flow records (Figure 10). It is known that concentrations of some major ions tend to vary inversely with flow because of dilution effects (Glozier, 2009; Bridge, 2003). High concentrations during low flow generally reflect the higher-mineralized composition of groundwater whereas low concentrations reflect the lower-mineralized water from snowmelt and/or rainfall runoff. This infers that the high dissolved magnesium concentration observed during the fall sampling event was a result of low flows in the Slave River in September.

No significant fall temporal trend was identified for dissolved magnesium in the Slave River (HDR, 2017), and no significant annual trend was identified. CCME and Alberta aquatic life guidelines for dissolved magnesium do not exist. A Health Canada human health guideline for magnesium is also not available. It is unlikely that any existing water uses could be affected, dissolved magnesium will continue to be monitored and assessed in future annual reports.

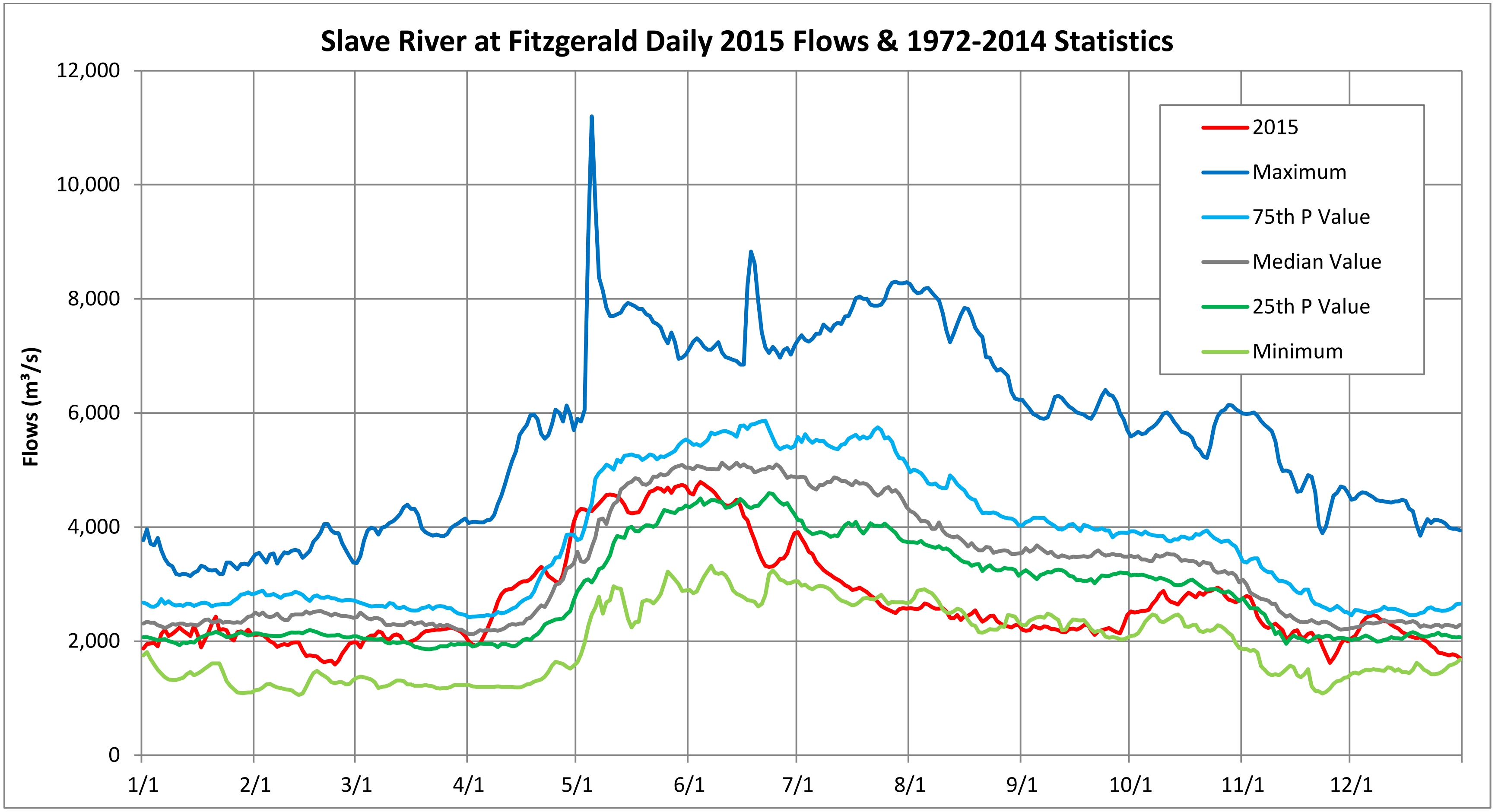

Figure 10: Slave River at Fitzgerald Daily Flows, 1972-2014 & 2015

5. Results - Hay River

For this assessment, 131[5] individual conventional water quality results were compared to Trigger 1 and Trigger 2. These water quality results were generated from water samples collected from the Hay River near the Alberta/NWT Boundary in 2015 on 4 occasions (April, May, July and October) by ECCC and analyzed for 41[6] different parameters.

5.1. Hay River 2015 Trigger 1 Assessment

As an initial screening step, the number of 2015 water quality concentrations that were higher than Trigger 1 was determined. If the number of observations higher than Trigger 1 was more than what was expected in a typical year (i.e., more than 50% of the values were above the median), the parameter was flagged. In 2015, 8 of the 41 parameters were flagged (Table 5).

Table 5: Hay River 2015 Trigger 1 Assessment Summary

Parameter	Trigger 1	Number of 2015 Observations higher than Trigger 1	Annual Trend?	Open Water Trend?	Under Ice Trend?
Dissolved Calcium	45.45	2/3	no	no	no
Dissolved Chloride	4.20	2/3	no	↓	no
Dissolved Magnesium	13.30	2/3	no	no	no
Dissolved Potassium	2.03	2/3	no	no	no
Dissolved Sodium	14.8	2/3	no	no	no
Specific Conductance	368	3/4	no	no	no
Total Suspended Solids	12	3/4	no	no	no
Total Strontium	138	2/3	no	no	no

↑: represents statistically significant increasing trend
↓: represents statistically significant decreasing trend
no: represents no statistically significant trend

[5] Thirty-three individual water quality results were not available from the laboratory. Unfortunately, sample bottles were lost during shipping following the July 2015 sampling event. If all results had been available, 164 individual water quality results would have been available to compare to the interim water quality triggers.

[6] Although there are 70 parameters listed in Table 8 (BWMA, Appendix E4), Interim Triggers are only available for 41 parameters due to limited historical data. As more data is collected, interim triggers will be developed for more parameters including total arsenic, total mercury and most dissolved metals.

5.2. Hay River 2015 Trigger 2 Assessment

To assess Trigger 2, the number of 2015 water quality observations with concentrations higher than Trigger 2 was determined. In 2015, 7 of the 41 parameters had one value that was above Trigger 2 (7/131 individual water quality results). The remaining 34 parameters were below the corresponding 90^{th} percentile (Trigger 2) values.

Concentrations of dissolved calcium, dissolved chloride, dissolved magnesium, dissolved sodium, dissolved sulphate, specific conductance and total dissolved solids were above Trigger 2 on one occasion corresponding with the sampling that occurred in October (Table 6).

Table 6: Hay River 2015 Trigger 2 Assessment Summary

Parameter	Trigger 2	2015 Value above Trigger 2	Historical Seasonal Maximum Value	Historical Annual Maximum Value	National or Provincial Guideline	Trend in Corresponding Season?
Dissolved Calcium (open-water)	49	53.9	66.4	115	--	no
Dissolved Chloride (open-water)	5.21	7.54	9.60	24.4	640[1], 120[1,2], 250[3]	↓
Dissolved Magnesium (open-water)	14.4	17.0	19.0	32.6	--	no
Total Dissolved Solids (open-water)	302	348	386	2700	--	no
Dissolved Sodium (open-water)	15.9	23.8	18.6	35.1	200[3]	no
Specific Conductance (open-water)	401	471	513	860	--	no
Dissolved Sulphate (open-water)	88.4	135	104	151	429[2], 500[3]	no

[1]CCME National Guideline for the Protection of Aquatic Life (chronic)
[2]Alberta Provincial Guideline for the Protection of Aquatic Life
[3]Health Canada Aesthetic Quality Guideline to address taste, odour and colour
--: guideline not available
↑: represents statistically significant increasing trend
↓: represents statistically significant decreasing trend
no: represents no statistically significant trend

5.3. Hay River 2015 Evaluation of Trigger 1 Flagged Parameters

Temporal trend assessment is an effective method to identify changes in water quality over time. Assessment of temporal trends has been done by graphical means supported with results from regression analyses. Temporal annual and seasonal trends were examined using the parametric Maximum Likelihood Estimates (MLE) non-detects regression at a significance level $\alpha=0.05$. As water quality data may not always trend in the same direction (i.e., monotonic) over the whole period of record, the piece-wise polynomial regression approach was also included in the trend assessment. This method allows a more thorough examination of the annual trends and helps to discern different patterns in the water quality data over time (HDR, 2015). Methods to assess long term trends are described fully in the Technical Report (HDR, 2015). All three types of trend assessment (annual, seasonal and piece-wise) were used to inform the Trigger 1 assessment.

Trend results were reviewed for the 8 parameters[7] that were flagged in the Trigger 1 assessment. Of these, no statistically significant increasing annual or seasonal trends were revealed (Table 5, HDR, 2017).

[7] Parameters that exhibited a statistically significant increasing annual trend without being flagged during the Trigger 1 assessment include pH and total vanadium (HDR, 2017). The trend results for all Hay River parameters are summarized in Appendix 1 (Table 9).

5.4. Hay River 2015 Evaluation of Trigger 2 Flagged Parameters

Of the 7 parameters with concentrations above Trigger 2, dissolved sodium and dissolved sulphate were above their respective historical seasonal maximum values and were evaluated further (Table 6).

5.4.1. Dissolved Sodium

Figure 11 is a scatter plot of the open-water dissolved sodium concentration data for the Hay River between 1988 and 2015. The scatter plot illustrates how the open-water data compare to Trigger 2 (i.e., 90th percentile). On October 13, 2015, the concentration of dissolved sodium was 23.8 mg/L which is higher than the open-water Trigger 2 (15.9 mg/L) and the historical open-water maximum value of 18.6 mg/L (Table 6).

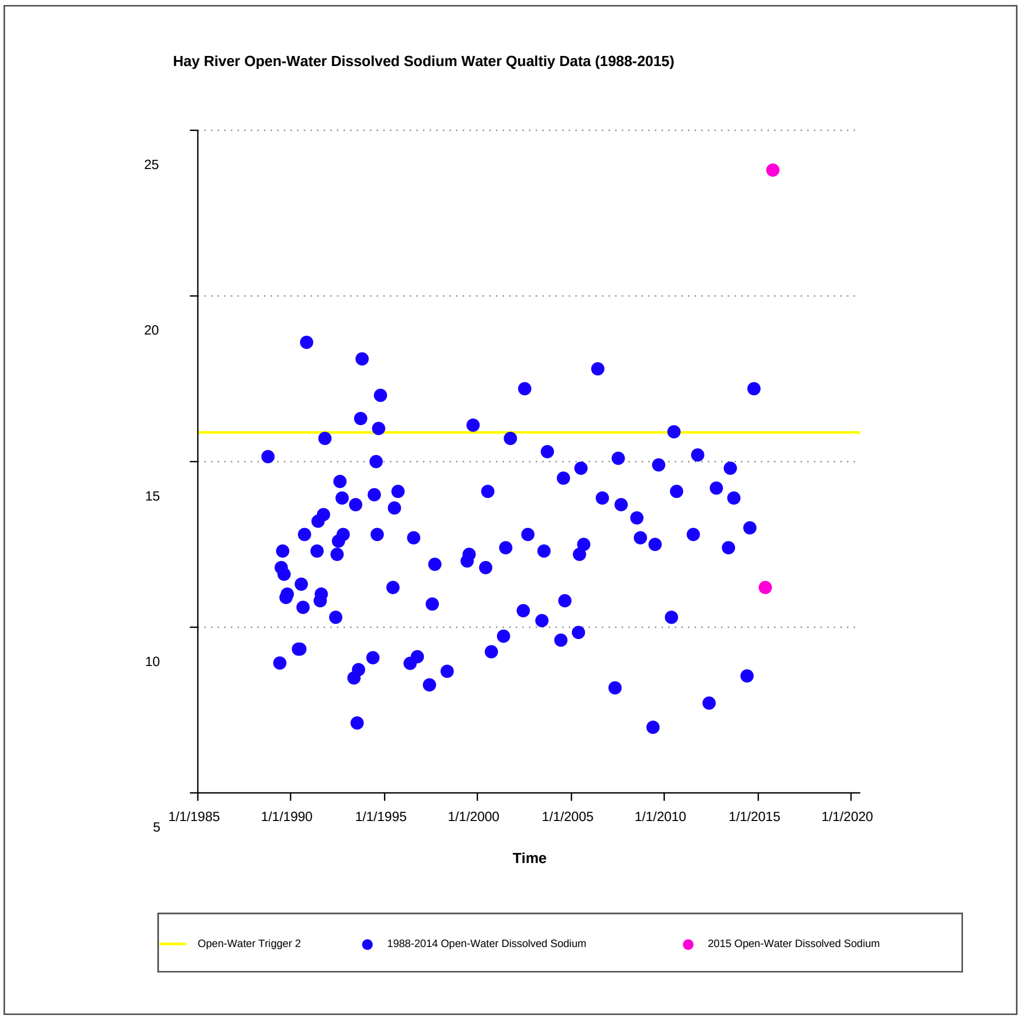

Figure 11: Hay River Open-Water Dissolved Sodium Water Quality Data (1988-2015)

Figure 12 is a scatter plot of the entire dissolved sodium dataset (1988-2015). None of the 2015 values (including the open-water observation) were higher than the historical maximum concentration observed at this site (35.1 mg/L).

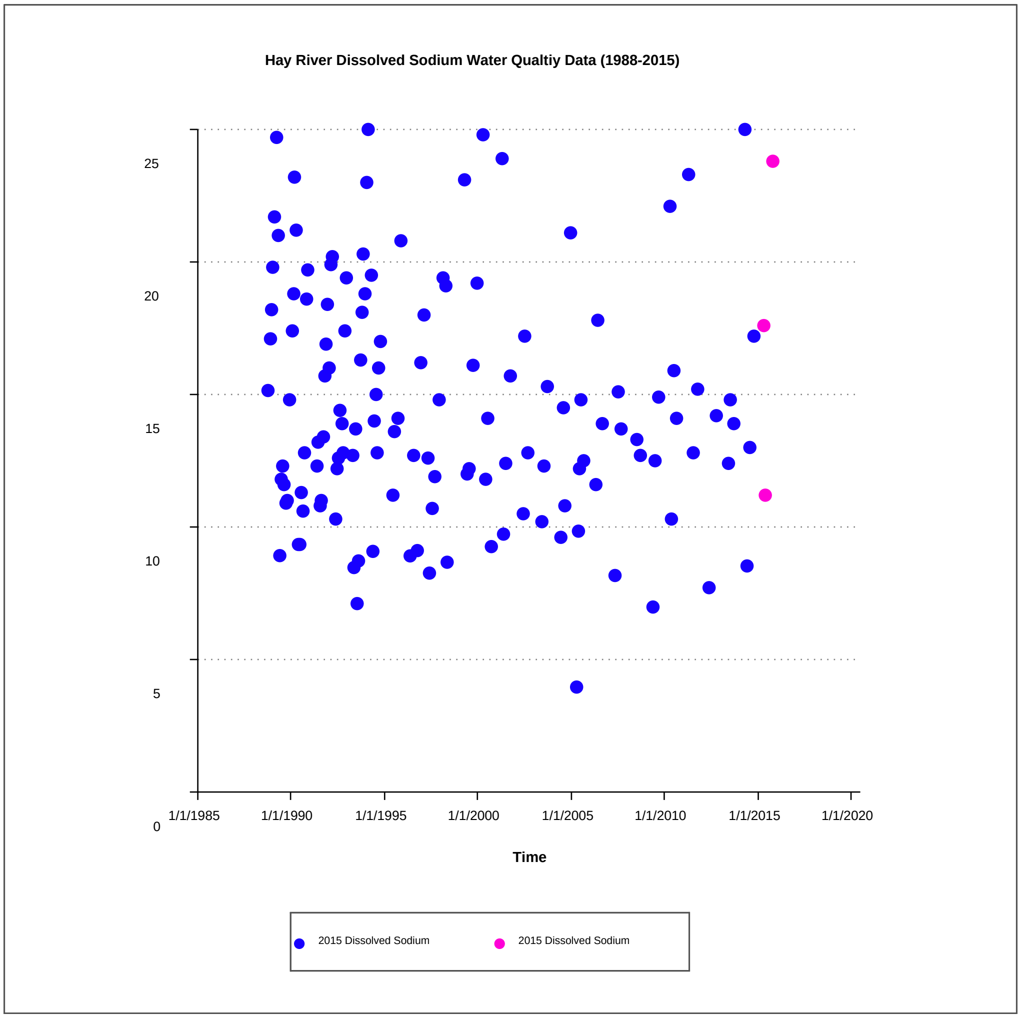

Figure 12: Hay River Dissolved Sodium Water Quality Data (1988-2015)

Examination of the 2015 Hay River water level data reveals that levels were low from May to October (Figure 13). October 2015 flows were relatively low compared to the 1986-2014 daily flow records (Figure 13). It is known that concentrations of salts tend to vary inversely with flow because of dilution effects (Glozier, 2009; Bridge, 2003). High concentrations during low flow generally reflect the higher-mineralized composition of groundwater that is less diluted by surface runoff (e.g., rainfall, snowmelt). This suggests that the high dissolved sodium open-water observation was a result of low flows in the river during the fall.

Trend analysis did not reveal any statistically significant trend for sodium at the site in either open-water, annual or annual piece-wise regression trend analysis (HDR, 2017).

CCME and Alberta aquatic life guidelines for dissolved sodium do not exist. Health Canada has established an aesthetic guideline for dissolved sodium of 200 mg/L. The concentrations in the river are well below the aesthetic guideline for taste, odour and colour, which suggests that existing water uses would not be affected. Future monitoring and assessment of this parameter will continue.

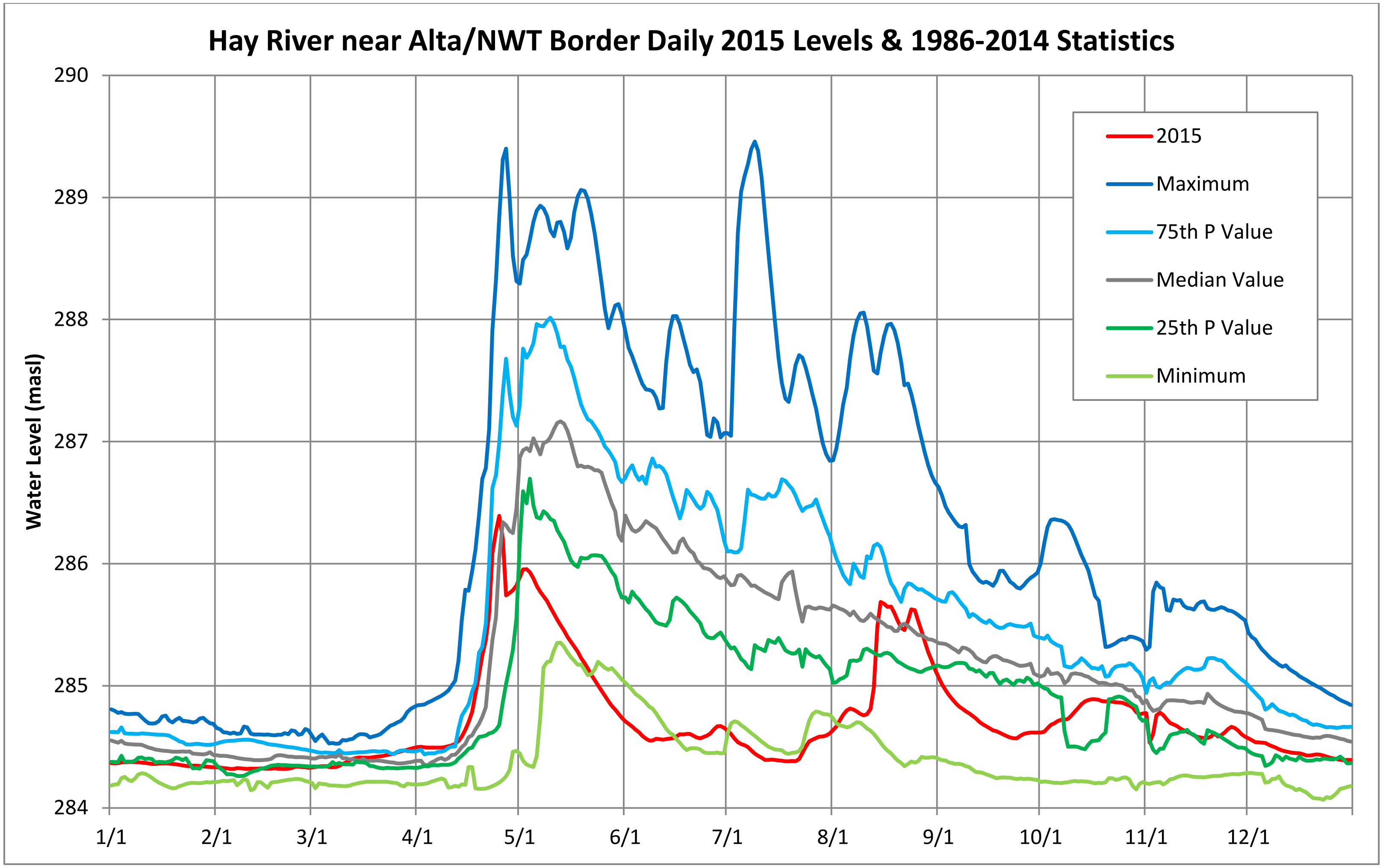

Figure 13: Hay River at the AB-NWT Border Water Levels, 1986-2014[8] & 2015

[8] Water level data between 1998-2010 are not unavailable.

5.4.2. Dissolved Sulphate

Figure 14 is a scatter plot of the open-water sulphate water quality data for the Hay River between 1988 and 2015. The scatter plot illustrates how the data compare to Trigger 2. On October 13, 2015, the sulphate concentration was 135 mg/L which is higher than the open-water Trigger 2 (88.4 mg/L) and the historical open-water maximum of 104 mg/L (Table 6).

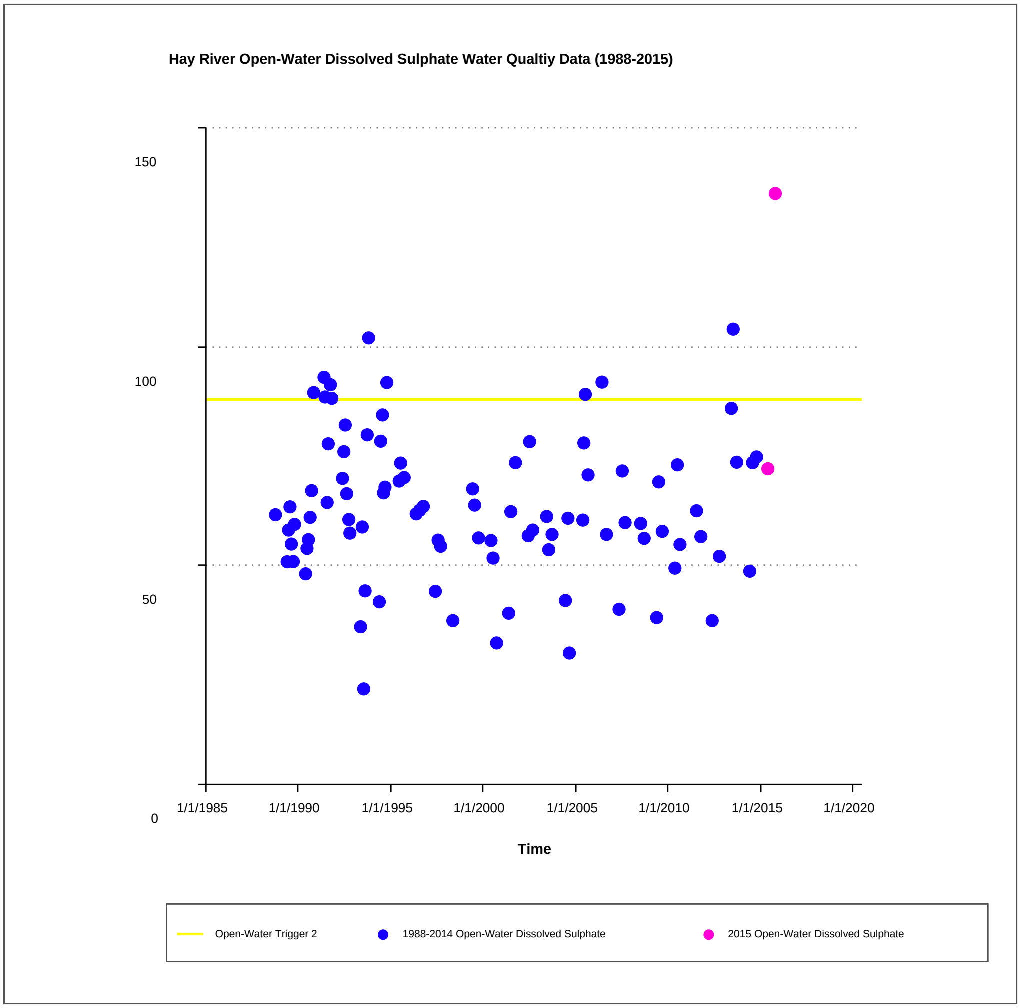

Figure 14: Hay River Open-Water Dissolved Sulphate Water Quality Data (1988-2015)

Figure 15 is a scatter plot of the entire dissolved sulphate dataset (1978-2015). None of the 2015 values (including the open-water observation) were higher than the historical maximum concentration observed at this site (151 mg/L).

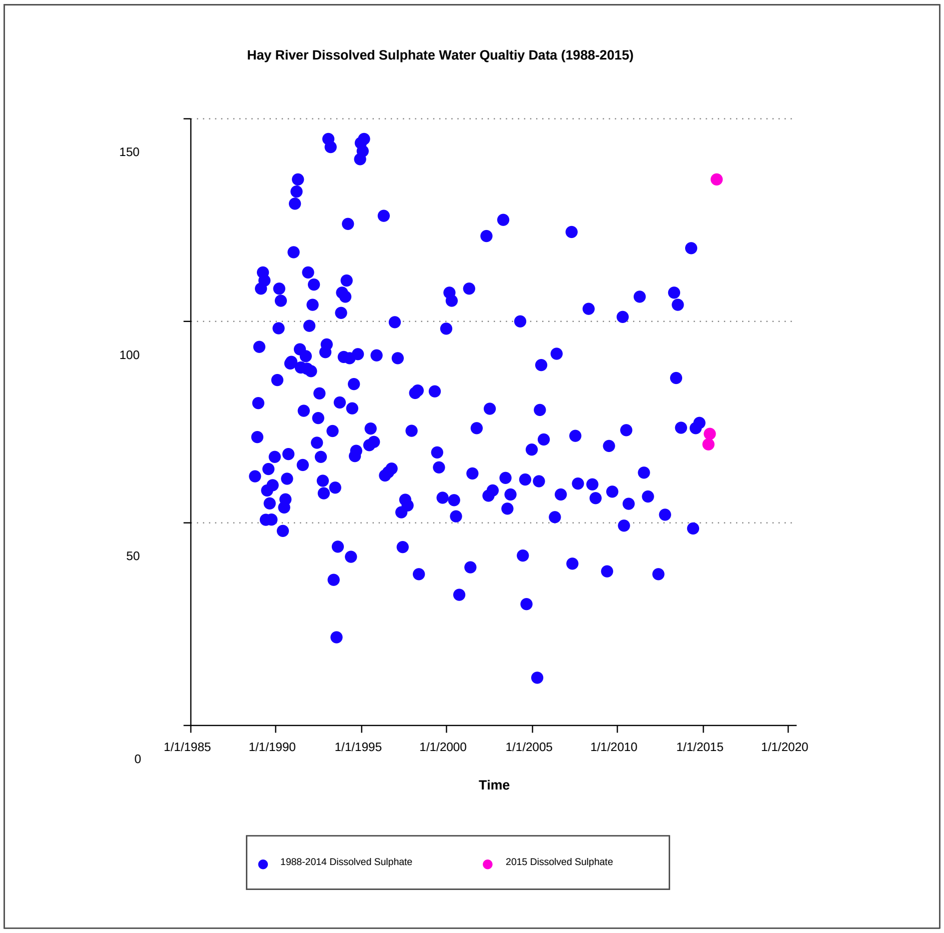

Figure 15: Hay River Dissolved Sulphate Water Quality Data (1988-2015)

The extended dry conditions experienced from May (Figure 13) likely led to the high dissolved sulphate concentration observed in the river in October. Concentrations of salts tend to vary inversely with flow because of dilution effects (Glozier, 2009; Bridge, 2003).

Trend analyses did not reveal any statistically significant temporal trends for dissolved sulphate at the site in either open-water, annual or annual piece-wise regression trend analysis (HDR, 2017).

For dissolved sulphate, Alberta has established an aquatic life guideline[9] of 429 mg/L and Health Canada has an established aesthetic guideline of 500 mg/L. A CCME aquatic life guideline for sulphate does not exist. The sulphate levels in the river are well below the relevant guidelines which suggest that the existing water uses would not be affected. Monitoring and assessment will continue.

[9] For water hardness measuring between 181-250mg/L; the October 2015 sample measured 205 mg/L.

6. Toxic, Bioaccumulative, Persistent Substances

To meet the commitment of virtual elimination of persistent, bioaccumulative, toxic substances that are listed in the AB-NWT BWMA, the BMC reports on the detection of any of substance subject to VE that is currently monitored in the Slave and Hay rivers (Table 7). The BMC will maintain and periodically update this list as information becomes available. Should an unmonitored toxic, bioaccumulative and persistent substance be detected by another party, this information will be evaluated by the BMC to determine if the substance should be added to relevant monitoring programs. Monitoring of these substances will be prioritized commensurate with the level of risk.

Table 7: Substances Subject to Virtual Elimination

Substances Subject to VE
Aldrin
Chlordane
Dieldrin
Endosulfan
Endrin
Heptachlor
Hexachlorobenzene
Hexachlorobutadiene
Hexachlorcyclohexane (HCH; alpha, beta, gamma)
Mirex
DDD, DDE, DDT
Toxaphene
PCBs
Pentachlorobenzene

6.1. VE Substances Assessment and Evaluation

ECCC has been monitoring substances subject to VE in Slave and Hay River surface water since 1994 whereas the GNWT has been monitoring substances subject to VE in the Slave River since 1990, and in the Hay River since 2004. To date, all substances subject to VE in water have been low (or not detectable) and below the CCME guidelines for the protection of aquatic life.

In 2015, three GNWT Slave and Hay River water samples were collected in June, July and August and analyzed for substances subject to VE listed in Table 7. Total-PCBs were detected, at very low concentrations, in both rivers and on all three sampling occasions. The maximum PCB concentration for the Slave River was measured at 0.506 ng/L and for the Hay River, 0.289 ng/L.

In the absence of a Canadian water quality guideline for PCBs, the United States Environmental Protection Agency (USEPA) guideline of 14 ng/L (USEPA, 2004) was used to provide context for concentrations in the Slave and Hay rivers. Compared to the USEPA guideline, the 2015 PCB levels in water are very low and do not pose a risk to aquatic life.

Given that the use of PCBs in Canada has been phased out for many years, the detection of PCBs in both the Hay and Slave rivers suggest that atmospheric transport, historical residual or most likely, laboratory contamination[10] are the probable sources of PCBs, rather than an upstream point source.

The monitoring for PCBs and substances subject to VE will continue.

[10] The level of detection used in the laboratory to measure PCBs in water is very small (ng/L; parts per trillion) and because of this, even a very minor quality control issue in the laboratory can lead to sample contamination. It is important to note that the Laboratory Method Blank concentrations, associated with the 2015 GNWT PCB samples, measured 0.123-0.205 ng/L which suggests that the levels reported may be a result of laboratory contamination.

7. BWMA Water Quality Tasks Underway

When the Agreement was signed in March of 2015, the Parties acknowledged that there were several areas of work that were required for it to be fully implemented. The Parties recognized that mutual learning would occur through the implementation phase and that modifications to triggers and objective development may require some implementation experience. The following tasks are underway:

7.1. Update Triggers 1 and 2

Appendix E4 (Tables 7 & 8) of the AB-NWT BWMA includes Interim Water Quality Trigger 1 (50^{th} percentile) and Trigger 2 (90^{th} percentile) for each conventional parameter. The triggers provide a measure against which future water quality data can be assessed. For the Slave River, the triggers were calculated based on a period of record of January 1972 to October 2012 (at the time, data were only available up to October 2012) whereas for the Hay River, the triggers were based on a period of record of October 1988 to July 2014. The triggers will be updated to reflect a period of record that ends in October 2014. October 2014 marks the month in which the last Slave and Hay River water sample was collected (in that calendar year) before the Agreement was signed in March 2015.

Furthermore, while most parameters are generally only a concern when levels are increasing, pH and dissolved oxygen can be problematic when levels are decreasing. Therefore work is underway way to develop a 10^{th} percentile trigger for these parameters for both rivers.

At the time of signing, *preliminary* interim water quality triggers were calculated for dissolved metals for the Hay River. The interim triggers were preliminary because there were less than 30 observations per parameter. Interim water quality triggers will be recalculated when the required minimum number of samples has been collected (i.e., n≥30).

7.2. Develop Interim Water Quality Triggers 1 and 2 for Mercury

At the time of signing, insufficient data were available to develop water quality triggers for mercury. Until recently, mercury was not routinely analyzed in the surface water samples collected from the Slave River at Fort Smith and Hay River near the Alberta/NWT Border monitoring sites. Due to the ability of mercury to bioaccumulate in organisms, the collection and analysis of mercury samples from the Slave and Hay rivers became a focus. In 2015, building on some previous water sampling for mercury, 5 water samples were collected from the Slave River (at Fort Smith). Figure 16 shows that mercury concentrations in the Slave River vary throughout the spring, summer and fall. The figure also illustrates how mercury concentrations can differ from year to year highlighting the importance of long-term data prior to the development of site-specific water quality triggers. To date, all data, except for a sample collected in July of 2013 from the Slave River, are below the CCME freshwater aquatic life guideline (26 ng/L) and well below Health Canada's drinking water quality guideline for mercury (1000 ng/L). Analysis of mercury in surface water samples collected from the Hay River started in 2016. The BMC anticipates that the minimum number of reliable results required to develop open-water interim water quality triggers for mercury will be available for the Slave and Hay rivers in 2018 and 2020, respectively.

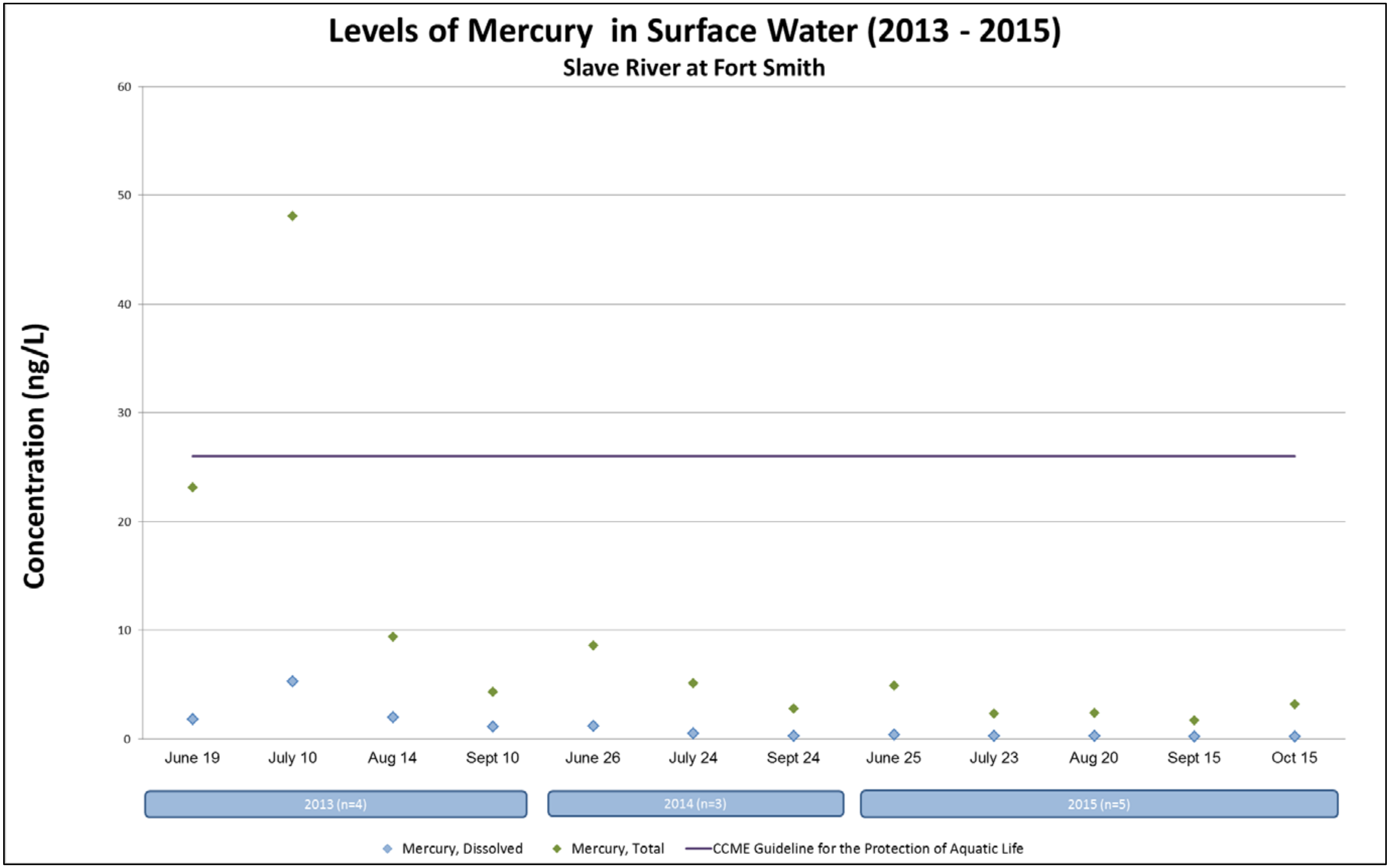

Figure 16: 2013-2015 Mercury Levels in Surface Water – Slave River at Fort Smith

7.3. Develop Water Quality Objectives

A technical workshop was hosted by the Government of the Northwest Territories in February 2016, with Mackenzie River Basin (MRB) jurisdictional technical representatives and subject matter experts to advance discussions on methods to derive site-specific water quality triggers and objectives. Workshop participants discussed water quality data management practices such as the handling of outliers, changing detection limits and censored data as well as methods to determine seasonality and period of record. The multi-jurisdictional learning workshop included exploring various methods to use triggers and objectives to track change over time. Progress on triggers and objectives is ongoing.

Other BMC Priorities

Other priorities for the BMC water quality technical staff include:

1) Reviewing water quality monitoring undertaken by ECCC and the GNWT. Discuss possibilities of merging the two sets of monitoring data to increase annual sample size.

2) Continuing to discuss methods and processes for the derivation of water quality objectives which may involve other jurisdictions within the Mackenzie River Basin.

3) Improving the use of water quality data from upstream water quality monitoring sites to inform transboundary water quality assessment.

4) Exploring additional statistical tests that can be used to identify changes in transboundary water quality.

8. Conclusion

Transboundary water quality interim triggers established for the two Class 3 Rivers between Alberta and NWT are designed to provide early warning of potential changes in water quality. Water Quality Trigger 1 is intended to identify changes in typical conditions and Trigger 2 is intended to identify changes in extreme conditions.

In the Slave River, 12 of the 66 parameters were flagged after comparison to Trigger 1 (annual median). Trend assessments revealed pre-existing (up to 2014) statistically significant increasing trends (annual, open-water) for nitrate/nitrite and dissolved sulphate and an increasing trend during the open-water season for dissolved sodium. Seven of the 66 parameters (in 9/590 individual water quality results) had one or two values above Trigger 2 (90^{th} percentile). Concentrations of the remaining 59 parameters were all below the corresponding Trigger 2. Only one dissolved magnesium sample was above its respective historical seasonal maximum but still below its historical annual maximum and no statistically significant trend was revealed. Extended low river flows prior to the sampling were likely the cause of the high values for the dissolved salt parameters observed in 2015.

In the Hay River, 8 out of 41 parameters were flagged after comparison to Trigger 1. No statistically significant increasing annual trends were revealed for any of these parameters. Seven of the 41 parameters (in 7/131 individual water quality results) were higher than Trigger 2 on one occasion (in October). Of these, dissolved sodium and sulphate were above their respective historical seasonal maximum but none were above their historical annual maximum value and no statistically significant trends were revealed. Extended low water levels prior to the sampling are likely the cause of the high dissolved sodium and sulphate values. All samples of the remaining 34 parameters were below the corresponding Trigger 2.

Another requirement of the BWMA is the reporting of any detection of toxic, bioaccumulative and persistent substances in the surface water of the Slave and Hay rivers. During the summer of 2015, three water samples were collected from both the Slave and Hay rivers and analyzed for fourteen virtual elimination substances. Total PCBs were detected on all three occasions in both rivers, but concentrations were low (0.139-0.506 ng/L) and do not pose any risk to aquatic life. Results suggest that remote atmospheric transport, historical residuals and/or laboratory contamination may be the potential sources for these compounds. No other substances subject to VE were detected in any of the 2015 water samples. Monitoring for PCBs and other toxic, bioaccumulative and persistent substances will continue.

Overall, the majority of water quality parameters assessed for 2015 in the Slave and Hay rivers were within their historical range. Although the 2015 sampling resulted in new seasonal maximum values for dissolved magnesium (Slave River), and dissolved sodium and sulphate

(Hay River), this is likely due to low water levels. Special attention will be given to these parameters and any statistically significant trending parameters in the following year's assessment.

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Appendix 1: Annual and Seasonal Trend Results for the Conventional Parameters of the Slave (Table 8) and Hay Rivers (Table 9)

Table 8: Slave River Annual and 2-Season Trend Analysis Results

Parameter	Period of Study	Unit	Season	n	No. BDL	P-value	Trend
ALKALINITY TOTAL CACO3	1972-2014	mg/L	ANNUAL	250	0	0.2745	no
ALKALINITY TOTAL CACO3		mg/L	OW	147	0	0.7541	no
ALKALINITY TOTAL CACO3		mg/L	IC	103	0	0.1681	no
ALUMINUM DISSOLVED	2006-2014	µg/L	ANNUAL	55	0	0.1790	no
ALUMINUM DISSOLVED		µg/L	OW	35	0	0.5113	no
ALUMINUM TOTAL	1993-2014	µg/L	ANNUAL	124	0	0.0879	no
ALUMINUM TOTAL		µg/L	OW	71	0	0.0013	↓
ALUMINUM TOTAL		µg/L	IC	53	0	0.3155	no
AMMONIA DISSOLVED	1993-2014	mg/L	ANNUAL	115	22	0.0629	no
AMMONIA DISSOLVED		mg/L	OW	68	13	0.0011	↓
AMMONIA DISSOLVED		mg/L	IC	47	9	0.5275	no
ANTIMONY DISSOLVED	2006-2014	µg/L	ANNUAL	55	1	0.8981	no
ANTIMONY DISSOLVED		µg/L	OW	35	0	0.8645	no
ANTIMONY TOTAL	2002-2014	µg/L	ANNUAL	75	0	0.9165	no
ANTIMONY TOTAL		µg/L	OW	44	0	0.5649	no
ANTIMONY TOTAL		µg/L	IC	31	0	0.3790	no
ARSENIC DISSOLVED	2006-2014	µg/L	ANNUAL	55	0	0.6025	no
ARSENIC DISSOLVED		µg/L	OW	35	0	0.5700	no
ARSENIC TOTAL	2003-2014	µg/L	ANNUAL	69	0	0.6232	no
ARSENIC TOTAL		µg/L	OW	41	0	0.9100	no
BARIUM DISSOLVED	2006-2014	µg/L	ANNUAL	55	0	0.2994	no
BARIUM DISSOLVED		µg/L	OW	35	0	0.5586	no
BARIUM TOTAL	1983-2014	µg/L	ANNUAL	206	41	0.2864	no
BARIUM TOTAL		µg/L	OW	115	17	0.6305	no
BARIUM TOTAL		µg/L	IC	91	24	0.5679	no
BERYLLIUM DISSOLVED	2006-2014	µg/L	ANNUAL	55	0	0.1127	no
BERYLLIUM DISSOLVED		µg/L	OW	35	0	0.0983	no
BERYLLIUM TOTAL	1993-2014	µg/L	ANNUAL	130	18	0.5837	no
BERYLLIUM TOTAL		µg/L	OW	74	2	0.0137	↓
BERYLLIUM TOTAL		µg/L	IC	56	16	0.3751	no
BISMUTH DISSOLVED	2006-2014	µg/L	ANNUAL	54	9	0.2524	no
BISMUTH DISSOLVED		µg/L	OW	34	3	0.5333	no
BISMUTH TOTAL	2003-2014	µg/L	ANNUAL	63	0	0.8678	no
BISMUTH TOTAL		µg/L	OW	36	0	0.4608	no
BORON DISSOLVED	2006-2014	µg/L	ANNUAL	55	0	0.3408	no

Parameter	Period of Study	Unit	Season	n	No. BDL	P-value	Trend
BORON DISSOLVED		µg/L	OW	35	0	0.1092	no
BORON TOTAL	2002-2014	µg/L	ANNUAL	75	0	0.0009	↑
BORON TOTAL		µg/L	OW	44	0	0.0182	↑
BORON TOTAL		µg/L	IC	31	0	0.0450	↑
CADMIUM DISSOLVED	2006-2014	µg/L	ANNUAL	55	0	0.4809	no
CADMIUM DISSOLVED		µg/L	OW	35	0	0.4231	no
CADMIUM TOTAL	1983-2014	µg/L	ANNUAL	208	45	0.3506	no
CADMIUM TOTAL		µg/L	OW	116	20	0.0877	no
CADMIUM TOTAL		µg/L	IC	92	25	0.4658	no
CALCIUM DISSOLVED/FILTERED	1972-2014	mg/L	ANNUAL	260	0	0.2145	no
CALCIUM DISSOLVED/FILTERED		mg/L	OW	151	0	0.8483	no
CALCIUM DISSOLVED/FILTERED		mg/L	IC	109	0	0.0328	↓
CARBON DISSOLVED ORGANIC	1978-2014	mg/L	ANNUAL	224	0	0.0005	↑
CARBON DISSOLVED ORGANIC		mg/L	OW	130	0	0.0018	↑
CARBON DISSOLVED ORGANIC		mg/L	IC	94	0	0.8851	no
CARBON PARTICULATE ORGANIC	1978-2014	mg/L	ANNUAL	230	0	0.7025	no
CARBON PARTICULATE ORGANIC		mg/L	OW	132	0	0.9298	no
CARBON PARTICULATE ORGANIC		mg/L	IC	98	0	0.0946	no
CHLORIDE DISSOLVED	1972-2014	mg/L	ANNUAL	259	0	0.4730	no
CHLORIDE DISSOLVED		mg/L	OW	151	0	0.7867	no
CHLORIDE DISSOLVED		mg/L	IC	108	0	0.8508	no
CHROMIUM DISSOLVED	2006-2014	µg/L	ANNUAL	55	0	0.6540	no
CHROMIUM DISSOLVED		µg/L	OW	35	0	0.6328	no
CHROMIUM TOTAL	1993-2014	µg/L	ANNUAL	130	4	0.1872	no
CHROMIUM TOTAL		µg/L	OW	74	0	0.0053	↓
CHROMIUM TOTAL		µg/L	IC	56	4	0.8852	no
COBALT DISSOLVED	2006-2012	µg/L	ANNUAL	55	0	0.8922	no
COBALT DISSOLVED		µg/L	OW	35	0	0.7165	no
COBALT TOTAL	1983-2014	µg/L	ANNUAL	209	30	0.2488	no
COBALT TOTAL		µg/L	OW	117	6	0.3892	no
COBALT TOTAL		µg/L	IC	92	24	0.9277	no
COPPER DISSOLVED	2006-2014	µg/L	ANNUAL	55	0	0.5985	no
COPPER DISSOLVED		µg/L	OW	35	0	0.3516	no
COPPER TOTAL	1983-2014	µg/L	ANNUAL	209	0	0.9962	no
COPPER TOTAL		µg/L	OW	117	0	0.7311	no
COPPER TOTAL		µg/L	IC	92	0	0.8621	no
IRON DISSOLVED	2006-2014	µg/L	ANNUAL	55	0	0.3326	no
IRON DISSOLVED		µg/L	OW	35	0	0.3941	no
IRON TOTAL	1993-2014	µg/L	ANNUAL	130	1	0.1703	no

Parameter	Period of Study	Unit	Season	n	No. BDL	P-value	Trend
IRON TOTAL		µg/L	OW	74	1	0.1159	no
IRON TOTAL		µg/L	IC	56	0	0.5454	no
LEAD DISSOLVED	2006-2014	µg/L	ANNUAL	55	0	0.0204	↓
LEAD DISSOLVED		µg/L	OW	35	0	0.0003	↓
LEAD TOTAL	1983-2014	µg/L	ANNUAL	209	25	0.7035	no
LEAD TOTAL		µg/L	OW	117	4	0.2327	no
LEAD TOTAL		µg/L	IC	92	21	0.6292	no
LITHIUM DISSOLVED	2006-2014	µg/L	ANNUAL	55	0	0.7605	no
LITHIUM DISSOLVED		µg/L	OW	35	0	0.4239	no
LITHIUM TOTAL	1993-2014	µg/L	ANNUAL	130	0	0.0062	↓
LITHIUM TOTAL		µg/L	OW	74	0	0.0001	↓
LITHIUM TOTAL		µg/L	IC	56	0	0.0265	↓
MAGNESIUM DISSOLVED/FILTERED	1978-2014	mg/L	ANNUAL	234	0	0.8616	no
MAGNESIUM DISSOLVED/FILTERED		mg/L	OW	135	0	0.8436	no
MAGNESIUM DISSOLVED/FILTERED		mg/L	IC	99	0	0.7043	no
MANGANESE DISSOLVED	2006-2014	µg/L	ANNUAL	55	0	0.8674	no
MANGANESE DISSOLVED		µg/L	OW	35	0	0.7911	no
MANGANESE TOTAL	1993-2014	µg/L	ANNUAL	130	0	0.5293	no
MANGANESE TOTAL		µg/L	OW	74	0	0.2787	no
MANGANESE TOTAL		µg/L	IC	56	0	0.9710	no
MOLYBDENUM DISSOLVED	2006-2014	µg/L	ANNUAL	55	0	0.9946	no
MOLYBDENUM DISSOLVED		µg/L	OW	35	0	0.5293	no
MOLYBDENUM TOTAL	1993-2014	µg/L	ANNUAL	130	2	0.0198	↓
MOLYBDENUM TOTAL		µg/L	OW	74	2	0.1574	no
MOLYBDENUM TOTAL		µg/L	IC	56	0	0.4890	no
NICKEL DISSOLVED	2006-2014	µg/L	ANNUAL	55	0	0.8394	no
NICKEL DISSOLVED		µg/L	OW	35	0	0.7223	no
NICKEL TOTAL	1983-2014	µg/L	ANNUAL	209	2	0.9226	no
NICKEL TOTAL		µg/L	OW	117	1	0.7144	no
NICKEL TOTAL		µg/L	IC	92	1	0.5583	no
NITRATE/ NITRITE	2005-2014	mg/L	ANNUAL	58	7	0.0108	↑
NITRATE/ NITRITE		mg/L	OW	35	5	0.0045	↑
NITROGEN DISSOLVED	1978-2014	mg/L	ANNUAL	218	0	0.0032	↑
NITROGEN DISSOLVED		mg/L	OW	127	0	0.0062	↑
NITROGEN DISSOLVED		mg/L	IC	91	0	0.0174	↑
OXYGEN DISSOLVED	1989-2014	mg/L	ANNUAL	140	0	0.1658	no
OXYGEN DISSOLVED		mg/L	OW	80	0	0.5593	no
OXYGEN DISSOLVED		mg/L	IC	60	0	0.6013	no
PH (LAB)	1972-2014	PH UNITS	ANNUAL	247	0	0.0322	↑

Parameter	Period of Study	Unit	Season	n	No. BDL	P-value	Trend
PH (LAB)		PH UNITS	OW	145	0	0.0302	↑
PH (LAB)		PH UNITS	IC	102	0	0.8433	no
PHOSPHOROUS TOTAL	1974-2014	mg/L	ANNUAL	229	0	0.4131	no
PHOSPHOROUS TOTAL		mg/L	OW	137	0	0.7068	no
PHOSPHOROUS TOTAL		mg/L	IC	92	0	0.5228	no
PHOSPHOROUS TOTAL DISSOLVED	1978-2014	mg/L	ANNUAL	218	32	0.1246	no
PHOSPHOROUS TOTAL DISSOLVED		mg/L	OW	130	17	0.0585	no
PHOSPHOROUS TOTAL DISSOLVED		mg/L	IC	88	15	0.2651	no
POTASSIUM DISSOLVED/FILTERED	1972-2014	mg/L	ANNUAL	260	0	0.5068	no
POTASSIUM DISSOLVED/FILTERED		mg/L	OW	151	0	0.2494	no
POTASSIUM DISSOLVED/FILTERED		mg/L	IC	109	0	0.0962	no
SELENIUM DISSOLVED	2006-2014	µg/L	ANNUAL	55	0	0.3280	no
SELENIUM DISSOLVED		µg/L	OW	35	0	0.3479	no
SELENIUM TOTAL	2003-2014	µg/L	ANNUAL	69	0	0.3520	no
SELENIUM TOTAL		µg/L	OW	41	0	0.9946	no
SILVER DISSOLVED	2006-2014	µg/L	ANNUAL	55	9	0.0277	↓
SILVER DISSOLVED		µg/L	OW	35	5	0.4738	no
SILVER TOTAL	1996-2014	µg/L	ANNUAL	102	21	0.8458	no
SILVER TOTAL		µg/L	OW	58	8	0.0054	↓
SILVER TOTAL		µg/L	IC	44	13	0.0711	no
SODIUM DISSOLVED/FILTERED	1972-2014	mg/L	ANNUAL	259	0	0.0932	no
SODIUM DISSOLVED/FILTERED		mg/L	OW	150	0	0.0058	↑
SODIUM DISSOLVED/FILTERED		mg/L	IC	109	0	0.3407	no
SPECIFIC CONDUCTANCE (LAB)	1972-2014	USIE/CM	ANNUAL	263	0	0.4146	no
SPECIFIC CONDUCTANCE (LAB)		USIE/CM	OW	153	0	0.3369	no
SPECIFIC CONDUCTANCE (LAB)		USIE/CM	IC	110	0	0.0538	no
STRONTIUM DISSOLVED	2006-2014	µg/L	ANNUAL	55	0	0.7336	no
STRONTIUM DISSOLVED		µg/L	OW	35	0	0.7873	no
STRONTIUM TOTAL	1993-2014	µg/L	ANNUAL	130	0	0.7281	no
STRONTIUM TOTAL		µg/L	OW	74	0	0.8420	no
STRONTIUM TOTAL		µg/L	IC	56	0	0.3963	no
SULPHATE DISSOLVED	1972-2014	mg/L	ANNUAL	259	0	0.0195	↑
SULPHATE DISSOLVED		mg/L	OW	151	0	0.0083	↑
SULPHATE DISSOLVED		mg/L	IC	108	0	0.4733	no
THALLIUM DISSOLVED	2006-2014	µg/L	ANNUAL	55	0	0.4674	no
THALLIUM DISSOLVED		µg/L	OW	35	0	0.4992	no
THALLIUM TOTAL	2002-2014	µg/L	ANNUAL	75	0	0.8120	no
THALLIUM TOTAL		µg/L	OW	44	0	0.6361	no
THALLIUM TOTAL		µg/L	IC	31	0	0.3450	no

Parameter	Period of Study	Unit	Season	n	No. BDL	P-value	Trend
TOTAL DISSOLVED SOLIDS	1993-2014	mg/L	ANNUAL	109	0	0.5762	no
TOTAL DISSOLVED SOLIDS		mg/L	OW	64	0	0.2534	no
TOTAL DISSOLVED SOLIDS		mg/L	IC	45	0	0.9745	no
TOTAL SUSPENDED SOLIDS	1972-2014	mg/L	ANNUAL	228	1	0.8214	no
TOTAL SUSPENDED SOLIDS		mg/L	OW	134	0	0.6015	no
TOTAL SUSPENDED SOLIDS		mg/L	IC	94	1	0.2748	no
TURBIDITY (LAB)	1972-2014	NTU	ANNUAL	246	0	0.4707	no
TURBIDITY (LAB)		NTU	OW	145	0	0.5545	no
TURBIDITY (LAB)		NTU	IC	101	0	0.9723	no
URANIUM DISSOLVED	2006-2014	µg/L	ANNUAL	55	0	0.9416	no
URANIUM DISSOLVED		µg/L	OW	35	0	0.8747	no
URANIUM TOTAL	2003-2014	µg/L	ANNUAL	69	0	0.6749	no
URANIUM TOTAL		µg/L	OW	41	0	0.9279	no
VANADIUM DISSOLVED	2006-2014	µg/L	ANNUAL	55	0	0.8531	no
VANADIUM DISSOLVED		µg/L	OW	35	0	0.8583	no
VANADIUM TOTAL	1983-2014	µg/L	ANNUAL	207	16	0.0705	no
VANADIUM TOTAL		µg/L	OW	117	2	0.2764	no
VANADIUM TOTAL		µg/L	IC	90	14	0.4340	no
ZINC DISSOLVED	2006-2014	µg/L	ANNUAL	55	0	0.6925	no
ZINC DISSOLVED		µg/L	OW	35	0	0.0012	↓
ZINC TOTAL	1983-2014	µg/L	ANNUAL	209	0	0.9399	no
ZINC TOTAL		µg/L	OW	117	0	0.6362	no
ZINC TOTAL		µg/L	IC	92	0	0.2441	no

NOTES:

- This table includes the MLE trend analysis results for parameters with sufficient sample size and small number of nondetects (n≥30 and BDL<40%). The results were based on data collected up to 2014.
- OW represents Open-Water; IC represents: Ice-Covered; n represents the total number of observations over the period of record; No.BDL represents the number of observations that were reported by the laboratory as observations below the detection analytical detection limit; P-value represents that significance level of the trend; ↑: represents statistically significant increasing trend; ↓: represents statistically significant decreasing trend; no: represents no statistically significant trend.

Table 9: Hay River Annual and 2-Season Trend Analysis Results

Parameter	Period of Study	Unit	Season	n	No. BDL	P-value	Trend
ALKALINITY TOTAL CACO3	1988-2014	mg/L	ANNUAL	154	0	0.8394	no
ALKALINITY TOTAL CACO3		mg/L	OW	92	0	0.5141	no
ALKALINITY TOTAL CACO3		mg/L	IC	62	0	0.1837	no
ALUMINUM TOTAL	1993-2014	µg/L	ANNUAL	99	0	0.7895	no
ALUMINUM TOTAL		µg/L	OW	64	0	0.3903	no
ALUMINUM TOTAL		µg/L	IC	35	0	0.4945	no
AMMONIA DISSOLVED	1993-2014	mg/L	ANNUAL	104	10	0.3422	no
AMMONIA DISSOLVED		mg/L	OW	68	9	0.2983	no
AMMONIA DISSOLVED		mg/L	IC	36	1	0.8245	no
ANTIMONY TOTAL	2006-2014	µg/L	ANNUAL	48	0	0.3133	no
ANTIMONY TOTAL		µg/L	OW	36	0	0.5152	no
BARIUM TOTAL	1988-2014	µg/L	ANNUAL	154	32	0.4474	no
BARIUM TOTAL		µg/L	OW	91	18	0.7019	no
BARIUM TOTAL		µg/L	IC	63	14	0.1178	no
BERYLLIUM TOTAL	1993-2014	µg/L	ANNUAL	103	32	0.1009	no
BERYLLIUM TOTAL		µg/L	OW	67	10	0.0687	no
BORON TOTAL	2002-2014	µg/L	ANNUAL	48	0	0.3827	no
BORON TOTAL		µg/L	OW	36	0	0.5035	no
CADMIUM TOTAL	1988-2014	µg/L	ANNUAL	154	19	0.6398	no
CADMIUM TOTAL		µg/L	OW	91	6	0.0012	↓
CADMIUM TOTAL		µg/L	IC	63	13	0.1134	no
CALCIUM DISSOLVED/FILTERED	1988-2014	mg/L	ANNUAL	154	0	0.8051	no
CALCIUM DISSOLVED/FILTERED		mg/L	OW	92	0	0.5192	no
CALCIUM DISSOLVED/FILTERED		mg/L	IC	62	0	0.3427	no
CARBON DISSOLVED ORGANIC	1988-2014	mg/L	ANNUAL	150	0	0.1943	no
CARBON DISSOLVED ORGANIC		mg/L	OW	89	0	0.2321	no
CARBON DISSOLVED ORGANIC		mg/L	IC	61	0	0.7266	no
CARBON PARTICULATE ORGANIC	1988-2014	mg/L	ANNUAL	153	0	0.7068	no
CARBON PARTICULATE ORGANIC		mg/L	OW	90	0	0.3604	no
CARBON PARTICULATE ORGANIC		mg/L	IC	63	0	0.0062	↑
CHLORIDE DISSOLVED	1988-2014	mg/L	ANNUAL	154	0	0.2128	no
CHLORIDE DISSOLVED		mg/L	OW	92	0	0.0001	↓
CHLORIDE DISSOLVED		mg/L	IC	62	0	0.5472	no
CHROMIUM TOTAL	1993-2014	µg/L	ANNUAL	103	4	0.5996	no
CHROMIUM TOTAL		µg/L	OW	67	1	0.4881	no

Parameter	Period of Study	Unit	Season	n	No. BDL	P-value	Trend
CHROMIUM TOTAL		µg/L	IC	36	3	0.5223	no
COBALT TOTAL	1988-2014	µg/L	ANNUAL	154	9	0.3334	no
COBALT TOTAL		µg/L	OW	91	1	0.2428	no
COBALT TOTAL		µg/L	IC	63	8	0.7074	no
COPPER TOTAL	1988-2014	µg/L	ANNUAL	154	0	0.6639	no
COPPER TOTAL		µg/L	OW	91	0	0.7666	no
COPPER TOTAL		µg/L	IC	63	0	0.7257	no
IRON TOTAL	1993-2014	µg/L	ANNUAL	103	0	0.9031	no
IRON TOTAL		µg/L	OW	67	0	0.801	no
IRON TOTAL		µg/L	IC	36	0	0.2646	no
LEAD TOTAL	1988-2014	µg/L	ANNUAL	154	28	0.5366	no
LEAD TOTAL		µg/L	OW	91	5	0.1417	no
LEAD TOTAL		µg/L	IC	63	23	0.0082	↓
LITHIUM TOTAL	2006-2014	µg/L	ANNUAL	103	0	0.0658	no
LITHIUM TOTAL		µg/L	OW	67	0	0	↓
LITHIUM TOTAL		µg/L	IC	36	0	0.0026	↓
MAGNESIUM DISSOLVED/FILTERED	1988-2014	mg/L	ANNUAL	154	0	0.7956	no
MAGNESIUM DISSOLVED/FILTERED		mg/L	OW	92	0	0.9651	no
MAGNESIUM DISSOLVED/FILTERED		mg/L	IC	62	0	0.3966	no
MANGANESE TOTAL	1993-2014	µg/L	ANNUAL	103	0	0.4101	no
MANGANESE TOTAL		µg/L	OW	67	0	0.1242	no
MANGANESE TOTAL		µg/L	IC	36	0	0.2533	no
MOLYBDENUM TOTAL	1993-2014	µg/L	ANNUAL	103	1	0.8413	no
MOLYBDENUM TOTAL		µg/L	OW	67	1	0.6628	no
MOLYBDENUM TOTAL		µg/L	IC	36	0	0.3082	no
NICKEL TOTAL	1988-2014	µg/L	ANNUAL	154	0	0.2406	no
NICKEL TOTAL		µg/L	OW	91	0	0.4366	no
NICKEL TOTAL		µg/L	IC	63	0	0.9493	no
NITRATE/ NITRITE	2005-2014	mg/L	ANNUAL	32	6	0.8647	no
NITROGEN DISSOLVED	1988-2014	mg/L	ANNUAL	154	16	0.1655	no
NITROGEN DISSOLVED		mg/L	OW	92	14	0.0542	no
NITROGEN DISSOLVED		mg/L	IC	62	2	0.0466	↓
OXYGEN DISSOLVED	1990-2014	mg/L	ANNUAL	118	0	0.6773	no
OXYGEN DISSOLVED		mg/L	OW	72	0	0.865	no
OXYGEN DISSOLVED		mg/L	IC	46	0	0.4607	no
PH (LAB)	1988-2014	PH UNITS	ANNUAL	156	0	0.0078	↑
PH (LAB)		PH UNITS	OW	94	0	0.0009	↑

Parameter	Period of Study	Unit	Season	n	No. BDL	P-value	Trend
PH (LAB)		PH UNITS	IC	62	0	0.6754	no
PHOSPHOROUS TOTAL	1988-2014	mg/L	ANNUAL	155	1	0.2747	no
PHOSPHOROUS TOTAL		mg/L	OW	93	0	0.2605	no
PHOSPHOROUS TOTAL		mg/L	IC	62	1	0.1226	no
PHOSPHOROUS TOTAL DISSOLVED	1988-2014	mg/L	ANNUAL	155	4	0.4099	no
PHOSPHOROUS TOTAL DISSOLVED		mg/L	OW	93	3	0.0083	↓
PHOSPHOROUS TOTAL DISSOLVED		mg/L	IC	62	1	0.4601	no
POTASSIUM DISSOLVED/FILTERED	1988-2014	mg/L	ANNUAL	154	0	0.4581	no
POTASSIUM DISSOLVED/FILTERED		mg/L	OW	92	0	0.5763	no
POTASSIUM DISSOLVED/FILTERED		mg/L	IC	62	0	0.7083	no
SELENIUM TOTAL	2003-2014	µg/L	ANNUAL	44	0	0.2269	no
SELENIUM TOTAL		µg/L	OW	33	0	0.6094	no
SILVER TOTAL	2003-2014	µg/L	ANNUAL	44	0	0.5308	no
SILVER TOTAL		µg/L	OW	33	0	0.548	no
SODIUM DISSOLVED/FILTERED	1988-2014	mg/L	ANNUAL	154	0	0.4847	no
SODIUM DISSOLVED/FILTERED		mg/L	OW	92	0	0.3825	no
SODIUM DISSOLVED/FILTERED		mg/L	IC	62	0	0.703	no
SPECIFIC CONDUCTANCE (LAB)	1988-2014	USIE/CM	ANNUAL	155	0	0.667	no
SPECIFIC CONDUCTANCE (LAB)		USIE/CM	OW	93	0	0.5122	no
SPECIFIC CONDUCTANCE (LAB)		USIE/CM	IC	62	0	0.5147	no
STRONTIUM TOTAL	1993-2014	µg/L	ANNUAL	103	0	0.7025	no
STRONTIUM TOTAL		µg/L	OW	67	0	0.4938	no
STRONTIUM TOTAL		µg/L	IC	36	0	0.9757	no
SULPHATE DISSOLVED	1988-2014	mg/L	ANNUAL	154	0	0.4995	no
SULPHATE DISSOLVED		mg/L	OW	92	0	0.5536	no
SULPHATE DISSOLVED		mg/L	IC	62	0	0.1744	no
THALLIUM TOTAL	2002-2014	µg/L	ANNUAL	48	0	0.7637	no
THALLIUM TOTAL		µg/L	OW	36	0	0.9048	no
TOTAL DISSOLVED SOLIDS	1993-2014	mg/L	ANNUAL	104	0	0.5278	no
TOTAL DISSOLVED SOLIDS		mg/L	OW	68	0	0.5642	no
TOTAL DISSOLVED SOLIDS		mg/L	IC	36	0	0.6767	no
TOTAL SUSPENDED SOLIDS	1988-2014	mg/L	ANNUAL	156	11	0.3452	no
TOTAL SUSPENDED SOLIDS		mg/L	OW	93	2	0.5358	no
TOTAL SUSPENDED SOLIDS		mg/L	IC	63	9	0.9212	no
TURBIDITY (LAB)	1988-2014	NTU	ANNUAL	156	0	0.9094	no
TURBIDITY (LAB)		NTU	OW	93	0	0.8984	no
TURBIDITY (LAB)		NTU	IC	63	0	0.7171	no

Parameter	Period of Study	Unit	Season	n	No. BDL	P-value	Trend
URANIUM TOTAL	2003-2014	µg/L	ANNUAL	44	0	0.1909	no
URANIUM TOTAL		µg/L	OW	33	0	0.7556	no
VANADIUM TOTAL	1988-2014	µg/L	ANNUAL	154	21	0.0246	↑
VANADIUM TOTAL		µg/L	OW	91	3	0.2644	no
VANADIUM TOTAL		µg/L	IC	63	18	0.4971	no
ZINC TOTAL	1988-2014	µg/L	ANNUAL	154	0	0.7229	no
ZINC TOTAL		µg/L	OW	91	0	0.4562	no
ZINC TOTAL		µg/L	IC	63	0	0.0007	↑

NOTES:

- This table includes the MLE trend analysis results for parameters with sufficient sample size and small number of nondetects (n≥30 and BDL<40%). The results were based on data collected up to 2014.
- OW represents Open-Water; IC represents: Ice-Covered; n represents the total number of observations over the period of record; No. BDL represents the number of observations that were reported by the laboratory as observations below the detection analytical detection limit; P-value represents that significance level of the trend; ↑: represents statistically significant increasing trend; ↓: represents statistically significant decreasing trend; no: represents no statistically significant trend.