ALBERTA-NWT TRANSBOUNDARY
WATER QUALITY
FOR SLAVE AND HAY RIVERS

2018 | 2019

QUALITÉ DES EAUX TRANSFRONTALIÈRES
ENTRE L'ALBERTA ET LES TNO
POUR LA RIVIÈRE DES ESCLAVES ET LA RIVIÈRE AU FOIN

a technical companion report to the

Alberta-Northwest Territories Bilateral Management Committee Annual Report to Ministers, 2018-2020

Surface water quality results for 2018 and 2019

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Executive Summary

The Bilateral Management Committee (BMC) releases this annual water quality report as a component of the reporting requirements of the Alberta-Northwest Territories Bilateral Water Management Agreement (BWMA). This is the fourth water quality report since the signing of the Agreement in 2015. It presents an assessment of the water quality data from the water samples collected from the Slave and Hay rivers in 2018 and 2019 and the cooperative efforts of the Alberta-NWT water quality technical team between April 2018 and March 2020.

Alberta and the NWT are committed to establishing transboundary water quality triggers and objectives for the Slave and Hay rivers. While the BMC continues to work on the development of transboundary water quality objectives, site-specific interim water quality triggers set at the 50th (Trigger 1) and 90th (Trigger 2) percentile were used for this assessment. Triggers are intended to provide an early warning of potential changing water quality conditions.

Water quality samples collected from the Slave and Hay rivers are analyzed for many parameters including major ions, nutrients and metals. For the 2018 and 2019 assessment, sixty-six parameters from eighteen samples collected on the Slave River throughout the two years were reviewed through a multi-stage approach. For the Hay River, forty different parameters from seven samples were reviewed over this time period.

For the 2018 Slave River results, forty-six of the 66 parameters were initially flagged during the Trigger 1 assessment. Of these, alkalinity, specific conductance, dissolved calcium, dissolved magnesium, dissolved sulphate, nitrate/nitrite, and dissolved strontium had also been flagged in 2015, 2016 and 2017. Under Trigger 2, thirty-two of the 66 parameters were flagged for further assessment. Of these, dissolved magnesium and dissolved sulphate were above their historical seasonal maximum values whereas nitrate/nitrite, dissolved sodium, dissolved cobalt and dissolved lithium were above their historical overall maximum values. In 2019, twenty-five of the 66 parameters were initially flagged during the Trigger 1 assessment. Of these, alkalinity, specific conductance, dissolved calcium, dissolved magnesium, dissolved sulphate, nitrate/nitrite, and dissolved strontium had also been flagged consecutively during the four previous years. Under Trigger 2, seventeen of the 66 parameters were flagged for further assessment. Of these, alkalinity and dissolved magnesium were above their historical seasonal maximum values whereas nitrate/nitrite was above its historical overall maximum value. Further analysis revealed statistically significant increasing trends for alkalinity, dissolved magnesium, dissolved sulphate and nitrate/nitrite.

For the Hay River 2018 sampling results, three of the 40 parameters were initially flagged during the Trigger 1 assessment. Of these, nitrate/nitrite was also flagged in 2016 and 2017. Under Trigger 2, twenty-nine of the 40 parameters were flagged, none of which exceeded their historical seasonal/annual maximum values. In 2019, two of the 40 parameters were flagged under Trigger 1 assessment. Of these, nitrate/nitrite had also been flagged in the three previous years. Under Trigger 2, only one parameter, nitrate/nitrite, was flagged. However, it was not over its historical seasonal maximum value. Further analysis revealed a statistically significant increasing trend for nitrate/nitrite.

The BWMA commits the BMC to report on the detection (presence or absence) of toxic, bioaccumulative and persistent substances that are primarily of human origin. During the summers of 2018 and 2019, two water samples from both the Slave and Hay rivers were analyzed for 14 substances that are subject to virtual elimination (VE). Some substances subject to VE were detected on each sampling occasion in each river, but at very low concentrations. Comparisons with the available corresponding United States Environmental Protection Agency (USEPA) Chronic Aquatic Life Criteria show that the levels detected pose no risk to aquatic life.

The 2018 and 2019 water quality assessment for the Slave and Hay rivers identified a few increasing trends in the past twenty years (alkalinity, nitrate/nitrite and dissolved magnesium in the Slave River, nitrate/nitrite in the Hay River). Although most of the changes are generally low in magnitude and are not concerning at present, the BMC will continue to watch these particular parameters. The Alberta-NWT water quality technical team has been actively working with technical staff from the other MRB jurisdictions to explore and develop standard approaches to assess trends in the transboundary rivers.

The Hay River at Alexandra Falls

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Le Comité bilatéral de gestion (CBG) diffuse son rapport annuel sur la qualité de l'eau pour satisfaire aux exigences en matière de rapports de l'Entente bilatérale sur la gestion des eaux (EBGE) entre le gouvernement de l'Alberta et le gouvernement des Territoires du Nord-Ouest. Il s'agit du quatrième rapport sur la qualité de l'eau depuis la conclusion de l'Entente en 2015. Il présente une évaluation des données sur la qualité de l'eau tirées des échantillons d'eau prélevés dans la rivière des Esclaves et la rivière au Foin en 2018 et 2019 et des efforts coopératifs de l'équipe technique sur la qualité de l'eau de l'Alberta et des Territoires du Nord-Ouest d'avril 2018 à mars 2020.

L'Alberta et les Territoires du Nord-Ouest sont déterminés à établir des déclencheurs et objectifs relatifs à la qualité des eaux transfrontalières pour la rivière des Esclaves et la rivière au Foin. Alors que le CBG continue d'élaborer des objectifs transfrontaliers relatifs à la qualité de l'eau, on a utilisé des déclencheurs provisoires sur la qualité de l'eau à des sites spécifiques fixés au 50^{e} (déclencheur 1) et au 90^{e} (déclencheur 2) centile pour cette évaluation. Les déclencheurs ont pour but de fournir une alerte rapide de changement potentiel des conditions relatives à la qualité de l'eau.

Les échantillons de qualité de l'eau prélevés dans la rivière des Esclaves et la rivière au Foin sont analysés selon de nombreux paramètres, dont les ions, nutriments et métaux importants. Pour les évaluations de 2018 et 2019, on a examiné 66 paramètres provenant de 18 échantillons prélevés dans la rivière des Esclaves au cours des deux années au moyen d'une approche par étapes. En ce qui concerne la rivière au Foin, on a examiné 40 paramètres différents provenant de 7 échantillons pendant cette période.

Concernant les résultats de 2018 pour la rivière des Esclaves, 46 des 66 paramètres ont d'abord été signalés lors de l'évaluation du déclencheur 1. Parmi ces signalements, on avait également relevé de l'alcalinité, une conductance spécifique, du calcium dissous, du magnésium dissous, du sulfate dissous, du nitrate ou du nitrite et du strontium dissous en 2015, 2016 et 2017. Du côté du déclencheur 2, on a signalé 32 des 66 paramètres pour une évaluation plus approfondie. Parmi ces signalements, le magnésium dissous et le sulfate dissous étaient supérieurs à leurs valeurs maximales saisonnières historiques, tandis que le nitrate ou le nitrite, le sodium dissous, le cobalt dissous et le lithium dissous étaient supérieurs à leurs valeurs maximales globales historiques. En 2019, 25 des 66 paramètres ont d'abord été signalés lors de l'évaluation du déclencheur 1. Parmi ces signalements, on avait également signalé de manière consécutive de l'alcalinité, une conductance spécifique, du calcium dissous, du magnésium dissous, du sulfate dissous, du nitrate ou du nitrite et du strontium dissous lors des quatre années précédentes. Du côté du déclencheur 2, on a signalé 17 des 66 paramètres pour une évaluation plus approfondie. Parmi ces signalements, l'alcalinité et le magnésium dissous étaient supérieurs à leurs valeurs maximales saisonnières historiques, tandis que le nitrate ou le nitrite était supérieur à sa valeur maximale globale historique. Une analyse plus approfondie a permis de révéler des tendances à la hausse statistiquement significatives concernant l'alcalinité, le magnésium dissous, le sulfate dissous et le nitrate ou le nitrite.

Concernant les résultats d'échantillonnage de 2018 pour la rivière au Foin, 3 des 40 paramètres ont d'abord été signalés lors de l'évaluation du déclencheur 1. Parmi ces signalements, le nitrate ou le nitrite avait également été signalé en 2016 et 2017. Du côté du déclencheur 2, 29 des 40 paramètres ont été signalés; aucun ne dépassait ses valeurs maximales saisonnières et annuelles historiques. En 2019, 2 des 40 paramètres ont été signalés lors de l'évaluation du déclencheur 1. Parmi ces signalements, le nitrate ou le nitrite avait déjà été signalé au cours des trois années précédentes. Du côté du déclencheur 2, un seul paramètre a été signalé, soit le nitrate ou le nitrite. Cependant, il n'était pas supérieur à sa valeur maximale saisonnière historique. Une analyse plus approfondie a permis de révéler une tendance à la hausse statistiquement significative concernant le nitrate ou le nitrite.

L'EBGE engage le CBG à déclarer la détection (présence ou absence) de substances toxiques, bioaccumulables et persistantes qui sont principalement d'origine humaine. Pendant les étés 2018 et 2019, on a analysé en même temps deux échantillons d'eau de la rivière des Esclaves et de la rivière au Foin pour y détecter quatorze substances soumises à la quasi-élimination. On a détecté certaines substances soumises à la quasi-élimination dans chaque échantillon de chaque rivière, mais à des concentrations très faibles. Les comparaisons avec les critères relatifs à la toxicité chronique pour la vie aquatique de l'Environmental Protection Agency (EPA) des États-Unis indiquent que les taux détectés ne présentent pas de risque pour la vie aquatique.

L'évaluation de la qualité de l'eau de 2018 et 2019 pour la rivière des Esclaves et la rivière au Foin a déterminé quelques tendances à la hausse au cours des vingt dernières années (alcalinité, nitrate et nitrite et magnésium dissous dans la rivière des Esclaves; nitrate et nitrite dans la rivière au Foin). Bien que la plupart des changements soient de faible ampleur et ne soient pas préoccupants pour l'instant, le CBG continue de surveiller ces paramètres particuliers. L'équipe technique sur la qualité de l'eau de l'Alberta et des Territoires du Nord-Ouest collabore de manière active avec le personnel technique des autres gouvernements du bassin du Mackenzie dans le but d'explorer et d'élaborer des démarches standards visant à évaluer les tendances dans les rivières transfrontalières.

1. Background

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

- Managing the Water Resources in a manner consistent with the maintenance of the Ecological Integrity of the Aquatic Ecosystem;
- Managing the use of the Water Resources in a sustainable manner for present and future generations;
- 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;
- 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
- Resolving issues in a cooperative and harmonious manner.

The Master Agreement provides broad guidance for negotiating individual bilateral agreements between provincial and territorial jurisdictions. In March 2015, the Alberta-NWT 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 facilitates improved monitoring and reporting and includes provisions to develop water quality, quantity and biological objectives to maintain the ecological integrity of transboundary water ecosystems.

After the BWMA was signed, a Bilateral Management Committee (BMC) was established to guide the implementation of the BWMA. Each year, the BMC releases a report that describes the activities undertaken during the previous fiscal year and summarizes the Slave and Hay River water quality data from the previous calendar year. This technical report includes the details and assessment for the water quality information that is summarized in the 2018-2020 BMC annual report. This report is intended to:

i. Describe the Slave and Hay River transboundary water quality monitoring programs used for this assessment (Section 2);

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

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

iv. Describe the activities of the Alberta-NWT water quality technical team for the 2018-2020 fiscal year and any upcoming transboundary water quality-related tasks (Section 7).

2. Transboundary Water Quality Monitoring Programs

Slave River

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

These programs 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 were used for this assessment.

Since 1960, ECCC has operated the Slave River at Fitzgerald monitoring site (AL07NB0001) 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 the Town of Fort Smith. Since monitoring began at this site, water samples have been collected from two to thirteen times a year. In 2018 and 2019, water quality samples were collected on nine occasions each year (January, February, March, May, June, July, August, September and October). The conventional data (physical parameters, major ions, nutrients and metals) from these water samples were used for this assessment.

Since 1990, Crown-Indigenous Relations and Northern Affairs Canada (up to April 1, 2014) and the GNWT (after April 1, 2014) have operated the Slave River at Fort Smith monitoring site (NWT07QA0004) 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 site, water and suspended sediment samples have been collected from one to twelve times a year. Water and suspended sediment samples were collected in June and August (2018) and June and July (2019). These data are also used as part of the water quality assessment, particularly for assessment of those substances subject to virtual elimination.

Table 1 presents a list of the water quality parameters assessed to fulfill the water quality reporting requirements of the BWMA. The Slave River at Fitzgerald and Slave River at Fort Smith monitoring locations are shown in Figure 1.

Table 1: Slave River parameters reviewed for the 2018-19 water quality assessment

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

Hay River

Along the transboundary reach of the Hay River there is one long-term transboundary water quality monitoring site (Figure 1) which is sampled under two separate 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 site (NW07OB0002) as part of their Long-term Monitoring Network. Samples were collected on a monthly basis from 1988 to 1994 and have been collected three to six times a year since 1995. Water quality samples were collected on three occasions in 2018 in May, July and September; and in 2019 on four occasions in April, May, July and August. Water quality data (physical parameters, major ions, nutrients and metals) from these water samples were used for this assessment.

Since 1995, Crown-Indigenous Relations and Northern Affairs Canada (up to April 1, 2014) and the GNWT (after 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. Water and suspended sediment samples were collected in June and August (2018) and June and July (2019). These data are used to assess those substances subject to virtual elimination.

Table 2 presents a list of the water quality parameters reviewed to fulfill the water quality reporting requirements of the AB-NWT BWMA.

Table 2: Hay River parameters reviewed for the 2018-19 water quality assessment

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

Figure 1: AB-NWT Transboundary Water Quality Monitoring Sites

3. Approach to Annual Water Quality Assessment

Introduction

Under the BWMA, the Hay and Slave rivers have been classified as Class 3 water bodies. An important task associated with a Class 3 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.

The BWMA defines a water quality trigger as a pre-defined early warning of potential changes in typical and/or extreme conditions which results in Jurisdictional and/or Bilateral Water Management to confirm that change. Triggers are an aid to manage water quality within the range of natural variability. Interim water quality triggers have been calculated based on ambient background concentrations of a parameter at the water quality site under consideration. Where water quality parameters exhibited seasonal differences, seasonal interim site-specific water quality triggers have been calculated.

In the BWMA, a water quality objective is defined as a conservative value that is protective of all uses of the water body, including the most sensitive use (AB-NWT 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 a priority. Steps towards the development of objectives are underway.

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.

Data Preparation

Initially, to determine the historical range of water quality in the Hay and Slave rivers, the Hay River dataset (1969-May 2014) and the Slave River dataset (1960-2012) were retrieved from ECCC. HDR Inc. 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. While these steps are fully described in the Technical Report (HDR, 2015), in summary the steps included: 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 are reported below laboratory method detection limits), and underlying distribution (normal, lognormal, gamma, etc.). 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 data, counts of censored data, means, medians, minimums, maximums and percentiles were calculated.

After reviewing the datasets, the time series used historic range for the Slave River was 1972-2012. Data collected before and during the filling of the Williston Reservoir (1960-1971) were not comparable and therefore not used. The time series used for the Hay River was 1988-2014, as 1988 marks the year 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 exhibit seasonality. To this end, the development of seasonal triggers was recommended and a year was divided into four seasons where possible: spring (May and June), summer (July and August), fall (September and October) and winter (from November to April) (HDR, 2015). Where sample size was insufficient for developing four seasonal triggers, the year was divided into two seasonal periods: open water (May through October) and under ice (November through April).

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 BWMA.

Originally, when the interim water quality triggers were calculated in 2014, only the data up to and including May of 2014 for the Hay River and October of 2012 for the Slave River were available. In 2016, the Hay and Slave River interim water quality triggers were updated to reflect a period of record that ends in October of 2014. October (2014) marks the month in which the last Slave and Hay River water quality samples were collected (in that calendar year) before the AB-NWT BWMA was signed in March 2015. All triggers (original and updated) for both rivers are included in Appendices 2 and 3 of this report.

Interim Water Quality Triggers Assessment

Since the interim water quality triggers (i.e., percentiles) are based on values that have been observed in the past, they are useful to help identify potential changes in water quality. As the triggers are set conservatively, not all values above a trigger necessarily signal a concern, but are used to highlight parameters that should be examined further to determine if a change is occurring.

Trigger 1 (Median) Assessment

Trigger 1 is intended to be an early warning signal of changes in typical (average or normal) conditions. For this report, the annual median (50th percentile calculated using multiple years of all-season data) was selected as Interim Trigger 1 (Trigger 1). Trigger 1 was calculated from historical ambient concentrations for all conventional parameters listed in Table 1 and Table 2.

Given that values above the median are expected, for this report, a parameter was only flagged if the number of values above Trigger 1 occurred more often than expected. For example:

<u>Slave River</u>

With 9 samples collected from the Slave River in each year (2018 and 2019), a parameter will:

- not be flagged if 4 or less values are greater than Trigger 1 (i.e., less than half (50%) of the values are above Trigger 1)
- be flagged if 5 or more values are greater than Trigger 1 (i.e., more than half (50%) of the values are above Trigger 1)

Hay River

With 3[1] and 4 samples collected from the Hay River in 2018 and 2019, respectively, a parameter will:

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

Trigger 2 (90th Percentile) Assessment

Trigger 2 is intended to be an early warning signal of changes in extreme (high values) conditions. For this report, the seasonal 90th percentile was selected as the Interim Trigger 2 (Trigger 2). Trigger 2 was calculated from historical ambient concentrations for all conventional parameters listed in Table 1 and Table 2. By definition, 10% of values for each parameter are expected to be above the 90th percentile (Trigger 2) each year if there has been no change to the water (no change in water quality).

To assess current extreme conditions, the 2018 and 2019 data were compared to Trigger 2, respectively. For both the Slave and Hay rivers, parameters were flagged for further review if a value was above Trigger 2.

Evaluation of Flagged Parameters

Any parameter flagged by Trigger 1 or 2 was further evaluated through a series of steps.

(i) Evaluating Trigger 1 Flagged Parameters

Parameters flagged in consecutive years (e.g., 2015, 2016, 2017, 2018 and 2019) were analyzed for long term trends to determine if the trend is in a direction of concern. In this report, a trend was declared statistically significant if the p-value was less than 0.05 (WQStat (2014) Plus v.9.4).

[1] One sample was lost upon shipment to the laboratory in 2018.

(ii) Evaluating Trigger 2 Flagged Parameters

Values above Trigger 2 were compared to their respective historical seasonal and historical maximum values to provide context. Any parameter above its historical seasonal (where available) and or historical maximum value was evaluated further by:

- Examining flow conditions and the suspended sediment levels to examine whether the values above Trigger 2 were attributable to any special flow conditions at the time of sampling; and,
- Comparing values to national and/or provincial water quality guidelines, where guidelines exist.

(iii) Further Evaluation

Any unexplained Trigger 1 and 2 flagged parameters undergo further investigation. The investigative phase may include, but not be limited to, the following steps:

- Examine water quality data from sampling sites such as Athabasca River at Baseline 27 and Peace River at Peace Point to see if similar patterns are emerging upstream.
- Identify anthropogenic sources that could be responsible.
- Evaluate whether the existing monitoring program is adequate.
- Evaluate whether the original triggers need to be reviewed and/or revised.

Toxic, Bioaccumulative and Persistent Substances Assessment

The Parties have agreed to the objective of virtual elimination (VE) of substances that are human-made, toxic, bioaccumulative and persistent. Through the BWMA, Alberta and NWT are committed to pollution prevention and sustainable development. Substances subject to VE that are monitored as part of this BWMA are listed in Table 1 and Table 2. As part of this assessment, the 2018 and 2019 data for substances subject to VE are reviewed, and the presence of each substance subject to VE is reported and discussed.

4. Slave River Water Quality Results

Slave River 2018:

In 2018, 594 individual water quality results were compared to Trigger 1 and Trigger 2. These water quality results were generated from water samples collected in 2018 by ECCC from the Slave River (at Fitzgerald) on nine occasions. Sixty-six parameters were analyzed in each sample.

Trigger 1

The 2018 water quality results were screened to highlight any water quality values higher than Trigger 1 (all-season median). If more than 50% of the values were higher than Trigger 1, the parameter was flagged. In 2018, 46 of the 66 parameters were flagged (Table 3). Seven of these 46 parameters, including alkalinity, specific conductance, dissolved calcium, dissolved magnesium, dissolved sulphate, nitrate/nitrite and dissolved strontium were also flagged in 2015, 2016 and 2017.

Table 3. Slave River 2018 Trigger 1 Assessment Summary

Parameter	Trigger 1	Number of Values higher than Trigger 1 (out of 9)
Alkalinity (mg/L)	84.2	5
Specific Conductance (us/cm)	211	9
Turbidity (NTU)	54	6
Total Dissolved Solids (mg/L)	133	7
Total Suspended Solids (mg/L)	76	5
Dissolved Calcium (mg/L)	28.3	8
Dissolved Magnesium (mg/L)	6.58	8
Dissolved Potassium (mg/L)	0.905	6
Dissolved Sodium (mg/L)	6.19	5
Dissolved Sulphate (mg/L)	18	8
Dissolved Organic Carbon (mg/L)	5.575	6
Particulate Organic Carbon (mg/L)	1.85	7
Nitrate/Nitrite (mg/L)	0.08	7
Dissolved Nitrogen (mg/L)	0.224	5
Total Phosphorus (mg/L)	0.087	7
Dissolved Aluminum (µg/L)	25.3	6
Total Aluminum (µg/L)	859	5
Total Arsenic (µg/L)	1.09	6
Dissolved Barium (µg/L)	46	6
Total Barium (µg/L)	80	5
Total Beryllium (µg/L)	0.064	5
Total Bismuth (µg/L)	0.017	5

Parameter	Trigger 1	Number of Values higher than Trigger 1 (out of 9)
Dissolved Boron (µg/L)	13.8	5
Total Boron (µg/L)	14.1	6
Total Chromium (µg/L)	1.405	5
Dissolved Cobalt (µg/L)	0.055	5
Total Cobalt (µg/L)	1	5
Total Copper (µg/L)	3.85	5
Total Iron (µg/L)	1990	6
Total Lead (µg/L)	1.6	5
Dissolved Lithium (µg/L)	3.98	6
Total Lithium (µg/L)	6.08	6
Dissolved Manganese (µg/L)	2.53	5
Total Manganese (µg/L)	57.6	6
Dissolved Nickel (µg/L)	1.21	5
Total Nickel (µg/L)	3.38	6
Dissolved Selenium (µg/L)	0.210	7
Total Selenium (µg/L)	0.230	6
Dissolved Strontium (µg/L)	134	5
Total Strontium (µg/L)	140	8
Dissolved Thallium (µg/L)	0.007	5
Total Thallium (µg/L)	0.028	5
Dissolved Uranium (µg/L)	0.408	8
Total Uranium (µg/L)	0.492	7
Total Vanadium (µg/L)	2.4	5
Total Zinc (µg/L)	11	5

Trigger 2

The 2018 water quality results were screened to highlight any values higher than Trigger 2. In 2018, 32 of the 66 parameters had concentrations above Trigger 2 (Table 4). Of these 32 parameters, dissolved magnesium and dissolved sulphate were above their historical seasonal maximum values (highlighted in green) whereas nitrate/nitrite, dissolved sodium, dissolved cobalt and dissolved lithium were above their historical overall maximum values (highlighted in red).

Table 4. Slave River 2018 Trigger 2 Assessment Summary

Parameter	Trigger 2	Value above Trigger 2	Historical Seasonal Maximum Value	Historical Annual Maximum Value	Guideline for the Protection of Aquatic Life
Alkalinity (mg/L)					
Spring (May)	92.8	93.8	121	121	20 (AB)
Fall (October)	92.2	95	97.7		
Dissolved Aluminum (µg/L)					
Annual (January)	65.2	177	226	226	100 (AB & BC)
Dissolved Barium (µg/L)					
Annual (March)	54.5	57.2	76.6	76.6	n/a
Total Barium (µg/L)					
Winter (March)	160	181	320	1730	n/a
Dissolved Beryllium (µg/L)					
Annual (January)	0.012	0.016	0.019	0.019	n/a
Dissolved Boron (µg/L)					
Annual (June)	19	22.2	28.3	28.3	n/a
Total Boron (µg/L)					
Annual (June)	20.1	23.7	39.3	39.3	1500 (AB & CCME) 1200 (BC)
Dissolved Calcium (mg/L)					
Fall (October)	30.9	33.7	41.7	42	n/a
Particulate Organic Carbon (mg/L)					
Winter (March)	7.99	9.19	24.2	68.5	n/a
Dissolved Cobalt (µg/L)					
Annual (January)	0.136	0.383	0.276	0.276	n/a
Total Cobalt (µg/L)					
Winter (March)	3.04	4.84	8.88	30.3	1.1 (AB; based on hardness of 100 mg/L) 110 (BC)
Dissolved Iron (µg/L)					
Annual (January)	193	421	527	527	300 (AB & CCME) 350 (BC)
Dissolved Lithium (µg/L)					
Annual (June)	5.34	6.2	6.1	6.1	n/a
Annual (July)		5.62			
Dissolved Magnesium (mg/L)					
Winter (January)	7.08	7.22	8.08	8.8	n/a
Summer (August)	7.86	8.56	8.8		

Parameter	Trigger 2	Value above Trigger 2	Historical Seasonal Maximum Value	Historical Annual Maximum Value	Guideline for the Protection of Aquatic Life
Fall (October)	7.48	8.63	7.86		
Dissolved Manganese (µg/L)					
Annual (October)	6.63	4.39	13.6	13.6	n/a
Total Manganese (µg/L)					
Under Ice (March)	330	332	761	1980	1000 (BC; based on hardness of 100 mg/L)
Total Nickel (µg/L)					
Winter (March)	9.18	12.2	25.5	92.9	52 (AB; based on hardness of 100 mg/L)
Nitrate/Nitrite (mg/L)					
Annual (January)	0.183	0.22	0.3	0.3	3 (AB & BC) 13 (CCME)
Annual (February)		0.24			
Annual (May)		0.2			
Annual (June)		0.27			
Annual (July)		0.2			
Annual (August)		0.39			
Annual (September)		0.25			
Total Phosphorus (mg/L)					
Winter (March)	0.359	0.403	1.23	4.67	n/a
Dissolved Potassium (mg/L)					
Summer (August)	1.26	1.54	2.01	3.63	n/a
Fall (September)	1.02	1.07	1.48		
Total Suspended Solids (mg/L)					
Winter (January)	343	408	1110	4880	n/a
Winter (March)	343	506	1110		
Dissolved Selenium (µg/L)					
Annual (May)	0.311	0.36	0.5	0.5	n/a
Total Selenium (µg/L)					
Annual (May)	0.39	0.4	0.88	0.88	1 (CCME) 2 (AB & BC)
Dissolved Sodium (mg/L)					
Summer (August)	7.39	13.5	8.85	11	n/a
Fall (October)	7.74	9.68	11		
Specific Conductance (uS/cm)					
Fall (October)	253	259	280	364	n/a
Dissolved Strontium (µg/L)					
Annual (October)	156	166	186	186	n/a

Parameter	Trigger 2	Value above Trigger 2	Historical Seasonal Maximum Value	Historical Annual Maximum Value	Guideline for the Protection of Aquatic Life
Dissolved Sulphate (mg/L)					
Fall (October)	21.7	25.7	24.8	37.2	100 (BC; based on hardness of 100 mg/L)
Turbidity (NTU)					
Winter (January)	195	226	900	6450	n/a
Winter (March)	195	318	900		
Dissolved Uranium (µg/L)					
Annual (January)	0.511	0.54	1.19	1.19	n/a
Dissolved Vanadium (µg/L)					
Annual (January)	0.507	0.74	0.898	0.898	n/a
Total Vanadium (µg/L)					
Winter (March)	8.04	10.5	24.1	84.8	n/a
Total Zinc (µg/L)					
Winter (March)	35.9	37.5	113.0	561.0	30 (CCME)

Note:AB (Alberta); BC (British Columbia); CCME (Canadian Council for Ministers of Environment); Season (Annual, Open-Water, Under-Ice, Spring, Summer, Fall or Winter) represents the season from which the trigger was derived for the Assessment; Month (in parentheses) represents the month in which the sample was collected; n/a, not available.

Slave River 2019:

In 2019, 594 individual water quality results were compared to Trigger 1 and Trigger 2. These water quality results were generated from water samples collected in 2019 by ECCC from the Slave River (at Fitzgerald) on nine occasions. Sixty-six parameters were analyzed in each sample.

Trigger 1

The 2019 water quality results were screened to highlight any water quality values higher than Trigger 1 (all-season median). If more than 50% of the values were higher than Trigger 1, the parameter was flagged. In 2019, 25 of the 66 parameters were flagged (Table 5). Of these, alkalinity, specific conductance, dissolved calcium, dissolved magnesium, dissolved sulphate, nitrate/nitrite and dissolved strontium were also flagged in 2015, 2016, 2017 and 2018.

Table 5. Slave River 2019 Trigger 1 Assessment Summary

Parameter	Trigger 1	Number of 2019 Values higher than Trigger 1 (out of 9)
Alkalinity (mg/L)	84.2	9
Specific Conductance (us/cm)	211	9
Dissolved Calcium (mg/L)	28.3	9

Parameter	Trigger 1	Number of 2019 Values higher than Trigger 1 (out of 9)
Dissolved Magnesium (mg/L)	6.575	9
Dissolved Potassium (mg/L)	0.905	7
Dissolved Sodium (mg/L)	6.19	7
Dissolved Sulphate (mg/L)	18	9
Dissolved Organic Carbon (mg/L)	5.575	5
Particulate Organic Carbon (mg/L)	1.85	5
Nitrate/Nitrite (mg/L)	0.08	9
Dissolved Nitrogen (mg/L)	0.224	8
Dissolved Arsenic (µg/L)	0.41	5
Dissolved Barium (µg/L)	46.4	6
Total Boron (µg/L)	14.1	5
Dissolved Lithium (µg/L)	3.98	6
Total Lithium (µg/L)	6.08	5
Dissolved Molybdenum (µg/L)	0.746	5
Total Molybdenum (µg/L)	0.629	5
Dissolved Nickel (µg/L)	1.21	5
Dissolved Selenium (µg/L)	0.21	7
Total Selenium (µg/L)	0.23	5
Dissolved Strontium (µg/L)	134	8
Total Strontium (µg/L)	140	7
Dissolved Uranium (µg/L)	0.408	7
Total Uranium (µg/L)	0.492	6

Trigger 2

The 2019 water quality results were screened to highlight any values higher than Trigger 2. In 2019, 17 of the 66 parameters had concentrations above Trigger 2 (Table 6). Of these 17 parameters, alkalinity and dissolved magnesium were above their historical seasonal maximum values (highlighted in green); whereas nitrate/nitrite was above its historical overall maximum values (highlighted in red).

Table 6. Slave River 2019 Trigger 2 Assessment Summary

Parameter	Trigger 2	Value above Trigger 2	Historical Seasonal Maximum Value	Historical Annual Maximum Value	Guideline for the Protection of Aquatic Life
Alkalinity (mg/L)					
Spring (June)	92.8	103	121	121	20 (AB)
Summer (July)	96.9	106	110		
Summer (August)	96.9	103	110		
Fall (September)	92.2	98.3	97.7		
Fall (October)	92.2	99.7	97.7		
Dissolved Arsenic (µg/L)					
Annual (August)	0.58	0.6	0.65	0.65	n/a
Dissolved Barium (µg/L)					
Annual (July)	54.5	59.2	76.6	76.6	n/a
Annual (August)		58.8			
Annual (September)		55.9			
Dissolved Calcium (mg/L)					
Spring (June)	33.5	33.6	37.5	42	n/a
Summer (August)	34.1	34.2	42		
Fall (September)	30.9	34	41.7		
Fall (October)	30.9	34.2	41.7		
Dissolved Organic Carbon (mg/L)					
Summer (August)	12.99	13	22.1	40.4	n/a
Fall (September)	8.72	11.7	11.9		
Fall (October)	8.72	11.7	11.9		
Dissolved Lithium (µg/L)					
Annual (August)	5.34	5.81	6.09	6.09	n/a
Annual (September)		5.68			
Annual (October)		5.96			
Dissolved Magnesium (mg/L)					
Winter (January)	7.08	7.21	8.08	8.8	n/a
Winter (February)	7.08	7.16	8.08		
Spring (June)	7.41	8.49	7.8		
Summer (July)	7.86	8.31	8.8		
Summer (August)	7.86	8.46	8.8		
Fall (September)	7.48	8.61	7.86		
Fall (October)	7.48	8.68	7.86		
Dissolved Molybdenum (µg/L)					
Annual (July)	0.946	1.04	2.56	2.56	

Parameter	Trigger 2	Value above Trigger 2	Historical Seasonal Maximum Value	Historical Annual Maximum Value	Guideline for the Protection of Aquatic Life
Nitrate/Nitrite (mg/L)					
Annual (January)	0.183	0.26	0.3	0.3	3 (AB & BC[i]) 13 (CCME)
Annual (February)		0.28			
Annual (March)		0.28			
Annual (May)		0.33			
Annual (June)		0.3			
Annual (July)		0.32			
Annual (August)		0.24			
Annual (September)		0.2			
Annual (October)		0.22			
Dissolved Potassium (mg/L)					
Fall (September)	1.02	1.05	1.48	3.63	n/a
Fall (October)	1.02	1.05	1.48		
Total Dissolved Solids (mg/L)					
Open Water (July)	196	203	265	360	n/a
Open Water (August)	196	249	265		
Dissolved Selenium (µg/L)					
Annual (June)	0.31	0.33	0.5	0.5	n/a
Annual (July)		0.35			
Dissolved Sodium (mg/L)					
Fall (October)	8.80	8.86	11	11	n/a
Specific Conductance (uS/cm)					
Fall (October)	253	265	280	364	n/a
Dissolved Strontium (µg/L)					
Annual (June)	156	162	186	186	n/a
Annual (July)		164			
Annual (August)		164			
Annual (September)		164			
Annual (October)		172			
Dissolved Sulphate (mg/L)					
Summer (August)	28.1	23.3	37.2	37.2	100 (BC; based on hardness 100 mg/L)
Fall (September)	21.7	24.2	24.8		
Fall (October)	21.7	23.8	24.8		
Dissolved Uranium (µg/L)					
Annual (July)	0.511	0.564	1.190	1.190	
Annual (August)		0.538			

i: AB (Alberta); ii: BC (British Columbia); iii CCME (Canadian Council for Ministers of Environment); Season (Annual, Open-Water, Under-Ice, Spring, Summer, Fall or Winter) represents the season from which the trigger was derived for the Assessment;

Parameter	Trigger 2	Value above Trigger 2	Historical Seasonal Maximum Value	Historical Annual Maximum Value	Guideline for the Protection of Aquatic Life
Month (in parentheses) represents the month in which the sample was collected.					

Slave River Water Quality Assessment and Discussion

To enhance the water quality assessment for the Slave River, the 2018 and 2019 water quality data were combined. The combined data provided an opportunity to explore the data slightly differently than has been done in previous years. The larger dataset allowed for more robust statistics which resulted in more useful information about the status and trends of water quality in the Slave River.

Trigger 1

Seven parameters including alkalinity, specific conductance, dissolved calcium, dissolved magnesium, dissolved sulphate, nitrate/nitrite and dissolved strontium have been flagged consistently since 2015. Further analysis revealed statistically significant ($p<0.05$) increasing trends for alkalinity, dissolved magnesium, dissolved sulphate and nitrate/nitrite suggesting that the levels of these four parameters are higher today than when consistent monitoring began in the Slave River. Figures 2-5 show how levels of alkalinity, dissolved magnesium, dissolved sulphate and nitrate/nitrite have changed in the Slave River.

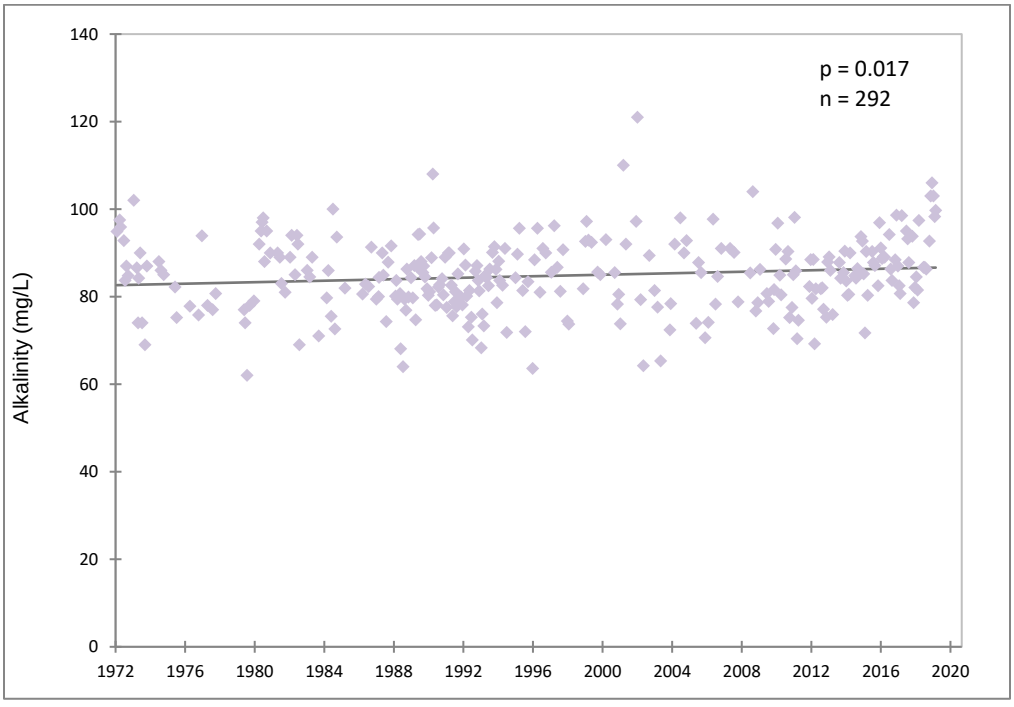

Figure 2. Levels of alkalinity in the Slave River (at Fitzgerald) between 1972 and 2019

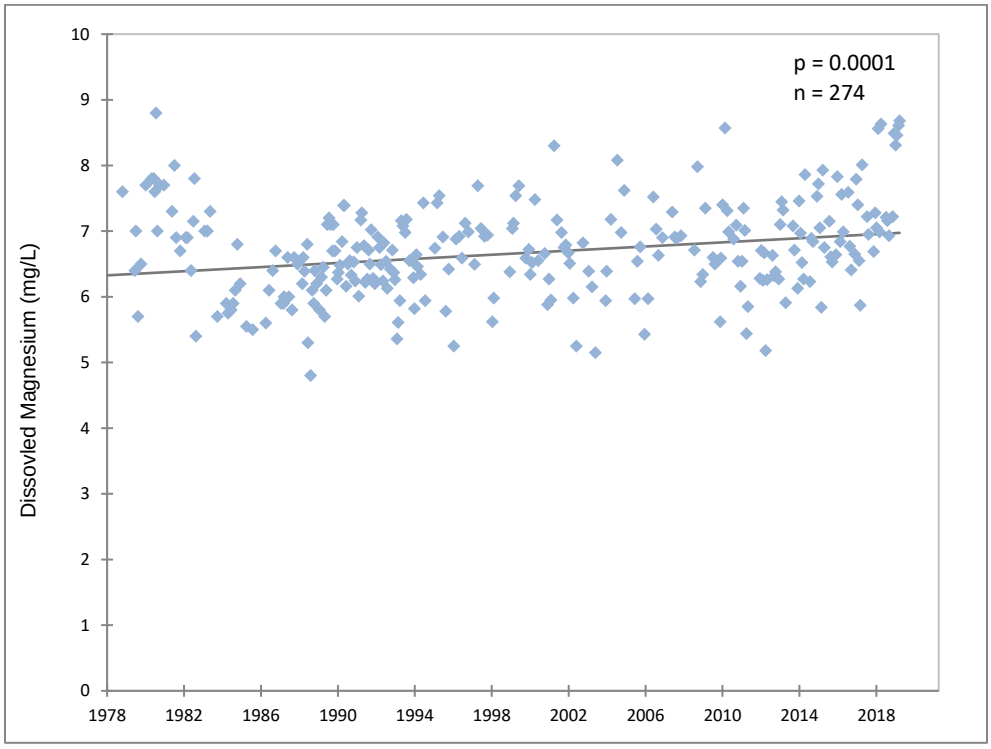

Figure 3. Levels of dissolved magnesium in the Slave River (at Fitzgerald) between 1978 and 2019

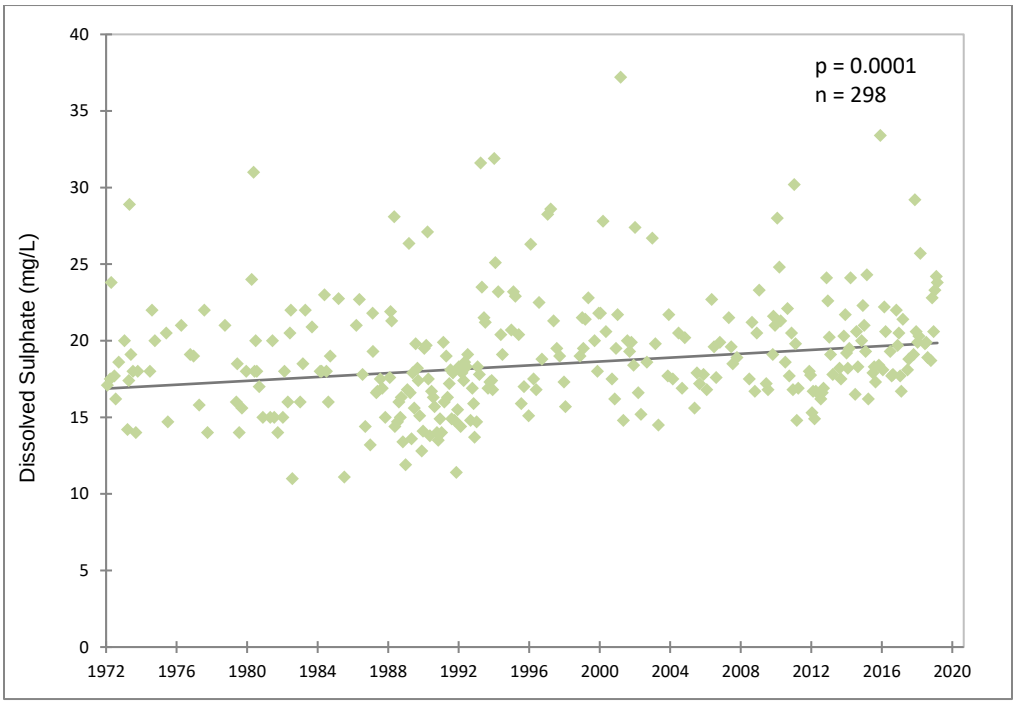

Figure 4. Levels of dissovled sulphate in the Slave River (at Fitzgerald) between 1972 and 2019

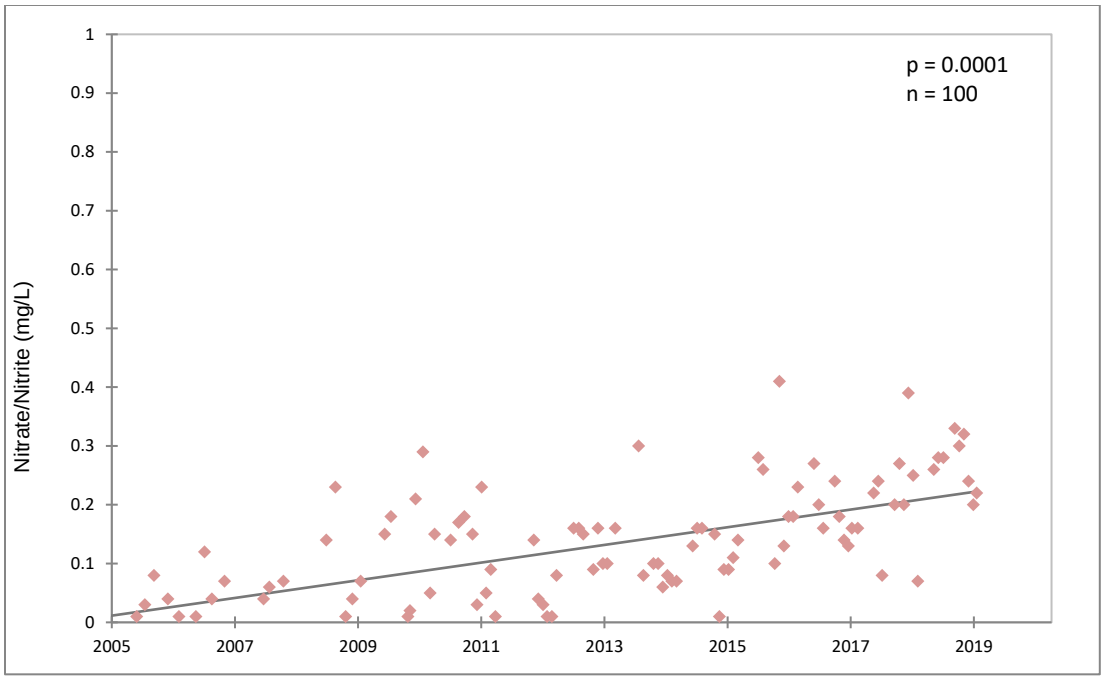

Figure 5. Levels of nitrate/nitrite in the Slave River (at Fitzgerald) between 2005 and 2019

To explore these trends and better understand what has been occurring in the most recent period of record, the latter halves of the datasets (2000-2019) were examined. Increasing trends in the latter half of the dataset were revealed for alkalinity (p=0.002; n=124), nitrate/nitrite (p=0.0001; n=100) and dissolved magnesium (p=0.0001; n=129) but not for dissolved sulphate (p=0.129; n=129). This suggests that while sulphate levels are higher today compared to the earlier years of monitoring (Figure 4), at least in the last two decades, dissolved sulphate levels in the Slave River are relatively stable (Figure 6).

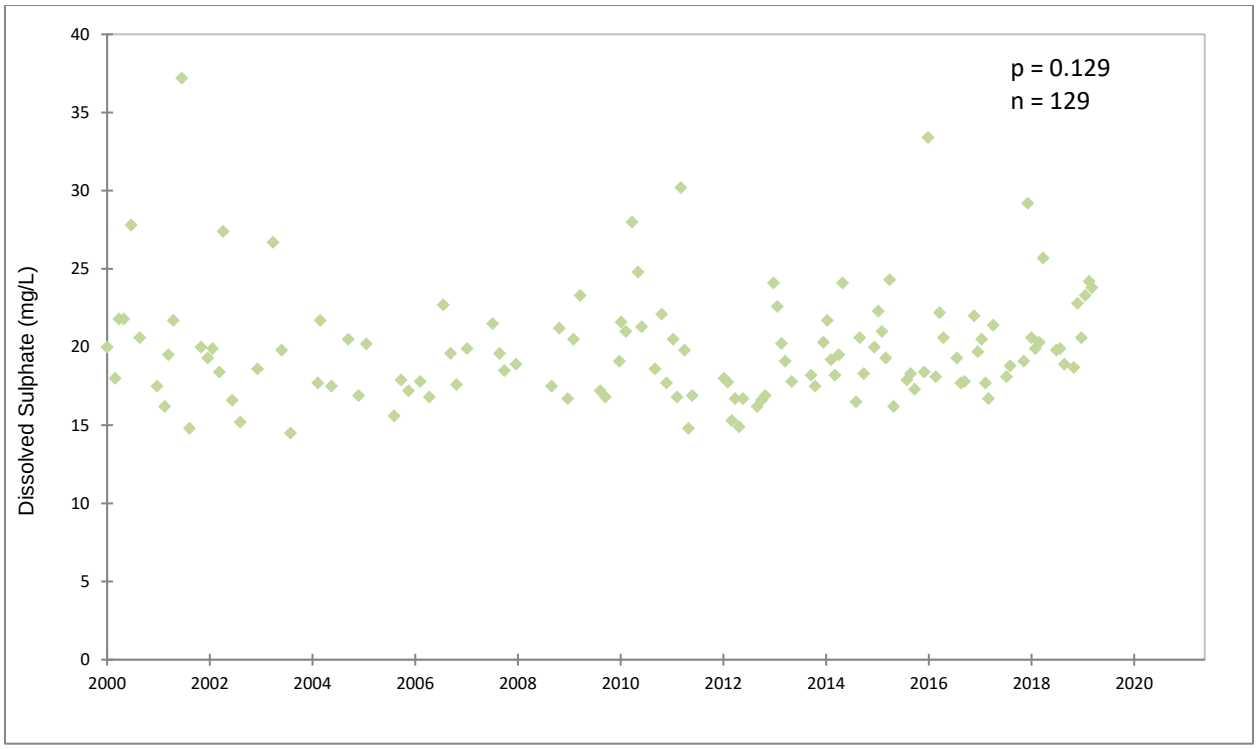

Figure 6. Levels of dissovled sulphate in the Slave River (at Fitzgerald) between 2000 and 2019

To further our understanding of the changes in alkalinity, dissolved magnesium as well as nitrate/nitrite levels in the Slave River, water quality data from upstream sampling sites were reviewed. In addition to the site at Fitzgerald, ECCC also operates a long-term water quality monitoring sites on the Peace River at Peace Point and on the Athabasca River at Baseline 27 (Figure 1). Data from these upstream sites were also examined for trends.

Similar to the Slave River, statistically significant ($p<0.05$) increasing trends were found for alkalinity ($p=0.023$; $n=159$; 2000-2019) and dissolved magnesium ($p=0.003$; $n=158$; 2000-2019) in the Peace River site. No other trends were found for Peace River sampling sites. No trends were detected for the Athabasca River sampling site. Given that the Peace River contributes almost 80% of the water to the Slave River, it is likely that changes in the levels of alkalinity and dissolved magnesium in the Slave River are being influenced by the levels of these parameters in the Peace River.

The BMC will continue to monitor these parameters in the Slave River and upstream tributaries and explore trends in the Peace River.

Trigger 2

Four parameters, alkalinity, dissolved magnesium, dissolved sulphate and nitrate/nitrite, were above their historical open water maximum values. Given that these parameters are among the parameters that have repeatedly exceeded Trigger 1 each year since 2015, it is not entirely unexpected to find that these parameters are also being flagged as part of the Trigger 2 assessment. The BMC will continue monitoring these parameters.

Two additional parameters, dissolved cobalt and dissolved lithium, were above their overall historical maximum values. The data used to calculate the historical levels for these parameters were from samples collected between 2005 and 2014. Eight years is a relatively short period of monitoring and it is likely that true range of natural variably was not captured at the time the calculations were made. It is recommended that the historical statistics and preliminary interim triggers for these parameters (and all dissolved metals) be revised with the water quality data up to and including 2019.

Lastly, a dissolved sodium value of 13.5 mg/L measured on August 20, 2018 was above its overall historical maximum value (11 mg/L). Dissolved sodium data were reviewed from two other Slave River GNWT monitoring programs. Sodium measured 6.2 mg/L (August 19; one day apart) and 7.3 mg/L (August 22) for the Transboundary Monitoring Program and South Slave Monitoring Program, respectively. Given that these other sodium values were within the normal range of water quality for the same time frame, no further analysis was undertaken.

5. Hay River Water Quality Results

Hay River 2018:

In 2018, 120 individual conventional water quality results were compared to Trigger 1 and Trigger 2. These water quality results were generated from water samples collected in 2018 by ECCC from the Hay River (near the Alberta/NWT Boundary) on three occasions. Forty parameters were analyzed in each sample.

Trigger 1

The 2018 water quality results were screened to highlight any water quality values higher than Trigger 1 (all-season median). If more than 50% of the values were higher than Trigger 1, the parameter was flagged. In 2018, three parameters were flagged (Table 7). Of these, nitrate/nitrite was also flagged in 2016 & 2017; and total antimony and total selenium were flagged for the first time.

Table 7. Hay River 2018 Trigger 1 Assessment Summary

Parameter	Trigger 1	Number of 2018 Values higher than Trigger 1 (out of 3)
Total Antimony (µg/L)	0.11	3
Nitrate/Nitrite (mg/L)	0.095	3
Total Selenium (µg/L)	0.24	3

Trigger 2

The 2018 water quality results were screened to highlight any values higher than Trigger 2. In 2018, 29 of the 40 parameters had concentrations above Trigger 2 (Table 8). Of these 29 parameters, none were above their historical seasonal maximum values.

Table 8. Hay River 2018 Trigger 2 Assessment Summary

Parameter	Trigger 2	Value above Trigger 2	Historical Seasonal Maximum Value	Historical Annual Maximum Value	Guideline for the Protection of Aquatic Life
Alkalinity (mg/L)					
Open-Water (September)	128	142	181	305	20 (AB)
Total Aluminum (µg/L)					
Open-Water (May)	2010	3270	7620	7620	100 (AB & BC)

Parameter	Trigger 2	Value above Trigger 2	Historical Seasonal Maximum Value	Historical Annual Maximum Value	Guideline for the Protection of Aquatic Life
Dissolved Ammonia (mg/L)					
Open-Water (May)	0.05	0.12	0.27	0.94	2.49 (CCME, AB, based on pH of 7.6 and temperature of 7.6)
Total Antimony (µg/L)					
Annual (May)	0.17	0.19		0.26	n/a
Total Barium (µg/L)					
Open-Water (May)	102	176	477	477	n/a
Total Beryllium (µg/L)					
Open-Water (May)	0.17	0.29	0.55	0.55	n/a
Dissolved Calcium (mg/L)					
Open-Water (September)	49	58	66	115	n/a
Particulate Organic Carbon (mg/L)					
Open-Water (May)	4.7	10.9	20.0	20.0	n/a
Chromium Total (µg/L)					
Open-Water (May)	3.3	5.4	11.9	11.9	n/a
Total Cobalt (µg/L)					
Open-Water (May)	2.7	5.5	9.0	9.0	0.8 (AB; based on hardness < 55 mg/L); 110 (BC)
Total Copper (µg/L)					
Open-Water (May)	7.0	13.4	23.8	23.8	2.5(CCME), 7(AB)
Total Iron (µg/L)					
Open-Water (May)	6402	12100	21500	21500	300 (CCME)
Total Lead (µg/L)					
Open-Water (May)	3.4	6.5	11.2	11.2	2.47 (CCME, AB)
Dissolved Magnesium (mg/L)					
Open-Water (September)	14.5	16	19.0	32.6	n/a
Total Manganese (µg/L)					
Open-Water (May)	168	433	485	1340	753 (BC; based on hardness of 33.7 mg/L)
Total Molybdenum (µg/L)					
Open-Water (September)	1.2	1.4	1.9	1.9	73 (CCME, AB)
Total Nickel (µg/L)					
Open-Water (May)	9.0	14.4	26.9	26.9	21 (AB; based on hardness of 33.7 mg/L)

Parameter	Trigger 2	Value above Trigger 2	Historical Seasonal Maximum Value	Historical Annual Maximum Value	Guideline for the Protection of Aquatic Life
Total Phosphorous (mg/L)					
Open-Water (May)	0.25	0.42	0.72	0.72	n/a
Total Suspended Solids (mg/L)					
Open-Water (May)	216	362	774	774	n/a
Total Selenium (µg/L)					
Annual (May)	0.39	0.4		0.51	1 (CCME) 2 (AB & BC)
Total Silver (µg/L)					
Annual (May)	0.06	0.156		0.18	0.25 (CCME, AB)
Dissolved Sodium (mg/L)					
Open-Water (September)	16.0	16.1	18.6	35.1	n/a
Specific Conductance (US/CM)					
Open-Water (September)	405	453	513	860	n/a
Total Strontium (µg/L)					
Open-Water (September)	156	166	190	346	n/a
Total Thallium (µg/L)					
Annual (May)	0.06	0.13		0.21	0.8 (CCME, AB)
Turbidity (NTU)					
Open-Water (May)	148	254	590	590	n/a
Total Uranium (µg/L)					
Annual (May)	1.5	1.53		2.1	15 (CCME, AB)
Total Vanadium (µg/L)					
Open-Water (May)	6.2	11.5	23.3	23.3	n/a
Zinc Total (µg/L)					
Open-Water (May)	22.4	52.9	90.8	90.8	30 (CCME)

AB (Alberta); BC (British Columbia); CCME (Canadian Council for Ministers of Environment); Season (Annual, Open-Water, Under-Ice, Spring, Summer, Fall or Winter) represents the season from which the trigger was derived for the Assessment; Month (in parentheses) represents the month in which the sample was collected.

Hay River 2019:

In 2019, 160 individual conventional water quality results were compared to Trigger 1 and Trigger 2. These water quality results were generated from water samples collected in 2019 by ECCC from the Hay River (near the Alberta/NWT Boundary) on four occasions. Forty parameters were analyzed in each sample.

Trigger 1

The 2019 water quality results were screened to highlight any water quality values higher than Trigger 1 (all-season median). If more than 50% of the values were higher than Trigger 1, the parameter was flagged. In 2019, two parameters were flagged (Table 9). Of these, nitrate/nitrite was also flagged in 2016, 2017 & 2018; and molybdenum was flagged for the first time.

Table 9. Hay River 2019 Trigger 1 Assessment Summary

Parameter	Trigger 1	Number of 2018 Values higher than Trigger 1 (out of 4)
Total Molybdenum (µg/L)	0.751	3
Nitrate/Nitrite (mg/L)	0.095	4

Trigger 2

The 2019 water quality results were screened to highlight any values higher than Trigger 2. In 2019, one of the 40 parameters was flagged (Table 10). The parameter, nitrate/nitrite, was not over its historical seasonal maximum value.

Table 10. Hay River 2019 Trigger 2 Assessment Summary

Parameter	Trigger 2	Value above Trigger 2	Historical Seasonal Maximum Value	Historical Annual Maximum Value	Guideline for the Protection of Aquatic Life
Nitrate/Nitrite (mg/L)					
Annual (April)	0.6	0.71	1.7	1.7	n/a

Season (Annual, Open-Water, Under-Ice, Spring, Summer, Fall or Winter) represents the season from which the trigger was derived for the Assessment; Month (in parentheses) represents the month in which the sample was collected.

Hay River Water Quality Assessment and Discussion

Further analysis on the Hay River flagged parameters revealed a statistically significant increasing trend ($p < 0.05$) for nitrate/nitrite (since 2005). As shown in Figure 7 and similar to the Slave River, the levels of nitrate/nitrite are generally increasing over the past 14 years. However, these slight changes are not significant enough to affect existing water uses. The BMC will continue to monitor the changes in the upcoming years and look into why these changes are occurring.

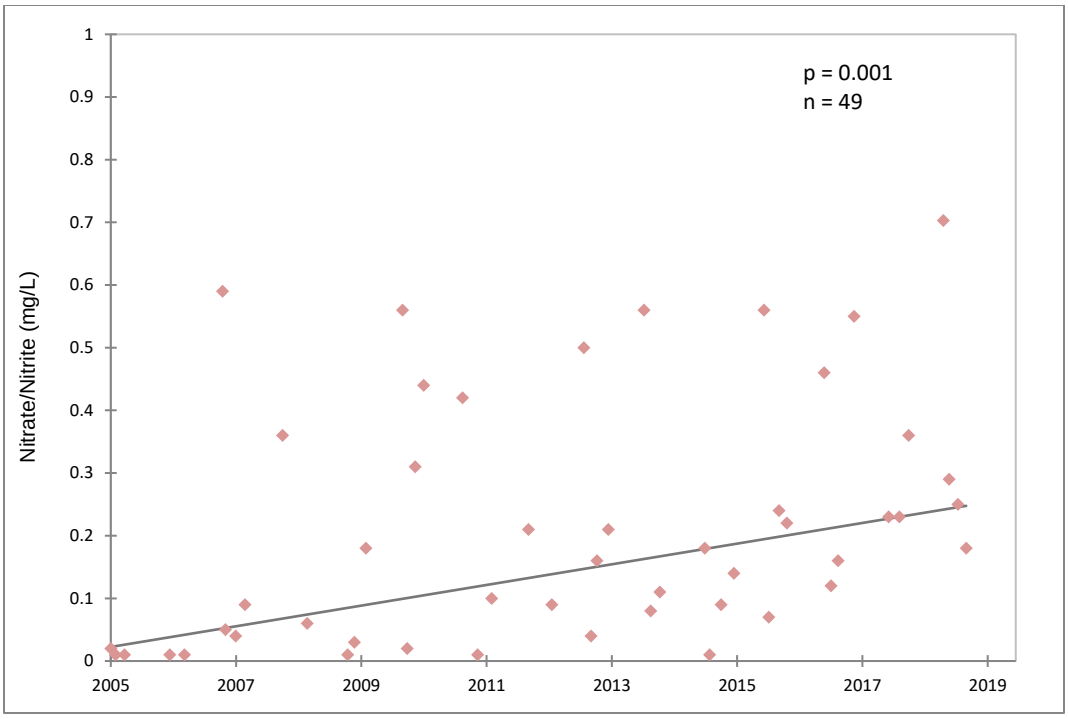

Figure 7. Levels of nitrate/nitrite in the Hay River (near the Border) between 2005 and 2019

6. Toxic, Bioaccumulative, Persistent Substances

To meet the commitment of virtual elimination (VE) of persistent, bioaccumulative, toxic substances that are listed in the BWMA, the BMC reports on the detection of any substance subject to VE that are currently monitored in the Slave and Hay rivers (Table 11). The BMC will maintain and periodically update this list as information becomes available on any new toxic, bioaccumulative and persistent substances or if the substance has been detected in other monitoring programs or by researchers.

Table 11: Substances Subject to Virtual Elimination

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

VE Substances Assessment and Evaluation

In 2018 and again in 2019, two water samples were collected from both rivers and analyzed for the VE substances listed in Table 11. The laboratory results are included in Table 12 and Table 13. Although some of these substances were detected, concentrations were very low. For context, comparisons with the available corresponding United States Environmental Protection Agency (USEPA) Chronic Aquatic Life Criteria show that the levels detected were considerably lower than levels that could cause concern. In the Slave River, total PCBs (June, 2018) were the highest measured substance subject to VE (0.57 ng/L); however, levels were below the USEPA freshwater aquatic life chronic criteria of 14 ng/L. In the Hay River, endosulfan (June, 2019) was the highest measured substance subject to VE (0.57 ng/L) and levels were below both the USEPA criteria (56 ng/L) and the CCME guideline (3 ng/L). These results indicate that there are no risks to aquatic life.

Table 12. VE substances in Slave River

Substance Subject to VE	Units	2018		2019		USEPA Chronic Criteria for the Protection of Aquatic Life	CCME Guideline for the Protection of Aquatic Life
		June	August	June	July		
Aldrin	ng/L	0.036		0.046	0.023	3000	
Chlordane - alpha	ng/L					4.3	
Chlordane - gamma	ng/L	0.013		0.050		4.3	
Chlordane - oxy	ng/L					4.3	
Dieldrin	ng/L					56	3
Endosulphan Sulphate	ng/L					56	3
alpha endosulphan	ng/L	0.534	0.531	0.316	0.490	56	3
beta endosulphan	ng/L	0.312	0.352	0.415	0.418	56	3
Endrin	ng/L	0.072				36	
Heptachlor	ng/L			0.091	0.051	3.8	
Heptachlor Epoxide	ng/L	0.085			0.067		
Hexachlorobenzene	ng/L	0.025	0.026	0.065	0.03		
Hexachlorobutadiene	ng/L	0.082	0.058	0.072	0.063		1300
Hexachlorcyclohexane (HCH alpha)	ng/L	0.029					
Hexachlorcyclohexane (HCH beta)	ng/L						
Hexachlorcyclohexane (HCH gamma)	ng/L				0.049	950	10
Mirex	ng/L				0.031	1	
DDD	ng/L						
DDE	ng/L						
DDT	ng/L					1	
Toxaphene	ng/L					0.2	
PCBs	ng/L	0.573	0.080	0.070	0.025	14	
Pentachlorobenzene	ng/L			0.026			6000

https://www.epa.gov/wqc/national-recommended-water-quality-criteria-aquatic-life-criteria-table#table
Criteria that are highlighted in blue are acute criteria, not chronic criteria.
Accessed in February 2021
If cell is empty, the value was reported as a value below the detection limit by the laboratory (the substance could not be detected by the laboratory).

Table 13. VE substances in Hay River

Substance Subject to VE	Units	2018		2019		USEPA Chronic Criteria for the Protection of Aquatic Life	CCME Guideline for the Protection of Aquatic Life
		June	August	June	July		
Aldrin	ng/L	0.034	0.026		0.021	3000	
Chlordane - alpha	ng/L					4.3	
Chlordane - gamma	ng/L	0.033				4.3	
Chlordane - oxy	ng/L					4.3	
Dieldrin	ng/L	0.012				56	3
Endosulphan Sulphate	ng/L					56	3
alpha endosulphan	ng/L	0.454	0.447	0.577	0.547	56	3
beta endosulphan	ng/L	0.520	0.532	0.350	0.529	56	3
Endrin	ng/L	0.024	0.036			36	
Heptachlor	ng/L			0.104		3.8	
Heptachlor Epoxide	ng/L	0.057					
Hexachlorobenzene	ng/L	0.036	0.022	0.058	0.019		
Hexachlorobutadiene	ng/L	0.116	0.057	0.079	0.088		1300
Hexachlorcyclohexane (HCH alpha)	ng/L						
Hexachlorcyclohexane (HCH beta)	ng/L						
Hexachlorcyclohexane (HCH gamma)	ng/L					950	10
Mirex	ng/L					1	
DDD	ng/L						
DDE	ng/L						
DDT	ng/L					1	
Toxaphene	ng/L					0.2	
PCBs	ng/L	0.239	0.094	0.049	0.042	14	
Pentachlorobenzene	ng/L	0.031	0.026				6000

https://www.epa.gov/wqc/national-recommended-water-quality-criteria-aquatic-life-criteria-table#table
Criteria that are highlighted in blue are acute criteria, not chronic criteria.
Accessed in February 2021
If cell is empty, the value was reported as a value below the detection limit by the laboratory (the substance could not be detected by the laboratory).

7. AB-NWT BMC Water Quality Tasks Underway

Throughout the year, GNWT and the Government of Alberta technical staff work together on water quality tasks related to the implementation of the AB-NWT BWMA. This year, tasks include:

1) Annual water quality data assessments of the water samples collected from the Slave and Hay rivers.

2) Ongoing water quality sampling specifically for the analysis of ultra-low levels of mercury in the Alberta-NWT Rivers. In 2019, adequate mercury samples were achieved for the Slave River to develop an interim trigger while the Hay River mercury dataset is still developing. Interim open-water triggers for total and dissolved mercury were applied to the 2019 Slave River data and the same will be applied to the Hay River 2020 data.

4) With the assistance of statistical and technical expertise, the Alberta-NWT technical staff are exploring a variety of methods to assess water quality trends/changes in transboundary water bodies. Consistently applied consensus-based approaches for trend assessment are critical with regard to reporting on water quality across jurisdictions. The increased levels of alkalinity, dissolved magnesium and nitrate/nitrite will be further explored throughout this process.

5) Working collaboratively with scientists from ECCC and McMaster University, the Alberta-NWT technical staff will be analyzing the types and levels of hydrocarbons in the water and suspended sediment samples collected from the major Mackenzie River Basin transboundary rivers including the Slave, Hay, Peel, Liard, Athabasca and Peace rivers. This work will contribute to our understanding of where these chemicals are coming from and how they change. The information will assist with the development of triggers and/or objectives for hydrocarbons.

8. Conclusion

Interim transboundary water quality triggers established for the Slave and Hay rivers are designed to provide an early warning of potential changes in water quality. Trigger 1 is intended to identify changes in typical conditions and Trigger 2 is intended to identify changes in extreme conditions.

For the 2018 Slave River results, forty six of the 66 parameters were initially flagged during the Trigger 1 assessment. Of these, alkalinity, specific conductance, dissolved calcium, dissolved magnesium, dissolved sulphate, nitrate/nitrite, and dissolved strontium were also flagged in 2015, 2016 and 2017. Further analysis revealed statistically significant increasing trends for alkalinity, dissolved magnesium, dissolved sulphate, and nitrate/nitrite. Under Trigger 2, thirty two of the 66 parameters were flagged for further assessment. Of these, dissolved magnesium and dissolved sulphate were above their historical seasonal maximum values. Nitrate/nitrite, dissolved sodium, dissolved cobalt, and dissolved lithium were above their historical overall maximum values.

In 2019, twenty five of the 66 parameters were flagged under Trigger 1 assessment. Of these, alkalinity, specific conductance, dissolved calcium, dissolved magnesium, dissolved sulphate, nitrate/nitrite, and dissolved strontium were also flagged in the four previous years. Further analysis revealed statistically significant increasing trends for alkalinity, dissolved magnesium, dissolved sulphate, and nitrate/nitrite. Under Trigger 2, seventeen of the 66 parameters were flagged for further assessment. Of these, alkalinity and dissolved magnesium were above their historical seasonal maximum values. Nitrate/nitrite was above its historical overall maximum values.

For the Hay River 2018 sampling results, three of the 40 parameters were initially flagged during the Trigger 1 assessment. Of these, nitrate/nitrite was also flagged in 2016 and 2017. Total antimony and total selenium were flagged for the first time. Further analysis revealed statistically significant increasing trends for nitrate/nitrite. Twenty-nine of the 40 parameters were flagged during the Trigger 2 assessment. However, none of them exceeded its historical seasonal maximum values.

In 2019, two of the 40 parameters were flagged under Trigger 1 assessment. Of these, nitrate/nitrite was also flagged in the three previous years. Total molybdenum was flagged for the first time. Further analysis revealed statistically significant increasing trends for nitrate/nitrite. Under Trigger 2, only one parameter, nitrate/nitrite, was flagged for further assessment. The nitrate/nitrite result was not over its historical seasonal maximum value.

During the summer of 2018 and 2019, two samples from each river were analyzed for 14 toxic, bioaccumulative and persistent substances in water. Some of these substances were detected on each sampling occasion in each river, but at very low concentrations. Comparisons with the available corresponding USEPA Chronic Aquatic Life Criteria show that the levels detected pose no risk to aquatic life.

Assessment of the 2018 and 2019 water quality data for the Slave and Hay rivers did flag a few trends in the past twenty years (alkalinity, nitrate/nitrite and dissolved magnesium in the Slave River, nitrate/nitrite in the Hay River) although most of the changes are generally in low magnitudes and are

not concerning at present. Continued monitoring and further assessment are needed for nitrate/nitrite for both the Slave and Hay rivers.

The Alberta-NWT BMC has been actively working with neighbouring jurisdictions with the establishment of the Mackenzie River Basin Water Quality Task Team to determine a consistent and consensus based evaluation approach to assess water quality trends in Transboundary Rivers. Monitoring and assessment for water quality parameters with triggers as well as the substances that are subject to virtual elimination will continue.

9. References

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Appendix 1: Mercury Levels in the Slave and Hay Rivers

In 2015, at the time of signing the AB-NWT BWMA, insufficient data were available to develop water quality triggers for mercury. Due to the ability of mercury to bioaccumulate in organisms, the collection and analysis of total (THg) and dissolved (DHg) mercury samples from the Slave and Hay Rivers became a priority.

The AB/NWT technical staff determined that a minimum of 30 samples are required prior to historical statistics and triggers are calculated. At the end of 2017, 32 samples had been collected from the Slave River which allowed for open-water Trigger calculation. Trigger 1 values were calculated as 7.45 ng/L (THg) and 0.80 ng/L (DHg). Trigger 2 values were calculated as 22.56 ng/L (THg) and 1.98 ng/L (DHg). These open-water triggers were applied to 2018 & 2019 mercury data (Figures 1-1 and 1-2). For the Hay River, open-water trigger values will be calculated and applied in the next BMC report; at the end of 2019, 31 open-water samples had been collected from the Hay River (Figures 1-3).

To date, all data, except for three Slave River samples (July 2013, Sept 2016 and July 2019), have been below the CCME freshwater aquatic life guideline (26 ng/L) and well below Health Canada's drinking water quality guideline (1000 ng/L) for mercury. The total mercury value in July 2019 (29.95 ng/L) was above its respective open-water Trigger 2 (22.56 ng/L; Figure 1-1).

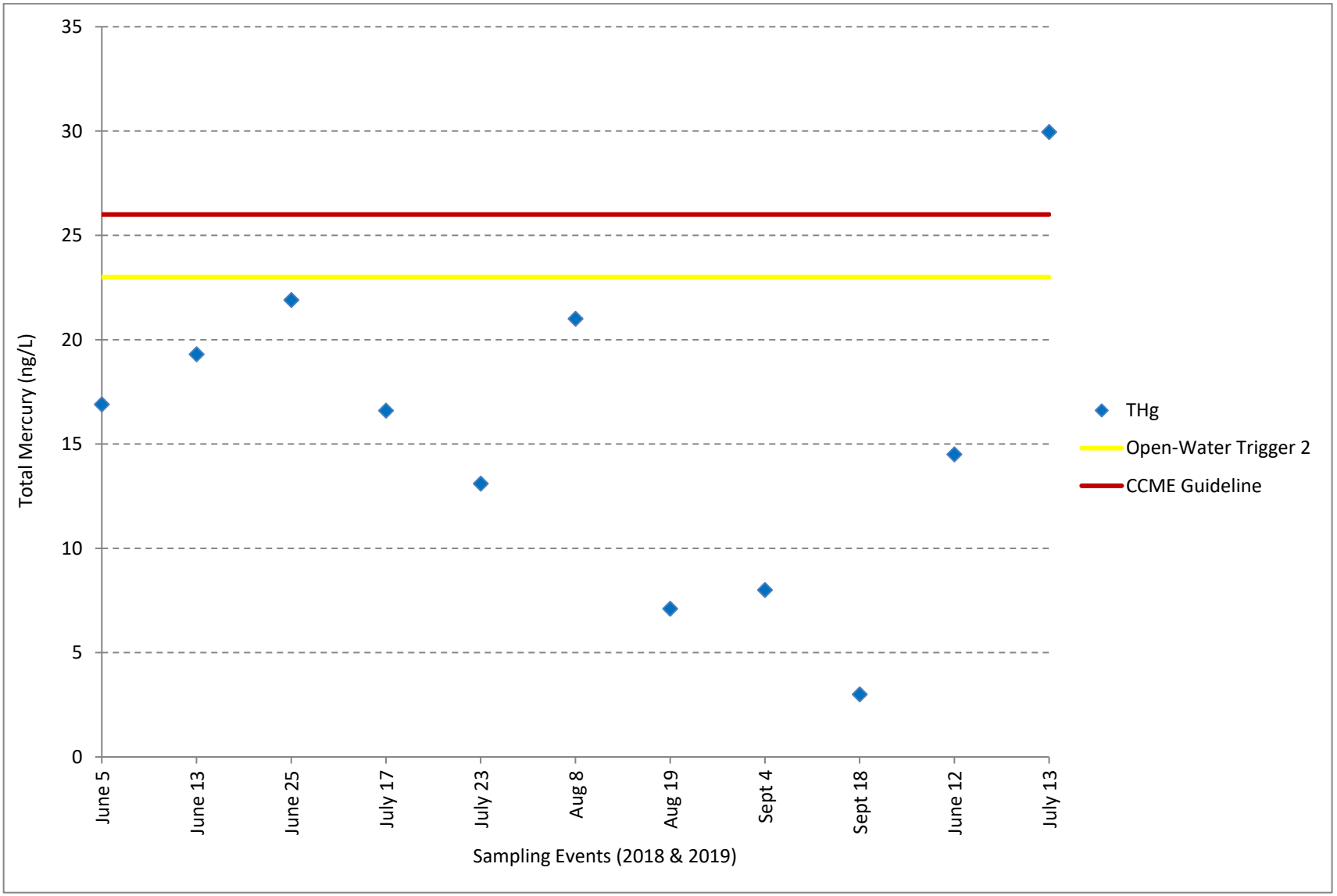

Figure 1-1: Total Mercury Levels in Surface Water – Slave River at Fort Smith (2018-2019)

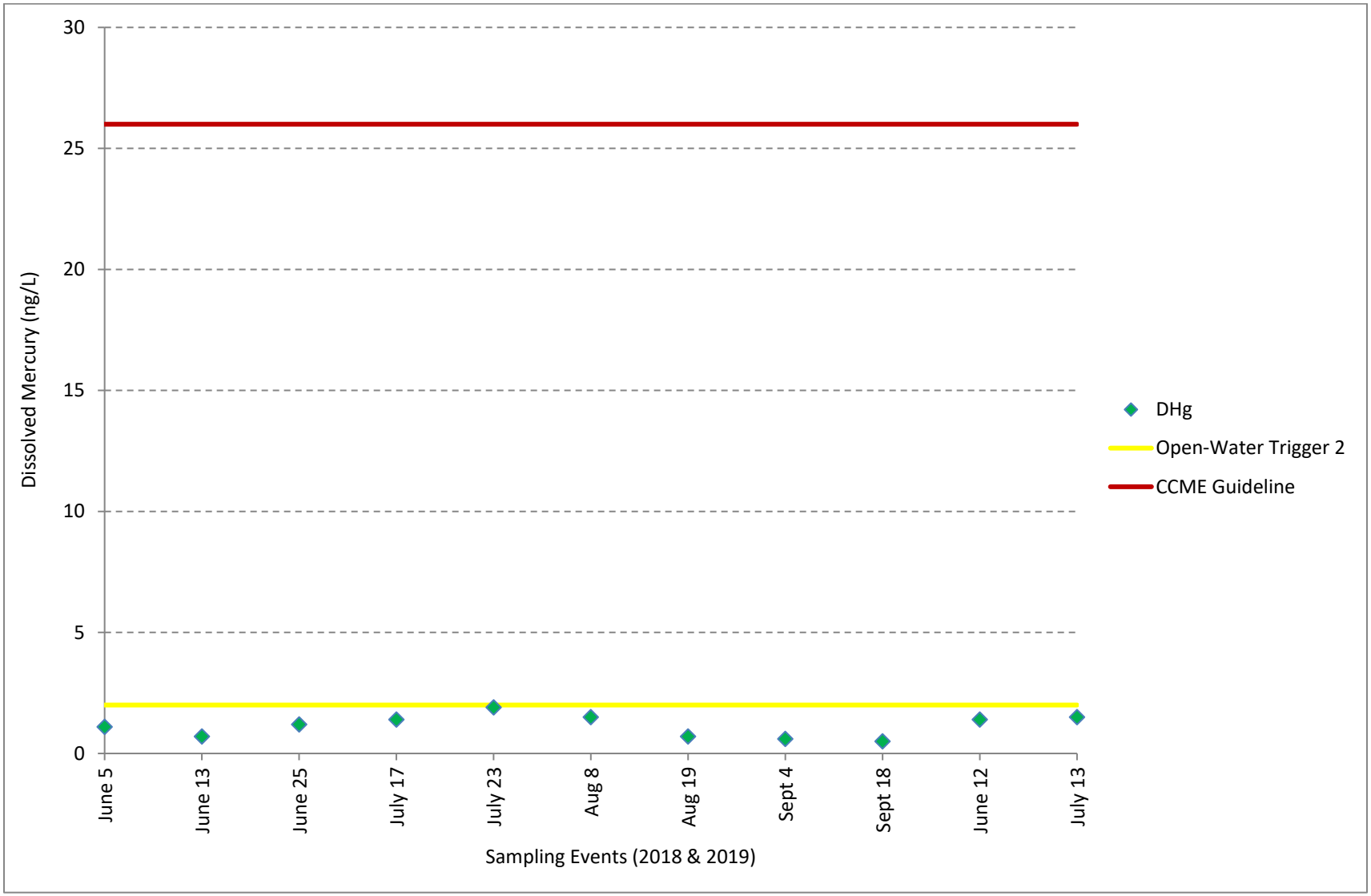

Figure 1-2: Dissolved Mercury Levels in Surface Water – Slave River at Fort Smith (2018-2019)

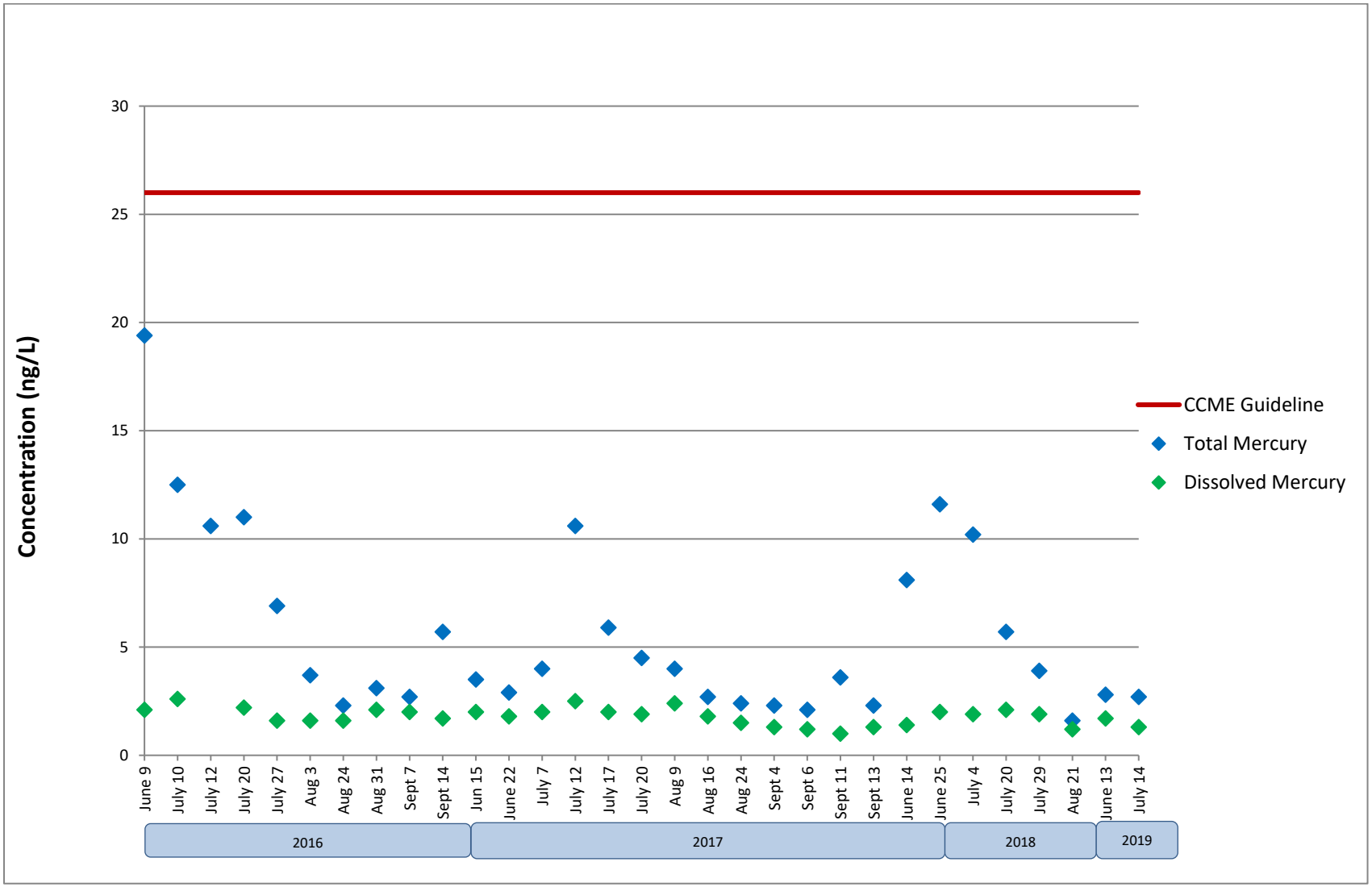

Figure 1-3. Total and Dissolved Levels of Mercury in the Hay River (2016-2019)

Appendix 2: Slave River Interim Water Quality Triggers [Original (POR_1) and Updated (POR_2)]

Parameters and Periods of Records (POR)	Units	Thresholds	SEASONAL								OPEN WATER/ ICE COVERED				ANNUAL	
			POR_1	POR_2	POR_1	POR_2	POR_1	POR_2	POR_1	POR_2	POR_1	POR_2	POR_1	POR_2	POR_1	POR_2
			Spring		Summer		Fall		Winter		Open Water		Ice Covered		Annual	
ALKALINITY	mg/L	n	46	50	49	53	41	44	98	103	136	147	98	103	234	250
POR_1: Jan 1972 - Oct 2012		max	121.0	121.0	110.0	110.0	97.7	97.7	104.0	104.0	121.0	121.0	104.0	104.0	121.0	121.0
POR_2: Jan 1972 - Oct 2014		50th P	84.7	85.0	85.9	85.9	81.0	80.8	84.4	84.3	83.7	83.7	84.4	84.3	84.3	84.2
		90th P	93.5	92.8	97.0	96.9	92.3	92.2	93.6	93.3	95.6	95.1	93.6	93.3	94.6	94.2
ALUMINUM DISSOLVED	µg/L	n	8	12	7	11	9	12	15	20	24	35	15	20	39	55
POR_1: May 2006 - Oct 2012		max	45.7	45.7	55.4	55.4	93.1	93.1	226.0	226.0	93.1	93.1	226.0	226.0	226.0	226.0
POR_2: May 2006 - Oct 2014		50th P	34.0	30.4	20.3	20.8	43.2	36.7	17.3	14.8	33.2	31.1	17.3	14.8	29.1	25.3
		90th P		45.0		53.8		92.3	170.8	127.3	77.1	58.7	170.8	127.3	90.4	65.2
ALUMINUM TOTAL	µg/L	n	21	25	18	22	21	24	48	53	60	71	48	53	108	124
POR_1: Apr 1993 - Oct 2012		max	15065	15065	48700	48700	2750	2750	9140	9140	48700	48700	9140	9140	48700	48700
POR_2: Apr 1993 - Oct 2014		50th P	1990	1990	2095	1870	696	671	223	198	1395	1330	223	198	907	859
		90th P	6058	5674	20710	16790	2084	2015	5132	4882	6192	5666	5132	4882	5690	5470
AMMONIA DISSOLVED	mg/L	n	19	23	18	22	20	23	42	47	57	68	42	47	99	115
POR_1: Apr 1993 - Oct 2012		max	0.120	0.120	0.085	0.085	0.114	0.114	0.330	0.330	0.120	0.120	0.330	0.330	0.330	0.330
POR_2: Apr 1993 - Oct 2014		50th P	0.019	0.015	0.013	0.011	0.011	0.010	0.018	0.013	0.013	0.011	0.018	0.013	0.014	0.013
		90th P	0.045	0.044	0.069	0.064	0.033	0.032	0.107	0.104	0.052	0.046	0.107	0.104	0.067	0.053
ANTIMONY DISSOLVED	µg/L	n	8	12	7	11	9	12	15	20	24	35	15	20	39	55
POR_1: May 2006 - Oct 2012		max	0.315	0.315	0.634	0.634	0.359	0.359	0.695	0.695	0.634	0.634	0.695	0.695	0.695	0.695
POR_2: May 2006 - Oct 2014		50th P	0.165	0.171	0.155	0.143	0.147	0.139	0.193	0.148	0.152	0.148	0.193	0.148	0.155	0.148
		90th P		0.294		0.571		0.308	0.544	0.430	0.338	0.316	0.544	0.430	0.359	0.316
ANTIMONY TOTAL	µg/L	n	11	15	10	14	12	15	26	31	33	44	26	31	59	75
POR_1: Mar 2002 - Oct 2012		max	0.310	0.310	0.498	0.498	0.113	0.112	1.360	1.360	0.498	0.498	1.360	1.360	1.360	1.360
POR_2: Mar 2002 - Oct 2014		50th P	0.145	0.178	0.139	0.137	0.085	0.084	0.198	0.135	0.118	0.115	0.198	0.135	0.130	0.121
		90th P	0.296	0.269	0.468	0.357	0.111	0.110	0.568	0.444	0.242	0.242	0.568	0.444	0.291	0.255
ARSENIC DISSOLVED	µg/L	n	8	12	7	11	9	12	15	20	24	35	15	20	39	55
POR_1: May 2006 - Oct 2012		max	0.580	0.580	0.580	0.650	0.500	0.500	0.640	0.640	0.580	**0.650**	0.640	0.640	0.640	**0.650**
POR_2: May 2006 - Oct 2014		50th P	0.400	0.465	0.500	0.510	0.440	0.425	0.300	0.265	0.445	0.470	0.300	0.265	0.410	0.410
		90th P		0.574		0.647		0.494	0.514	0.422	0.570	0.584	0.514	0.422	0.560	0.580
ARSENIC TOTAL	µg/L	n	10	14	9	13	11	14	23	28	30	41	23	28	53	69
POR_1: Apr 2003 - Oct 2012		max	4.26	4.26	11.30	11.30	1.34	**1.81**	4.67	4.67	11.30	11.30	4.67	4.67	11.30	11.30
POR_2: Apr 2003 - Oct 2014		50th P	1.48	1.55	1.32	1.32	1.06	1.06	0.64	0.48	1.21	1.27	0.64	0.48	1.08	1.09
		90th P	4.21	4.22		8.08	1.29	1.58	3.83	3.34	3.59	3.64	3.83	3.34	3.53	3.26

Parameters and Periods of Records (POR)	Units	Thresholds	SEASONAL								OPEN WATER/ ICE COVERED				ANNUAL	
			POR_1	POR_2	POR_1	POR_2	POR_1	POR_2	POR_1	POR_2	POR_1	POR_2	POR_1	POR_2	POR_1	POR_2
			Spring		Summer		Fall		Winter		Open Water		Ice Covered		Annual	
BARIUM DISSOLVED	µg/L	n	8	12	7	11	9	12	15	20	24	35	15	20	39	55
POR_1: May 2006 - Oct 2012		max	54.3	**55.2**	76.6	76.6	50.6	50.6	49.8	49.8	76.6	76.6	49.8	49.8	76.6	76.6
POR_2: May 2006 - Oct 2014		50th P	48.8	49.4	52.0	52.0	44.2	44.1	44.9	43.6	48.1	47.5	44.9	43.6	47.0	46.4
		90th P		54.9		72.9		50.2	49.1	48.7	55.1	55.2	49.1	48.7	54.3	54.5
BARIUM TOTAL	µg/L	n	35	39	33	37	36	39	86	91	104	115	86	91	190	206
POR_1: Nov 1983 - Oct 2012		max	564	564	1730	1730	131	131	320	320	1730	1730	320	320	1730	1730
POR_2: Nov 1983 - Oct 2014		50th P	116	116	108	107	73	72	80	80	93	89	80	80	80	80
		90th P	391	308	541	522	102	100	160	160	296	287	160	160	206	208
BERYLLIUM DISSOLVED	µg/L	n	8	12	7	11	9	12	15	20	24	35	15	20	39	55
POR_1: May 2006 - Oct 2012		max	0.013	0.013	0.016	0.016	0.010	0.010	0.019	0.019	0.016	0.016	0.019	0.019	0.019	0.019
POR_2: May 2006 - Oct 2014		50th P	0.006	0.007	0.007	0.007	0.006	0.006	0.002	0.002	0.006	0.006	0.002	0.002	0.005	0.005
		90th P		0.013		0.016		0.010	0.014	0.011	0.012	0.013	0.014	0.011	0.011	0.012
BERYLLIUM TOTAL	µg/L	n	22	26	19	23	22	25	51	56	63	74	51	56	114	130
POR_1: Apr 1993 - Oct 2012		max	0.955	0.955	2.190	2.190	0.210	0.210	0.620	0.620	2.190	2.190	0.620	0.620	2.190	2.190
POR_2: Apr 1993 - Oct 2014		50th P	0.140	0.160	0.128	0.120	0.060	0.060	0.050	0.050	0.110	0.106	0.050	0.050	0.070	0.064
		90th P	0.681	0.529	1.990	1.754	0.174	0.168	0.318	0.282	0.686	0.515	0.318	0.282	0.500	0.414
BISMUTH DISSOLVED	µg/L	n	7	11	7	11	9	12	15	20	23	34	15	20	38	54
POR_1: Jul 2006 - Oct 2012		max	0.0180	0.0180	0.0040	0.0040	0.0030	0.0030	0.0090	0.0090	0.0180	0.0180	0.0090	0.0090	0.0180	0.0180
POR_2: Jul 2006 - Oct 2014		50th P	0.0020	0.0020	0.0010	0.0017	0.0020	0.0015	0.0020	0.0010	0.0020	0.0020	0.0020	0.0010	0.0020	0.0016
		90th P		0.0152		0.0038		0.0030	0.0090	0.0087	0.0040	0.0035	0.0090	0.0087	0.0060	0.0040
BISMUTH TOTAL	µg/L	n	8	12	8	12	9	12	22	27	25	36	22	27	47	63
POR_1: Apr 2003 - Oct 2012		max	0.069	0.069	0.112	0.112	0.020	**0.028**	0.062	0.062	0.112	0.112	0.062	0.062	0.112	0.112
POR_2: Apr 2003 - Oct 2014		50th P	0.025	0.032	0.023	0.020	0.015	0.015	0.011	0.005	0.020	0.020	0.011	0.005	0.018	0.017
		90th P		0.064		0.091		0.026	0.055	0.052	0.058	0.051	0.055	0.052	0.052	0.051
BORON DISSOLVED	µg/L	n	8	12	7	11	9	12	15	20	24	35	15	20	39	55
POR_1: May 2006 - Oct 2012		max	18.3	**23.6**	28.3	28.3	19.4	19.4	14.1	14.1	28.3	28.3	14.1	14.1	28.3	28.3
POR_2: May 2006 - Oct 2014		50th P	14.5	17.3	15.9	17.6	14.9	15.3	10.0	10.0	15.0	17.0	10.0	10.0	12.7	13.8
		90th P		22.2		26.9		19.2	13.5	12.9	18.9	20.1	13.5	12.9	17.9	19.0
BORON TOTAL	µg/L	n	11	15	10	14	12	15	26	31	33	44	26	31	59	75
POR_1: Mar 2002 - Oct 2012		max	25.2	**27.3**	39.3	39.3	18.9	18.9	19.5	19.5	39.3	39.3	19.5	19.5	39.3	39.3
POR_2: Mar 2002 - Oct 2014		50th P	15.9	18.7	15.4	16.9	14.8	15.4	10.9	10.6	15.0	16.5	10.9	10.6	13.9	14.1
		90th P	23.9	26.3	37.3	31.6	18.3	18.8	17.7	17.0	19.0	24.6	17.7	17.0	18.9	20.1
CADMIUM DISSOLVED	µg/L	n	8	12	7	11	9	12	15	20	24	35	15	20	39	55
POR_1: May 2006 - Oct 2012		max	0.022	**0.036**	0.056	0.056	0.025	0.025	0.355	0.355	0.056	0.056	0.355	0.355	0.355	0.355
POR_2: May 2006 - Oct 2014		50th P	0.016	0.016	0.016	0.019	0.015	0.016	0.101	0.073	0.016	0.016	0.101	0.073	0.021	0.020
		90th P		0.032		0.050		0.025	0.316	0.281	0.025	0.025	0.316	0.281	0.112	0.109

Parameters and Periods of Records (POR)	Units	Thresholds	SEASONAL								OPEN WATER/ ICE COVERED				ANNUAL	
			POR_1	POR_2	POR_1	POR_2	POR_1	POR_2	POR_1	POR_2	POR_1	POR_2	POR_1	POR_2	POR_1	POR_2
			Spring		Summer		Fall		Winter		Open Water		Ice Covered		Annual	
CADMIUM TOTAL	µg/L	n	36	40	34	38	35	38	87	92	105	116	87	92	192	208
POR_1: Nov 1983 - Oct 2012		max	15.00	15.00	11.30	11.30	1.23	1.23	3.40	3.40	15.00	15.00	3.40	3.40	15.00	15.00
POR_2: Nov 1983 - Oct 2014		50th P	0.40	0.40	0.30	0.25	0.10	0.10	0.11	0.10	0.20	0.20	0.11	0.10	0.20	0.20
		90th P	1.45	1.28	3.52	3.06	0.94	0.91	1.00	1.00	1.52	1.33	1.00	1.00	1.20	1.11
CALCIUM DISSOLVED/FILTERED	mg/L	n	47	51	49	53	44	47	104	109	140	151	104	109	244	260
POR_1: Jan 1972 - Oct 2012		max	37.5	37.5	42.0	42.0	41.7	41.7	40.5	40.5	42.0	42.0	40.5	40.5	42.0	42.0
POR_2: Jan 1972 - Oct 2014		50th P	28.9	29.0	28.8	29.1	26.8	26.8	28.3	28.3	28.2	28.3	28.3	28.3	28.3	28.3
		90th P	33.9	33.5	34.3	34.1	30.7	30.9	31.9	31.8	32.7	32.2	31.9	31.8	32.2	32.1
CARBON DISSOLVED ORGANIC	mg/L	n	41	45	41	45	37	40	89	94	119	130	89	94	208	224
POR_1: Nov 1978 - Oct 2012		max	20.20	20.20	22.10	22.10	11.90	11.90	40.40	40.40	22.10	22.10	40.40	40.40	40.40	40.40
POR_2: Nov 1978 - Oct 2014		50th P	8.11	8.60	7.84	7.95	5.80	5.95	4.00	4.00	7.20	7.40	4.00	4.00	5.45	5.58
		90th P	13.24	13.82	12.36	12.99	9.04	8.72	6.22	6.11	11.90	12.60	6.22	6.11	10.60	11.00
CARBON PARTICULATE ORGANIC	mg/L	n	41	44	42	46	39	42	93	98	122	132	93	98	215	230
POR_1: Nov 1978 - Oct 2012		max	18.50	18.50	68.50	68.50	5.25	**6.45**	24.20	24.20	68.50	68.50	24.20	24.20	68.50	68.50
POR_2: Nov 1978 - Oct 2014		50th P	4.16	4.26	3.80	3.75	1.70	1.70	0.72	0.72	2.80	2.72	0.72	0.72	1.85	1.85
		90th P	12.98	12.85	26.97	22.53	2.90	3.60	8.85	7.99	13.05	12.14	8.85	7.99	10.60	10.31
CHLORIDE DISSOLVED	mg/L	n	47	51	49	53	44	47	103	108	140	151	103	108	243	259
POR_1: Jan 1972 - Oct 2012		max	8.01	8.01	6.78	6.78	9.01	**9.05**	11.00	11.00	9.01	**9.05**	11.00	11.00	11.00	11.00
POR_2: Jan 1972 - Oct 2014		50th P	4.40	4.00	3.77	3.89	5.97	6.20	5.42	5.40	4.57	4.56	5.42	5.40	5.00	5.00
		90th P	7.02	6.86	5.90	6.01	7.27	7.50	7.60	7.52	7.00	7.08	7.60	7.52	7.20	7.20
CHROMIUM DISSOLVED	µg/L	n	8	12	7	11	9	12	15	20	24	35	15	20	39	55
POR_1: May 2006 - Oct 2012		max	0.170	0.170	0.221	0.221	0.230	0.230	2.090	2.090	0.230	0.230	2.090	2.090	2.090	2.090
POR_2: May 2006 - Oct 2014		50th P	0.123	0.123	0.100	0.100	0.124	0.122	0.251	0.156	0.120	0.120	0.251	0.156	0.130	0.124
		90th P		0.164		0.209		0.218	1.532	1.099	0.205	0.178	1.532	1.099	0.480	0.428
CHROMIUM TOTAL	µg/L	n	22	26	19	23	22	25	51	56	63	74	51	56	114	130
POR_1: Apr 1993 - Oct 2012		max	22.10	22.10	50.40	50.40	4.70	4.70	12.40	12.40	50.40	50.40	12.40	12.40	50.40	50.40
POR_2: Apr 1993 - Oct 2014		50th P	3.63	3.63	2.90	2.60	1.19	1.17	0.64	0.50	2.21	2.10	0.64	0.50	1.55	1.41
		90th P	15.25	11.72	31.00	28.40	3.51	3.42	8.70	8.01	14.70	9.50	8.70	8.01	9.50	9.06
COBALT DISSOLVED	µg/L	n	8	12	7	11	9	12	15	20	24	35	15	20	39	55
POR_1: May 2006 - Oct 2012		max	0.102	0.102	0.118	0.118	0.105	0.105	0.276	0.276	0.118	0.118	0.276	0.276	0.276	0.276
POR_2: May 2006 - Oct 2014		50th P	0.064	0.066	0.047	0.047	0.060	0.061	0.050	0.042	0.060	0.060	0.050	0.042	0.060	0.055
		90th P		0.096		0.112		0.098	0.219	0.180	0.104	0.095	0.219	0.180	0.144	0.136
COBALT TOTAL	µg/L	n	36	40	34	38	36	39	87	92	106	117	87	92	193	209
POR_1: Nov 1983 - Oct 2012		max	13.85	13.85	30.30	30.30	2.70	2.70	8.88	8.88	30.30	30.30	8.88	8.88	30.30	30.30
POR_2: Nov 1983 - Oct 2014		50th P	2.15	2.25	1.76	1.61	0.80	0.80	0.50	0.50	1.44	1.40	0.50	0.50	1.00	1.00
		90th P	8.41	6.65	14.30	11.82	1.72	1.60	3.25	3.04	6.20	5.88	3.25	3.04	5.25	5.20

Parameters and Periods of Records (POR)	Units	Thresholds	SEASONAL								OPEN WATER/ ICE COVERED				ANNUAL	
			POR_1	POR_2	POR_1	POR_2	POR_1	POR_2	POR_1	POR_2	POR_1	POR_2	POR_1	POR_2	POR_1	POR_2
			Spring		Summer		Fall		Winter		Open Water		Ice Covered		Annual	
COPPER DISSOLVED	µg/L	n	8	12	7	11	9	12	15	20	24	35	15	20	39	55
POR_1: May 2006 - Oct 2012		max	3.61	**3.81**	5.56	5.56	3.87	3.87	10.60	10.60	5.56	5.56	10.60	10.60	10.60	10.60
POR_2: May 2006 - Oct 2014		50th P	2.08	2.46	2.07	2.13	1.34	1.33	2.43	1.85	1.84	2.07	2.43	1.85	2.07	2.00
		90th P		3.75		5.29		3.59	8.28	6.45	4.04	3.83	8.28	6.45	4.21	3.87
COPPER TOTAL	µg/L	n	36	40	34	38	36	39	87	92	106	117	87	92	193	209
POR_1: Nov 1983 - Oct 2012		max	46.00	46.00	97.00	97.00	8.90	8.90	30.20	30.20	97.00	97.00	30.20	30.20	97.00	97.00
POR_2: Nov 1983 - Oct 2014		50th P	7.05	7.43	5.00	4.75	2.78	2.76	2.00	1.80	4.39	4.26	2.00	1.80	3.90	3.85
		90th P	23.91	20.98	41.10	33.58	4.57	4.26	10.42	10.40	18.43	18.10	10.42	10.40	15.34	15.10
DISSOLVED OXYGEN	mg/L	n		25		24		31		60		80		60		140
		max		12.40		14.50		15.46		16.60		15.46		16.60		16.60
POR_2: Aug 1989 - Oct 2014		min		6.00		6.40		9.00		9.40		6.00		9.40		6.00
		10th P		6.00		6.40		9.00		9.40		6.00		9.40		6.16
		50th P		9.47		8.21		10.90		13.00		9.58		13.00		11.41
		90th P		10.84		9.12		13.01		14.06		11.90		14.06		13.60
IRON DISSOLVED	µg/L	n	8	12	7	11	9	12	15	20	24	35	15	20	39	55
POR_1: May 2006 - Oct 2012		max	165	165	156	**200**	266	266	527	527	266	266	527	527	527	527
POR_2: May 2006 - Oct 2014		50th P	115	116	67	88	103	103	77	67	102	102	77	67	91	91
		90th P		164		193		250	424	339	197	189	424	339	211	193
IRON TOTAL	µg/L	n	22	26	19	23	22	25	51	56	63	74	51	56	114	130
POR_1: Apr 1993 - Oct 2012		max	41900	41900	128000	128000	7280	7280	23000	23000	128000	128000	23000	23000	128000	128000
POR_2: Apr 1993 - Oct 2014		50th P	4065	4690	4020	3140	1813	1750	473	412	2910	2865	473	412	2015	1990
		90th P	12450	12250	71100	62020	5246	5192	11180	10380	16160	15250	11180	10380	15250	12550
LEAD DISSOLVED	µg/L	n	8	12	7	11	9	12	15	20	24	35	15	20	39	55
POR_1: May 2006 - Oct 2012		max	0.239	0.239	0.773	0.773	0.203	0.203	0.814	0.814	0.773	0.773	0.814	0.814	0.814	0.814
POR_2: May 2006 - Oct 2014		50th P	0.096	0.100	0.100	0.110	0.129	0.084	0.213	0.149	0.101	0.100	0.213	0.149	0.129	0.110
		90th P		0.209		0.672		0.186	0.803	0.758	0.255	0.217	0.803	0.758	0.417	0.403
LEAD TOTAL	µg/L	n	36	40	34	38	36	39	87	92	106	117	87	92	193	209
POR_1: Nov 1983 - Oct 2012		max	22.20	22.20	50.90	50.90	4.80	4.80	27.40	27.40	50.90	50.90	27.40	27.40	50.90	50.90
POR_2: Nov 1983 - Oct 2014		50th P	3.18	3.30	2.77	2.60	1.25	1.20	0.90	0.86	2.30	2.20	0.90	0.86	1.67	1.60
		90th P	11.72	10.79	24.40	20.72	3.06	3.00	6.62	6.60	8.95	8.91	6.62	6.60	8.28	7.60
LITHIUM DISSOLVED	µg/L	n	8	12	7	11	9	12	15	20	24	35	15	20	39	55
POR_1: May 2006 - Oct 2012		max	5.34	**5.85**	6.09	6.09	5.45	5.45	3.90	3.90	6.09	6.09	3.90	3.90	6.09	6.09
POR_2: May 2006 - Oct 2014		50th P	4.23	4.76	4.70	5.05	4.39	4.92	3.20	3.20	4.43	5.00	3.20	3.20	3.90	3.98
		90th P		5.79		5.94		5.42	3.90	3.89	5.40	5.53	3.90	3.89	5.30	5.34
LITHIUM TOTAL	µg/L	n	22	26	19	23	22	25	51	56	63	74	51	56	114	130
POR_1: Apr 1993 - Oct 2012		max	36.25	36.25	56.90	56.90	12.20	12.20	34.40	34.40	56.90	56.90	34.40	34.40	56.90	56.90
POR_2: Apr 1993 - Oct 2014		50th P	8.00	8.39	9.20	7.00	6.10	6.10	4.00	3.90	7.22	7.10	4.00	3.90	6.10	6.08
		90th P	20.79	18.91	54.10	49.70	10.15	9.70	11.86	11.76	21.04	18.40	11.86	11.76	16.05	14.36

Parameters and Periods of Records (POR)	Units	Thresholds	SEASONAL								OPEN WATER/ ICE COVERED				ANNUAL	
			POR_1	POR_2	POR_1	POR_2	POR_1	POR_2	POR_1	POR_2	POR_1	POR_2	POR_1	POR_2	POR_1	POR_2
			Spring		Summer		Fall		Winter		Open Water		Ice Covered		Annual	
MAGNESIUM DISSOLVED/FILTERED	mg/L	n	42	46	42	46	40	43	94	99	124	135	94	99	218	234
POR_1: Nov 1978 - Oct 2012		max	7.80	7.80	8.80	8.80	7.70	**7.86**	8.08	8.08	8.80	8.80	8.08	8.08	8.80	8.80
POR_2: Nov 1978 - Oct 2014		50th P	6.49	6.49	6.91	6.95	6.52	6.50	6.58	6.59	6.55	6.55	6.58	6.59	6.56	6.58
		90th P	7.40	7.41	7.94	7.86	7.42	7.48	7.06	7.08	7.54	7.54	7.06	7.08	7.44	7.45
MANGANESE DISSOLVED	µg/L	n	8	12	7	11	9	12	15	20	24	35	15	20	39	55
POR_1: May 2006 - Oct 2012		max	4.87	4.87	3.40	3.40	5.63	5.63	13.60	13.60	5.63	5.63	13.60	13.60	13.60	13.60
POR_2: May 2006 - Oct 2014		50th P	2.17	2.17	1.61	1.65	2.80	2.50	4.32	3.87	2.09	2.12	4.32	3.87	3.12	2.53
		90th P		4.35		3.35		5.19	13.60	13.47	4.51	3.85	13.60	13.47	9.07	6.63
MANGANESE TOTAL	µg/L	n	22	26	19	23	22	25	51	56	63	74	51	56	114	130
POR_1: Mar 1993 - Oct 2012		max	658	658	1980	1980	135	135	761	761	1980	1980	761	761	1980	1980
POR_2: Mar 1993 - Oct 2014		50th P	85	88	104	84	51	50	16	14	72	71	16	14	58	58
		90th P	471	370	1350	1115	81	89	359	330	361	319	359	330	356	311
MERCURY TOTAL	ng/L	n									32					
POR_1: June 2013 – July 2019		max									48.10					
		50th P									7.45					
		90th P									22.56					
MERCURY DISSOLVED	ng/L	n									32					
POR_1: June 2013 – July 2019		max									5.28					
		50th P									0.80					
		90th P									1.98					
MOLYBDENUM DISSOLVED	µg/L	n	8	12	7	11	9	12	15	20	24	35	15	20	39	55
POR1: May 2006 - Oct 2012		max	1.045	1.045	2.560	2.560	0.810	0.810	1.070	1.070	2.560	2.560	1.070	1.070	2.560	2.560
POR_2: May 2006 - Oct 2014		50th P	0.759	0.796	0.872	0.859	0.700	0.699	0.739	0.715	0.787	0.778	0.739	0.715	0.770	0.746
		90th P		1.035		2.239		0.808	0.954	0.873	1.000	0.976	0.954	0.873	0.954	0.946
MOLYBDENUM TOTAL	µg/L	n	22	26	19	23	22	25	51	56	63	74	51	56	114	130
POR1: Apr 1993 - Oct 2012		max	1.750	1.750	3.000	3.000	0.900	0.900	1.000	1.000	3.000	3.000	1.000	1.000	3.000	3.000
POR_2: Apr 1993 - Oct 2014		50th P	0.596	0.570	0.800	0.675	0.636	0.627	0.606	0.631	0.631	0.626	0.606	0.631	0.629	0.629
		90th P	0.900	0.900	2.400	2.120	0.800	0.800	0.800	0.800	1.124	1.050	0.800	0.800	0.900	0.898
NICKEL DISSOLVED	µg/L	n	8	12	7	11	9	12	15	20	24	35	15	20	39	55
POR1: May 2006 - Oct 2012		max	2.74	**2.80**	4.46	4.46	1.48	1.48	2.26	2.26	4.46	4.46	2.26	2.26	4.46	4.46
POR_2: May 2006 - Oct 2014		50th P	1.37	1.63	1.64	1.60	1.06	1.03	1.15	0.90	1.25	1.29	1.15	0.90	1.24	1.21
		90th P		2.78		4.00		1.40	2.20	2.13	2.37	2.45	2.20	2.13	2.16	2.20
NICKEL TOTAL	µg/L	n	36	40	34	38	36	39	87	92	106	117	87	92	193	209
POR1: Nov 1983 - Oct 2012		max	41.55	41.55	92.90	92.90	8.60	8.60	25.50	25.50	92.90	92.90	25.50	25.50	92.90	92.90
POR_2: Nov 1983 - Oct 2014		50th P	6.85	7.05	5.55	5.20	2.80	2.78	1.70	1.55	5.00	4.90	1.70	1.55	3.50	3.38
		90th P	26.44	20.80	41.00	36.68	6.21	6.00	9.97	9.18	19.96	18.96	9.97	9.18	15.72	15.80

Parameters and Periods of Records (POR)	Units	Thresholds	SEASONAL								OPEN WATER/ ICE COVERED				ANNUAL	
			POR_1	POR_2	POR_1	POR_2	POR_1	POR_2	POR_1	POR_2	POR_1	POR_2	POR_1	POR_2	POR_1	POR_2
			Spring		Summer		Fall		Winter		Open Water		Ice Covered		Annual	
NITRATE/NITRITE	mg/L	n	8	12	7	11	9	12	18	23	24	35	18	23	42	58
POR_1: Oct 2005 - Oct 2012		max	0.210	0.210	0.290	0.290	0.150	**0.160**	0.230	**0.300**	0.290	0.290	0.230	**0.300**	0.290	**0.300**
POR_2: Oct 2005 - Oct 2014		50th P	0.040	0.095	0.050	0.070	0.050	0.070	0.085	0.120	0.045	0.070	0.085	0.120	0.070	0.080
		90th P		0.195		0.278		0.157	0.185	0.210	0.220	0.180	0.185	0.210	0.201	0.183
NITROGEN DISSOLVED	mg/L	n	39	43	41	45	36	39	86	91	116	127	86	91	202	218
POR1: Nov 1978 - Oct 2012		max	0.670	0.670	0.610	0.610	0.464	0.464	2.000	2.000	0.670	0.670	2.000	2.000	2.000	2.000
POR_2: Nov 1978 - Oct 2014		50th P	0.270	0.280	0.240	0.242	0.180	0.183	0.206	0.210	0.233	0.240	0.206	0.210	0.219	0.224
		90th P	0.544	0.548	0.425	0.428	0.356	0.352	0.527	0.516	0.417	0.461	0.527	0.516	0.451	0.465
pH	pH units	n		25		24		31		60		145		102		247
		max		12.40		14.50		15.46		16.6		8.30		8.22		8.30
POR_2: Jan 1972 - Oct 2014		min		6.00		6.40		9.00		9.40		7.33		6.80		6.80
		10th P		6.00		6.40		9.00		9.40		7.36		6.82		7.33
		50th P		9.47		8.21		10.90		13.00		7.97		7.89		7.91
		90th P		10.84		9.12		13.01		14.06		8.12		8.06		8.10
PHOSPHOROUS TOTAL	mg/L	n	42	46	45	49	39	42	87	92	126	137	87	92	213	229
POR_1: Jul 1974 - Oct 2012		max	2.280	2.280	4.670	4.670	0.229	0.229	1.230	1.230	4.670	4.670	1.230	1.230	4.670	4.670
POR_2: Jul 1974 - Oct 2014		50th P	0.207	0.209	0.189	0.170	0.078	0.078	0.030	0.030	0.132	0.130	0.030	0.030	0.088	0.087
		90th P	0.695	0.687	1.718	1.670	0.140	0.137	0.382	0.359	0.660	0.586	0.382	0.359	0.518	0.491
PHOSPHOROUS TOTAL DISSOLVED	mg/L	n	40	44	41	45	38	41	83	88	119	130	83	88	202	218
POR_1: Nov 1978 - Oct 2012		max	0.136	0.136	0.100	0.100	0.075	0.075	0.123	0.123	0.136	0.136	0.123	0.123	0.136	0.136
POR_2: Nov 1978 - Oct 2014		50th P	0.016	0.015	0.012	0.012	0.010	0.009	0.008	0.008	0.010	0.010	0.008	0.008	0.010	0.010
		90th P	0.061	0.055	0.033	0.032	0.014	0.013	0.020	0.020	0.034	0.033	0.020	0.020	0.030	0.030
POTASSIUM DISSOLVED/FILTERED	mg/L	n	47	51	49	53	44	47	104	109	140	151	104	109	244	260
POR_1: Jan 1972 - Oct 2012		max	2.58	2.58	2.01	2.01	1.48	1.48	3.63	3.63	2.58	2.58	3.63	3.63	3.63	3.63
POR_2: Jan 1972 - Oct 2014		50th P	1.20	1.21	0.95	0.96	0.86	0.87	0.84	0.84	0.95	0.97	0.84	0.84	0.90	0.91
		90th P	2.16	2.12	1.26	1.26	1.00	1.02	1.50	1.50	1.53	1.61	1.50	1.50	1.50	1.50
SELENIUM DISSOLVED	µg/L	n	8	12	7	11	9	12	15	20	24	35	15	20	39	55
POR_1: May 2006 - Oct 2012		max	0.355	**0.370**	0.500	0.500	0.210	0.210	0.270	**0.290**	0.500	0.500	0.270	**0.290**	0.500	0.500
POR_2: May 2006 - Oct 2014		50th P	0.270	0.270	0.270	0.270	0.180	0.170	0.210	0.210	0.230	0.240	0.210	0.210	0.210	0.210
		90th P		0.366		0.463		0.207	0.258	0.268	0.338	0.334	0.258	0.268	0.310	0.311
SELENIUM TOTAL	µg/L	n	10	14	9	13	11	14	23	28	30	41	23	28	53	69
POR_1: Apr 2003 - Oct 2012		max	0.405	**0.650**	0.880	0.880	0.235	0.235	0.470	0.470	0.880	0.880	0.470	0.470	0.880	0.880
POR_2: Apr 2003 - Oct 2014		50th P	0.290	0.305	0.270	0.270	0.180	0.180	0.230	0.230	0.255	0.250	0.230	0.230	0.230	0.230
		90th P	0.404	0.528		0.728	0.232	0.225	0.334	0.314	0.404	0.414	0.334	0.314	0.382	0.390
SILVER DISSOLVED	µg/L	n	8	12	7	11	9	12	15	20	24	35	15	20	39	55
POR_1: May 2006 - Oct 2012		max	0.0050	0.0050	0.0050	0.0050	0.0030	0.0030	0.0730	0.0730	0.0050	0.0050	0.0730	0.0730	0.0730	0.0730
POR_2: May 2006 - Oct 2014		50th P	0.0020	0.0020	0.0020	0.0020	0.0020	0.0015	0.0040	0.0025	0.0020	0.0020	0.0040	0.0025	0.0020	0.0020
		90th P		0.0050		0.0046		0.0027	0.0490	0.0321	0.0040	0.0044	0.0490	0.0321	0.0150	0.0074

Parameters and Periods of Records (POR)	Units	Thresholds	SEASONAL								OPEN WATER/ ICE COVERED				ANNUAL	
			POR_1	POR_2	POR_1	POR_2	POR_1	POR_2	POR_1	POR_2	POR_1	POR_2	POR_1	POR_2	POR_1	POR_2
			Spring		Summer		Fall		Winter		Open Water		Ice Covered		Annual	
SILVER TOTAL	µg/L	n	17	21	14	18	16	19	39	44	47	58	39	44	86	102
POR_1: Apr 1996 - Oct 2012		max	0.152	0.152	0.487	0.487	0.500	0.500	0.685	0.685	0.500	0.500	0.685	0.685	0.685	0.685
POR_2: Apr 1996 - Oct 2014		50th P	0.100	0.086	0.050	0.043	0.016	0.015	0.100	0.065	0.048	0.039	0.100	0.065	0.069	0.049
		90th P	0.133	0.128	0.444	0.409	0.220	0.100	0.157	0.129	0.133	0.128	0.157	0.129	0.135	0.127
SODIUM DISSOLVED/FILTERED	mg/L	n	47	51	49	53	43	46	104	109	139	150	104	109	243	259
POR_1: Jan 1972 - Oct 2012		max	10.00	10.00	8.85	8.85	9.06	11.00	9.52	9.52	10.00	11.00	9.52	9.52	10.00	11.00
POR_2: Jan 1972 - Oct 2014		50th P	6.50	6.33	5.96	6.20	6.90	7.13	6.09	6.06	6.40	6.46	6.09	6.06	6.19	6.19
		90th P	8.12	8.06	7.30	7.39	8.61	8.80	7.74	7.71	8.17	8.18	7.74	7.71	7.99	8.00
SPECIFIC CONDUCTANCE (LAB)	µS/cm	n	47	51	50	54	45	48	105	110	142	153	105	110	247	263
POR_1: Jan 1972 - Oct 2012		max	364	364	300	300	280	280	262	262	364	364	262	262	364	364
POR_2: Jan 1972 - Oct 2014		50th P	212	213	213	215	200	202	210	210	211	212	210	210	210	211
		90th P	262	260	256	254	247	253	240	240	256	254	240	240	250	249
STRONTIUM DISSOLVED	µg/L	n	8	12	7	11	9	12	15	20	24	35	15	20	39	55
POR_1: May 2006 - Oct 2012		max	151	151	180	180	186	186	157	157	186	186	157	157	186	186
POR_2: May 2006 - Oct 2014		50th P	127	127	138	139	140	138	140	133	130	134	140	133	134	134
		90th P		147		176		182	156	155	170	164	156	155	157	156
STRONTIUM TOTAL	µg/L	n	22	26	19	23	22	25	51	56	63	74	51	56	114	130
POR_1: Apr 1993 - Oct 2012		max	199	199	353	353	195	195	205	205	353	353	205	205	353	353
POR_2: Apr 1993 - Oct 2014		50th P	139	140	155	155	141	141	133	133	147	147	133	133	139	140
		90th P	178	172	290	265	165	170	158	157	192	185	158	157	174	175
SULPHATE DISSOLVED	mg/L	n	47	51	49	53	44	47	103	108	140	151	103	108	243	259
POR_1: Jan 1972 - Oct 2012		max	31.0	31.0	37.2	37.2	24.8	24.8	31.9	31.9	37.2	37.2	31.9	31.9	37.2	37.2
POR_2: Jan 1972 - Oct 2014		50th P	20.5	20.5	18.5	18.6	17.4	17.8	17.5	17.5	18.6	19.1	17.5	17.5	18.0	18.0
		90th P	27.2	27.0	28.1	28.1	21.5	21.7	20.8	20.7	26.3	26.1	20.8	20.7	23.1	23.2
THALLIUM DISSOLVED	µg/L	n	8	12	7	11	9	12	15	20	24	35	15	20	39	55
POR_1: May 2006 - Oct 2012		max	0.024	0.024	0.012	0.012	0.025	0.025	0.079	0.079	0.025	0.025	0.079	0.079	0.079	0.079
POR_2: May 2006 - Oct 2014		50th P	0.010	0.008	0.008	0.008	0.009	0.007	0.008	0.006	0.010	0.008	0.008	0.006	0.009	0.007
		90th P		0.021		0.012		0.022	0.047	0.024	0.020	0.015	0.047	0.024	0.024	0.016
THALLIUM TOTAL	µg/L	n	11	15	10	14	12	15	26	31	33	44	26	31	59	75
POR_1: Mar 2002 - Oct 2012		max	0.313	0.313	0.480	0.480	0.047	0.045	0.199	0.199	0.480	0.480	0.199	0.199	0.480	0.480
POR_2: Mar 2002 - Oct 2014		50th P	0.053	0.058	0.039	0.039	0.025	0.024	0.015	0.011	0.037	0.038	0.015	0.011	0.030	0.028
		90th P	0.281	0.218	0.440	0.312	0.045	0.043	0.129	0.108	0.148	0.141	0.129	0.108	0.138	0.136
TOTAL DISSOLVED SOLIDS	mg/L	n	15	21	14	20	16	23	40	45	45	64	40	45	85	109
POR_1: Apr 1993 - Oct 2012		max	265	265	260	260	168	168	360	360	265	265	360	360	360	360
POR_2: Apr 1993 - Oct 2014		50th P	173	163	151	151	129	128	130	129	146	145	130	129	132	133
		90th P	236	216	233	204	167	163	164	162	209	196	164	162	184	180

Parameters and Periods of Records (POR)	Units	Thresholds	SEASONAL								OPEN WATER/ ICE COVERED				ANNUAL	
			POR_1	POR_2	POR_1	POR_2	POR_1	POR_2	POR_1	POR_2	POR_1	POR_2	POR_1	POR_2	POR_1	POR_2
			Spring		Summer		Fall		Winter		Open Water		Ice Covered		Annual	
TOTAL SUSPENDED SOLIDS	mg/L	n	39	45	39	45	37	44	89	94	115	134	89	94	204	228
POR_1: Jan 1972 - Oct 2012		max	2320	2320	4880	4880	279	279	1110	1110	4880	4880	1110	1110	4880	4880
POR_2: Jan 1972 - Oct 2014		50th P	210	211	148	136	59	60	18	16	121	111	18	16	76	76
		90th P	1370	1091	1117	1023	141	132	360	343	704	557	360	343	535	463
TURBIDITY (LAB)	NTU	n	44	48	48	52	42	45	96	101	134	145	96	101	230	246
POR_1: Jan 1972 - Oct 2012		max	1910	1910	6450	6450	155	155	900	900	6450	6450	900	900	6450	6450
POR_2: Jan 1972 - Oct 2014		50th P	142	159	81	79	49	48	14	11	77	77	14	11	56	55
		90th P	850	730	1591	1351	81	87	211	195	453	448	211	195	360	361
URANIUM DISSOLVED	µg/L	n	8	12	7	11	9	12	15	20	24	35	15	20	39	55
POR_1: May 2006 - Oct 2012		max	0.718	0.718	1.190	1.190	0.409	0.409	0.561	0.561	1.190	1.190	0.561	0.561	1.190	1.190
POR_2: May 2006 - Oct 2014		50th P	0.427	0.438	0.445	0.418	0.372	0.370	0.412	0.407	0.403	0.408	0.412	0.407	0.409	0.408
		90th P		0.664		1.051		0.409	0.515	0.483	0.629	0.530	0.515	0.483	0.539	0.511
URANIUM TOTAL	µg/L	n	10	14	9	13	11	14	23	28	30	41	23	28	53	69
POR_1: Apr 2003 - Oct 2012		max	1.270	1.270	4.910	4.910	0.534	0.534	1.240	1.240	4.910	4.910	1.240	1.240	4.910	4.910
POR_2: Apr 2003 - Oct 2014		50th P	0.613	0.638	0.499	0.499	0.432	0.441	0.510	0.450	0.517	0.527	0.510	0.450	0.510	0.492
		90th P	1.269	1.265		3.382	0.525	0.531	1.060	0.872	1.216	1.186	1.060	0.872	1.060	1.090
VANADIUM DISSOLVED	µg/L	n	8	12	7	11	9	12	15	20	24	35	15	20	39	55
POR_1: May 2006 - Oct 2012		max	0.500	0.500	0.537	0.537	0.559	0.559	0.898	0.898	0.559	0.559	0.898	0.898	0.898	0.898
POR_2: May 2006 - Oct 2014		50th P	0.352	0.361	0.400	0.429	0.392	0.354	0.230	0.223	0.377	0.378	0.230	0.223	0.351	0.351
		90th P		0.490		0.529		0.546	0.730	0.595	0.527	0.507	0.730	0.595	0.537	0.507
VANADIUM TOTAL	µg/L	n	36	40	34	38	36	39	87	90	106	117	87	90	193	207
POR_1: Nov 1983 - Oct 2012		max	40.50	40.50	84.80	84.80	8.80	8.80	24.10	24.10	84.80	84.80	24.10	24.10	84.80	84.80
POR_2: Nov 1983 - Oct 2014		50th P	5.28	5.44	3.78	3.64	1.80	1.80	0.70	0.70	3.56	3.51	0.70	0.70	2.40	2.40
		90th P	19.47	17.71	39.85	38.77	4.71	3.90	8.40	8.04	15.97	14.94	8.40	8.04	13.60	13.57
ZINC DISSOLVED	µg/L	n	8	12	7	11	9	12	15	20	24	35	15	20	39	55
POR_1: May 2006 - Oct 2012		max	1.01	1.01	3.45	3.45	3.41	3.41	27.50	27.50	3.45	3.45	27.50	27.50	27.50	27.50
POR_2: May 2006 - Oct 2014		50th P	0.65	0.65	0.60	0.70	0.80	0.74	3.13	2.76	0.73	0.70	3.13	2.76	1.00	0.80
		90th P		0.98		3.12		2.76	19.34	13.35	2.60	1.46	19.34	13.35	7.80	6.19
ZINC TOTAL	µg/L	n	36	40	34	38	36	39	87	92	106	117	87	92	193	209
POR_1: Nov 1983 - Oct 2012		max	191.7	191.7	561.0	561.0	27.1	27.1	113.0	113.0	561.0	561.0	113.0	113.0	561.0	561.0
POR_2: Nov 1983 - Oct 2014		50th P	20.0	20.9	13.2	12.1	6.7	6.6	7.4	6.0	12.5	12.2	7.4	6.0	11.2	11.0
		90th P	79.4	61.0	146.5	133.3	14.9	13.1	38.8	35.9	62.0	59.9	38.8	35.9	49.5	49.3

Notes:
1. 50th P (Trigger 1; typical conditions).
2. 90th P (Trigger 1; extreme conditions).
3. POR: Period of Record.
4. Spring: May and June; Summer: July and August; Fall: September and October; Winter: November through April.
5. Open-Water: Spring, Summer and Fall; Ice-Covered: Winter.
6. Although all interim triggers (4-season, 2-season and annual) are included in this table, only if n>30 for each season (e.g., Spring, Summer, Fall and Winter) will the interim triggers be used otherwise the interim triggers in the next season classification (e.g., Open-Water and Ice-Covered, or Annual) will be used.

Appendix 3: Hay River Interim Water Quality Triggers [Original (POR_1) and Updated (POR_2)]

Parameters and Periods of Records (POR)	Units	Thresholds	SEASONAL								OPEN-WATER/ICE-COVERED				ANNUAL	
			POR_1	POR_2	POR_1	POR_2	POR_1	POR_2	POR_1	POR_2	POR_1	POR_2	POR_1	POR_2	POR_1	POR_2
			Spring		Summer		Fall		Winter		Open Water		Ice Covered		Annual	
ALKALINITY	mg/L	n	34	34	29	31	26	27	62	62	89	92	62	62	151	154
POR_1: Oct 1988 - May 2014		max	110.0	110.0	129.0	129.0	181.0	181.0	305.0	305.0	181.0	181.0	305.0	305.0	305.0	305.0
POR_2: Oct 1988 - Oct 2014		50th P	68.7	68.7	102.0	100.0	113.5	116.0	190.5	190.5	93.4	94.2	190.5	190.5	117.0	116.5
		90th P	91.2	91.2	121.0	120.8	161.9	160.6	271.7	271.7	127.0	128.4	271.7	271.7	240.6	240.0
ALUMINUM DISSOLVED	*µg/L*	*n*	*8*	*8*	*7*	*8*	*5*	*6*	*6*	*6*	*20*	*22*	*6*	*6*	*26*	*28*
POR_1: Aug 2006 - May 2014		*max*	*61.6*	*61.6*	*43.5*	*43.5*	*27.9*	*27.9*	*20.8*	*20.8*	*61.6*	*61.6*	*20.8*	*20.8*	*61.6*	*61.6*
POR_2: Aug 2006 - Oct 2014		*50th P*	*40.5*	*40.5*	*22.9*	*22.0*	*17.5*	*16.3*	*9.4*	*9.4*	*27.7*	*25.7*	*9.4*	*9.4*	*22.0*	*21.0*
		90th P									*49.1*	*48.6*	-		*47.7*	*47.2*
ALUMINUM TOTAL	µg/L	n	25	25	21	22	16	17	35	35	62	64	35	35	97	99
POR_1: Apr 1993 - May 2014		max	7620	7620	2200	2200	864	864	1450	1450	7620	7620	1450	1450	7620	7620
POR_2: Apr 1993 - Oct 2014		50th P	976	976	323	321	265	263	89	88	436	421	89	88	196	196
		90th P	2804	2804	989	974	699	675	211	211	2086	2010	211	211	1618	1580
AMMONIA DISSOLVED	mg/L	n	26	26	22	24	18	18	36	36	66	68	36	36	102	104
POR_1: Apr 1993 - May 2014		max	0.270	0.270	0.099	0.099	0.056	0.056	0.938	0.938	0.270	0.270	0.938	0.938	0.938	0.938
POR_2: Apr 1993 - Oct 2014		50th P	0.015	0.015	0.017	0.015	0.019	0.019	0.070	0.070	0.018	0.017	0.070	0.070	0.022	0.021
		90th P	0.097	0.097	0.060	0.058	0.046	0.046	0.217	0.217	0.054	0.053	0.217	0.217	0.140	0.138
ANTIMONY DISSOLVED	*µg/L*	*n*	*8*	*8*	*7*	*8*	*5*	*6*	*6*	*6*	*20*	*22*	*6*	*6*	*26*	*28*
POR_1: Aug 2006 - May 2014		*max*	*0.280*	*0.280*	*0.165*	*0.165*	*0.215*	*0.215*	*0.190*	*0.190*	*0.280*	*0.280*	*0.190*	*0.190*	*0.280*	*0.280*
POR_2: Aug 2006 - Oct 2014		*50th P*	*0.174*	*0.174*	*0.153*	*0.152*	*0.172*	*0.165*	*0.103*	*0.103*	*0.165*	*0.161*	*0.103*	*0.103*	*0.157*	*0.155*
		90th P									*0.214*	*0.211*			*0.205*	*0.202*
ANTIMONY TOTAL	µg/L	n	14	14	13	14	7	8	12	12	34	36	12	12	46	48
POR_1: Apr 2002 - May 2014		max	0.257	0.257	0.167	0.167	0.122	0.122	0.169	0.169	0.257	0.257	0.169	0.169	0.257	0.257
POR_2: Apr 2002 - Oct 2014		50th P	0.117	0.117	0.122	0.121	0.100	0.100	0.081	0.081	0.114	0.114	0.081	0.081	0.108	0.108
		90th P	0.228	0.228	0.164	0.163			0.165	0.165	0.173	0.170	0.165	0.165	0.168	0.167
ARSENIC DISSOLVED	µg/L	n	8	8	7	8	5	6	6	6	20	22	6	6	26	28
POR1: Aug 2006 - May 2014		max	0.840	0.840	1.120	1.120	1.570	1.570	0.530	0.530	1.570	1.570	0.530	0.530	1.570	1.570
POR_2: Aug 2006 - Oct 2014		50th P	0.665	0.665	0.980	0.980	0.830	0.795	0.510	0.510	0.835	0.835	0.510	0.510	0.765	0.765
		90th P									1.219	1.197			1.153	1.131
ARSENIC TOTAL	*µg/L*	*n*	*8*	*8*	*7*	*8*	*5*	*6*	*6*	*6*	*20*	*22*	*6*	*6*	*26*	*28*
POR1: Aug 2006 - May 2014		*max*	*5.89*	*5.89*	*2.04*	*2.04*	*1.98*	*1.98*	*1.08*	*1.08*	*5.89*	*5.89*	*1.08*	*1.08*	*5.89*	*5.89*
POR_2: Aug 2006 - Oct 2014		*50th P*	*2.97*	*2.97*	*1.61*	*1.55*	*1.37*	*1.22*	*0.89*	*0.89*	*1.62*	*1.61*	*0.89*	*0.89*	*1.49*	*1.46*
		90th P									*3.52*	*3.44*			*3.27*	*3.19*
BARIUM DISSOLVED	*µg/L*	*n*	*8*	*8*	*7*	*8*	*5*	*6*	*6*	*6*	*20*	*22*	*6*	*6*	*26*	*28*
POR1: Aug 2006 - May 2014		*max*	*48.5*	*48.5*	*54.1*	*54.1*	*50.6*	*50.6*	*66.6*	*66.6*	*54.1*	*54.1*	*66.6*	*66.6*	*66.6*	*66.6*
POR_2: Aug 2006 - Oct 2014		*50th P*	*32.0*	*32.0*	*41.5*	*41.1*	*41.3*	*41.4*	*55.7*	*55.7*	*37.9*	*39.6*	*55.7*	*55.7*	*41.4*	*41.4*
		90th P									*50.4*	*50.0*			*58.8*	*57.9*
BARIUM TOTAL	µg/L	n	33	33	30	31	26	27	63	63	89	91	63	63	152	154
POR1: Oct 1988 - May 2014		max	298	298	477	477	109	109	203	203	477	477	203	203	477	477
POR_2: Oct 1988 - Oct 2014		50th P	75	75	58	58	55	55	80	80	60	59	80	80	67	67

Parameters and Periods of Records (POR)	Units	Thresholds	SEASONAL								OPEN-WATER/ICE-COVERED				ANNUAL	
			POR_1	POR_2	POR_1	POR_2	POR_1	POR_2	POR_1	POR_2	POR_1	POR_2	POR_1	POR_2	POR_1	POR_2
			Spring		Summer		Fall		Winter		Open Water		Ice Covered		Annual	
		90th P	119	119	97	95	83	82	110	110	102	102	110	110	106	105
BERYLLIUM DISSOLVED	*µg/L*	*n*	*8*	*8*	*7*	*8*	*5*	*6*	*6*	*6*	*20*	*22*	*6*	*6*	*26*	*28*
POR1: Aug 2006 - May 2014		*max*	*0.017*	*0.017*	*0.017*	*0.017*	*0.014*	*0.014*	*0.023*	*0.023*	*0.017*	*0.017*	*0.023*	*0.023*	*0.023*	*0.023*
POR_2: Aug 2006 - Oct 2014		*50th P*	*0.014*	*0.014*	*0.014*	*0.014*	*0.011*	*0.011*	*0.010*	*0.010*	*0.014*	*0.014*	*0.010*	*0.010*	*0.014*	*0.013*
		90th P									*0.017*	*0.017*			*0.017*	*0.017*
BERYLLIUM TOTAL	µg/L	n	26	26	22	23	17	18	36	36	65	67	36	36	101	103
POR1: Apr 1993 - May 2014		max	0.548	0.548	0.160	0.160	0.090	0.090	0.120	0.120	0.548	0.548	0.120	0.120	0.548	0.548
POR_2: Apr 1993 - Oct 2014		50th P	0.089	0.089	0.048	0.046	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050
		90th P	0.234	0.234	0.093	0.091	0.074	0.072	0.050	0.050	0.176	0.172	0.050	0.050	0.138	0.136
BISMUTH DISSOLVED	*µg/L*	*n*	*8*	*8*	*7*	*8*	*5*	*6*	*6*	*6*	*20*	*22*	*6*	*6*	*26*	*28*
POR1: Aug 2006 - May 2014		*max*	*0.0060*	*0.0060*	*0.0040*	*0.0040*	*0.0050*	*0.0050*	*0.0010*	*0.0010*	*0.0060*	*0.0060*	*0.0010*	*0.0010*	*0.0060*	*0.0060*
POR_2: Aug 2006 - Oct 2014		*50th P*	*0.0040*	*0.0035*	*0.0030*	*0.0030*	*0.0030*	*0.0025*	*0.0010*	*0.0010*	*0.0030*	*0.0030*	*0.0010*	*0.0010*	*0.0030*	*0.0030*
		90th P							*0.0010*	*0.0010*	*0.0050*	*0.0050*	*0.0010*	*0.0010*	*0.0050*	*0.0050*
BISMUTH TOTAL POR_1: Apr 2003 - Sep 2009 POR_2: Apr 2003 - Sep 2009	µg/L	Under Review														
BORON DISSOLVED	*µg/L*	*n*	*8*	*8*	*7*	*8*	*5*	*6*	*6*	*6*	*20*	*22*	*6*	*6*	*26*	*28*
POR1: Aug 2006 - May 2014		*max*	*37.1*	*37.1*	*36.9*	*36.9*	*35.2*	*36.2*	*56.8*	*56.8*	*37.1*	*37.1*	*56.8*	*56.8*	*56.8*	*56.8*
POR_2: Aug 2006 - Oct 2014		*50th P*	*25.3*	*25.3*	*28.4*	*29.7*	*29.1*	*29.4*	*44.7*	*44.7*	*28.7*	*29.1*	*44.7*	*44.7*	*30.0*	*30.6*
		90th P									*36.7*	*36.7*			*49.5*	*48.2*
BORON TOTAL	µg/L	n	14	14	13	14	7	8	12	12	34	36	12	12	46	48
POR1: Apr 2002 - May 2014		max	39.8	39.8	46.5	46.5	35.0	**35.9**	61.4	61.4	46.5	46.5	61.4	61.4	61.4	61.4
POR_2: Apr 2002 - Oct 2014		50th P	27.5	27.5	31.5	32.0	29.2	31.2	42.3	42.3	29.2	29.9	42.3	42.3	32.0	32.6
		90th P	37.4	37.4	42.6	41.7			60.0	60.0	36.3	36.2	60.0	60.0	47.3	46.8
CADMIUM DISSOLVED	*µg/L*	*n*	*8*	*8*	*7*	*8*	*5*	*6*	*6*	*6*	*20*	*22*	*6*	*6*	*26*	*28*
POR1: Aug 2006 - May 2014		*max*	*0.034*	*0.034*	*0.028*	***0.046***	*0.034*	*0.034*	*0.186*	*0.186*	*0.034*	***0.046***	*0.186*	*0.186*	*0.186*	*0.186*
POR_2: Aug 2006 - Oct 2014		*50th P*	*0.026*	*0.026*	*0.024*	*0.025*	*0.029*	*0.024*	*0.048*	*0.048*	*0.025*	*0.025*	*0.048*	*0.048*	*0.029*	*0.029*
		90th P									*0.034*	*0.034*			*0.064*	*0.055*
CADMIUM TOTAL	µg/L	n	33	33	30	31	26	27	63	63	89	91	63	63	152	154
POR1: Oct 1988 - May 2014		max	2.56	2.56	1.57	1.57	0.40	0.40	1.10	1.10	2.56	2.56	1.10	1.10	2.56	2.56
POR_2: Oct 1988 - Oct 2014		50th P	0.20	0.20	0.10	0.10	0.10	0.10	0.20	0.20	0.12	0.11	0.20	0.20	0.19	0.17
		90th P	0.86	0.86	0.40	0.40	0.30	0.30	0.52	0.52	0.50	0.50	0.52	0.52	0.50	0.50
CALCIUM DISSOLVED/FILTERED	mg/L	n	34	34	30	31	26	27	62	62	90	92	62	62	152	154
POR1: Oct 1988 - May 2014		max	43.8	43.8	51.4	51.4	66.4	66.4	115.0	115.0	66.4	66.4	115.0	115.0	115.0	115.0
POR_2: Oct 1988 - Oct 2014		50th P	31.6	31.6	42.7	42.9	45.2	45.2	73.7	73.7	40.0	40.1	73.7	73.7	45.5	45.9
		90th P	40.7	40.7	48.1	48.0	60.1	59.4	99.5	99.5	49.0	49.2	99.5	99.5	87.6	87.1
CARBON DISSOLVED ORGANIC	mg/L	n	33	33	29	31	25	25	61	61	87	89	61	61	148	150
POR1: Oct 1988 - May 2014		max	29.80	29.80	40.40	40.40	37.20	37.20	72.60	72.60	40.40	40.40	72.60	72.60	72.60	72.60
POR_2: Oct 1988 - Oct 2014		50th P	24.25	24.25	26.20	26.20	30.15	30.15	28.20	28.20	25.60	25.60	28.20	28.20	26.20	26.20
		90th P	26.46	26.46	34.10	34.04	34.06	34.06	37.20	37.20	32.72	32.60	37.20	37.20	34.42	34.37

Parameters and Periods of Records (POR)	Units	Thresholds	SEASONAL								OPEN-WATER/ICE-COVERED				ANNUAL	
			POR_1	POR_2	POR_1	POR_2	POR_1	POR_2	POR_1	POR_2	POR_1	POR_2	POR_1	POR_2	POR_1	POR_2
			Spring		Summer		Fall		Winter		Open Water		Ice Covered		Annual	
CARBON PARTICULATE ORGANIC	mg/L	n	32	32	31	31	26	27	63	63	89	90	63	63	152	153
POR1: Oct 1988 - July 2014		max	20.00	20.00	4.93	4.93	3.72	3.72	5.63	5.63	20.00	20.00	5.63	5.63	20.00	20.00
POR_2: Oct 1988 - Oct 2014		50th P	3.11	3.11	1.81	1.81	1.23	1.19	0.68	0.68	2.10	2.08	0.68	0.68	1.18	1.16
		90th P	7.47	7.47	3.89	3.89	3.23	3.22	1.57	1.57	4.77	4.75	1.57	1.57	3.85	3.84
CHLORIDE DISSOLVED	mg/L	n	34	34	31	31	26	27	62	62	91	92	62	62	153	154
POR1: Oct 1988 - July 2014		max	4.80	4.80	9.60	9.60	7.87	7.87	24.40	24.40	9.60	9.60	24.40	24.40	24.40	24.40
POR_2: Oct 1988 - Oct 2014		50th P	2.84	2.84	2.70	2.70	4.09	4.20	7.42	7.42	2.84	2.87	7.42	7.42	4.20	4.24
		90th P	4.06	4.06	4.60	4.60	6.45	6.37	12.27	12.27	5.21	5.17	12.27	12.27	10.36	10.35
CHROMIUM DISSOLVED	*µg/L*	*n*	*8*	*8*	*7*	*8*	*5*	*6*	*6*	*6*	*20*	*22*	*6*	*6*	*26*	*28*
POR_1: Aug 2006 - May 2014		*max*	*0.260*	*0.260*	*0.184*	*0.184*	*0.204*	*0.204*	*0.232*	*0.232*	*0.260*	*0.260*	*0.232*	*0.232*	*0.260*	*0.260*
POR_2: Aug 2006 - Oct 2014		*50th P*	*0.174*	*0.174*	*0.143*	*0.147*	*0.120*	*0.115*	*0.113*	*0.113*	*0.148*	*0.148*	*0.113*	*0.113*	*0.142*	*0.142*
		90th P									*0.204*	*0.203*			*0.212*	*0.207*
CHROMIUM TOTAL	µg/L	n	26	26	22	23	17	18	36	36	65	67	36	36	101	103
POR1: Apr 2003 - May 2014		max	11.90	11.90	3.70	3.70	1.50	1.50	2.26	2.26	11.90	11.90	2.26	2.26	11.90	11.90
POR_2: Apr 2003 - Oct 2014		50th P	1.54	1.54	0.65	0.60	0.40	0.35	0.34	0.34	0.79	0.77	0.34	0.34	0.50	0.50
		90th P	4.96	4.96	1.95	1.90	1.10	1.05	0.66	0.66	3.37	3.26	0.66	0.66	2.79	2.70
COBALT DISSOLVED	*µg/L*	*n*	*8*	*8*	*7*	*8*	*5*	*6*	*6*	*6*	*20*	*22*	*6*	*6*	*26*	*28*
POR1: Aug 2006 - May 2014		*max*	*0.293*	*0.293*	*0.228*	*0.228*	*0.275*	*0.275*	*2.200*	*2.200*	*0.293*	*0.293*	*2.200*	*2.200*	*2.200*	*2.200*
POR_2: Aug 2006 - Oct 2014		*50th P*	*0.191*	*0.191*	*0.177*	*0.163*	*0.257*	*0.232*	*0.436*	*0.436*	*0.189*	*0.189*	*0.436*	*0.436*	*0.210*	*0.207*
		90th P									*0.275*	*0.274*			*0.501*	*0.478*
COBALT TOTAL	µg/L	n	33	33	30	31	26	27	63	63	89	91	63	63	152	154
POR1: Oct 1988 - May 2014		max	8.96	8.96	2.90	2.90	1.90	1.90	2.71	2.71	8.96	8.96	2.71	2.71	8.96	8.96
POR_2: Oct 1988 - Oct 2014		50th P	1.57	1.57	0.77	0.74	0.66	0.65	0.50	0.50	0.86	0.85	0.50	0.50	0.70	0.70
		90th P	3.26	3.26	2.13	2.06	1.13	1.12	1.30	1.30	2.75	2.72	1.30	1.30	2.20	2.20
COPPER DISSOLVED	*µg/L*	*n*	*8*	*8*	*7*	*8*	*5*	*6*	*6*	*6*	*20*	*22*	*6*	*6*	*26*	*28*
POR1: Aug 2006 - May 2014		*max*	*5.26*	*5.26*	*2.76*	***3.25***	*2.79*	*2.79*	*2.48*	*2.48*	*5.26*	*5.26*	*2.48*	*2.48*	*5.26*	*5.26*
POR_2: Aug 2006 - Oct 2014		*50th P*	*2.85*	*2.85*	*2.15*	*2.17*	*1.93*	*1.90*	*1.66*	*1.66*	*2.29*	*2.29*	*1.66*	*1.66*	*2.04*	*2.04*
		90th P									*3.40*	*3.38*			*3.35*	*3.33*
COPPER TOTAL	µg/L	n	33	33	30	31	26	27	63	63	89	91	63	63	152	154
POR1: Oct 1988 - May 2014		max	23.80	23.80	7.40	7.40	3.90	3.90	5.60	5.60	23.80	23.80	5.60	5.60	23.80	23.80
POR_2: Oct 1988 - Oct 2014		50th P	3.93	3.93	2.74	2.77	2.21	2.14	2.10	2.10	3.00	2.90	2.10	2.10	2.50	2.50
		90th P	9.68	9.68	4.86	4.82	3.29	3.26	3.10	3.10	7.01	6.98	3.10	3.10	5.08	5.08
DISSOLVED OXYGEN	µg/L	n max min														
POR_2: Sep 1990 - Oct 2014		10th P							Under Review							
		50th P 90th P														
IRON DISSOLVED	*µg/L*	*n*	*8*	*8*	*7*	*8*	*5*	*6*	*6*	*6*	*20*	*22*	*6*	*6*	*26*	*28*
POR1: Aug 2006 - May 2014		*max*	*504*	*504*	*795*	*795*	*1350*	*1350*	*1160*	*1160*	*1350*	*1350*	*1160*	*1160*	*1350*	*1350*
POR_2: Aug 2006 - Oct 2014		*50th P*	*335*	*335*	*581*	*554*	*468*	*450*	*692*	*692*	*429*	*415*	*692*	*692*	*484*	*450*

Parameters and Periods of Records (POR)	Units	Thresholds	SEASONAL								OPEN-WATER/ICE-COVERED				ANNUAL	
			POR_1	POR_2	POR_1	POR_2	POR_1	POR_2	POR_1	POR_2	POR_1	POR_2	POR_1	POR_2	POR_1	POR_2
			Spring		Summer		Fall		Winter		Open Water		Ice Covered		Annual	
		90th P									*785*	*764*			*926*	*859*
IRON TOTAL	µg/L	n	26	26	22	23	17	18	36	36	65	67	36	36	101	103
POR1: Apr 1993 - May 2014		max	21500	21500	6250	6250	2790	2790	5610	5610	21500	21500	5610	5610	21500	21500
POR_2: Apr 1993 - Oct 2014		50th P	3570	3570	1635	1580	1500	1455	2080	2080	1790	1780	2080	2080	2010	1980
		90th P	8423	8423	3010	3000	2646	2628	3112	3112	6434	6402	3112	3112	5090	5040
LEAD DISSOLVED	*µg/L*	*n*	*8*	*8*	*7*	*8*	*5*	*6*	*6*	*6*	*20*	*22*	*6*	*6*	*26*	*28*
POR1: Aug 2006 - May 2014		*max*	*0.436*	*0.436*	*0.193*	***0.213***	*0.241*	*0.241*	*0.208*	*0.208*	*0.436*	*0.436*	*0.208*	*0.208*	*0.436*	*0.436*
POR_2: Aug 2006 - Oct 2014		*50th P*	*0.179*	*0.179*	*0.156*	*0.165*	*0.121*	*0.104*	*0.047*	*0.047*	*0.154*	*0.154*	*0.047*	*0.047*	*0.148*	*0.148*
		90th P									*0.281*	*0.272*			*0.254*	*0.245*
LEAD TOTAL	µg/L	n	33	33	30	31	26	27	63	63	89	91	63	63	152	154
POR1: Oct 1988 - May 2014		max	11.20	11.20	4.70	4.70	2.40	2.40	2.70	2.70	11.20	11.20	2.70	2.70	11.20	11.20
POR_2: Oct 1988 - Oct 2014		50th P	1.76	1.76	0.71	0.71	0.59	0.58	0.50	0.50	0.90	0.82	0.50	0.50	0.70	0.70
		90th P	4.38	4.38	3.23	3.16	1.51	1.44	1.30	1.30	3.40	3.38	1.30	1.30	2.57	2.55
LITHIUM DISSOLVED	*µg/L*	*n*	*8*	*8*	*7*	*8*	*5*	*6*	*6*	*6*	*20*	*22*	*6*	*6*	*26*	*28*
POR1: Aug 2006 - May 2014		*max*	*14.70*	*14.70*	*14.60*	*14.60*	*14.00*	***14.50***	*27.40*	*27.40*	*14.70*	*14.70*	*27.40*	*27.40*	*27.40*	*27.40*
POR_2: Aug 2006 - Oct 2014		*50th P*	*8.17*	*8.17*	*13.10*	*13.10*	*13.60*	*13.75*	*20.50*	*20.50*	*12.75*	*12.75*	*20.50*	*20.50*	*13.30*	*13.30*
		90th P									*14.54*	*14.57*			*22.12*	*21.64*
LITHIUM TOTAL	µg/L	n	26	26	22	23	17	18	36	36	65	67	36	36	101	103
POR1: Apr 1993 - May 2014		max	28.60	28.60	21.00	21.00	34.70	34.70	70.40	70.40	34.70	34.70	70.40	70.40	70.40	70.40
POR_2: Apr 1993 - Oct 2014		50th P	12.60	12.60	14.00	13.90	14.20	14.15	24.15	24.15	13.90	13.90	24.15	24.15	15.30	15.30
		90th P	19.98	19.98	17.73	17.64	32.86	32.63	56.11	56.11	23.98	23.24	56.11	56.11	34.52	34.34
MAGNESIUM DISSOLVED/FILTERED	mg/L	n	34	34	31	31	26	27	62	62	91	92	62	62	153	154
POR_1: Oct 1988 - Jul 2014		max	13.20	13.20	14.40	14.40	19.00	19.00	32.60	32.60	19.00	19.00	32.60	32.60	32.60	32.60
POR_2: Oct 1988 - Oct 2014		50th P	8.66	8.66	12.10	12.10	13.45	13.50	21.40	21.40	11.30	11.30	21.40	21.40	13.30	13.30
		90th P	11.90	11.90	13.30	13.30	16.62	17.58	29.25	29.25	14.40	14.54	29.25	29.25	26.00	26.00
MANGANESE DISSOLVED	*µg/L*	*n*	*8*	*8*	*7*	*8*	*5*	*6*	*6*	*6*	*20*	*22*	*6*	*6*	*26*	*28*
POR1: Aug 2006 - July 2014		*max*	*27.20*	*27.20*	*35.20*	*35.20*	*96.80*	*96.80*	*367.00*	*367.00*	*96.80*	*96.80*	*367.00*	*367.00*	*367.00*	*367.00*
POR_2: Aug 2006 - Oct 2014		*50th P*	*16.45*	*16.45*	*5.65*	*4.60*	*11.00*	*15.35*	*241.50*	*241.50*	*10.70*	*10.70*	*241.50*	*241.50*	*16.45*	*16.45*
		90th P									*34.40*	*32.80*			*252.60*	*248.20*
MANGANESE TOTAL	µg/L	n	26	26	22	23	17	18	36	36	65	67	36	36	101	103
POR1: Apr 1993 - May 2014		max	479	479	485	485	118	118	1340	1340	485	485	1340	1340	1340	1340
POR_2: Apr 1993 - Oct 2014		50th P	94	94	79	79	67	64	192	192	78	78	192	192	97	95
		90th P	198	198	132	131	116	115	666	666	169	168	666	666	296	295
MERCURY DISSOLVED	ng/L	Under Development														
MERCURY TOTAL	ng/L	Under Development														

Parameters and Periods of Records (POR)	Units	Thresholds	SEASONAL								OPEN-WATER/ICE-COVERED				ANNUAL	
			POR_1	POR_2	POR_1	POR_2	POR_1	POR_2	POR_1	POR_2	POR_1	POR_2	POR_1	POR_2	POR_1	POR_2
			Spring		Summer		Fall		Winter		Open Water		Ice Covered		Annual	
MOLYBDENUM DISSOLVED	*µg/L*	*n*	*8*	*8*	*7*	*8*	*5*	*6*	*6*	*6*	*20*	*22*	*6*	*6*	*26*	*28*
POR1: Aug 2006 - May 2014		*max*	*0.986*	*0.986*	*0.968*	*0.968*	*1.240*	*1.240*	*1.020*	*1.020*	*1.240*	*1.240*	*1.020*	*1.020*	*1.240*	*1.240*
POR_2: Aug 2006 - Oct 2014		*50th P*	*0.744*	*0.744*	*0.771*	*0.792*	*0.727*	*0.749*	*0.795*	*0.795*	*0.744*	*0.763*	*0.795*	*0.795*	*0.763*	*0.768*
		90th P									*0.984*	*1.073*			*0.996*	*1.029*
MOLYBDENUM TOTAL	µg/L	n	26	26	22	23	17	18	36	36	65	67	36	36	101	103
POR1: Apr 1993 - May 2014		max	1.100	1.100	1.890	1.890	1.600	1.600	1.200	1.200	1.890	1.890	1.200	1.200	1.890	1.890
POR_2: Apr 1993 - Oct 2014		50th P	0.769	0.769	0.876	0.872	0.700	0.710	0.622	0.622	0.756	0.781	0.622	0.622	0.749	0.751
		90th P	1.030	1.030	1.270	1.260	1.600	1.600	1.051	1.051	1.216	1.208	1.051	1.051	1.182	1.164
NICKEL DISSOLVED	*µg/L*	*n*	*8*	*8*	*7*	*8*	*5*	*6*	*6*	*6*	*20*	*22*	*6*	*6*	*26*	*28*
POR1: Aug 2006 - May 2014		*max*	*3.84*	*3.84*	*3.69*	*3.69*	*3.20*	*3.20*	*7.78*	*7.78*	*3.84*	*3.84*	*7.78*	*7.78*	*7.78*	*7.78*
POR_2: Aug 2006 - Oct 2014		*50th P*	*3.02*	*3.02*	*3.08*	*2.94*	*2.72*	*2.70*	*3.55*	*3.55*	*2.85*	*2.80*	*3.55*	*3.55*	*3.17*	*3.11*
		90th P									*3.76*	*3.75*			*3.80*	*3.79*
NICKEL TOTAL	µg/L	n	33	33	30	31	26	27	63	63	89	91	63	63	152	154
POR_1: Oct 1988 - May 2014		max	26.90	26.90	12.40	12.40	6.80	6.80	9.22	9.22	26.90	26.90	9.22	9.22	26.90	26.90
POR_2: Oct 1988 - Oct 2014		50th P	5.50	5.50	4.12	4.09	3.41	3.33	3.50	3.50	4.19	4.15	3.50	3.50	3.90	3.90
		90th P	11.56	11.56	8.08	8.06	5.13	5.12	5.36	5.36	9.19	9.03	5.36	5.36	7.72	7.60
NITRATE/NITRITE	mg/L	n	10	10	8	10	5	5	7	7	23	25	7	7	30	32
POR_1: Jun 2005 - May 2014		max	0.310	0.310	1.355	1.355	0.210	0.210	1.730	1.730	1.355	1.355	1.730	1.730	1.730	1.730
POR_2: Jun 2005 - Oct 2014		50th P	0.035	0.035	0.025	0.065	0.100	0.100	0.560	0.560	0.050	0.060	0.560	0.560	0.090	0.095
		90th P	0.300	0.300		1.264					0.388	0.362			0.587	0.581
NITROGEN DISSOLVED	mg/L	n	33	33	30	32	27	27	62	62	90	92	62	62	152	154
POR1: Oct 1988 - May 2014		max	1.060	1.060	1.160	1.160	1.260	1.260	3.470	3.470	1.260	1.260	3.470	3.470	3.470	3.470
POR_2: Oct 1988 - Oct 2014		50th P	0.598	0.598	0.594	0.628	0.727	0.727	0.924	0.924	0.617	0.620	0.924	0.924	0.718	0.720
		90th P	0.958	0.958	0.962	0.953	1.184	1.184	1.498	1.498	1.009	1.006	1.498	1.498	1.267	1.265
pH	pH units	n		34		30		27		62		91		62		153
		max		8.19		8.19		8.30		8.16		8.30		8.16		8.30
POR_2: Oct 1988 - Oct 2014		min		7.38		6.98		7.25		6.91		6.98		6.91		6.91
		10th P		7.38		6.98		7.25		6.91		6.98		6.91		6.95
		50th P		7.63		7.89		7.98		7.46		7.81		7.46		7.65
		90th P		7.95		8.13		8.16		7.79		8.12		7.79		8.06
PHOSPHOROUS TOTAL	mg/L	n	34	34	30	32	27	27	62	62	91	93	62	62	153	155
POR1: Oct 1988 - May 2014		max	0.720	0.720	0.320	0.320	0.180	0.180	0.392	0.392	0.720	0.720	0.392	0.392	0.720	0.720
POR_2: Oct 1988 - Oct 2014		50th P	0.166	0.166	0.108	0.105	0.080	0.080	0.054	0.054	0.107	0.106	0.054	0.054	0.080	0.080
		90th P	0.393	0.393	0.244	0.241	0.153	0.153	0.113	0.113	0.256	0.254	0.113	0.113	0.228	0.228
PHOSPHOROUS TOTAL DISSOLVED	mg/L	n	34	34	30	32	27	27	62	62	91	93	62	62	153	155
POR1: Oct 1988 - May 2014		max	0.447	0.447	0.072	0.072	0.097	0.097	0.255	0.255	0.447	0.447	0.255	0.255	0.447	0.447
POR_2: Oct 1988 - Oct 2014		50th P	0.025	0.025	0.024	0.022	0.026	0.026	0.027	0.027	0.025	0.024	0.027	0.027	0.026	0.026
		90th P	0.047	0.047	0.052	0.051	0.090	0.090	0.049	0.049	0.050	0.050	0.049	0.049	0.049	0.049
POTASSIUM DISSOLVED/FILTERED	mg/L	n	34	34	31	31	26	27	62	62	91	92	62	62	153	154
POR_1: Oct 1988 - Jul 2014		max	3.40	3.40	2.97	2.97	2.79	2.79	4.79	4.79	3.40	3.40	4.79	4.79	4.79	4.79
POR_2: Oct 1988 - Oct 2014		50th P	2.04	2.04	1.74	1.74	1.79	1.80	2.42	2.42	1.90	1.91	2.42	2.42	2.03	2.03

Parameters and Periods of Records (POR)	Units	Thresholds	SEASONAL								OPEN-WATER/ICE-COVERED				ANNUAL	
			POR_1	POR_2	POR_1	POR_2	POR_1	POR_2	POR_1	POR_2	POR_1	POR_2	POR_1	POR_2	POR_1	POR_2
			Spring		Summer		Fall		Winter		Open Water		Ice Covered		Annual	
		90th P	2.68	2.68	2.70	2.70	2.55	2.53	3.12	3.12	2.67	2.66	3.12	3.12	2.87	2.87
SELENIUM DISSOLVED	*µg/L*	*n*	*8*	*8*	*7*	*8*	*5*	*6*	*6*	*6*	*20*	*22*	*6*	*6*	*26*	*28*
POR_1: May 2006 - May 2014		*max*	*0.330*	*0.330*	*0.390*	*0.390*	*0.210*	*0.210*	*0.500*	*0.500*	*0.390*	*0.390*	*0.500*	*0.500*	*0.500*	*0.500*
POR_2: May 2006 - Oct 2014		*50th P*	*0.200*	*0.200*	*0.220*	*0.225*	*0.210*	*0.210*	*0.195*	*0.195*	*0.210*	*0.210*	*0.195*	*0.195*	*0.210*	*0.210*
		90th P									*0.322*	*0.306*			*0.369*	*0.363*
SELENIUM TOTAL	µg/L	n	13	13	12	13	6	7	11	11	31	33	11	11	42	44
POR_1: Apr 2003 - Jul 2014		max	0.510	0.510	0.290	0.290	0.300	0.300	0.500	0.500	0.510	0.510	0.500	0.500	0.510	0.510
POR_2: Apr 2003 - Oct 2014		50th P	0.250	0.250	0.250	0.250	0.235	0.230	0.210	0.210	0.250	0.250	0.210	0.210	0.240	0.240
		90th P	0.482	0.482	0.287	0.286			0.476	0.476	0.372	0.354	0.476	0.476	0.387	0.385
SILVER DISSOLVED	*µg/L*	*n*	*8*	*8*	*7*	*8*	*5*	*6*	*6*	*6*	*20*	*22*	*6*	*6*	*26*	*28*
POR_1: Aug 2006 - May 2014		*max*	*0.0080*	*0.0080*	*0.0090*	*0.0090*	*0.0040*	*0.0040*	*0.0470*	*0.0470*	*0.0090*	*0.0090*	*0.0470*	*0.0470*	*0.0470*	*0.0470*
POR_2: Aug 2006 - Oct 2014		*50th P*	*0.0060*	*0.0055*	*0.0050*	*0.0045*	*0.0030*	*0.0030*	*0.0030*	*0.0030*	*0.0040*	*0.0040*	*0.0030*	*0.0030*	*0.0040*	*0.0035*
		90th P									*0.0080*	*0.0074*			*0.0080*	*0.0081*
SILVER TOTAL	µg/L	n	13	13	12	13	6	7	11	11	31	33	11	11	42	44
POR_1: Apr 2003 - May 2014		max	0.183	0.183	0.029	0.029	0.012	0.012	0.057	0.057	0.183	0.183	0.057	0.057	0.183	0.183
POR_2: Apr 2003 - Oct 2014		50th P	0.040	0.040	0.015	0.012	0.007	0.007	0.007	0.007	0.017	0.017	0.007	0.007	0.013	0.012
		90th P	0.144	0.144	0.029	0.029			0.049	0.049	0.070	0.069	0.049	0.049	0.066	0.064
SODIUM DISSOLVED/FILTERED	mg/L	n	34	34	31	31	26	27	62	62	91	92	62	62	153	154
POR_1: Oct 1988 - Jul 2014		max	17.80	17.80	17.20	17.20	18.60	18.60	35.10	35.10	18.60	18.60	35.10	35.10	35.10	35.10
POR_2: Oct 1988 - Oct 2014		50th P	10.30	10.30	12.80	12.80	14.15	14.20	21.45	21.45	12.50	12.50	21.45	21.45	14.80	14.80
		90th P	13.85	13.85	14.96	14.96	17.33	17.38	32.65	32.65	15.86	15.97	32.65	32.65	27.62	27.50
SPECIFIC CONDUCTANCE (LAB)	µS/cm	n	33	33	30	32	27	28	62	62	90	93	62	62	152	155
POR1: Oct 1988 - May 2014		max	367	367	398	398	513	513	860	860	513	513	860	860	860	860
POR_2: Oct 1988 - Oct 2014		50th P	264	264	339	341	376	380	584	584	322	322	584	584	368	369
		90th P	356	356	395	396	452	449	793	793	401	405	793	793	693	690
STRONTIUM DISSOLVED	*µg/L*	*n*	*8*	*8*	*7*	*8*	*5*	*6*	*6*	*6*	*20*	*22*	*6*	*6*	*26*	*28*
POR1: Aug 2006 - May 2014		*max*	*135*	*135*	*157*	*157*	*149*	***157***	*272*	*272*	*157*	*157*	*272*	*272*	*272*	*272*
POR_2: Aug 2006 - Oct 2014		*50th P*	*83*	*83*	*139*	*139*	*138*	*141*	*244*	*244*	*135*	*135*	*244*	*244*	*138*	*138*
		90th P									*148*	*155*			*265*	*264*
STRONTIUM TOTAL	µg/L	n	26	26	22	23	17	18	36	36	65	67	36	36	101	103
POR_1: Apr 1993 - May 2014		max	138	138	162	162	190	190	346	346	190	190	346	346	346	346
POR_2: Apr 1993 - Oct 2014		50th P	100	100	133	134	140	141	224	224	126	126	224	224	138	138
		90th P	132	132	161	161	186	186	305	305	156	156	305	305	256	255
SULPHATE DISSOLVED	mg/L	n	34	34	31	31	26	27	62	62	91	92	62	62	153	154
POR_1: Oct 1988 - Jul 2014		max	93.0	93.0	104.0	104.0	102.0	102.0	151.0	151.0	104.0	104.0	151.0	151.0	151.0	151.0
POR_2: Oct 1988 - Oct 2014		50th P	58.5	58.5	62.6	62.6	61.1	61.6	105.0	105.0	61.0	61.1	105.0	105.0	73.4	73.5
		90th P	87.2	87.2	83.9	83.9	91.5	91.4	141.4	141.4	88.4	88.4	141.4	141.4	119.8	119.5
THALLIUM DISSOLVED	*µg/L*	*n*	*8*	*8*	*7*	*8*	*5*	*6*	*6*	*6*	*20*	*22*	*6*	*6*	*26*	*28*
POR_1: Aug 2006 - May 2014		*max*	*0.010*	*0.010*	*0.021*	*0.021*	*0.011*	*0.011*	*0.011*	*0.011*	*0.021*	*0.021*	*0.011*	*0.011*	*0.021*	*0.021*
POR_2: Aug 2006 - Oct 2014		*50th P*	*0.008*	*0.008*	*0.011*	*0.011*	*0.008*	*0.008*	*0.007*	*0.007*	*0.008*	*0.008*	*0.007*	*0.007*	*0.008*	*0.008*
		90th P									*0.017*	*0.016*			*0.014*	*0.013*

Parameters and Periods of Records (POR)	Units	Thresholds	SEASONAL								OPEN-WATER/ICE-COVERED				ANNUAL	
			POR_1	POR_2	POR_1	POR_2	POR_1	POR_2	POR_1	POR_2	POR_1	POR_2	POR_1	POR_2	POR_1	POR_2
			Spring		Summer		Fall		Winter		Open Water		Ice Covered		Annual	
THALLIUM TOTAL	µg/L	n	14	14	13	14	7	8	12	12	34	36	12	12	46	48
POR_1: Apr 2002 - May 2014		max	0.205	0.205	0.038	0.038	0.016	0.016	0.052	0.052	0.205	0.205	0.052	0.052	0.205	0.205
POR_2: Apr 2002 - Oct 2014		50th P	0.043	0.043	0.021	0.021	0.014	0.012	0.010	0.010	0.023	0.022	0.010	0.010	0.017	0.017
		90th P	0.149	0.149	0.036	0.036			0.042	0.042	0.073	0.072	0.042	0.042	0.066	0.064
TOTAL DISSOLVED SOLIDS	mg/L	n	26	26	22	24	18	18	36	36	66	68	36	36	102	104
POR_1: Apr 1993 - May 2014		max	288	288	308	**708**	386	386	2700	2700	386	**708**	2700	2700	2700	2700
POR_2: Apr 1993 - Oct 2014		50th P	206	206	255	261	277	277	414	414	249	251	414	414	267	269
		90th P	276	276	295	304	344	344	549	549	302	310	549	549	481	486
TOTAL SUSPENDED SOLIDS	mg/L	n	34	34	30	32	27	27	63	63	91	93	63	63	154	156
POR_1: Oct 1988 - May 2014		max	774	774	222	222	77	77	160	160	774	774	160	160	774	774
POR_2: Oct 1988 - Oct 2014		50th P	95	95	37	37	19	19	6	6	41	41	6	6	12	12
		90th P	285	285	148	139	51	51	12	12	218	216	12	12	148	146
TURBIDITY (LAB)	NTU	n	34	34	30	32	27	27	63	63	91	93	63	63	154	156
POR1: Oct 1988 - May 2014		max	590	590	210	210	68	68	119	119	590	590	119	119	590	590
POR_2: Oct 1988 - Oct 2014		50th P	71	71	29	27	20	20	13	13	33	33	13	13	18	18
		90th P	230	230	97	95	47	47	21	21	149	148	21	21	117	116
URANIUM DISSOLVED	*µg/L*	*n*	*8*	*8*	*7*	*8*	*5*	*6*	*6*	*6*	*20*	*22*	*6*	*6*	*26*	*28*
POR_1: Aug 2006 - May 2014		*max*	*0.606*	*0.606*	*0.696*	*0.696*	*0.922*	***0.958***	*2.000*	*2.000*	*0.922*	***0.958***	*2.000*	*2.000*	*2.000*	*2.000*
POR_2: Aug 2006 - Oct 2014		*50th P*	*0.307*	*0.307*	*0.509*	*0.510*	*0.602*	*0.625*	*1.345*	*1.345*	*0.480*	*0.500*	*1.345*	*1.345*	*0.536*	*0.571*
		90th P									*0.691*	*0.854*			*1.472*	*1.424*
URANIUM TOTAL	µg/L	n	13	13	12	13	6	7	11	11	31	33	11	11	42	44
POR1: Apr 2003 - May 2014		max	1.820	1.820	0.983	0.983	0.994	0.994	2.140	2.140	1.820	1.820	2.140	2.140	2.140	2.140
POR_2: Apr 2003 - Oct 2014		50th P	0.617	0.617	0.594	0.601	0.654	0.663	1.260	1.260	0.602	0.617	1.260	1.260	0.645	0.654
		90th P	1.454	1.454	0.912	0.888			2.040	2.040	0.976	0.975	2.040	2.040	1.494	1.450
VANADIUM DISSOLVED	*µg/L*	*n*	*8*	*8*	*7*	*8*	*5*	*6*	*6*	*6*	*20*	*22*	*6*	*6*	*26*	*28*
POR1: Aug 2006 - May 2014		*max*	*0.442*	*0.442*	*0.530*	*0.530*	*0.687*	*0.687*	*0.231*	*0.231*	*0.687*	*0.687*	*0.231*	*0.231*	*0.687*	*0.687*
POR_2: Aug 2006 - Oct 2014		*50th P*	*0.418*	*0.418*	*0.487*	*0.482*	*0.352*	*0.336*	*0.189*	*0.189*	*0.439*	*0.434*	*0.189*	*0.189*	*0.418*	*0.418*
		90th P									*0.552*	*0.547*			*0.537*	*0.532*
VANADIUM TOTAL	µg/L	n	33	33	30	31	26	27	63	63	89	91	63	63	152	154
POR_1: Oct 1988 - May 2014		max	23.30	23.30	7.80	7.80	3.40	3.40	4.73	4.73	23.30	23.30	4.73	4.73	23.30	23.30
POR_2: Oct 1988 - Oct 2014		50th P	2.90	2.90	1.48	1.47	1.09	1.08	0.50	0.50	1.60	1.60	0.50	0.50	0.95	0.95
		90th P	9.64	9.64	3.55	3.50	2.12	2.08	0.86	0.86	6.32	6.24	0.86	0.86	4.01	3.95
ZINC DISSOLVED	*µg/L*	*n*	*8*	*8*	*7*	*8*	*5*	*6*	*6*	*6*	*20*	*22*	*6*	*6*	*26*	*28*
POR_1: Aug 2006 - May 2014		*max*	*1.98*	*1.98*	*1.41*	*1.41*	*1.54*	*1.54*	*14.40*	*14.40*	*1.98*	*1.98*	*14.40*	*14.40*	*14.40*	*14.40*
POR_2: Aug 2006 - Oct 2014		*50th P*	*1.25*	*1.25*	*1.21*	*1.23*	*0.90*	*0.80*	*9.65*	*9.65*	*1.19*	*1.19*	*9.65*	*9.65*	*1.28*	*1.28*
		90th P									*1.64*	*1.62*			*12.03*	*11.81*
ZINC TOTAL	µg/L	n	33	33	30	31	26	27	63	63	89	91	63	63	152	154
POR_1: Oct 1988 - May 2014		max	90.8	90.8	22.2	22.2	9.3	9.3	40.9	40.9	90.8	90.8	40.9	40.9	90.8	90.8
POR_2: Oct 1988 - Oct 2014		50th P	13.7	13.7	5.6	5.6	4.1	4.0	4.9	4.9	6.3	6.3	4.9	4.9	5.6	5.6
		90th P	32.9	32.9	12.1	12.1	7.4	7.3	17.0	17.0	22.5	22.4	17.0	17.0	21.7	21.5

Notes:

1. 50th P (Trigger 1; typical conditions).
2. 90th P (Trigger 1; extreme conditions).
3. POR: Period of Record.
4. Spring: May and June; Summer: July and August; Fall: September and October; Winter: November through April.
5. Open-Water: Spring, Summer and Fall; Ice-Covered: Winter.
6. Italicized values represent preliminary interim water quality triggers (where n<30). Interim water quality triggers will be calculated when n>30.
7. Although all interim triggers (4-season, 2-season and annual) are included in this table, only if n>30 for all seasons (e.g., Spring, Summer, Fall and Winter) will the interim triggers be used otherwise the interim triggers in the next season classification (e.g., Open-Water and Ice-Covered, or Annual) will be used.
8. Total Bismuth is under review. Discussions are required with ECCC to discuss Hay River monitoring program/results for total bismuth.

Appendix 4. 2018 & 2019 Trigger Assessment Summary

Table 4-1. Slave River 2018 & 2019 Trigger 1 Assessment Summary

Parameter	Trigger 1	Number of 2018 Values higher than Trigger 1 (out of 9)	Number of 2019 Values higher than Trigger 1 (out of 9)
Alkalinity (mg/L)	84.2	5	9
Specific Conductance (us/cm)	211	9	9
Turbidity (NTU)	54.85	6	0
Total Dissolved Solids (mg/L)	133	7	0
Total Suspended Solids (mg/L)	76	5	0
Dissolved Calcium (mg/L)	28.3	8	9
Dissolved Magnesium (mg/L)	6.575	8	9
Dissolved Potassium (mg/L)	0.905	6	7
Dissolved Sodium (mg/L)	6.19	5	7
Dissolved Sulphate (mg/L)	18	8	9
Dissolved Organic Carbon (mg/L)	5.575	6	5
Particulate Organic Carbon (mg/L)	1.85	7	5
Nitrate/Nitrite (mg/L)	0.08	7	9
Dissolved Nitrogen (mg/L)	0.224	5	8
Total Phosphorus (mg/L)	0.087	7	0
Dissolved Aluminum (µg/L)	25.3	6	0
Total Aluminum (µg/L)	859	5	0
Dissolved Arsenic (µg/L)	0.410	0	5
Total Arsenic (µg/L)	1.09	6	0
Dissolved Barium (µg/L)	46.4	6	6
Total Barium (µg/L)	80	5	0
Total Beryllium (µg/L)	0.064	5	0
Total Bismuth (µg/L)	0.017	5	0

Parameter	Trigger 1	Number of 2018 Values higher than Trigger 1 (out of 9)	Number of 2019 Values higher than Trigger 1 (out of 9)
Dissolved Boron (µg/L)	13.8	5	0
Total Boron (µg/L)	14.1	6	5
Total Chromium (µg/L)	1.405	5	0
Dissolved Cobalt (µg/L)	0.055	5	0
Total Cobalt (µg/L)	1	5	0
Total Copper (µg/L)	3.85	5	0
Total Iron (µg/L)	1990	6	0
Total Lead (µg/L)	1.6	5	0
Dissolved Lithium (µg/L)	3.98	6	6
Total Lithium (µg/L)	6.08	6	5
Dissolved Manganese (µg/L)	2.53	5	0
Total Manganese (µg/L)	57.6	6	0
Dissolved Molybdenum (µg/L)	0.746	0	5
Total Molybdenum (µg/L)	0.629	0	5
Dissolved Nickel (µg/L)	1.21	5	5
Total Nickel (µg/L)	3.38	6	0
Dissolved Selenium (µg/L)	0.21	7	7
Total Selenium (µg/L)	0.23	6	5
Dissolved Strontium (µg/L)	134	5	8
Total Strontium (µg/L)	140	8	7
Dissolved Thallium (µg/L)	0.007	5	0
Total Thallium (µg/L)	0.028	5	0
Dissolved Uranium (µg/L)	0.408	8	7
Total Uranium (µg/L)	0.492	7	6
Total Vanadium (µg/L)	2.4	5	0
Total Zinc (µg/L)	11	5	0

Table 4-2. Hay River 2018 & 2019 Trigger 1 Assessment Summary

Parameter	Trigger 1	Number of 2018 Values higher than Trigger 1 (out of 3)	Number of 2019 Values higher than Trigger 1 (out of 4)
Alkalinity (mg/L)	117	1	1
Total Aluminum (µg/L)	196	2	1
Dissolved Ammonia (mg/L)	0.021	1	1
Total Antimony (µg/L)	0.108	3	1
Total Barium (µg/L)	66.8	2	0
Total Beryllium (µg/L)	0.05	2	0
Total Boron (µg/L)	32.6	1	1
Total Cadmium (µg/L)	0.173	1	0
Dissolved Calcium (mg/L)	45.9	1	1
Dissolved Organic Carbon (mg/L)	26.2	1	2
Particulate Organic Carbon (mg/L)	1.16	2	2
Dissolved Chloride (mg/L)	4.24	1	1
Total Chromium (µg/L)	0.5	2	0
Total Cobalt (µg/L)	0.7	2	0
Total Copper (µg/L)	2.5	2	1
Total Iron (µg/L)	1980	2	0
Total Lead (µg/L)	0.7	2	0
Total Lithium (µg/L)	15.3	0	1
Dissolved Magnesium (mg/L)	13.3	1	1
Total Manganese (µg/L)	94.6	2	1
Total Molybdenum (µg/L)	0.751	2	3
Total Nickel (µg/L)	3.9	2	1
Nitrate/Nitrite (mg/L)	0.095	3	4
Nitrogen Dissolved (mg/L)	0.72	2	2
Total Phosphorous (mg/L)	0.08	2	0

Parameter	Trigger 1	Number of 2018 Values higher than Trigger 1 (out of 3)	Number of 2019 Values higher than Trigger 1 (out of 4)
Total Dissolved Phosphorous (mg/L)	0.026	0	0
Dissolved Potassium (mg/L)	2.03	1	2
Total Dissolved Solids (mg/L)	269	1	1
Total Suspended Solids (mg/L)	12	2	0
Total Selenium (µg/L)	0.24	3	1
Total Silver (µg/L)	0.012	2	0
Dissolved Sodium (mg/L)	14.8	1	1
Specific Conductance (us/cm)	369	1	1
Total Strontium (µg/L)	138	1	1
Dissolved Sulphate (mg/L)	73.45	1	1
Total Thallium (µg/L)	0.017	2	0
Turbidity (NTU)	17.95	2	1
Total Uranium (µg/L)	0.654	2	2
Total Vanadium (µg/L)	0.952	2	1
Total Zinc (µg/L)	5.59	2	0