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Mrs. Tyree Mullaney
Mackenzie Valley Land and Water Board
P.O. Box 2130
4922- 48th Street
7th Floor YK Centre Mall
Yellowknife, NT
X1A 2P6

Re: Application for 2025 mercury testing at Bluefish Hydroelectric plant.

Hello Mrs Mullaney,

The Northwest Territories Power Corporation (NTPC) owns and operates the Bluefish Hydroelectric Facility, Yellowknife River, approximately 26 km northwest of Yellowknife, NT. Bluefish Hydroelectric includes two hydroelectric generation plants, which provide power to the North Slave electrical grid, in conjunction with the power generated by the other components of the north slave electrical grid; Snare Hydroelectric Facility and the Jackfish Lake Generating Station.

NTPC holds a Type A Water Licence (MV2020L4-0005) from the Mackenzie Valley Land and Water Board (MVLWB), which authorizes the storage and diversion of water under normal operations of the facility.

In 2022, NTPC completed a *Mercury Monitoring Study* as per *Part G, Condition 2* of the Water Licence. NTPC submitted the results - *Mercury Monitoring Study Report*[1] - to the MVLWB in April of 2023.

The results of the 2022 Mercury Monitoring Study Report indicate that there was slight increase in mercury concentration within the inundated area between 2018 to 2022. The results also suggest an overall downward trend in mercury levels between monitoring efforts in 2014 and 2022, respectively. The report also recommended NTPC continue monitoring efforts in 2025. This aligns with *Part G, Condition 3 of the water licence.*

<u>Part G, Condition 3 of Type A Water Licence MV2020L4-0005 states:</u>

Every three years following implementation of the MMS Design Plan, or as directed by the

[1] Mercury Monitoring Report Citation

Board, the Licensee shall submit to the Board, for approval, a revised MMS Design Plan.

As per Part G, Condition 3 of the Water Licence, NTPC is required to submit to the Board, for approval, a *revised Mercury Monitoring Design Plan* three years following the implementation of the MMS Design Plan. As such, NTPC has reviewed updated the *Mercury Monitoring Study Design Plan* to incorporate recommendations from the 2022 MMS Report. If approved by the Board, the *revised Mercury Monitoring Design Plan* will be implemented by NTPC during the 2025 open water season. NTPC is including the attached document(s) for Board approval:

Bluefish Hydroelectric Facility – Mercury Monitoring Design Plan. V3

NTPC is requesting approval of the attached '*Mercury Monitoring Study Design Plan. V3',* as per Part G, Condition 3 of the Water Licence. Changes to the MMS Design Plan are summarized in the document's revision table. The revised study design plan includes the following changes that have been adapted from the original methodology:

- Removal of the condition to remove the otolith bone to be removed from Slimy Sculpin for aging purposes. The Mercury study report submitted in 2023 showed that using the otolith bone for aging, produced results that did not correlate to past results in Slimy Sculpin. However, using the length measurement for aging purposes did have a high correlation for Slimy Sculpin.

NTPC is requesting clearance from the MVLWB to conduct mercury testing during the 2025 open water season as per MMS Design Plan.V3.

Please inform NTPC any thoughts or concerns from this request or if there is any additional information or actions required.

Thanks for your time,

Sincerely,

Richard Johnstone

Richard Johnstone (BSc. Hon)
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NORTHWEST TERRITORIES POWER CORPORATION
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MERCURY MONITORING STUDY DESIGN PLAN

BLUEFISH HYDROELECTRIC FACILITY

BLUEFISH LAKE, NORTHWEST TERRITORIES

Water Licence MV2024L4-0005
Version 1

DOCUMENT REVISION HISTORY

Version #	Issue Date	Revised Section(s)	Description of Revision
1	October 2021	-	First version
2	December 2021	See Appendix A, Table A-1	Revised to incorporate recommendations from Public Review
3	March 2022	See Appendix A, Table A-2	Revised to incorporate recommendations from Public Review
4	November 2024		Revised to include testing results from 2022

CONFORMITY TABLE

Water Licence Schedule 3 Item 1	Requirement	Applicable Section of the Mercury Monitoring Study Design Plan
a	A plain language summary	Section 1.1
b	Study objectives	Section 3.1
c	Site characterization including, but not limited to, a description of the aquatic environment of Bluefish Lake where previous mercury monitoring studies related to the Bluefish Dam construction have been completed, a summary of all mercury data obtained during previous mercury monitoring studies related to the Bluefish Dam construction, and any other information deemed relevant	Section 2
d	Field and laboratory methods including, but not limited to, sampling locations, timing, frequency, sample sizes, and parameters	Sections 4.1 to 4.7
e	Data analysis methods including, but not limited to, evaluation of mercury levels and trends over time and comparison to relevant guidelines	Section 4.8 to 4.9
f	Quality assurance/quality control	Section 5
g	A Response Framework including low, moderate, and high Action Levels as well as response actions to be taken if Action Levels are exceeded	Section 6

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1 INTRODUCTION

1.1 PLAIN LANGUAGE SUMMARY

This document is the Bluefish Hydroelectric Facility (Bluefish Facility) Mercury Monitoring Study Design Plan (MMS Design Plan) that outlines the process planned to continue monitoring mercury levels in fish in Bluefish Lake. The construction of a new impoundment dam at the Bluefish Facility in 2012 resulted in flooding a small section of the Yellowknife River. Concerns were raised that flooding could result in methyl-mercury production, which could have consequences for resident fish in Bluefish Lake. As a result of these concerns the Northwest Territories Power Corporation (NTPC) was required to monitor mercury concentrations by previous water licences MV2009L4-0004 (for construction of the dam) and MV2005L4-0008 (for the operation of the facility). NTPC has been monitoring mercury concentrations in a target indicator species (Slimy Sculpin [*Cottus cognatus*]) and game fish such as Northern Pike (*Esox lucius*) and Lake Trout *(Salvelinus namaycush)* in Bluefish Lake since construction of the dam as required by these water licences.

Water Licence MV2020L4-0005 was issued to NTPC on April 3, 2021 and requires that NTPC design and implement an MMS Design Plan (this document). Condition 2 of Part G of MV2020L4-0005 states "Within 6 months of the effective date of this Licence, the Licensee shall submit to the Board, for approval, a MMS Design Plan. The MMS Design Plan shall be in accordance with the requirements of Schedule 3, condition 1." This MMS Design Plan includes all requirements for reporting to the Mackenzie Valley Land and Water Board (MVLWB). This includes objectives, site characterization, field and laboratory methods, data analysis methods, quality assurance/quality control, and a response framework that determines when to act based on mercury monitoring results. The results of the MMS will be submitted to the MVLWB upon completion of the study and made available for public review, as is required in the Water Licence.

Condition 1 of Schedule 2 of MV2020L4-0005 requires NTPC to complete a workshop to gather stakeholder input on various Water Licence Submissions including the Mercury Monitoring Study Design Plan. NTPC completed stakeholder engagement for the MMS Design Plan throughout September and October 2021 and hosted the *Mercury Monitoring Study Workshop for the Bluefish Hydroelectric Facility* on Wednesday, September 8, 2021 which was attended by 6 stakeholder organizations. While developing this document, NTPC also followed up with stakeholder groups who could not attend the workshop to gather input on the submission. The details of the engagement process which included notification emails, stakeholder workshop and engagement meetings is outlined in detail in the Bluefish Mercury Monitoring Study Design Engagement Log. Feedback from the stakeholder engagement process was directly incorporated into the MSS Study Design.

Appendix A includes a conformity table that summarizes recent updates to the MMS Design Plan that were made to address feedback provided by the public review of the plan, as requested by the MVLWB.

1.2 BACKGROUND

The Northwest Territories Power Corporation operates the Bluefish Facility on the Yellowknife River, between Bluefish Lake and Prosperous Lake. The construction and operation of the impoundment dam for Bluefish Lake was regulated under Fisheries Act Authorization (FAA) 09-HCAA-CA-00079 and Water Licence MV2009L4-0004. Construction of a new primary impoundment dam in 2012 included flooding a section of the Yellowknife River immediately upstream of the new dam, an area now effectively part of Bluefish Lake (Figure 1-1).

Concerns were raised that flooding could result in mercury generation, with consequences to the biota. Flooding of land in the creation of a reservoir, particularly in wetlands in boreal areas, has been associated with increases in methyl-mercury production (e.g., Mitchell et al. 2008). Bioaccumulation of mercury in large-bodied predatory fish tissue has been documented in other northern areas within the Mackenzie River and Great Slave Lake basins (Evans et al. 2005). Pre-development estimates indicated that the new dam would result in the permanent flooding of 3.4 ha of the shoreline and was expected to increase the Bluefish Lake surface area by 2.7% and volume by 2.4% (from the estimated surface area of 298 ha and volume of 20,018,465 m^3 at elevation 167.55 m). However, mercury levels in Bluefish Lake have remained below the national medians reported in the Canadian Fish Mercury Database for Lake Trout and Northern Pike, and are similar to the national median for Slimy Sculpin (Depew et al. 2013). Under Water License MV2009L4-0004, NTPC was required to develop a mercury special effects monitoring study to evaluate effects of the release of methyl-mercury as a result of flooding the area between the existing dam and the new primary impoundment dam.

From the construction of the new primary impoundment dam in 2012 until 2018, NTPC has monitored the mercury concentrations within the inundated area (IA) and ‘control’ (i.e., reference) locations within Bluefish Lake. Total mercury concentrations in Slimy Sculpin (*Cottus cognatus*), Northern Pike (*Esox lucius*), and Lake Trout (*Salvelinus namaycush*) were measured to assess mercury levels and trends. Following the 2018 program, the mercury monitoring program was considered by NTPC to be complete as mercury concentrations had stabilized and/or decreased in Slimy Sculpin, Lake Trout, and Northern Pike, potentially on trajectories returning to pre-construction levels in the IA of Bluefish Lake (as per the Terms of Reference for a Mercury Special Effects Study, Version 6, Golder 2016).

The current operating water licence for Bluefish, MV2020L4-0005 includes conditions pertaining to operations of the facility, including the requirement for further monitoring of mercury in fish. Condition G.1 of the licence states that ‘*The Licensee shall design and implement a Mercury Monitoring Study (MMS).’* The MMS is defined in *Schedule 3: Conditions Applying to Aquatic Effects Monitoring* of MV2020L4-0005. This document is the first stage in fulfilment of Condition G.1, Schedule 3 and all conditions and related to the MMS.

General guidance and lake-specific guidance on the consumption of fish is provided by the GNWT (GNWT-HSS 2021). There is no specific consumption guidance for Bluefish Lake, and NTPC will provide any information required for an updated assessment. NTPC cannot make recommendations regarding the consumption of fish.

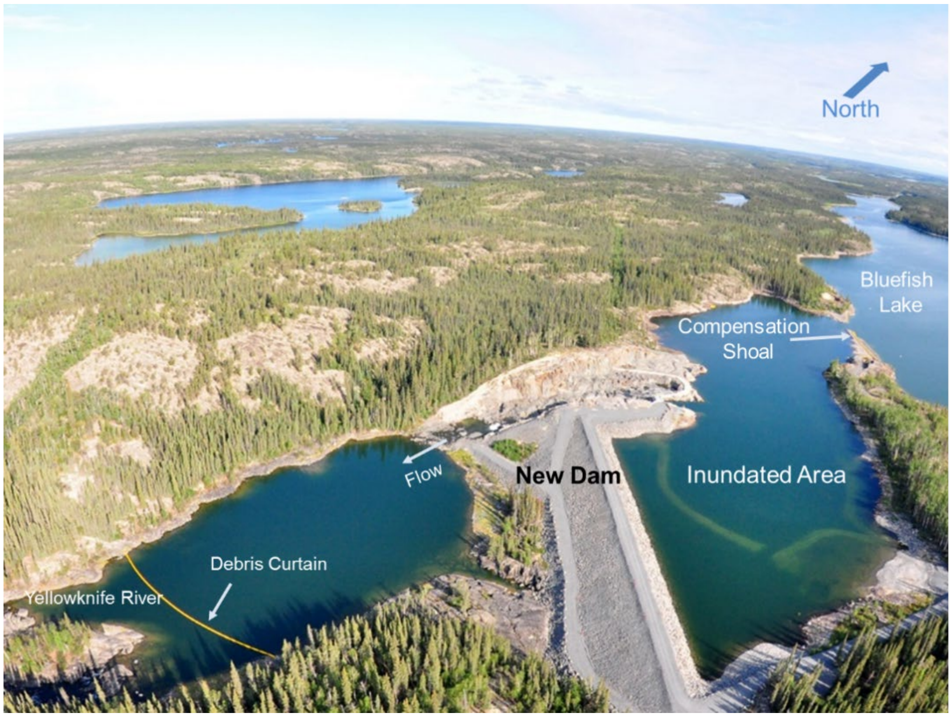


Figure 1-1: Bluefish Lake and the Inundated Area

1.3 PREVIOUS STUDIES

The previously completed documents that report on mercury monitoring at the Bluefish Facility between 2011-2018 and 2022. are summarized in Table 1-1. All of these reports were submitted to the MVLWB and are available on the online registry.

Table 1-1. Previously Completed Mercury Monitoring Reports at the Bluefish Facility

Report Title	Year of Sampling	Fish Species Sampled for Mercury
Fisheries Investigations in Bluefish Lake [a]	2011	Northern Pike, Lake Trout, Lake Whitefish, Walleye
Bluefish Lake Fisheries Studies [b]	2012	Slimy Sculpin, Northern Pike, Lake Trout
Bluefish Lake Hydroelectric Plant 2013 Fisheries and Flow Monitoring Report [c]	2013	Slimy Sculpin
Bluefish Lake Hydroelectric Plant 2014 Fisheries and Flow Monitoring Report [d]	2014	Slimy Sculpin
Bluefish Lake Hydroelectric Plant 2015 Fisheries and Flow Monitoring Report [e]	2015	Slimy Sculpin
Bluefish Lake Hydroelectric Plant 2016 Fisheries and Flow Monitoring Report [f]	2016	Northern Pike, Lake Trout
Bluefish Lake Hydroelectric Plant 2018 Fisheries and Flow Monitoring Report [g]	2018	Slimy Sculpin, Northern Pike
Bluefish Lake Hydroelectric Plant 2022 Fisheries and Flow Monitoring Report [i]	2022	Slimy Sculpin

Sources:
(a) Golder 2012
(b) Golder 2013a
(c) Golder 2014
(d) Golder 2015
(e) Golder 2016a
(f) Golder 2017
(g) Golder 2019
(g) WSP 2022

1.4 RESPONSIBILITY AND ACCOUNTABILITY

NTPC is ultimately responsible for the success of the MMS Design Plan and reviews all relevant documents, action thresholds, and response plans. An NTPC Project Supervisor is responsible for the overall implementation and management of the MMS Design Plan, including reporting.

1.5 APPROVAL

This MMS Design Plan is submitted to the MVLWB in conformity with Water Licence Part G, Condition 2:

> *Within 6 months of the effective date of this Licence, the Licensee shall submit to the Board, for approval, a MMS Design Plan. The MMS Design Plan shall be in accordance with the requirements of Schedule 3, Condition 1.*

A revised version of the MMS Design Plan was submitted to the MVLWB in 2022, in conformity with Water Licence Part G, Condition 3:

Every three years following implementation of the MMS Design Plan, or as directed by the Board, the Licensee shall submit to the Board, for approval, a revised MMS Design Plan.

2 SITE CHARACTERIZATION

2.1 STUDY REGION

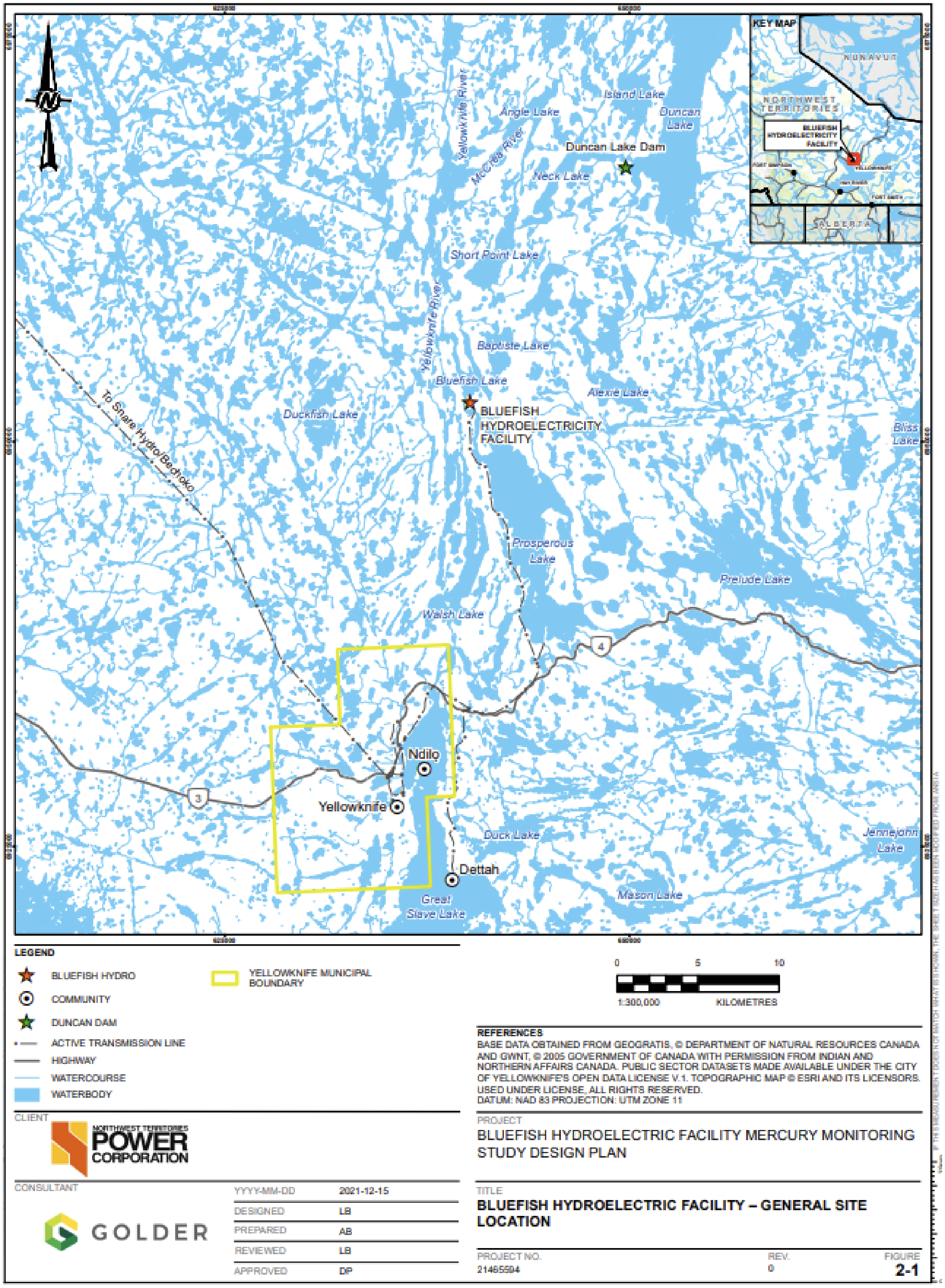
The Yellowknife River drainage basin is in the subarctic Canadian Shield (Taiga Shield Ecozone) north of Yellowknife, Northwest Territories. The Yellowknife River flows south into Yellowknife Bay, part of Great Slave Lake, near Yellowknife. The drainage area of the Yellowknife River at the inlet to Prosperous Lake is estimated to be approximately 11,300 km² (ECCC 2018). The Bluefish Facility is approximately 24 km upstream of Great Slave Lake.

Bluefish Lake receives flow from the Yellowknife River system via Duncan Lake which has a small control structure at the outlet. The majority of storage for the Bluefish Facility is provided by Duncan Lake, which is much larger than Bluefish Lake. Water flows from Duncan Lake, through the McCrea River, Neck Lake, Short Point Lake, Angle Lake, and then Quyta Lake. From Quyta Lake, water flows over a set of rapids before entering Bluefish Lake. A dam was built at the natural rapids outflow of Bluefish Lake in the Yellowknife River in 1942. The Yellowknife River flows through the Bluefish Facility along its historic channel and enters Prosperous Lake through Reach 1, with most flows passing through a 780 m intake tunnel-penstocks to two generation stations on the shore of upper Prosperous Lake; G1 generation station and G2 generation station. The generating stations consist of two generators and their respective outflows. Figure 2-1 provides an overview map of the study region.

2.2 BLUEFISH LAKE

Bluefish Lake has a surface area of 3.06 km². Shoreline substrate is predominantly cobble and boulder while deeper areas have a thick clay/silt layer over rock substrate. Lake habitat varies from shallow silty bays to a maximum of 33 m depth. Fifteen species of fish have been documented in Bluefish Lake: Walleye (*Sander vitreus*), Arctic Grayling (*Thymallus arcticus*), Burbot (*Lota lota*), Northern Pike (*Esox Lucius)*, Lake Chub (*Couesius plumbeus*), Spottail Shiner (*Notropis hudsonius*), Lake Trout, White Sucker (*Catostomus commersonii*), Longnose Sucker (*Catostomus catostomus*), Round Whitefish (*Prosopium cylindraceum*), Cisco (*Coregonus artedi*), Lake Whitefish (*Coregonus clupeaformis*), Ninespine Stickleback (*Pungitius pungitius*), and Slimy Sculpin (*Cottus cognatus*) (Golder 2013). Pygmy Whitefish (*Prosopium coulterii*) was discovered in Bluefish Lake in 2012, which was the first reported occurrence for this species in the Great Slave Lake area (Vecsei and Panayi 2015).

Figure 2-1: General Site Location



Summary of Results of Previous Mercury Monitoring Studies

As per the Water License MV2009L4-0004, several studies were completed to assess mercury concentrations and trends in fish residing in the IA between the former dam and the current dam. Large and small-bodied fish were lethally sampled in Bluefish Lake in 2011 and 2012 to develop a dataset for total mercury concentrations in fish tissue samples from Bluefish Lake prior to flooding.

Total mercury concentrations in Slimy Sculpin tissue were monitored throughout 2012 to 2015 in Bluefish Lake. This initial investigation on Slimy Sculpin showed higher mercury concentrations in Slimy Sculpin occupying the IA in comparison to fish captured in other areas of Bluefish Lake. In response to this, a non-lethal sampling program was conducted in Bluefish Lake in 2016 targeting Northern Pike and Lake Trout to assess mercury concentrations in predatory fish. The 2016 results indicated that there were no increasing trends in mercury concentrations for Lake Trout, but concentrations were elevated in some Northern Pike samples. Therefore, the 2016 study recommended continued monitoring of Northern Pike and Slimy Sculpin in 2018 and 2022 to determine trends in mercury levels in the IA of Bluefish Lake.

In 2018, the follow-up program found that total mercury concentrations for Northern Pike decreased slightly and were not significantly different between 2016 and 2018, suggesting mercury concentrations stabilized in Bluefish Lake between 2016 and 2018. Total mercury concentrations in Slimy Sculpin steadily declined in the IA between 2014 and 2018, which also suggests methyl-mercury concentrations were returning to background conditions in the IA of Bluefish Lake.

In 2022, a follow up study found that there were some increases in mercury from 2018 to 2022. Although there was a relatively minor increase in total mercury concentrations in Slimy Sculpin in 2022 versus 2018, concentrations remain significantly lower than those reported in 2014 and 2015. Length-adjusted mean mercury concentrations also showed a greater increase from 2018 to 2022 in the Control Area than in the Inundated Area, suggesting mercury levels are continuing to fall in the Inundated Area. The increase in observed concentrations in both the Control Area and Inundated Area in 2022 versus 2018 may reflect natural annual variability in mercury

Mercury concentrations were compared to available national guidelines. Mercury concentrations in Northern Pike and Lake Trout were compared to the Canadian Food Inspection Agency (CFIA) guidelines for chemical contaminants in fish of 0.5 mg/kg ww of mercury in fish and fish products for commercial sale (CFIA 2017). Mercury concentrations in Slimy Sculpin were compared to the Canadian Council of Ministers of the Environment (CCME), Canadian Tissue Residue Guidelines for the Protection of Wildlife Consumers of Aquatic Biota, set at 0.033 mg/kg ww (CCME 2001). This is a guideline for methyl-mercury, and therefore, considered a conservative guideline when applied to total mercury concentrations analyzed for Bluefish Lake.

2.2.1 Slimy Sculpin

Slimy Sculpin are a small bottom-feeding fish species and are not a game species consumed by humans. A total of 124 Slimy Sculpin were sampled from Bluefish Lake between 2012 and 2018, with 84 fish sampled from the control area, and 40 from the IA. Sample size in the IA was less than the recommended 15 fish in 2015 and 2018, which may have reduced the power of the study and increased the margin of error; however, the sample size was still within Environmental Effects Monitoring guidelines of 8 samples from the each of the exposure and reference area for tissue analyses (Environment Canada 2012). Slimy Sculpin ranged in length from 27 to 90 mm (Table 2-1). Median mercury levels ranged from 0.014 to 0.028 mg/kg in the control area, and from 0.023 to 0.056 mg/kg in the IA, overlapping the national median of 0.03 mg/kg reported for the Canadian Fish Mercury Database (Depew et al. 2013). Of the 84 samples collected from the control area, mercury concentrations exceeded CCME tissue residue guidelines (i.e., 0.033 mg/kg ww) in 11% of samples collected between 2012 and 2018 (n=9; CCME 2001). Of the 40 samples collected from the IA, mercury concentrations exceeded CCME tissue residue guidelines in 80% of samples collected in 2012 (n=16), 58% of samples collected in 2015 (n=7), and 13% of samples collected in 2018 (n=1, Figure 2-2).

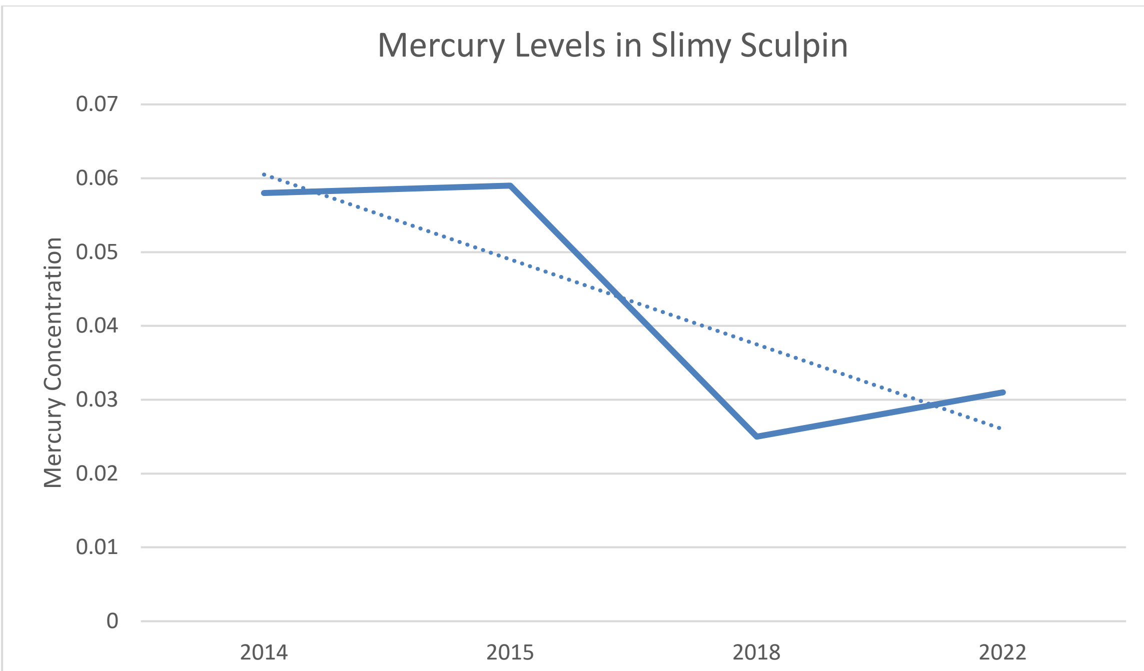
Total mercury concentrations in Slimy Sculpin carcass tissue were significantly different between years (P = 0.042), and sampling areas (P = <0.001). No interaction was observed between year and site (P = 0.125). Total mercury concentrations in the IA were 112% greater when compared to the control area; however, the magnitude of difference varied among years, with mercury concentrations steadily declining in the IA between 2014 and 2018 (Figure 2-3): 121% difference observed in 2014, a 177% difference in 2015, and a 55% difference in 2018. The decline in total mercury concentrations over time in Slimy Sculpin carcass tissue suggests methyl-mercury concentrations are trending to background levels in the IA of Bluefish Lake. ANCOVA LSM (analysis of covariance least squared mean) values were used to generate Figure 2-3, as the concentration values are adjusted by body size to provide a realistic or standardized comparison of different datasets collected throughout the program.

Table 2-1: Descriptive Statistics for Slimy Sculpin Captured from Bluefish Lake, 2012 to 2018 and 2022

Variable	Measurement	Control Area						Inundated Area			
		2012	2013	2014	2015	2018	2022	2014	2015	2018	2022
Total Length	n	45	10	6	12	11	18	20	12	8	19
	Mean	53	51	58	61	57	60	65	65	55	60
	Median	53	49	58	61	58	63	71	64	55	61
	SD	13.8	14.5	2.3	5.6	6.6	10.4	18.6	10.6	12.7	12.7
	SE	2.1	4.6	0.9	1.6	2	2.5	4.2	3.1	4.5	2.9
	Minimum	27	30	55	50	47	39	28	50	39	38
	Maximum	83	68	60	69	65	74	90	85	75	88
Total Mercury (mg/kg ww)	n	45	10	6	12	11	14	20	12	8	15
	Mean	0.026	0.031	0.021	0.016	0.017	0.023	0.058	0.059	0.025	0.031
	Median	0.027	0.028	0.019	0.014	0.016	0.021	0.056	0.053	0.023	0.029

	SD	0.007	0.008	0.006	0.008	0.004	0.006	0.03	0.042	0.01	0.01
	SE	0.001	0.003	0.002	0.002	0.001	0.001	0.007	0.012	0.003	0.003
	Minimum	0.005	0.024	0.015	0.01	0.011	0.016	0.014	0.013	0.015	0.016
	Maximum	0.04	0.049	0.03	0.041	0.023	0.038	0.115	0.151	0.043	0.059
	ANCOVA LSM	N/A	N/A	0.021	0.015	0.017	0.023	0.047	0.041	0.027	0.026

n = sample size; SD = standard deviation; SE = standard error; ww = wet weight; ANCOVA LSM = analysis of covariance least squared mean; N/A = not available.



Source: Canadian Tissue Residue Guidelines for the Protection of Wildlife Consumers of Aquatic Life: Methyl Mercury (CCME 2001)
wwt = wet weight; CCME = Canadian Council of Ministers of the Environment

Figure 2-2*:* **Total Mercury Concentration Against Total Length for Slimy Sculpin Sampled from the Inundated Area of Bluefish Lake, 2014 to 2018**

ww = wet weight; CA = control area; IA = recently inundated area

Figure 2-3: **Total Mercury Concentrations for Slimy Sculpin Carcass Tissue Sampled Between 2014 and 2018 from the Inundated Area and Control Area**

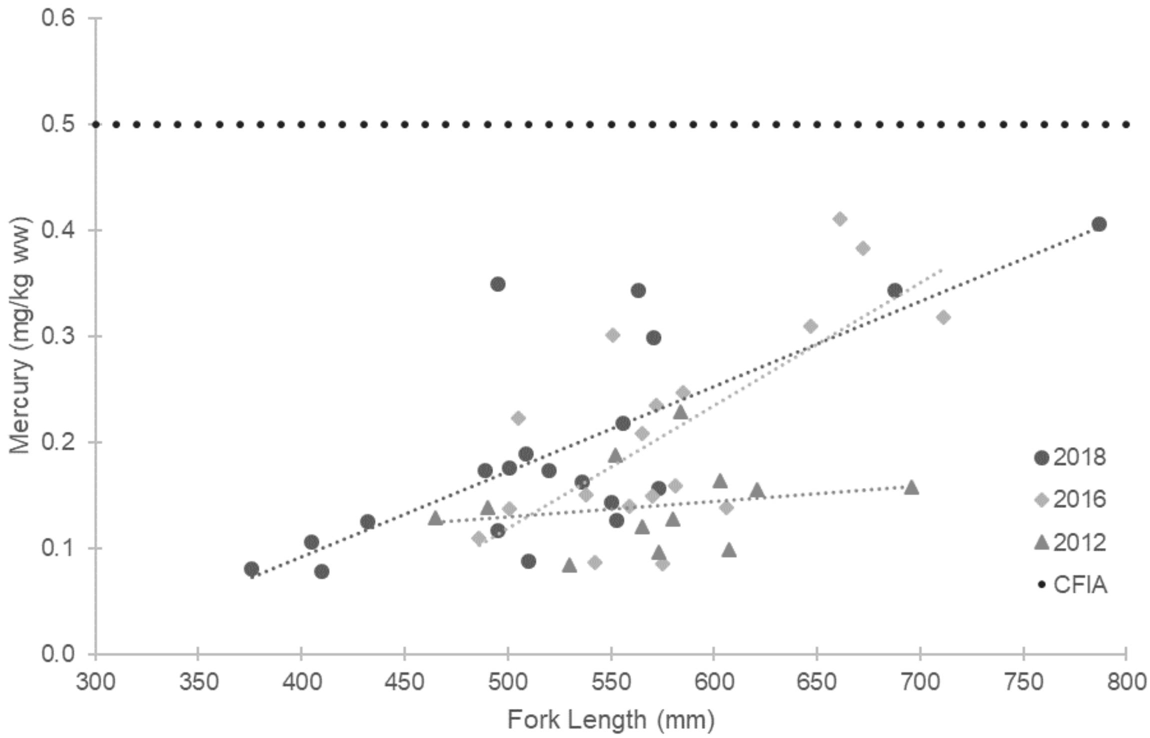
2.2.2 Northern Pike

A total of 50 Northern Pike were sampled from Bluefish Lake between 2012 and 2018, ranging in length from 376 to 787 mm (Table 2-2). Median concentrations of total mercury in Northern Pike muscle tissue ranged from 0.133 to 0.184 mg/kg ww, with the greatest concentrations observed in 2016. The reported statistics are below the national median of 0.38 mg/kg for skinless fillets from Northern Pike reported in Depew et al. (2013). Total mercury concentrations did not exceed CFIA guidelines (i.e., 0.5 mg/kg ww), for any of the fish sampled (Figure 2-4). Total mercury concentrations for Northern Pike muscle tissue were significantly different when comparing between 2012, 2016 and 2018 (P = 0.008). Relative to pre-disturbance data collected in 2012, total mercury concentrations were significantly greater in 2016 (P = 0.060, 22%), and 2018 (P = 0.006, 31%). Mercury concentrations decreased slightly and were not significantly different between 2016 and 2018 (P = 0.572), suggesting mercury concentrations stabilized in Bluefish Lake between 2016 and 2018.

Table 2-2: Summary Statistics of Northern Pike Captured from Bluefish Lake, 2012 to 2018

Variable	Measurement	Bluefish Lake		
		2012	2016	2018
Fork Length (mm)	n	12	18	20
	Mean	572	579	526
	Median	577	571	515
	SD	60.7	60.9	93.5
	SE	17.5	14.3	20.9
	Minimum	465	486	376
	Maximum	696	711	787
Total Mercury (mg/ kg ww)	n	12	18	20
	Mean	0.14	0.21	0.192
	Median	0.133	0.184	0.168
	SD	0.041	0.100	0.100
	SE	0.012	0.023	0.022
	Minimum	0.084	0.085	0.078
	Maximum	0.228	0.411	0.406
	ANCOVA LSM	0.126	0.171	0.194

Notes: n = sample size; SD = standard deviation; SE = standard error; ww = wet weight; ANCOVA LSM = analysis of covariance least squared mean.



Source: CFIA guideline for human consumption (CFIA 2017)
ww = wet weight; CFIA = Canadian Food Inspection Agency

Figure 2-4: Total Mercury Concentration Against Fork Length for Northern Pike Sampled from Bluefish Lake, 2012 to 2018.

2.2.3 Lake Trout

A total of 35 Lake Trout were sampled from Bluefish Lake in 2012 and 2016, ranging in length from 448 to 722 mm (Table 2-3). Median concentrations of total mercury in Lake Trout muscle tissue were 0.226 mg/kg ww in 2012 and 0.198 mg/kg ww in 2016, in both cases below the national median of 0.28 mg/kg for skinless fillets reported in the Canadian Fish Mercury Database (Depew et al. 2012). Total mercury concentrations did not exceed CFIA guidelines (i.e., 0.5 mg/kg ww), for any of the fish sampled (Figure 2-5) in 2012 or 2016. Due to the limited sample size available for comparisons in 2011, 2011 data were excluded from statistical analyses.

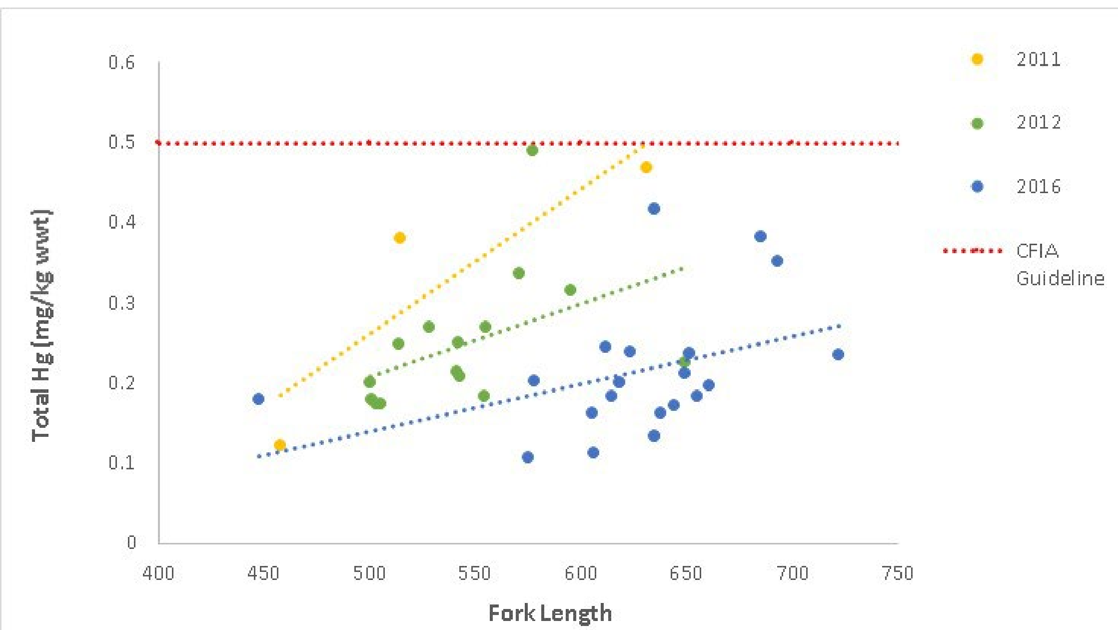
Mercury concentrations from Lake Trout tissue plugs collected in 2016 were compared to historical muscle mercury concentrations measured during lethal sampling in 2012. Total mercury concentration in Lake Trout muscle plugs collected in 2016 was significantly lower than in individuals sampled in 2012 ($P = 0.07$, 32%).

The reason why Lake Trout and Northern Pike show opposite trends, and why Lake Trout concentrations declined from 2012 to 2016 are unclear. An explanation for the opposing trends could be related to the different life history of the two species. When NTPC replaced the old dam, it was expected that any methyl-mercury generation would be in the newly flooded area and resident small-bodied fish within the area would be most exposed (Golder 2013). It is possible that the inundated area is not commonly used for Lake Trout but is commonly used for Northern Pike, the expected primary consumer of the small-bodied fish (e.g., Slimy Sculpin) within inundated areas.

Table 2-3: Summary Statistics of Lake Trout Captured from Bluefish Lake in 2012 and 2016

Variable	Measurement	Lake Trout		
		2011	2012	2016
Fork Length (mm)	n	3	15	20
	Mean	535	545	627
	Median	515	542	635
	SD	88.2	41.2	55.6
	SE	50.9	10.6	12.4
	Minimum	458	500	448
	Maximum	631	649	722
Total Mercury (mg/kg wwt)	n	3	15	20
	Mean	0.324	0.249	0.216
	Median	0.381	0.226	0.198
	SD	0.180	0.083	0.083
	SE	0.104	0.022	0.019
	Minimum	0.122	0.173	0.106
	Maximum	0.469	0.489	0.417

Notes: n = sample size; SD = standard deviation; SE = standard error; mm = millimetre; mg/kg wwt = milligram per kilogram wet weight.



Notes: Hg = mercury; mg/kg wwt = milligrams per kilograms of wet weight; mm = millimeter; CFIA = Canadian Food Inspection Agency guideline for human consumption (CFIA 2017)

Figure 2-5: Scatterplot and Linear Regression of Total Mercury Concentration on Fork Length of Lake Trout from Bluefish Lake in 2011, 2012 and 2016.

3 STUDY APPROACH

Methyl-mercury is a toxic substance that is rapidly absorbed by fish either directly from water passing over its gills or ingested with food items. Fish eliminate mercury at a very slow rate, and concentrations of this substance are known to bio-accumulate and bio-magnify (Ontario Ministry of the Environment 2011). Fish represent higher trophic levels in the aquatic food web and are known to accumulate higher tissue residues of methyl-mercury than other aquatic organisms.

Results from an experimental study in a boreal system in northwest Ontario show a maximum net increase of 70 mg of methyl-mercury per hectare per year in the first year following flooding, declining annually thereafter (St. Louis et al. 2004). Elevated mercury levels have been detected in fish in other areas of the Mackenzie River basin (Evans et al. 2005). As such, the monitoring program was initiated in the year following flooding of the area between the old dam and the new dam, and the assessment approach for this study focuses on the accumulation of methyl-mercury in fish of Bluefish Lake.

Studies have indicated that over 90% of the mercury accumulated in fish tissues is methyl-mercury. Therefore, analysis of total mercury in fish tissues is proposed, under the assumption that values of total mercury would be in the form of methyl-mercury.

The MMS Design Plan focuses on monitoring the target species (Slimy Sculpin) and game fish (Northern Pike). Game fish monitoring will proceed only if the concentrations in target species meets the criteria for the respective Action Level. Lake Trout are not considered for monitoring, as mercury levels in Lake Trout declined between 2012 and 2016 and to avoid unnecessary mortalities during sampling. The results suggest that Lake Trout diets were not affected by mercury concentrations within the inundated area post-dam construction.

3.1 OBJECTIVES

Monitoring objectives will be implemented to fulfill aquatic effects monitoring in relation to the Water Licence MV2020L4-0005. The objectives of the MMS Design Plan are to confirm that mercury levels in the target species in the flooded area of Bluefish Lake are stable or declining, and to provide evidence that game species remain safe for human consumption. Recorded concentrations of mercury will be compared to results from previous years to assess trends over time, and to available guidelines to confirm that the fish are safe to eat for both human consumption and wildlife consumption.

4 MONITORING

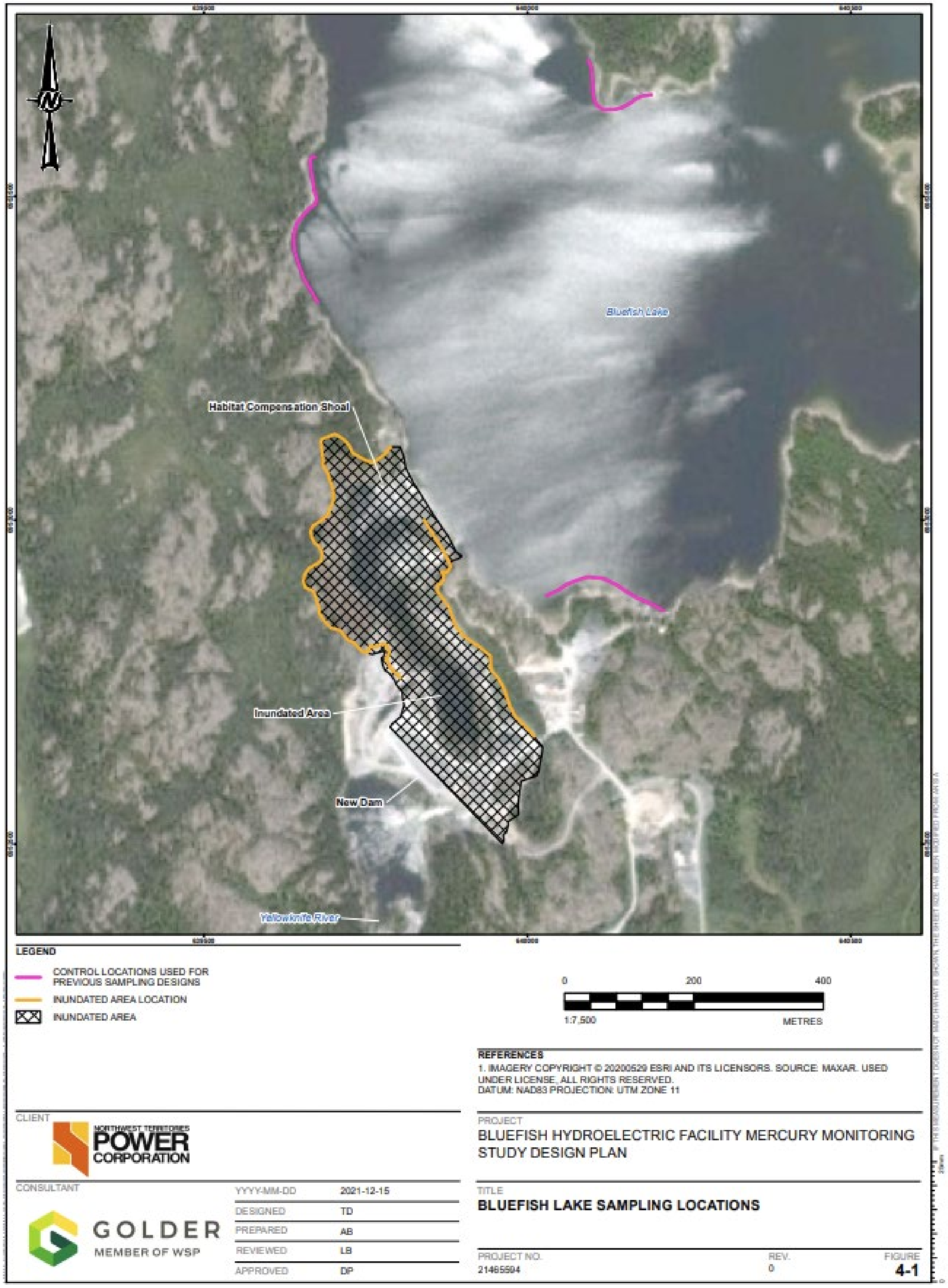
4.1 TARGET SPECIES SELECTION

During pre-construction studies completed in Bluefish Lake fall of 2011 and 2012, Slimy Sculpin were identified as the most suitable target species for mercury monitoring. The species was chosen due to its local abundance and sedentary lifestyle, characterized by limited foraging ranges and high site fidelity.

4.2 SAMPLING LOCATIONS

Similar to previous study years, sampling locations will include the IA between the former dam face (also known as the shoal) and the current dam, and a ‘control’ (i.e., reference) area away of the IA where was minimal inundation of surrounding terrestrial areas from the construction of the new dam. Slimy Sculpin will be collected from the IA and reference areas of Bluefish Lake with suitable habitat (such as the south shore of Bluefish Lake near the headgate, and the shoreline of the island in Bluefish Lake) (Figure 4-1).

Figure 4-1: Bluefish Lake Sampling Locations



4.3 TIMING AND FREQUENCY

Part G, Condition 4 of the Water Licence requires that the MMS Design Plan is implemented during open water season of 2025, with the Mercury Monitoring Study Report be submitted for MVLWB approval beginning March 31, 2025 and no later than March 31 of every three years thereafter. Thus, fish collection programs are required in 2025 and every three years thereafter, until such time as monitoring is no longer required. To coincide with the timing of previously completed surveys at Bluefish Lake, it is recommended that sampling is completed in the fall, late September to mid-October.

4.4 DATA COLLECTION

Slimy Sculpin will be collected by electrofishing (Smith-Root Model LR24) by qualified aquatic biologists, and the collection and handling of Slimy Sculpin will follow conditions and guidance provided under sampling permits provided by DFO. Backpack electrofishing has been most effective at dawn and dusk, using settings of 50 hertz and 250 to 300 volts. Experience in other regions suggest that Slimy Sculpin are best captured with short intermittent bursts of current; this technique often means the fish will not be alerted via lowpower peripheral shocking (Arciszewski et al. 2010).

As the primary objective of the study is to detect an increasing trend in mercury, an *a priori* power analysis was undertaken to estimate the number of individuals required to detect an increase (one-tailed test) in total mercury of Bluefish Lake Slimy Sculpin from the observed average of 0.026 mg/kg (45 individuals tested during pre-construction) and standard deviation of 0.007 mg/kg relative to the CCME threshold of 0.033 mg/kg (Golder 2013b). A statistical power of 90% was applied following the guidance in the Aquatic Effects Monitoring Program Guidelines (INAC 2009). The results of this power analysis recommended a minimum collection of 15 Slimy Sculpin from Bluefish Lake to detect a difference greater than the CCME threshold using $\alpha = \beta = 0.10$. Thus, the minimum Slimy Sculpin sample size from the flooded area (i.e., IA) was proposed to be at least 15 individuals of any size class, providing that individuals are large enough for mercury analysis (i.e., weigh more than 5 grams [g]). This approach is supported by previous research that demonstrated that mercury levels are relatively constant over the size classes commonly encountered during monitoring studies at Bluefish Lake (Golder 2013).

Captured Slimy Sculpin will be collected in a bucket filled with aerated lake water and brought back to the laboratory on-site for processing. Fish will be sacrificed with a blow to the head, measured for total length (mm) and weight (g), sex and stage will be determined. The carcasses will be weighed and individually bagged in a new plastic, sealable bag, then frozen prior to shipping.

4.5 GAME FISH

If required by an Action Level or a Response Plan, game fish will be assessed for mercury levels. Northern Pike is the recommended species to be sampled if game fish sampling is required, as the fish are available in sufficient numbers in Bluefish Lake, easily captured, and Northern Pike tissue concentrations were responsive to effects incurred by flooding over the past several years. Lake Trout is not recommended for monitoring because mercury concentrations in Lake Trout did not change in response to the effects of recent flooding from the construction of the new dam. Monitoring of Lake Trout was discontinued after 2016, and because sampling of Lake Trout is more likely to lead to mortalities.

4.5.1 Sampling Locations

Northern Pike will be sampled from areas sampled during previous monitoring efforts, including within the IA and the northwest arm and the south shore of Bluefish Lake.

4.5.2 Timing and Frequency

Northern Pike will only be sampled if required by an Action Level or a Response Plan. To coincide with timing of previous surveys, sampling will be conducted between the end of September and the end of October.

4.5.3 Data Collection

Game fish will be captured by angling and gill-netting, and the collection and handling of Northern Pike will follow conditions and guidance provided under permits provided by DFO. Angling was the preferred method used in all previous Northern Pike surveys and is expected to be the preferred method for future sampling. Fish will be captured by casting from a boat using un-baited barbless three-hook spoons. Shorelines with dense grassy habitat will be targeting to capture Northern Pike while avoiding non-target species. Northern Pike within the length range of previously sampled fish (376 to 787 mm) or greater will be targeted for mercury analyses, releasing smaller fish following length and weight measurements. If a suitable sample size of Northern Pike (15 fish) that represent a range of fish lengths cannot be collected by angling, gill nets will be used. The proposed minimum sample size of 15 fish from the entirety of Bluefish Lake, including the IA, is predicted to have sufficient power to detect trends recognizing that the recommended sample size for environmental effects monitoring for metal mining is only eight fish (Environment Canada 2012).

Northern Pike captured for tissue sampling will be transferred to a container filled with aerated lake water. Once the fish have recovered, they will be photographed, measured for fork length and weight, and the scales covering approximately 1 cm^2 on the right side of the dorsal fin will be removed using a ceramic knife. The first three fin rays will be removed from the left pelvic fin and stored in a labelled paper envelope for ageing of captured fish. Two plugs of muscle tissue will be excised using a 4 mm biopsy (**Error! Reference source not found.**), transferred into a 2 mL cryogenic vial, and stored in a freezer prior to shipping to a laboratory. Sampled fish will be returned to Bluefish Lake immediately following application of Vetbond, where they will be visually monitored as they recover from the procedure.

This sampling method is much less intrusive than lethal sampling methods as fish are live released after sampling. It is not expected to measurably influence or bias mercury concentration results relative to results derived from larger fillets that require lethal sampling for processing (Baker et al. 2004).

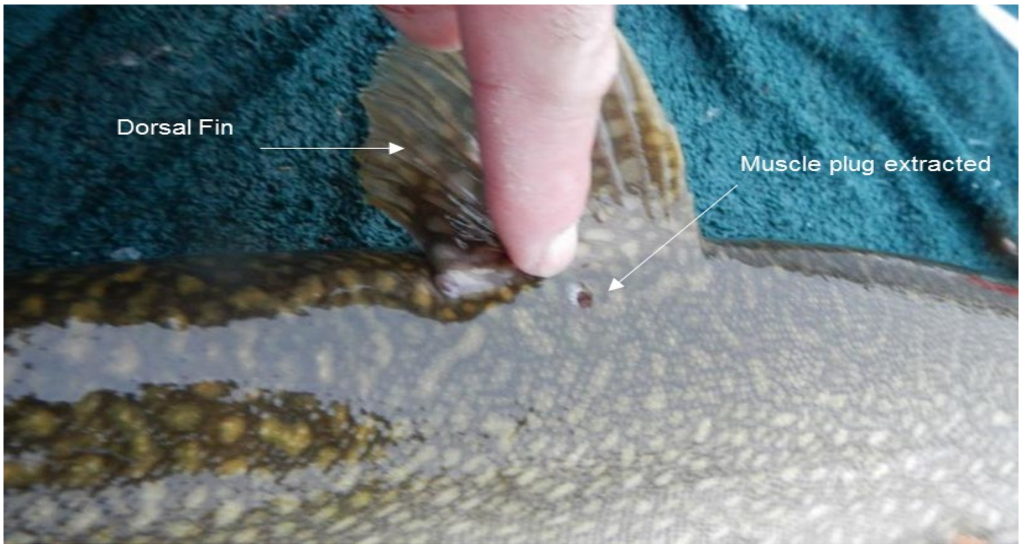


Figure 4-2: Fish Captured during Mercury Monitoring in Bluefish Lake Showing Area Where Muscle Plug was Extracted

4.6 SUPPORTING ENVIRONMENTAL INFORMATION

For each day of fish collection in Bluefish Lake, water quality parameters will be recorded. These include surface water temperature (degrees Celsius), conductivity (microSiemens per centimetre), dissolved oxygen (DO% saturation and DO milligrams per litre) and pH.

4.7 LABORATORY METHODS

Samples will be analyzed for moisture content (%) gravimetrically by drying the sample at less than 60°C, and total mercury concentration (mg/kg wet weight [ww]) by cold vapour atomic fluorescence spectroscopy

4.8 DATA ANALYSIS

Descriptive statistics will be calculated for fish length and mercury concentrations, based on species, year and area, including the sample size, mean, median, standard error (SE), standard deviation (SD), minimum, and maximum values. To determine whether mercury concentrations in fish tissue are changing over time, results will be compared to data collected between 2012 and 2018. As mercury has been shown to bioaccumulate in fish tissue (i.e., accumulate in higher concentrations in larger individuals; Wood et al. 2012), statistical comparisons will be made using analysis of covariance (ANCOVA) with length as a covariate to control for this variability. Mercury concentrations will be compared using a two-way ANCOVA, comparing mercury concentrations in carcass tissue across years, as well as spatially, from the IA and control area, with total length and age as covariates. Consideration of an age covariate will depend on whether suitable ageing structures (e.g., fin ray) can be collected using non-lethal methods. Mercury, age, and length data will be log-transformed prior to analysis.

The assumptions of ANCOVA are that the residuals of the data being fit to the model are normally distributed and have equal variance between groups. The assumption of normality will be assessed using the Shapiro-Wilk test with an α of 0.05. Levene's test will be used to assess equality of variances between sampling areas with an α of 0.05. If assumptions of a parametric statistical test cannot be met, non-parametric statistical methods will be used (e.g., permutational ANOVA).

Statistical outliers will be evaluated using studentized residuals (SR) from the ANCOVA models. When an outlier is detected, the validity of the data point will be examined. If the outlier is determined to be the result of a data entry error, it will be corrected; if the outlier is not the result of data entry errors and could not be resolved otherwise, the analysis will be completed with and without the outlier included.

4.9 COMPARISON TO GUIDELINES

Mercury concentrations in Northern Pike and Slimy Sculpin tissue will be compared to available national guidelines. Mercury concentrations in Northern Pike will be compared to the CFIA guidelines for chemical contaminants in fish of 0.5 mg/kg ww of mercury in fish and fish products for commercial sale (CFIA 2017). While fish from Bluefish Lake are not sold commercially, this guideline is considered relevant for recreational fisheries. Mercury concentrations in Slimy Sculpin will be compared to the CCME Canadian Tissue Residue Guidelines for the Protection of Wildlife Consumers of Aquatic Biota, set at 0.033 mg/kg ww (CCME 2001).

5 QUALITY ASSURANCE/QUALITY CONTROL

Quality assurance and quality control procedures will be applied to field sampling, laboratory analyses, data entry, data analyses, and report preparation. Samples will be labelled, preserved, and shipped according to standard protocols. Specific work instructions outlining each field task in detail will be provided to the field personnel by the task manager. Detailed field notes will be recorded in waterproof field books and on pre-printed waterproof field data sheets in either pencil or indelible ink. Data sheets and sample labels will be checked at the end of each field day for completeness and accuracy and will be scanned into electronic copies at the completion of the field program. Chain-of-custody forms will be used to track shipment and receipt of samples.

Under the CALA (Canadian Association for Laboratory Accreditation) accreditation program, performance evaluation assessments will be conducted for laboratory procedures, methods, and internal QC.

Data screening will be performed prior to statistical analyses. Fish health data will be recorded as box plots and scatterplots to visually examine data for potential data entry errors or unusual data. Outliers, as detected by the qualitative screening, will be removed from the dataset only if they will be determined to be the result of human error (i.e., sampling or measurement error).

Upon receipt of tissue chemistry data from labs, standard checks will be performed to screen for potential data quality issues:

- review that each requested parameter was analyzed
- comparison of method detection limits to the quote provided by the lab
- review of units
- review of any hold time exceedances
- review of internal laboratory QA/QC results

Internal quality assurance/quality control (QA/QC) procedures will be undertaken by the selected lab; internal quality control samples will include laboratory blanks, control samples, and reference materials that must be within the lab's standard acceptable limits. ALS Labs, an accredited CALA lab, is recommended for tissue chemistry for consistency with the previous years. North/South Consultants Inc. in Winnipeg, Manitoba is recommended for ageing fin rays for consistency with previous years.

6 RESPONSE FRAMEWORK

The overall goal of a Response Framework is to provide a systematic approach to responding to the results of a monitoring program. Information generated by the Response Framework is used to ensure that project-related effects always remain within acceptable limits (MVLWB and GNWT 2019).

6.1 ACTION LEVELS

The Water Licence Part G Condition 5 and 6 require the development of Action Levels:

Condition 5: If any low Action Level established in the approved MMS Design Plan is exceeded, the Licensee shall, at a minimum, implement the response actions described in the approved MMS Design Plan, and report the exceedance in the MMS Report.

Condition 6: If any moderate or high Action Level established in the approved MMS Design Plan is exceeded, the Licensee shall: a) Within the timeframe identified in the approved MMS Design Plan, notify the Board and an Inspector; and b) Within the timeframe identified in the approved MMS Design Plan, or as otherwise directed by the Board, submit an MMS Response Plan to the Board for approval.

The Action Levels relative to mercury concentrations are provided in Table 6-1. Reports of actions under the Response Framework will be provided to the MVLWB as per the expected conditions of a Type A Water Licence.

Table 6-1: Action Levels for the Mercury Monitoring Study

Action Level	Measurement Indicator	Actions to Consider in the Design Plan or Response Plan
Low	Mercury concentrations in Slimy Sculpin in the IA are significantly higher than 2015/2018 levels (i.e., trending higher), and levels are significantly higher in the IA versus control area in Bluefish Lake	Continue monitoring of Slimy Sculpin and include monitoring of Northern Pike for the following monitoring year Sampling will occur in sequential years until such time as the Low Action Level is no longer triggered
Moderate	Mercury concentrations in Slimy Sculpin in the IA remain elevated compared to previous years for second consecutive year of monitoring, and levels remain significantly higher in the IA versus control area in Bluefish Lake for second consecutive year **AND** Mercury concentrations in Northern Pike sampled from Bluefish Lake are significantly higher than 2016/2018 levels	Continue mercury monitoring in Slimy Sculpin and Northern Pike, and extend the duration of the monitoring period by a minimum of 1 year Sampling will occur in sequential years until such time as the Moderate Action Level is no longer triggered Expand the scope of the monitoring to include root analysis investigation on potential sources for mercury
High	Mercury concentrations in Slimy Sculpin in the IA have significantly increased over duration of 3-year monitoring period and the majority (>50%) of collected samples show exceedances above the CCME guideline **AND** Mercury concentrations in Northern Pike sampled from Bluefish Lake remain elevated compared to previous years for second consecutive year of monitoring, and the median level (for the median fish size) is above the CFIA guideline	Continue mercury monitoring in target species and game fish species, and extend the duration of the monitoring period by a minimum of 3 years Consider an ecological risk assessment or discuss findings with GNWT Department of Health and Social Services

6.2 TIMEFRAME

If any moderate or high Action Level established in the response framework is exceeded, the MVLWB and an Inspector will be notified by March 31 following completion of sampling completed the previous fall. If an MMS Response Plan is required, it will be submitted to the MVLWB for approval within three months following the MMS Annual Report.

7 REPORTING

As per Part G, Condition 4 of the Water Licence, NTPC will submit an MMS Report summarizing the mercury sampling program and analytical laboratory results to the MVLWB by March 31, 2023 and no later than 31 March of every three years thereafter. The report should contain the items indicated in the Licence Schedule 3 Item 2.

8 REFERENCES

Arciszewski, T., M.A., Gray, K.R., Munkittrick, and C. Baron. 2010. Guidance for the collection and sampling of slimy sculpin (*Cottus cognatus*) in northern Canadian lakes for environmental effects monitoring (EEM). Canadian Technical Report of Fisheries and Aquatic Sciences. 2909: v + 21 p.

Baker, R.F., P.J. Blanchfield, M.J. Patterson, R.J. Flett and L. Wesson. 2004. Evaluation of nonlethal methods for the analysis of mercury in fish tissue. Transactions of the American Fisheries Society 133: 568-576.

CCME (Canadian Council of Ministers of the Environment). 2001. Canadian Tissue Residue Guidelines for the Protection of Wildlife Consumers of Aquatic Biota: Summary Table. Updated. Canadian Council of Ministers of the Environment, Winnipeg, MB.

CFIA (Canadian Food Inspection Agency). 2017. Canadian food inspection agency fish products standards and methods manual: Appendix 3: Canadian guidelines for chemical contaminants and toxins in fish and fish products. Ottawa, ON.

Depew, D.C., Burgess, N.M., Anderson, M.R., Baker, R., Bhavsar, S.P., Bodaly, R.A., Eckley, C.S., Evans, M.S., Gantner, N., Graydon, J.A. and Jacobs, K., 2013. An Overview of Mercury Concentrations in Freshwater Fish Species: A National Fish Mercury Dataset for Canada. Canadian Journal of Fisheries and Aquatic Sciences, 70(3), pp.436-451.

Environment Canada. 2012. Metal Mining Technical Guidance for Environmental Effects Monitoring. National EEM Office, Ottawa, ON, Canada.

ECCC (Environment and Climate Change Canada). 2018. Station Information, Real-Time and Historic Data for Bluefish Lake Near Yellowknife, Stations 07SB0023 and 07SB015. Available at: http://wateroffice.ec.gc.ca/. Accessed: 04 March 2018.

Evans, M.S., W.L. Lockhart, L. Doetzel, G. Low, D. Muir, K. Kidd, G. Stephens and J. Delaronde. 2005. Elevated mercury concentrations in fish in lakes in the Mackenzie River Basin: The role of physical, chemical, and biological factors. Science of the Total Environment 351: 479-500.

GNWT-HSS (Government of the Northwest Territories Department of Health and Social Services). 2021. Fish Consumption Guidance. https://www.hss.gov.nt.ca/en/services/fish-consumption-guidance. Accessed September 2021.

Golder (Golder Associates Ltd.). 2012. Fisheries Investigations in Bluefish Lake, October 2011. Prepared by Golder Associates Ltd. for the Northwest Territories Power Corporation. Technical Memorandum. 5 July 2012.

Golder. 2013a. Bluefish Lake Fisheries Studies. Prepared by Golder Associates Ltd. for the Northwest Territories Power Corporation. Technical Memorandum. 31 March 2013.

Golder. 2013b. Terms of Reference for a Mercury Special Effects Study, Revision 4. Prepared by Golder Associates Ltd. for the Northwest Territories Power Corporation. Technical Memorandum. 17 May 2013. See public registry for Water Licence MV2009L4-0004 at mvlwb.com.

Golder. 2014. Bluefish Lake Hydroelectric Plant 2013 Fisheries and Flow Monitoring Report. Prepared by Golder Associates Ltd. for the Northwest Territories Power Corporation. March 2014.

Golder. 2015. Bluefish Lake Hydroelectric Plant 2014 Fisheries and Flow Monitoring Report. Prepared by Golder Associates Ltd. for the Northwest Territories Power Corporation. March 2015.

Golder. 2016a. Bluefish Lake Hydroelectric Plant 2015 Fisheries and Flow Monitoring Report. Prepared by Golder Associates Ltd. for the Northwest Territories Power Corporation. May 2016.

Golder. 2016b. Terms of Reference for a Mercury Special Effects Study, Revision 6. Prepared by Golder Associates Ltd. for the Northwest Territories Power Corporation. Technical Memorandum. 23 June 2016. Approved by the MVLWB on 11 August 2016. See public registry for Water Licence MV2005L4-0008 at mvlwb.com.

Golder. 2017. Bluefish Lake Hydroelectric Plant 2016 Fisheries and Flow Monitoring Report. Prepared by Golder Associates Ltd. for the Northwest Territories Power Corporation. April 2017.

Golder. 2018. Bluefish Lake Hydroelectric Plant 2017 Fisheries and Flow Monitoring Report. Prepared by Golder Associates Ltd. for the Northwest Territories Power Corporation. April 2018.

Golder. 2019. Bluefish Lake Hydroelectric Plant 2018 Fisheries and Flow Monitoring Report. Prepared by Golder Associates Ltd. for the Northwest Territories Power Corporation. May 2019.

INAC (Indian and Northern Affairs Canada). 2009. Guidelines for Designing and Implementing Aquatic Effects Monitoring Programs for Development Projects in the Northwest Territories, AEMP Technical Guidance Document – Volume 4. Prepared by Zajdlik, B., D.D. MacDonald, and INAC Water Resources Division.

MVLWB and GNWT (Mackenzie Valley Land and Water Board and the Government of the Northwest Territories). 2019. Guidelines for Aquatic Effects Monitoring Programs.

Mitchell, C.P.J., B.A. Branfireun and R.K. Kolka. 2008. Spatial Characteristics of Net Methylmercury Production Hot Spots in Peatlands. Environmental Science & Technology 42 (4): 1010-1016.

Ontario Ministry of the Environment. 2011. Guide to Eating Ontario Sport Fish. www.ontario.ca/fishguide.

St. Louis, V., Rudd, J.M., Kelly, C.A., Bodaly, R.A., Patterson, P.J., Beaty, K.G., Hesslein, R.H., Heyes, A., and Majewski, A.R. 2004. The Rise and Fall of Mercury Methylation in an Experimental Reservoir. Environmental Science & Technology 38: 1348-1358.

Vecsei P, Panayi D. 2015. Range extension for Pygmy Whitefish (*Prosopium coulterii*) in the Northwest Territories, Canada. Can. Field. Nat., 129:70–75.

Wood CM, Farrell AP, Brauner CJ. 2012. Homeostasis and Toxicology of Non-Essential Metals. Elvsevier, New York, NY, US.